CT Testing:
Theory and Practice

Presented Tom Lawton, TESCO

For North Carolina Electric Meter School
Advanced
Wednesday, June 26, 2019 at 1:45 p.m.

What we will cover

- Why do we test CT’s?
- Shop testing
- How to read and interpret a transformer face plate
- Types of field tests
- Magnetization effects and demagnetization

Shop Testing

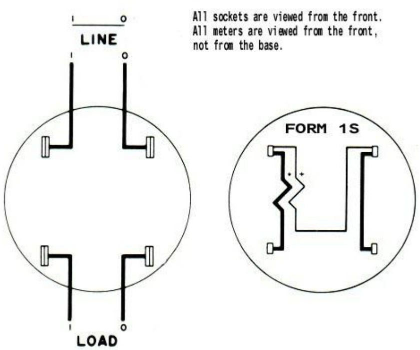
- New Transformers
  - Manufacturer's tests
  - Utility tests

Self Contained vs. Transformer Rated

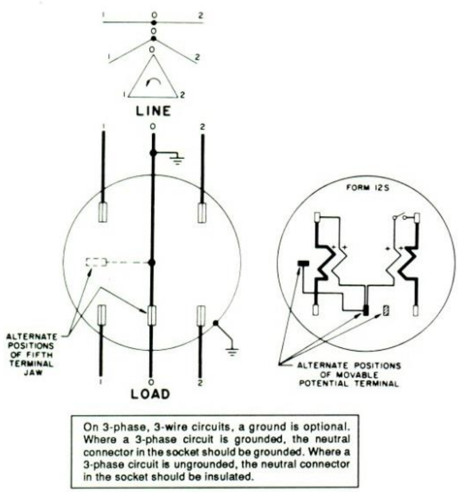
1S, 2S, 3S, 4S, 9S, 12S, 16S, 45S, etc., etc.

What’s the Difference?

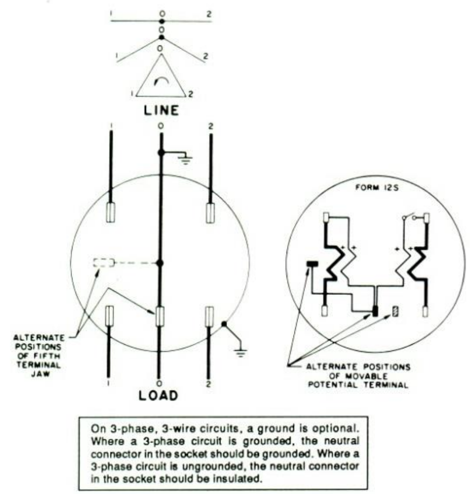
Different Forms for Different Services and Applications



FORM 1S
1ø, 2 W CIRCUIT
1 Stator, 2 W Meter, Self-Contained



2 Stator, 3ø, 3 W (Network) Meter, Self-Contained



2 Stator, 3ø, 3 W (Network) Meter, Self-Contained

TESCO

Self Contained vs. Transformer Rated

Self Contained

(direct)

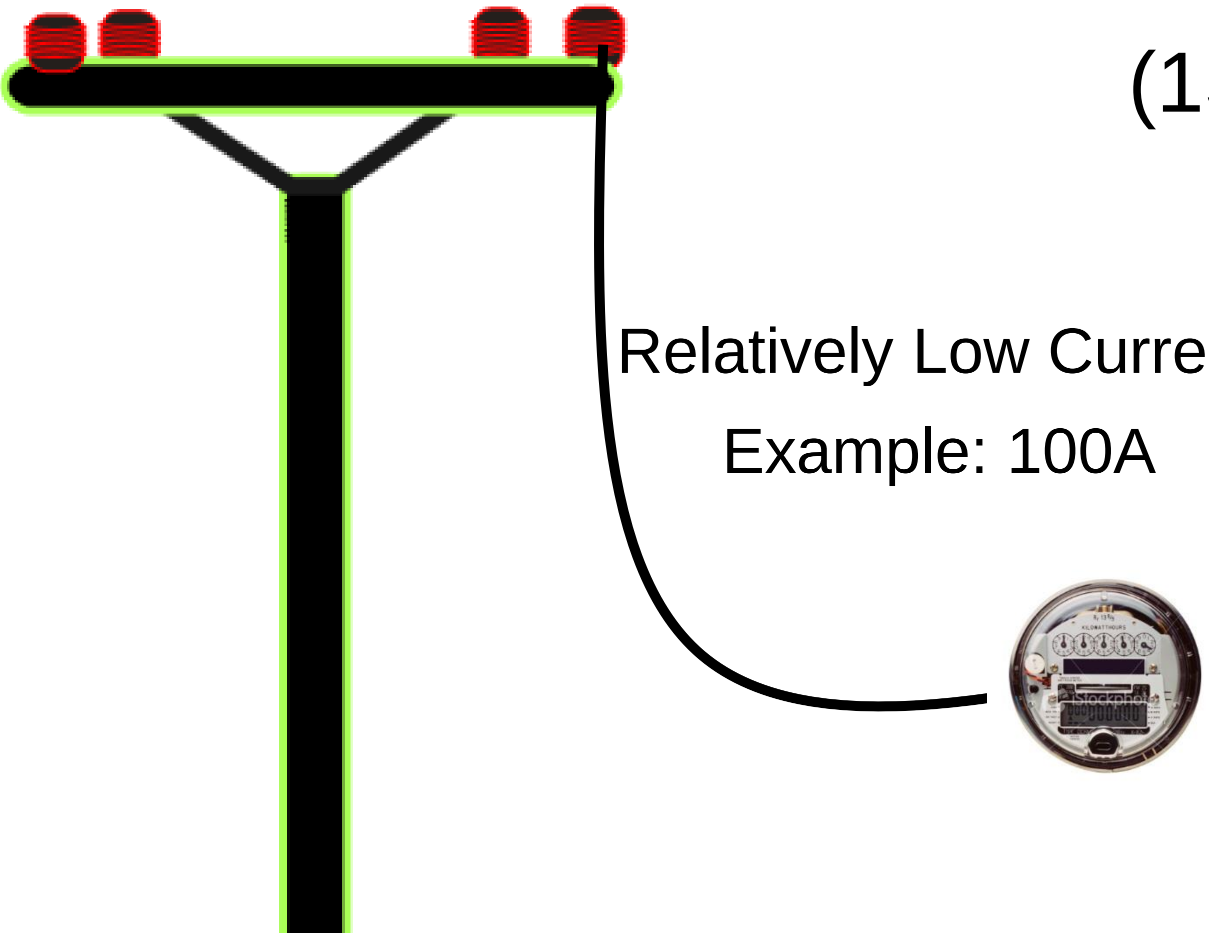
Transformer Rated

(indirect)

Self Contained

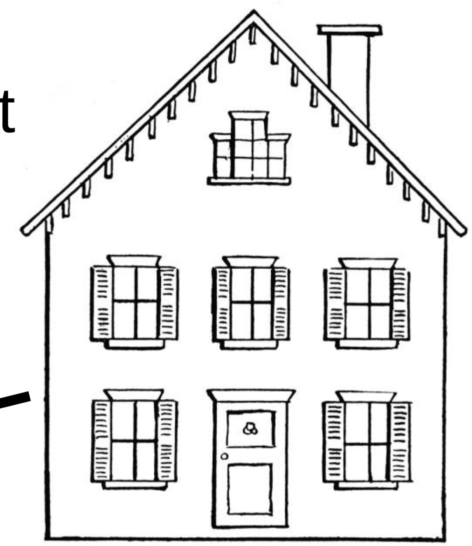
Primarily Residential

(1S, 2S, 12S)



Relatively Low Current

Example: 100A



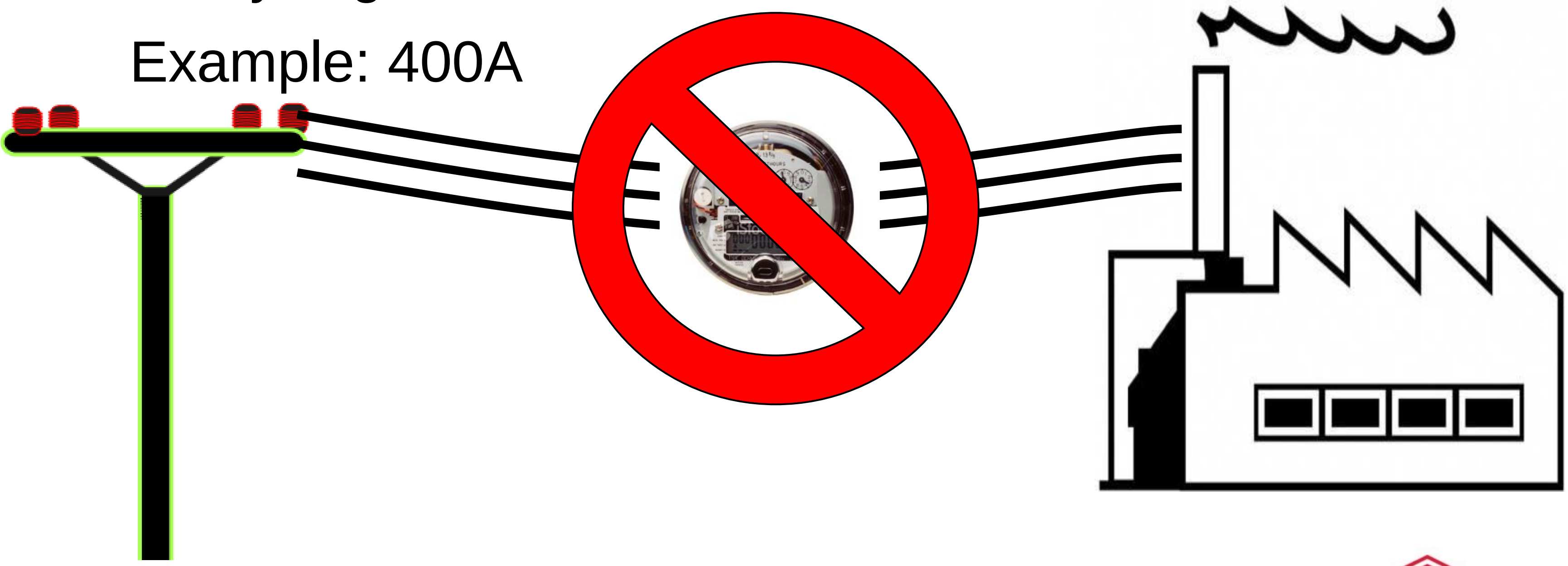
Transformer Rated

Primarily Commercial/Industrial

(9S, 16S)

Relatively High Current

Example: 400A



What is a CT?

“A **current transformer** (**CT**) is used for measurement of alternating electric currents. Current transformers, together with voltage (or potential) transformers (VT or PT), are known as **instrument transformers**. When current in a circuit is too high to apply directly to measuring instruments, a current transformer produces a reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments. A current transformer isolates the measuring instruments from what may be very high voltage in the monitored circuit. Current transformers are commonly used in metering and protective relays in the electrical power industry.” - Wikipedia

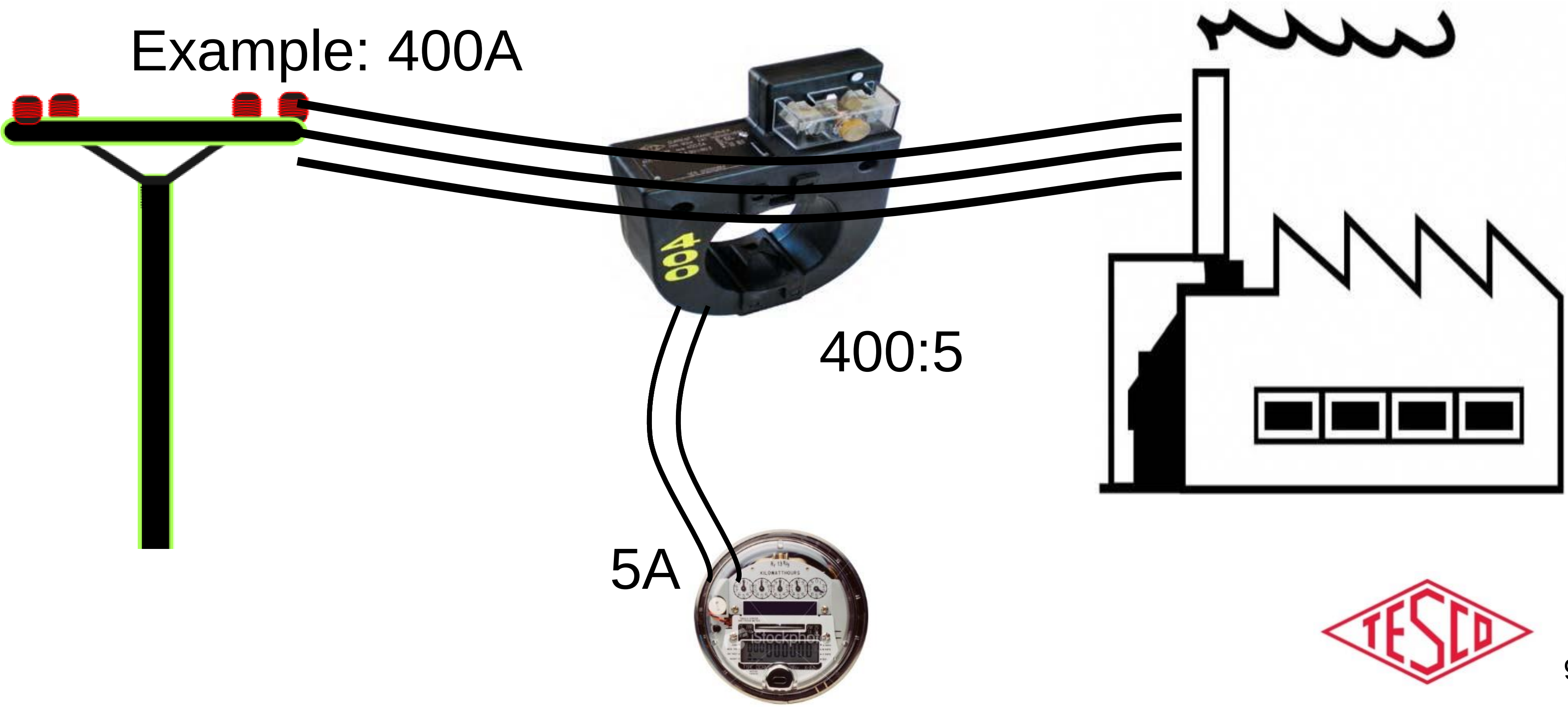
Transformer Rated

Primarily Commercial/Industrial

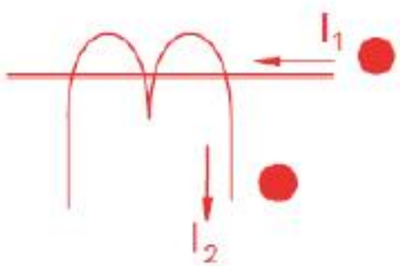
(9S, 16S)

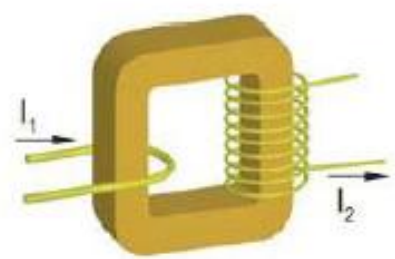
Relatively High Current

Example: 400A



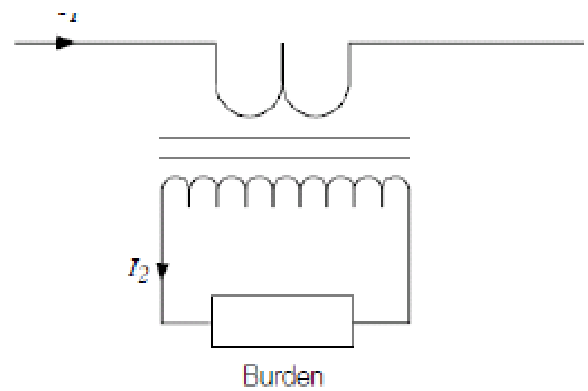
Current Transformers Conceptual Representation



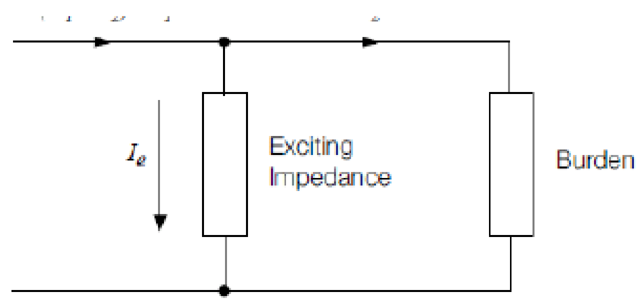


$$I_1 \times N_1 = I_2 \times N_2$$

Ideal. No losses



$$I_2 = \frac{N_1}{N_2} \times I_1$$



$$I_2 = \frac{N_1}{N_2} \times I_1 - I_e$$

Real, with core losses

CT's – Functions and Terminology

Ratio

For instance, a CT with a 400:5 ratio will produce 5A on the secondary, when 400A are applied to the primary.

CT's – Functions and Terminology

Thermal Rating Factor

A value representing the amount by which the primary current can be increased without exceeding the allowable temperature rise.

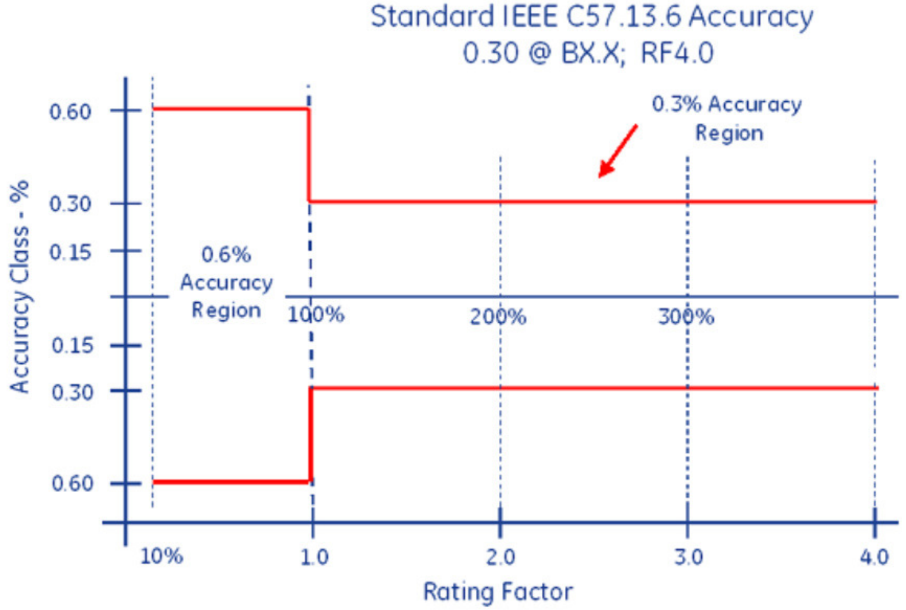
For instance, a RF of 4.0 at 30° ambient on a 400:5 ratio CT would allow for a primary current up to 1600A.

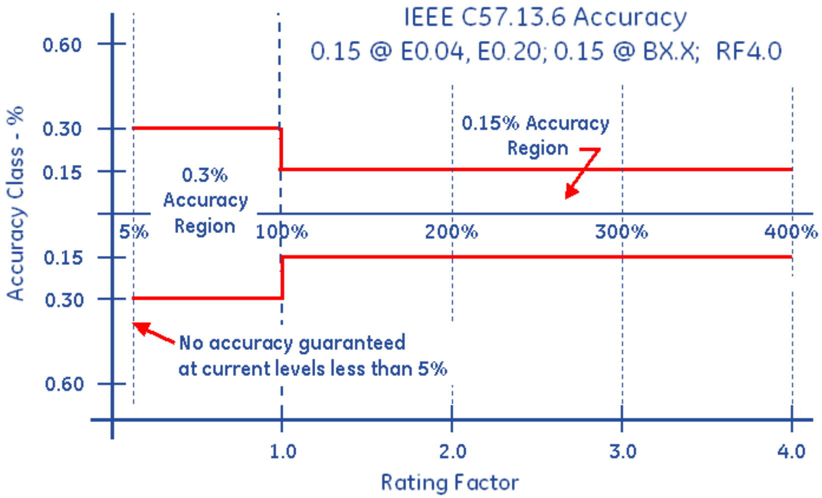
CT's – Functions and Terminology

Accuracy Classifications and Burden

All CT's fall within an accuracy class.

IEEE Standards have defined accuracy classes.



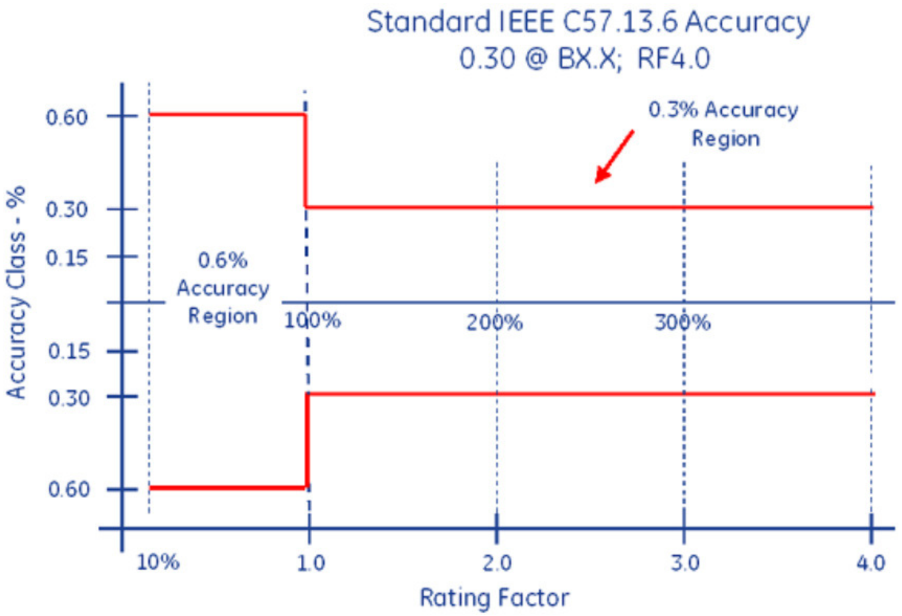


TESCO

CT's – Functions and Terminology

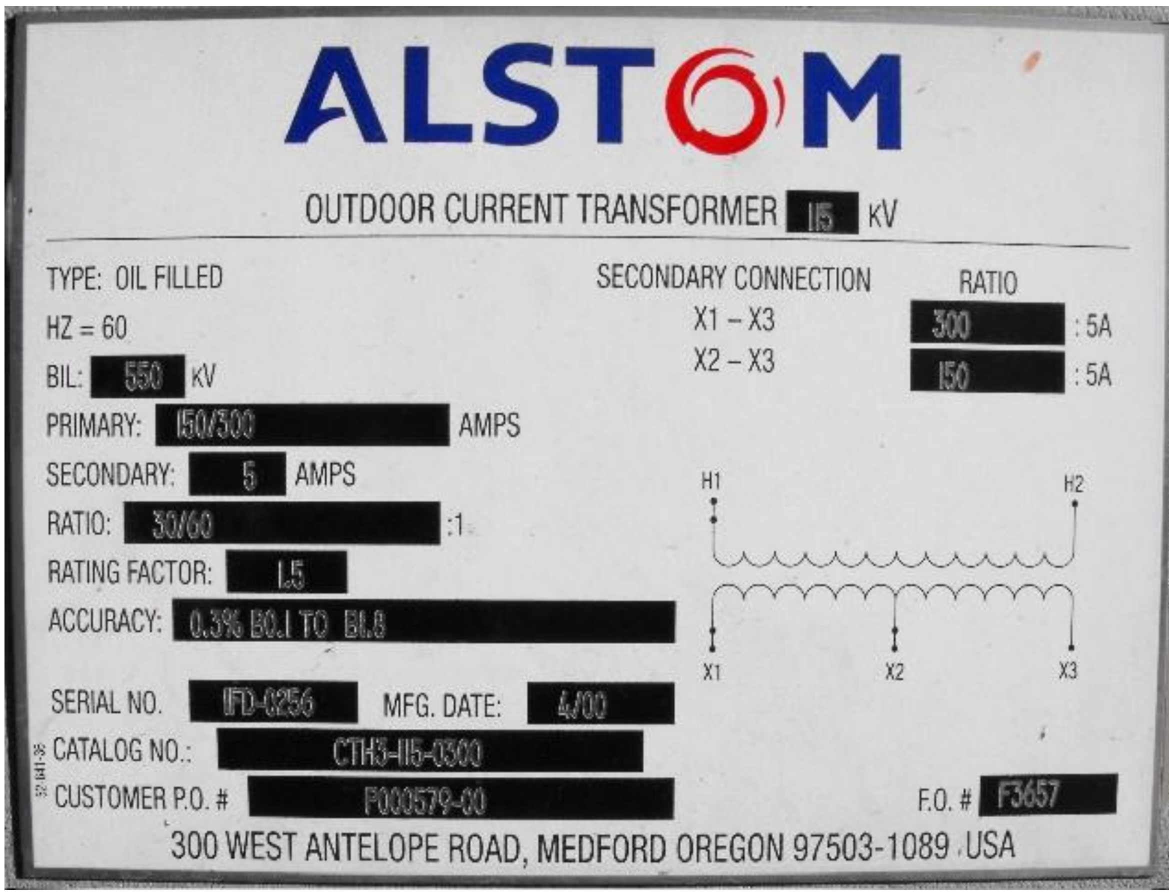
Accuracy Classifications and Burden

Example: 0.3% @ B0.1, B0.2, B0.5



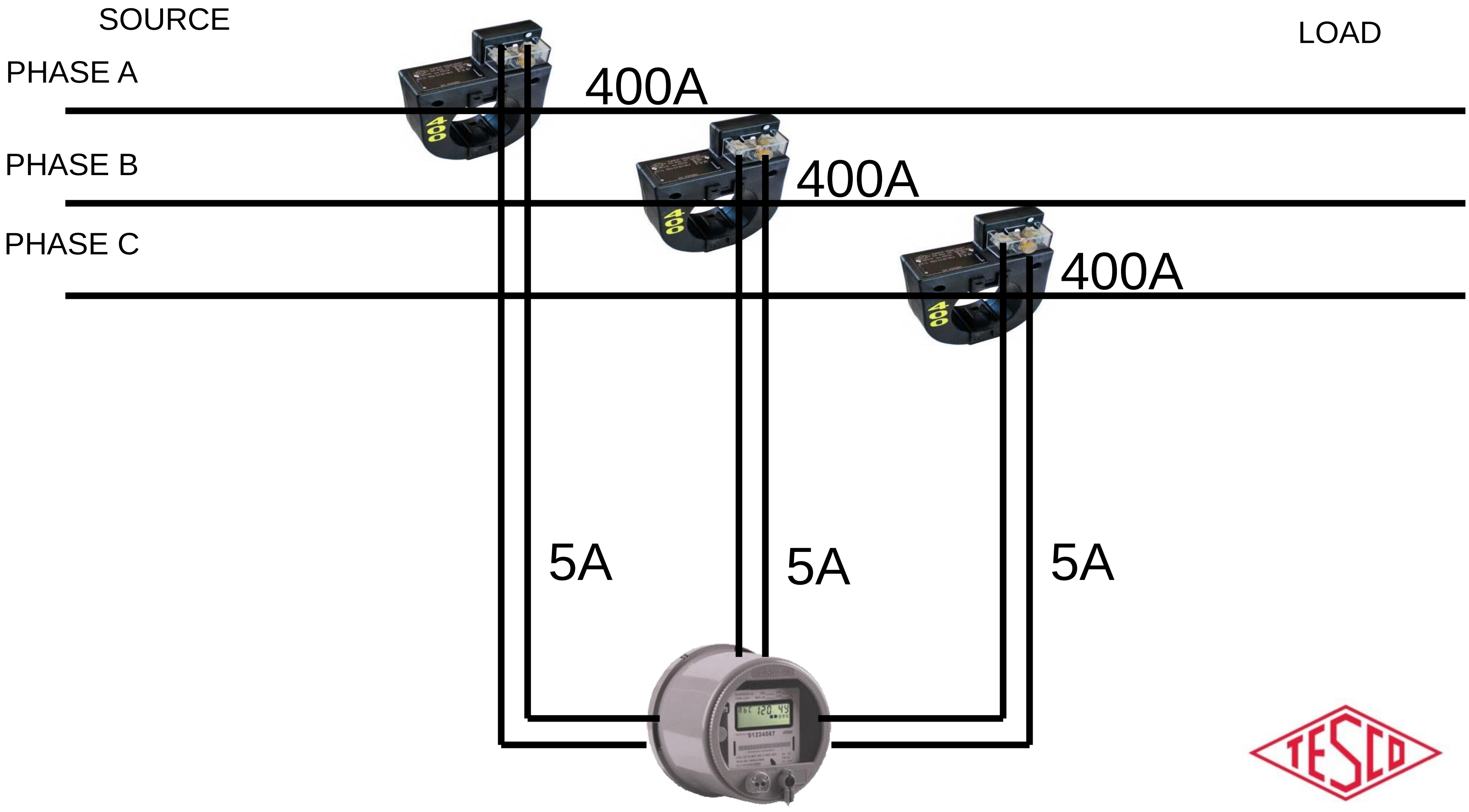
CT's – Functions and Terminology

Faceplate



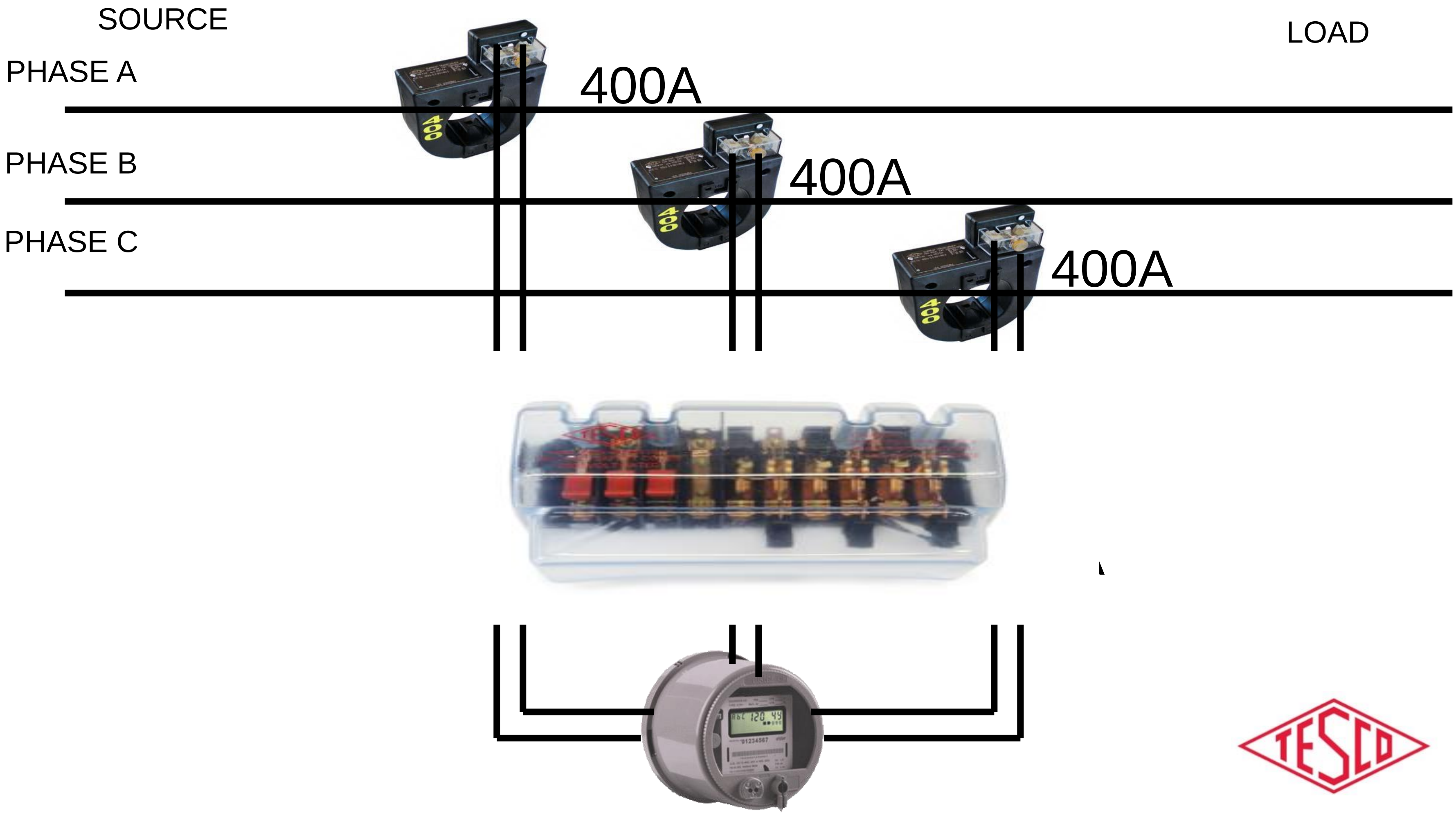
Transformer Rated

9S Meter Installation



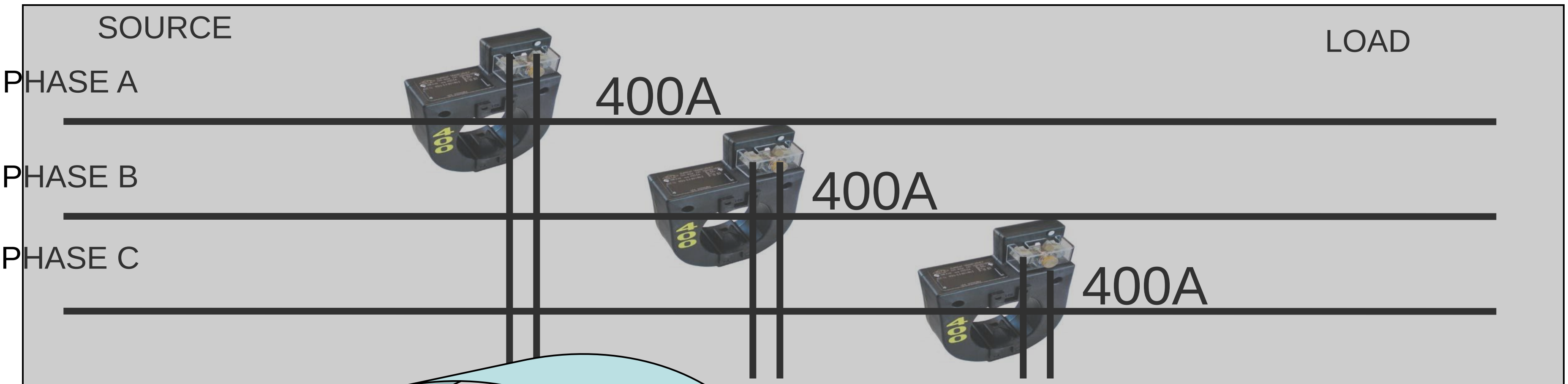
Transformer Rated

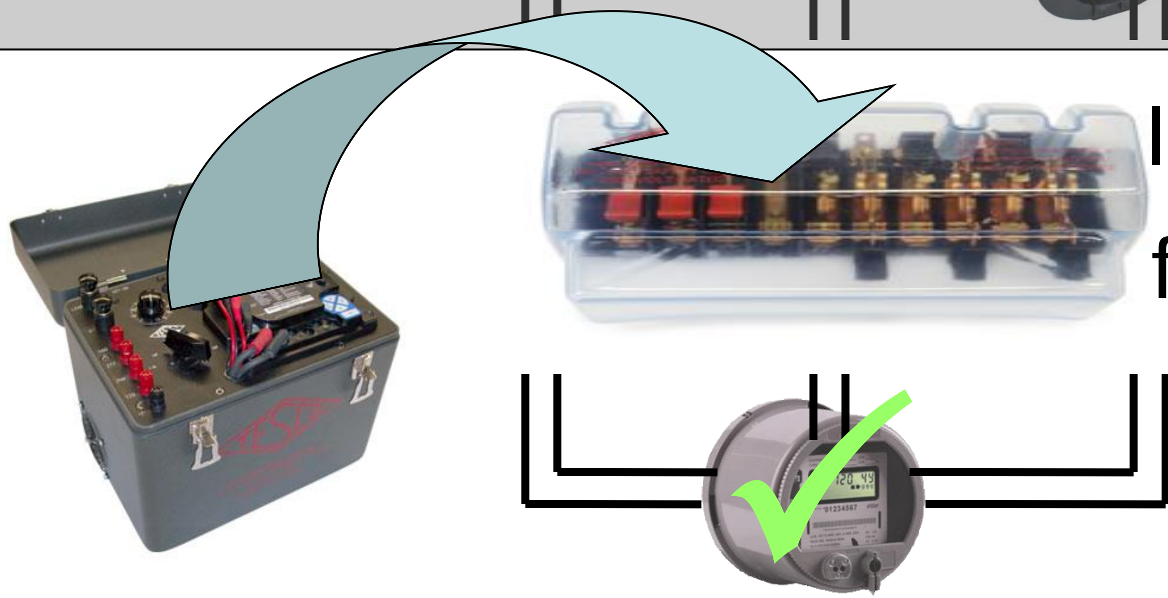
9S Meter Installation



Meter Testing

9S Meter Installation

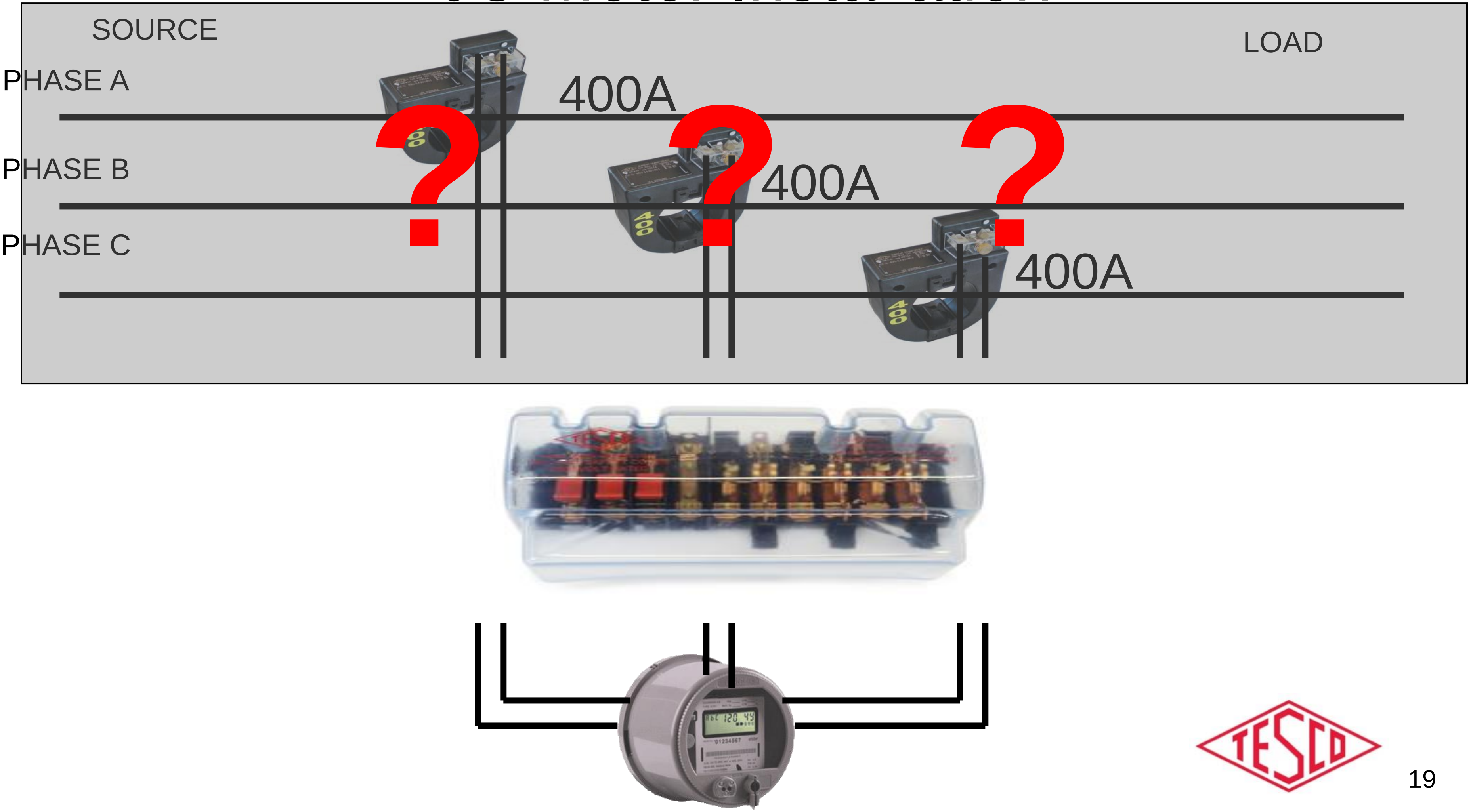




Isolate the Meter from the Service

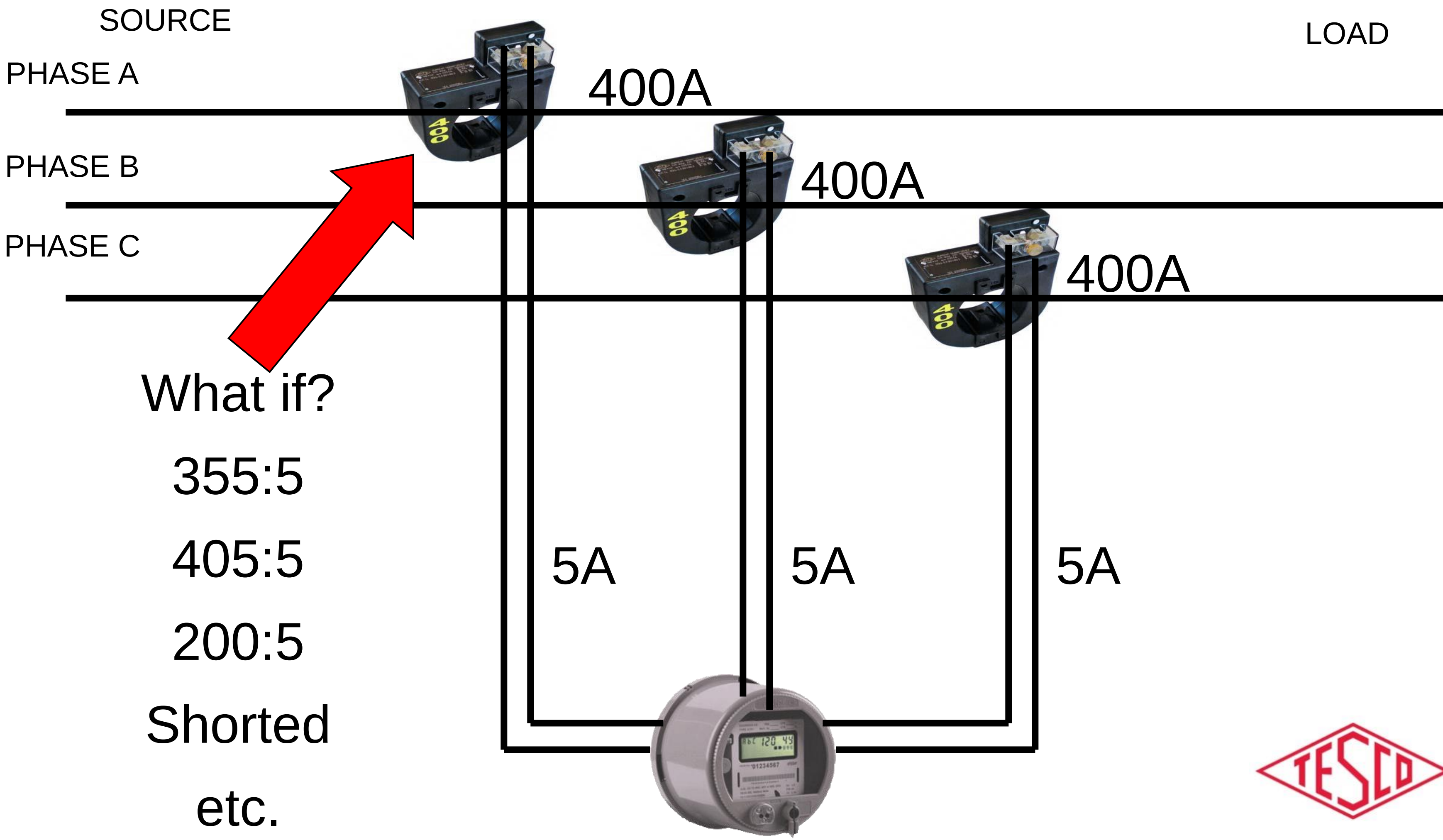
Meter Testing

9S Meter Installation



Meter Testing

9S Meter Installation



CT Testing

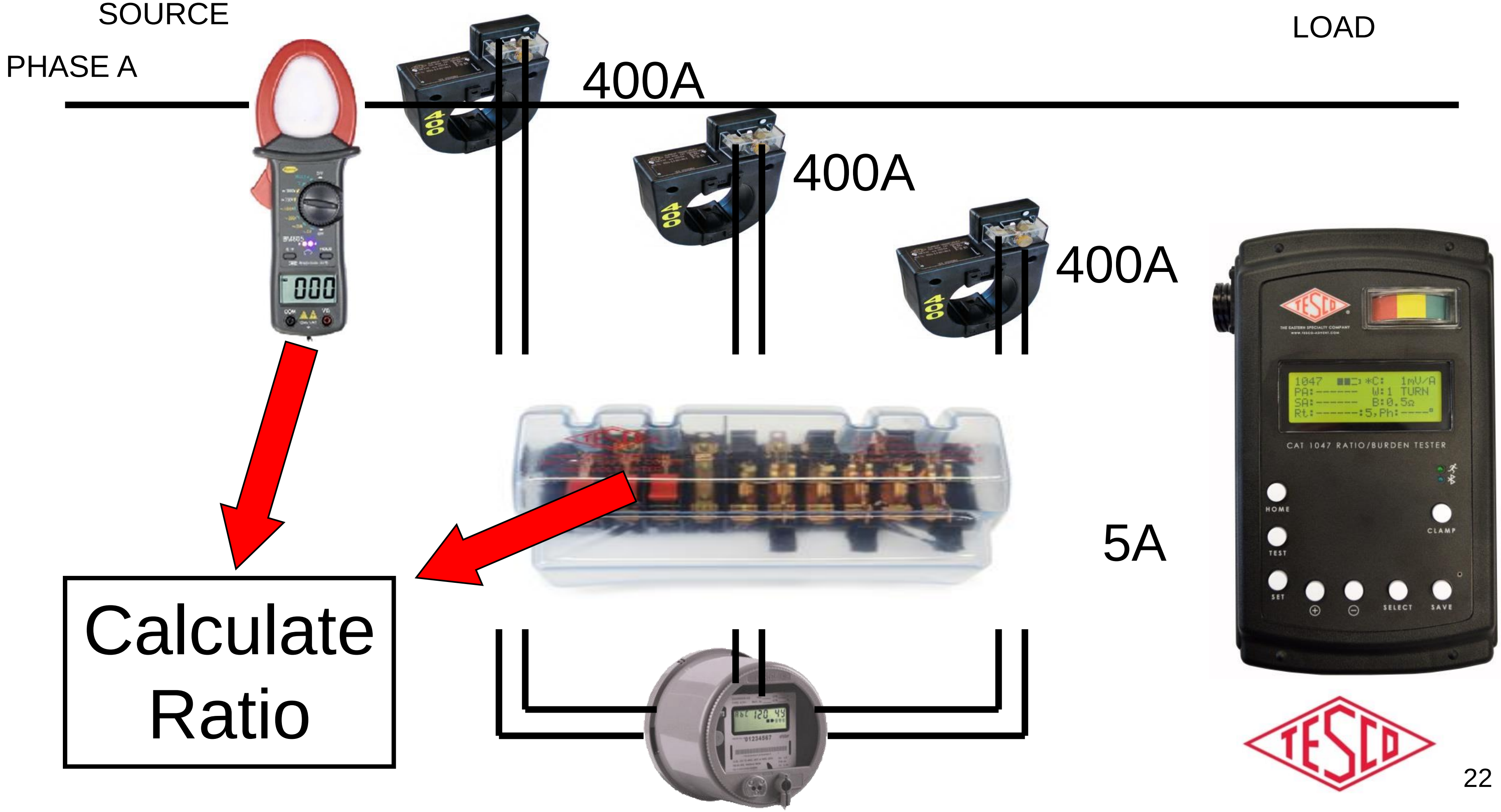
CT Testing is Important!

1) Test for correct ratio

2) Test for functionality at rated burdens

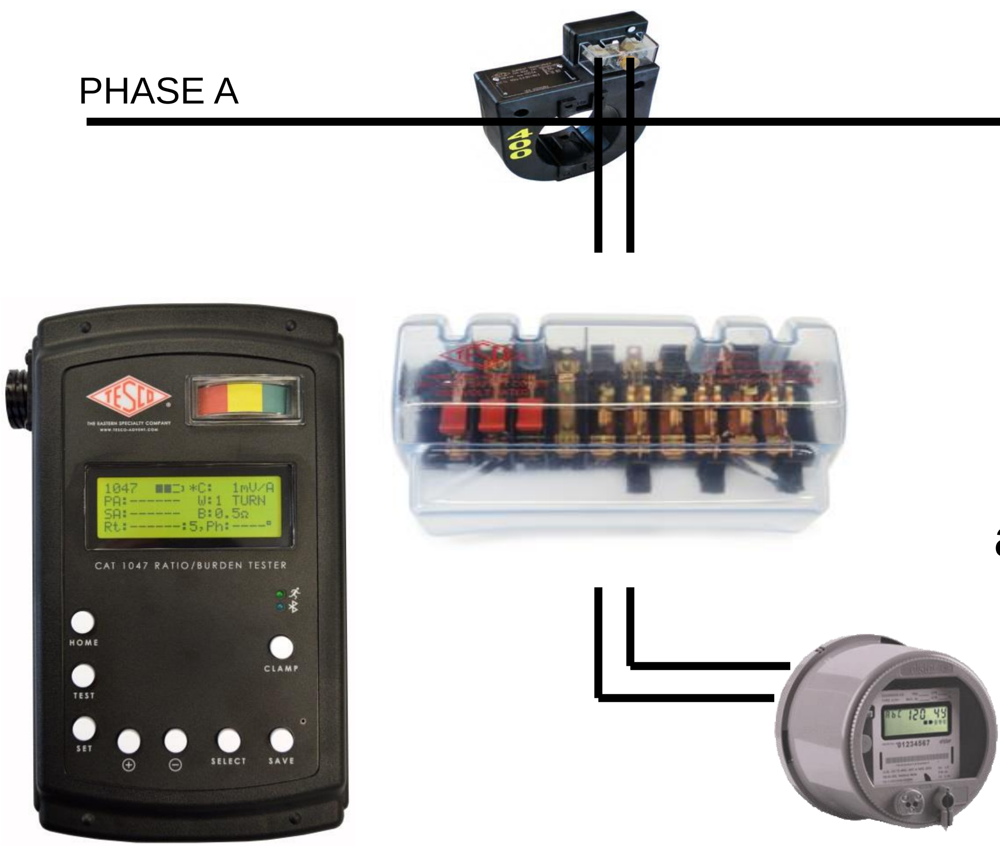
Ratio Testing

Ratio of Primary Current to Secondary Current



Burden Testing

Functionality with Burden Present on the Secondary Loop

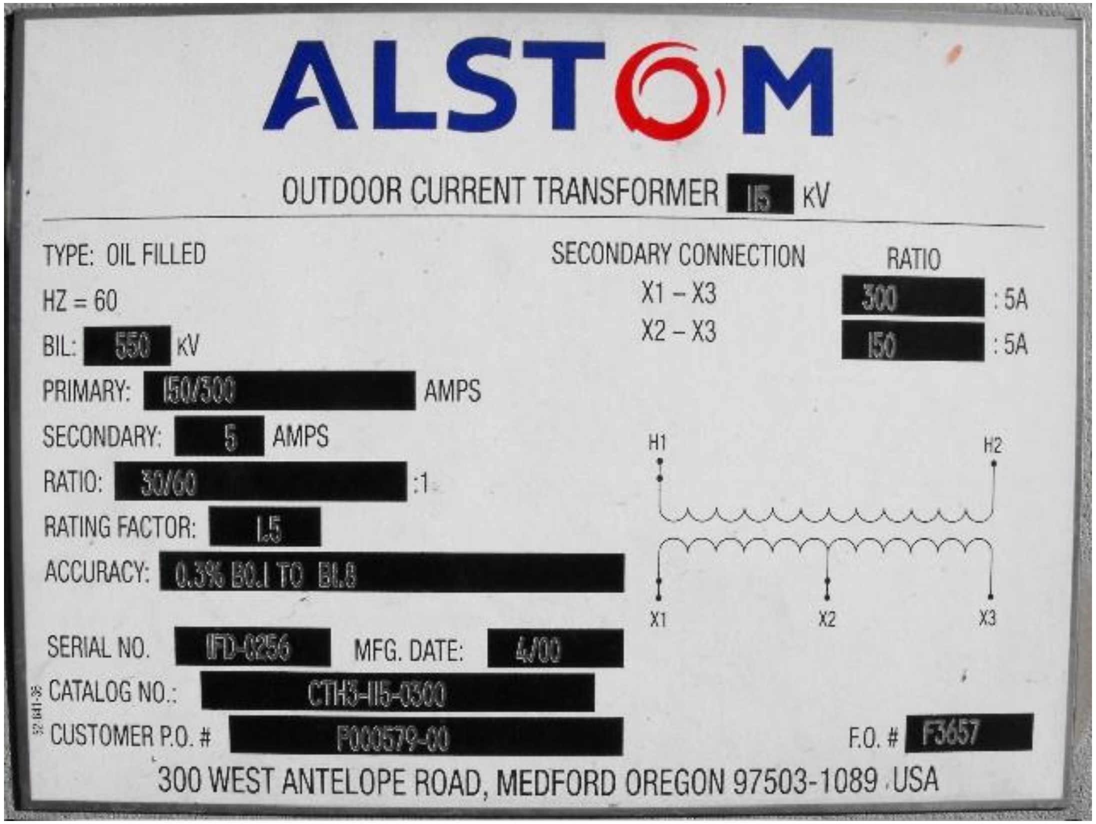


Some burden will always be present – junctions, meter coils, test switches, cables, etc.

CT's must be able to maintain an accurate ratio with burden on the secondary.

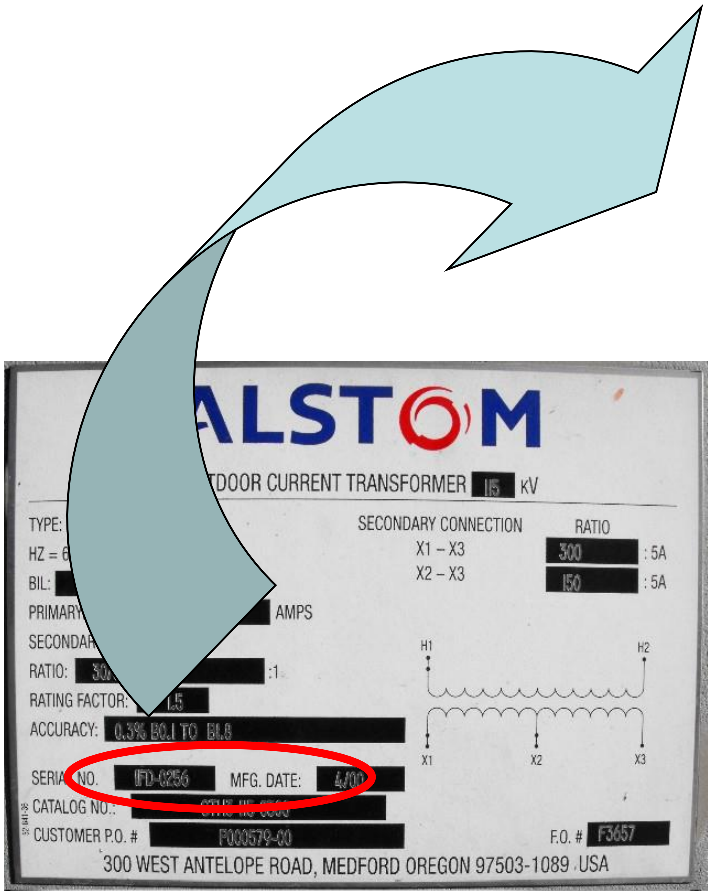
Burden Testing

Functionality with Burden Present on the Secondary Loop



Burden Testing

Functionality with Burden Present on the Secondary Loop



Example Burden Spec:

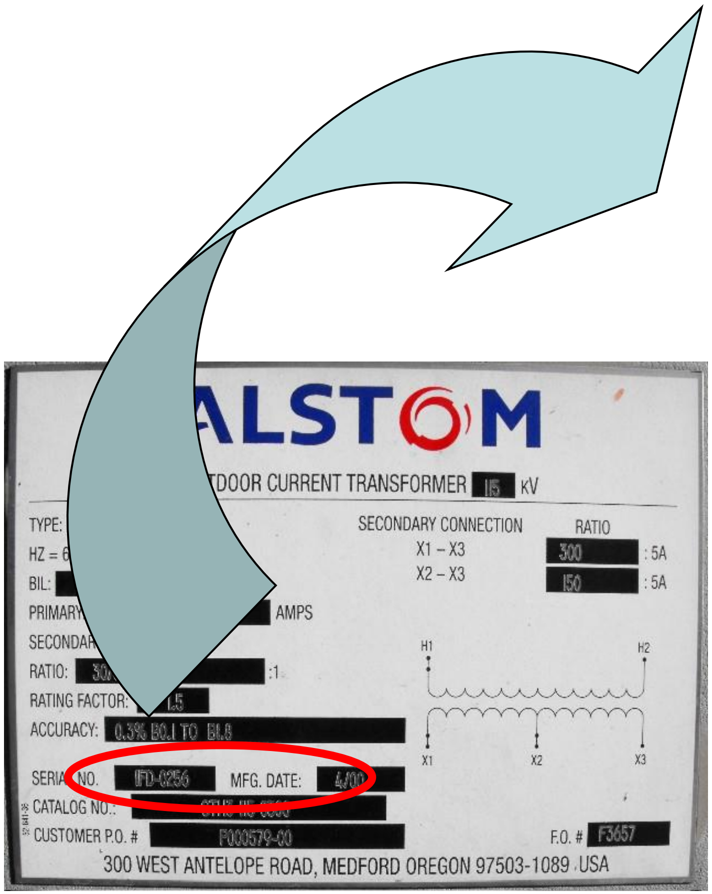
0.3% @ B0.1, B0.2, B0.5

or

There should be less than the 0.3% change in secondary current from initial (“0” burden) reading, when up to 0.5Ohms of burden is applied

Burden Testing

Functionality with Burden Present on the Secondary Loop



ANSI Burden Values

0.1 Ohms

0.2 Ohms

0.5 Ohms

1 Ohms

2 Ohms

4 Ohms

8 Ohms

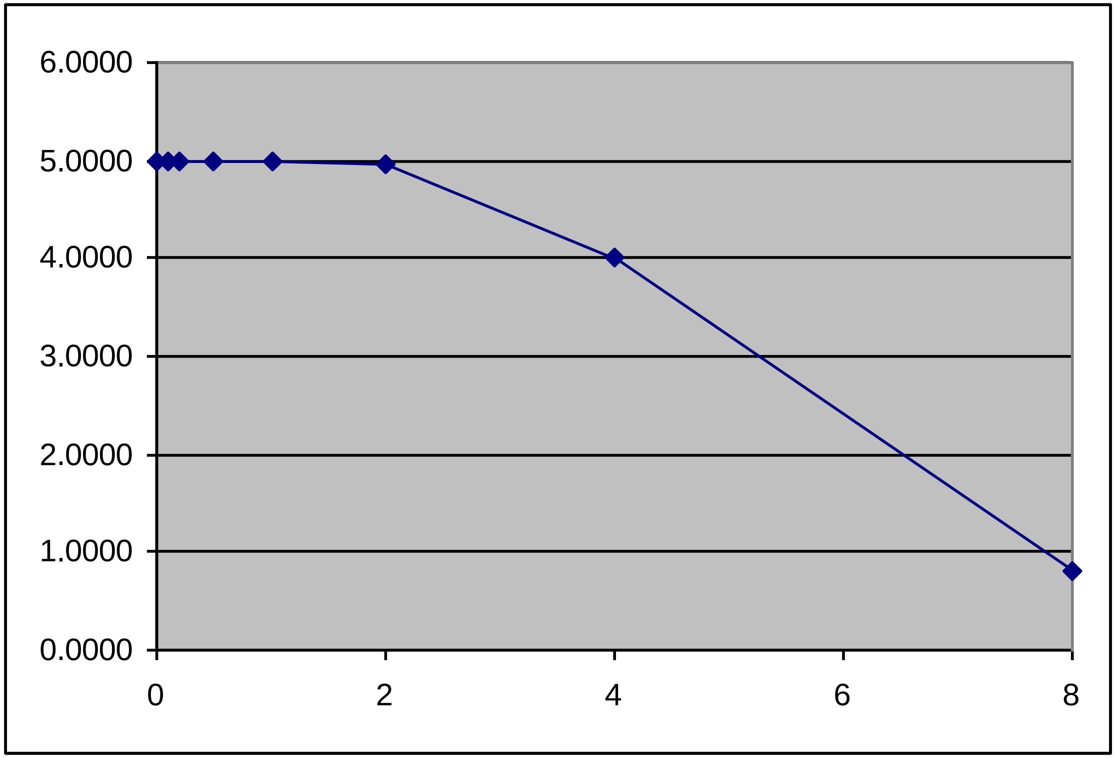
Burden Testing

0.3% @ B0.1, B0.2, B0.5

Initial Reading = 5Amps

0.3% x 5A = 0.015A

5A – 0.015 = 4.985A



Burden	Reading
0	5.0000
0.1	4.9999
0.2	4.9950
0.5	4.9900
1	4.9800
2	4.9500
4	4.0000
8	0.8000

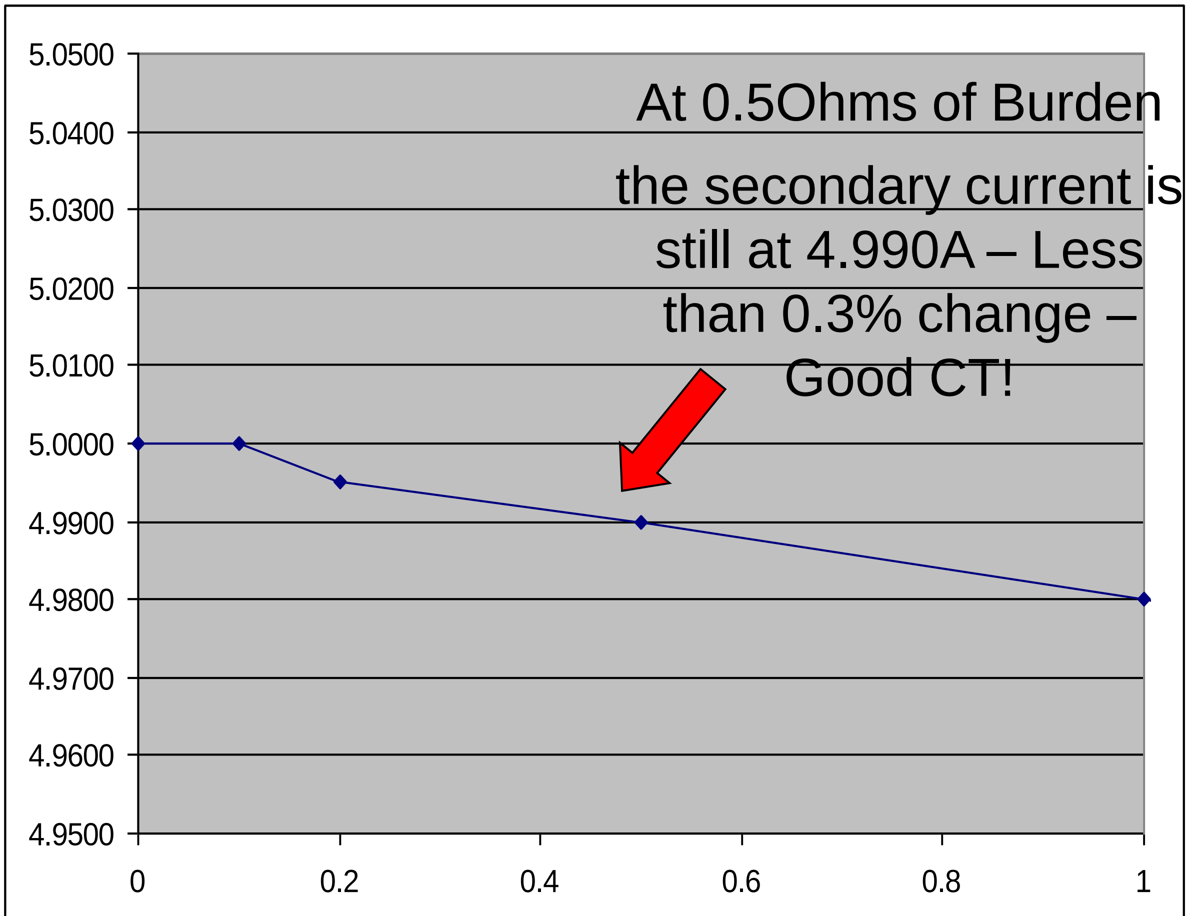
Burden Testing

0.3% @ B0.1, B0.2, B0.5

Initial Reading = 5Amps

0.3% x 5A = 0.015A

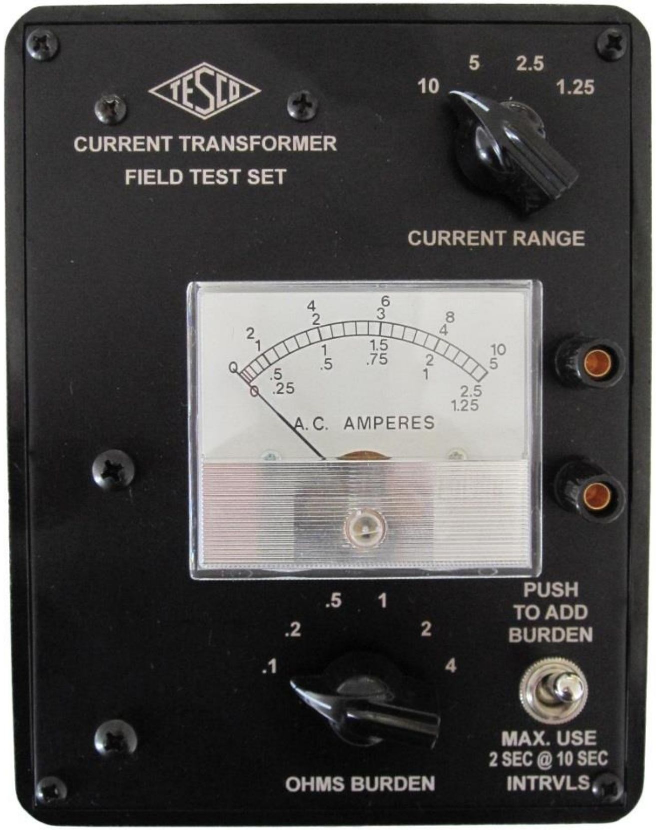
5A – 0.015 = 4.985A



Burden	Reading
0	5.0000
0.1	4.9999
0.2	4.9950
0.5	4.9900
1	4.9800
2	4.9500
4	4.0000
8	0.8000

Analog Testing

Application of Burden and Calculation



Manual reading of initial and post-burden secondary currents

Admittance Testing

Admittance test results are not immediately intuitive.

Some analysis and interpretation is need.

What do all these mS values mean?

Admittance Testing

What is Admittance?

Measured in units of MiliSiemens (mS)

Admittance is the inverse of impedance.

Impedance is the opposition to current.

Therefore, admittance testing measures the overall "health" of the secondary loop of the CT.

Admittance Testing

Admittance testing devices inject an audio sine wave signal into the secondary loop of the CT.

The resulting current is measured.

The voltage of the initial signal is known.

From these two parameters, the impedance, and thus the admittance can be calculated.

Admittance Testing

Three phase process is recommended.

1. Test each CT individually
2. Test the matched sets
3. Test over time

De-magnetization

CT's can become magnetized, due to a number of reasons, including leaving the shorting clip open, near lightning strikes, and harmonic content.

CT's can be demagnetized by slowly and smoothly increasing the secondary resistance until saturation occurs, and then slowly and smoothly decreasing the secondary resistance.

A resistance that will cause a secondary current reduction of 65% to 75% will typically put the CT into saturation.

What we covered

- Why do we test CT's?
- Shop testing
- How to read and interpret a transformer face plate
- Types of field tests
- Magnetization effects and demagnetization

Questions?

Tom Lawton

TESCO – The Eastern Specialty Company

Bristol, PA

215-785-2338

This presentation can also be found under Meter Conferences and Schools on the TESCO website: www.tescometering.com