Ratio, Burden, Admittance Testing

Prepared by Tom Lawton, TESCO
The Eastern Specialty Company

For North Carolina Electric Meter School
Advanced
Wednesday, June 16, 2021 at 9:30 a.m.

Agenda – Advanced Session

What we will not cover!

- The Very Basics: meter forms and
- self-contained vs. transformer rated

What we will cover

- CT Functionality Basics
- The Faceplate:
  - Terminology and Specifications
- Ratio Testing
- Burden Testing
- Admittance Testing
- Demag Functions
- Roundtable – after Complete Site Testing is finished:
  - What you do and why?

What is a CT? a PT?

“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

Shop Testing

- Accuracy Testing
- Meter Communications Performance
- Software & Firmware Verification
- Setting Verification
- Functional Testing
- Disconnect/Reconnect Functionality and as left setting
- Ratio and accuracy testing
- Polarity checking
- Accuracy class determination

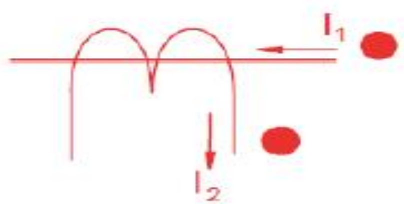
Shop Testing Programs

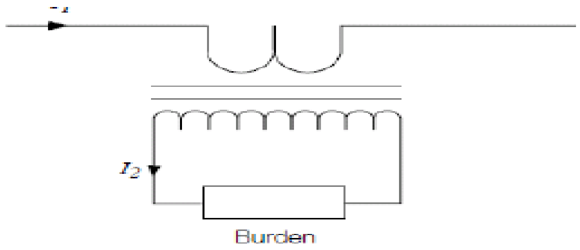
- 100% of all Transformers
  - If not possible then sample testing of all and 100% of all those over a certain size for CT's and all VT's (generally not a large volume)
- Transformer testing should include
  - Ratio and accuracy testing
  - Polarity checking
  - Accuracy class determination
- 100% of all transformer rated meters
  - If not possible then sample testing of all transformer rated meters and 100% of all those going into a certain size service and over
- Meter testing should include
  - Software & Firmware Verification
  - Setting Verification
  - Functional Testing
  - Disconnect/Reconnect Functionality
    and as left setting

Current Transformers Conceptual Representation

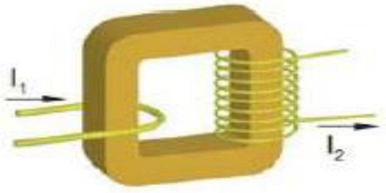
As current is applied in the primary, it produces a magnetic flux in the core. This flux flows through the core and induces a current in the secondary windings and circuit that is proportional to the number of turns.

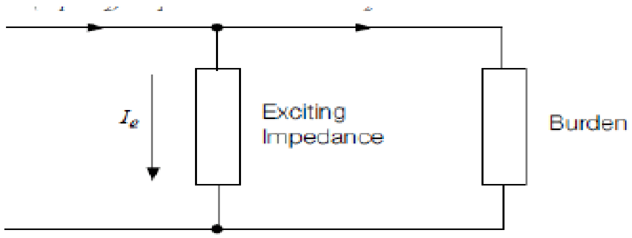
Ideal. No losses





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



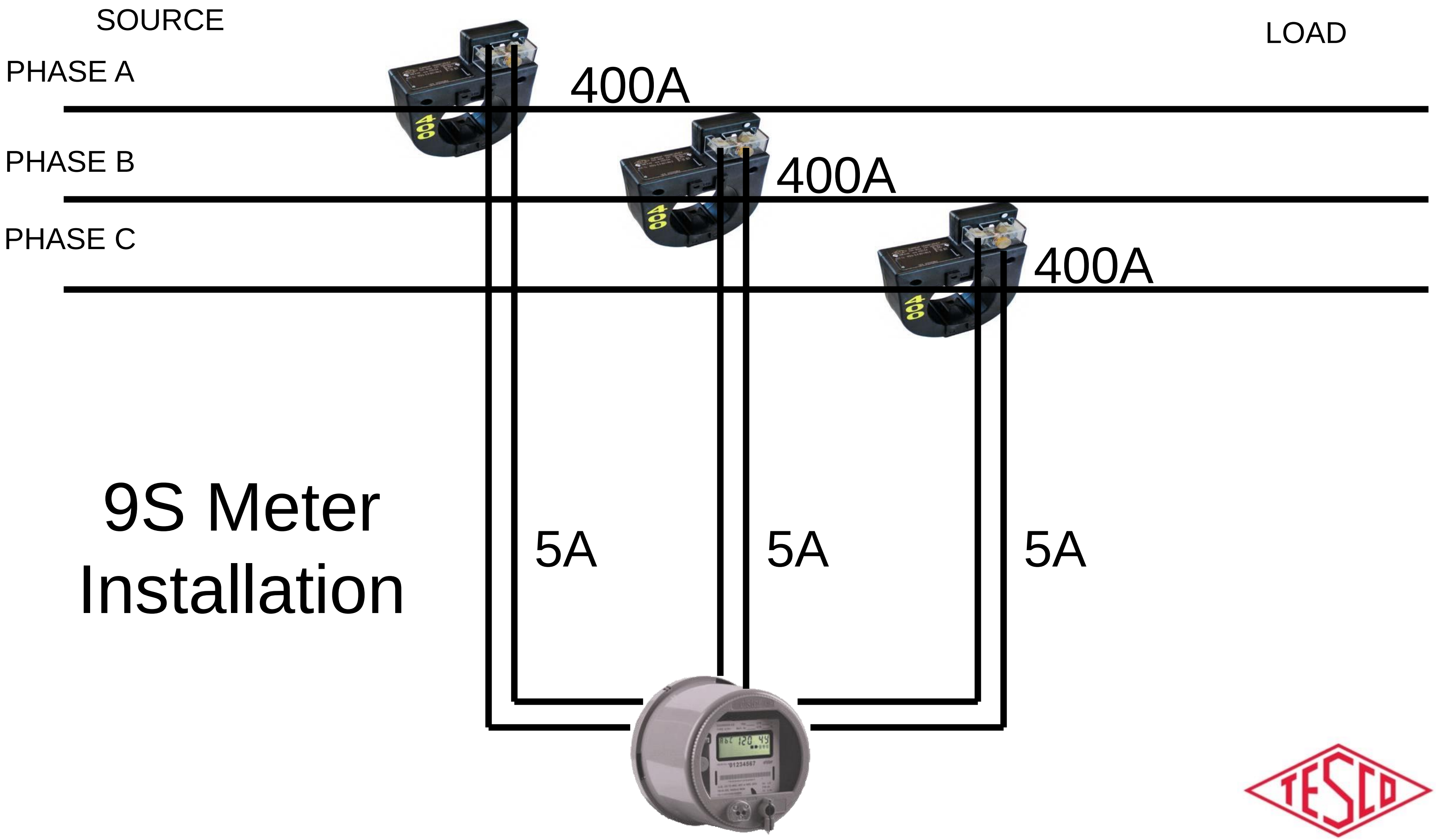


$$I_2 = \frac{N_1}{N_2} \times I_1 - I_e$$

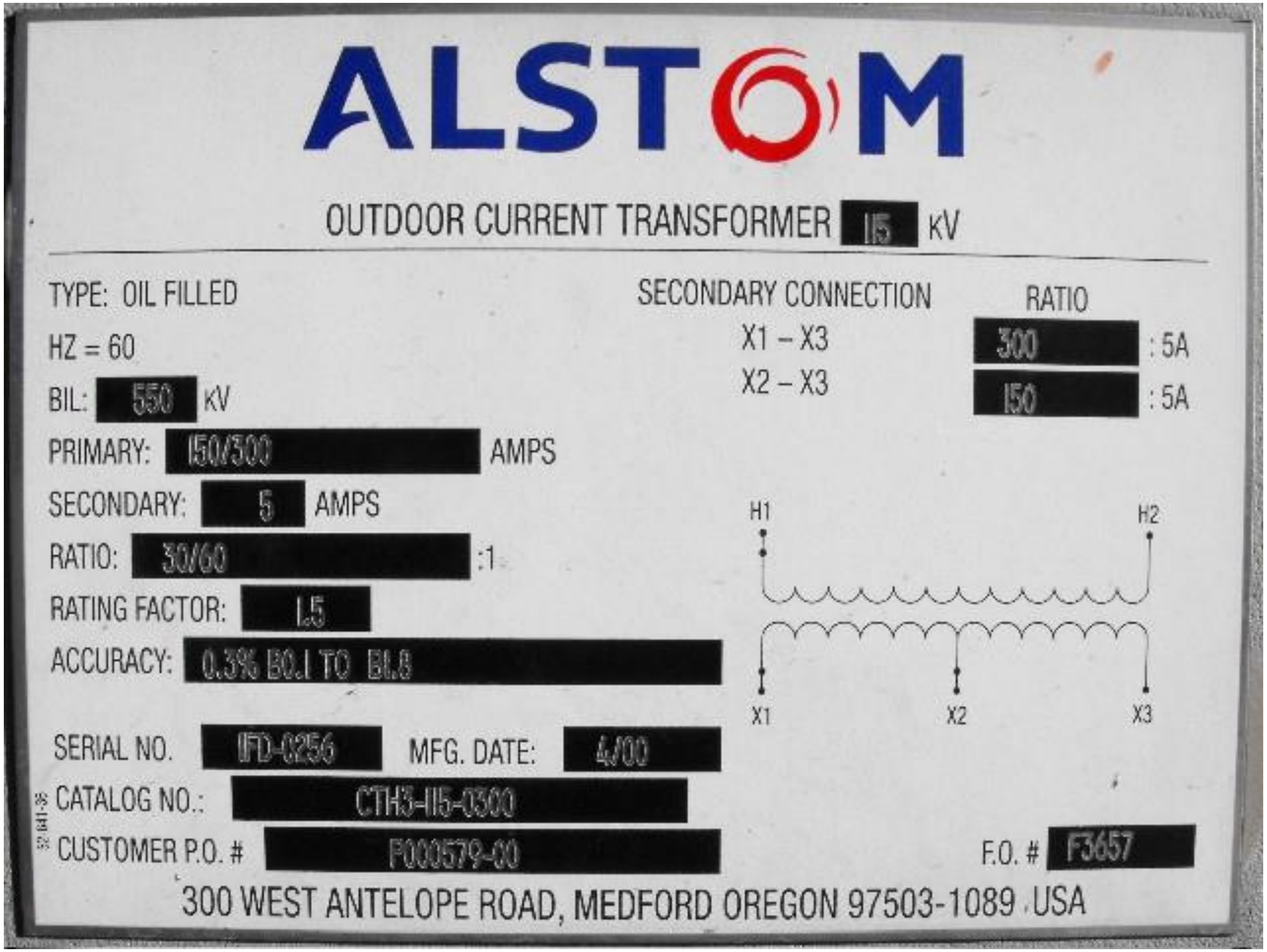
$$I_1 \times N_1 = I_2 \times N_2$$

Real, with core losses

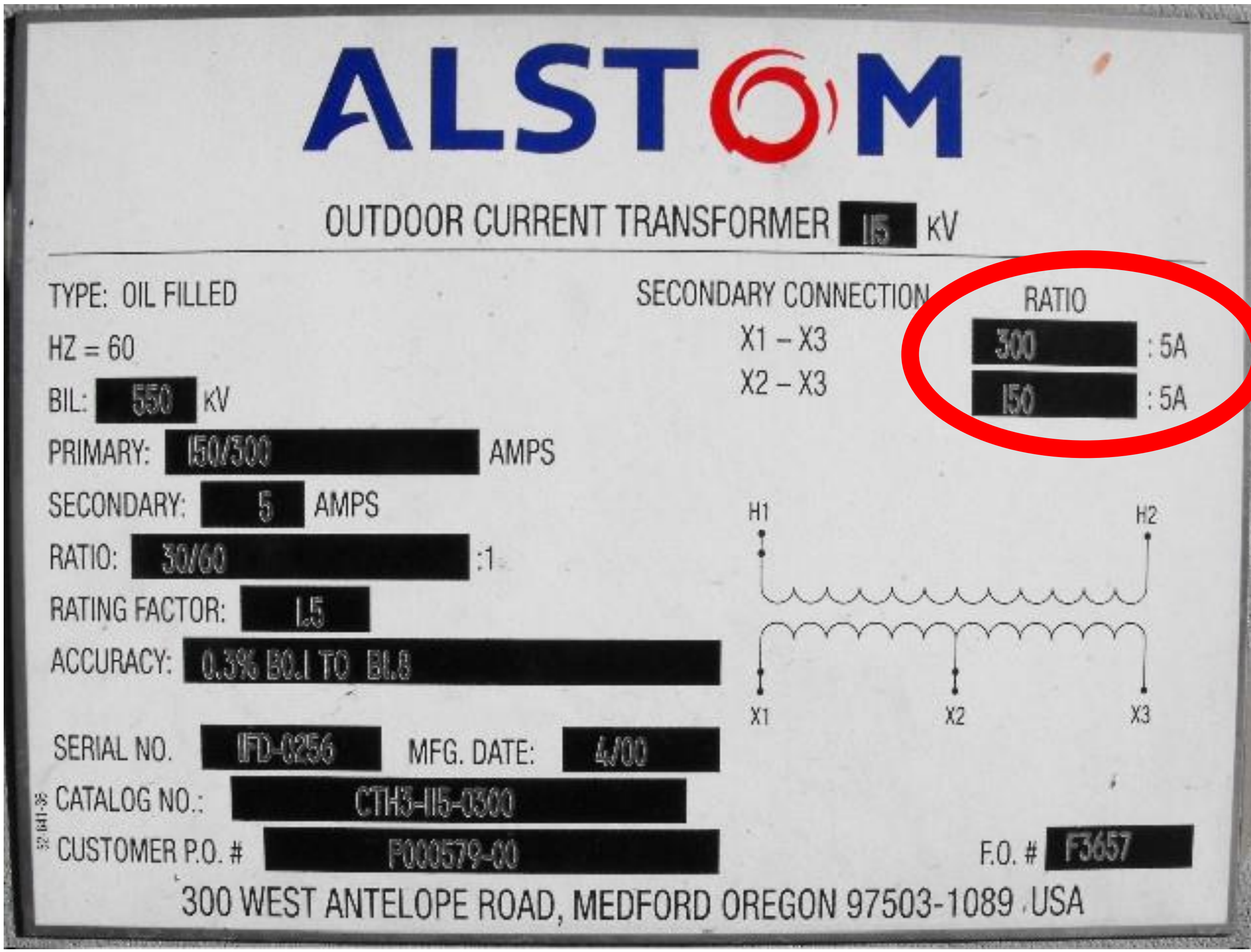
Example Application



Faceplate Specifications



Faceplate Specifications

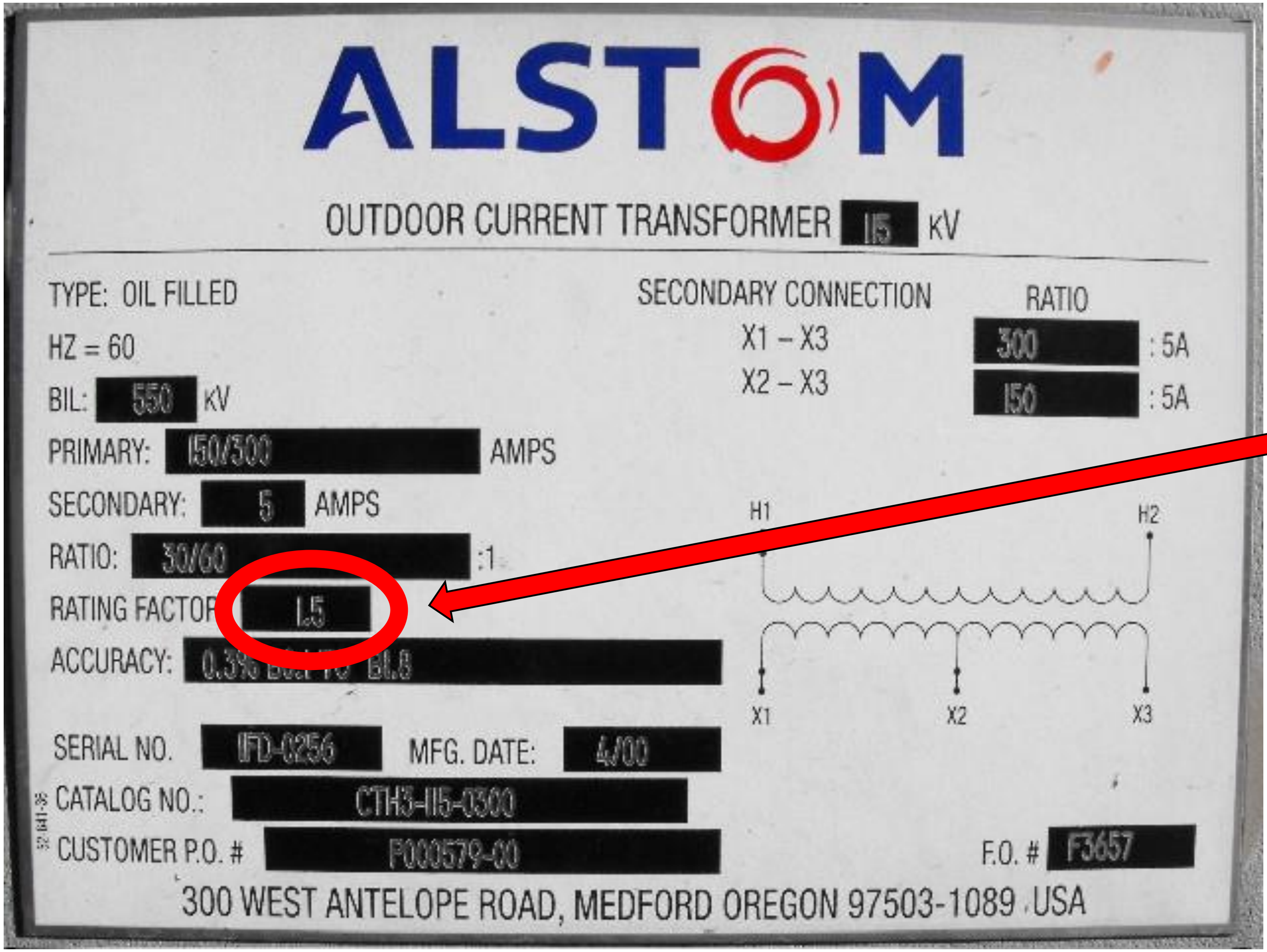


Ratio

CT's Ratio

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

Faceplate Specifications



Thermal factor

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.

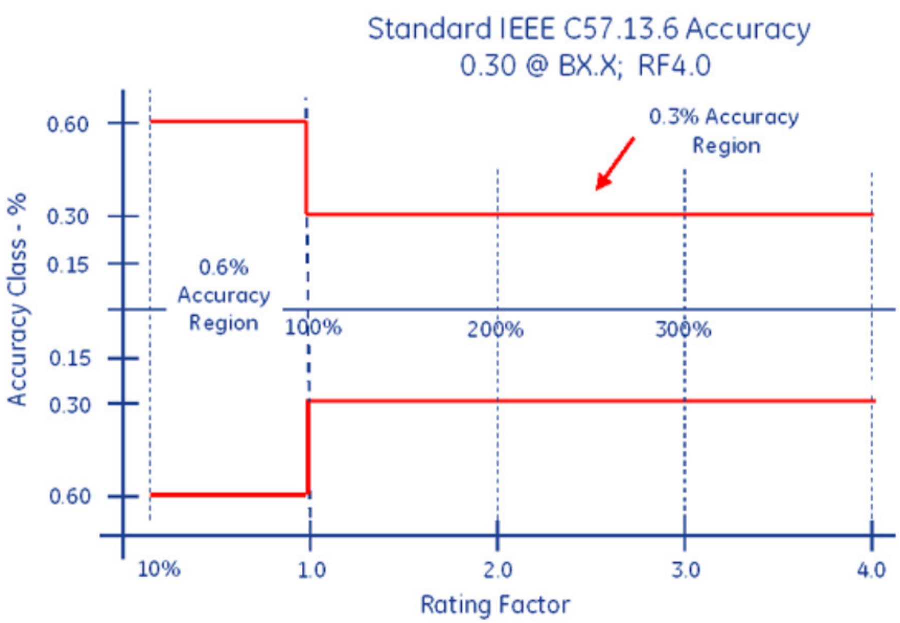
For instance, a RF of 4.0 at 30° ambient on a 400:5 ratio CT would allow for a primary current up to 1600A.

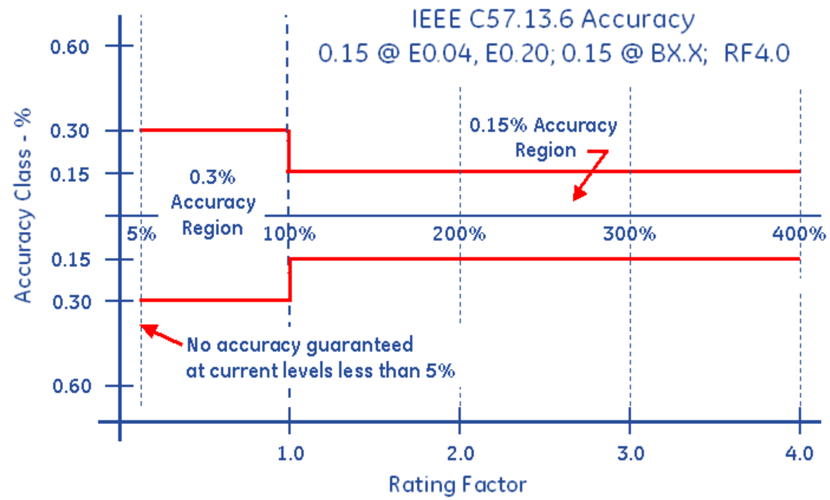
Faceplate Specifications

Accuracy Classifications

All CT's fall within an accuracy class.

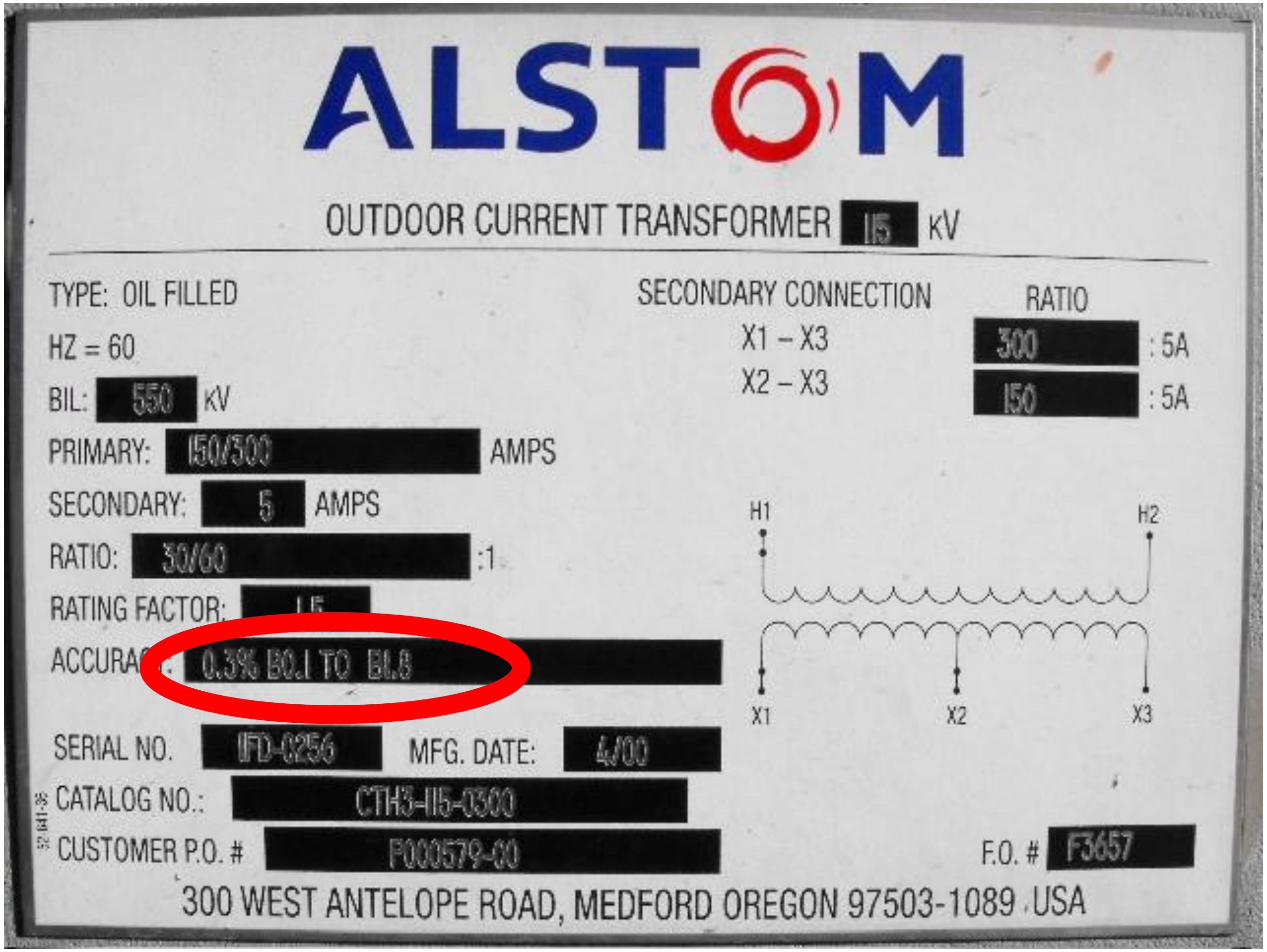
IEEE Standards have defined accuracy classes.





Faceplate Specifications

Burden Rating

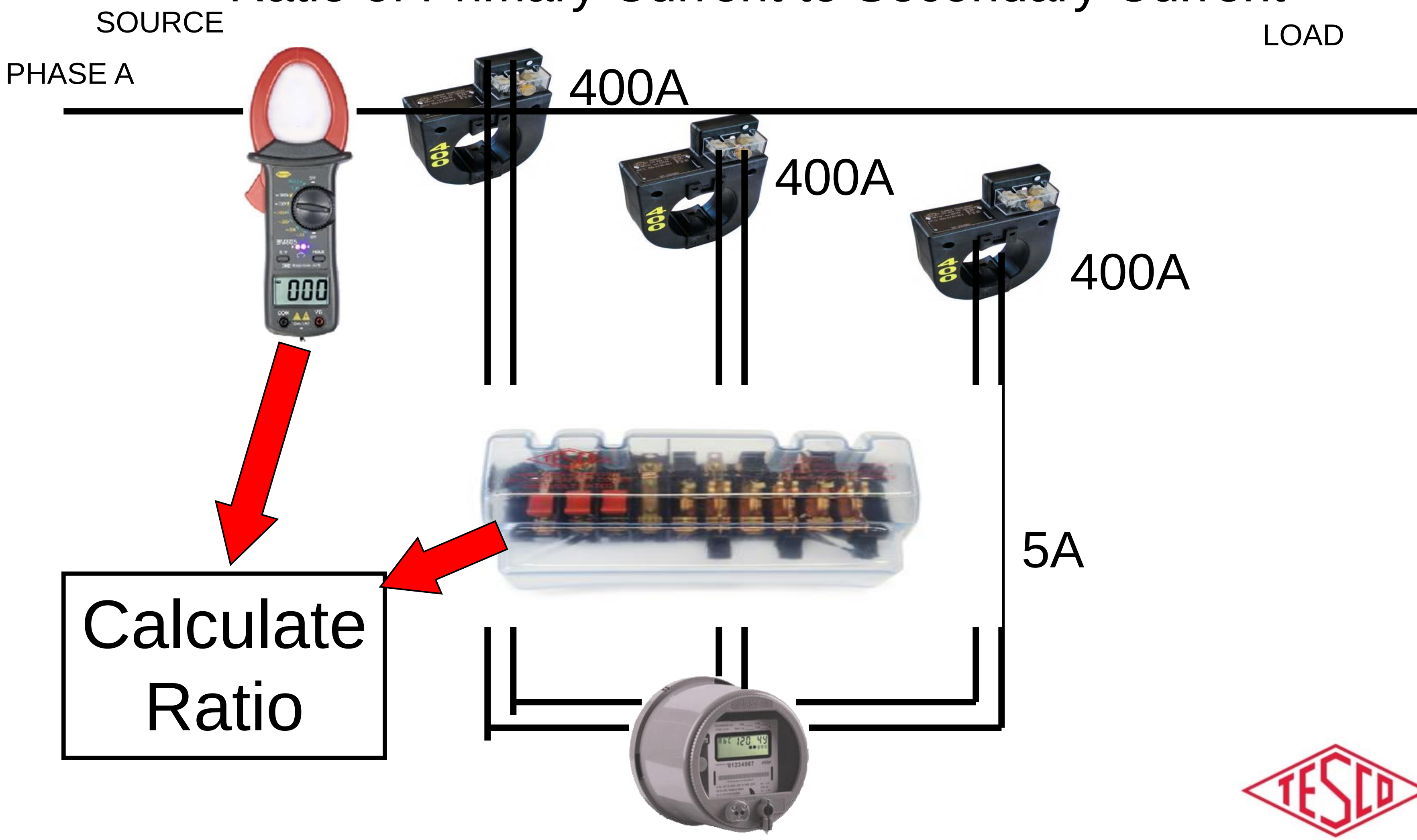


Burden Rating

The burden range, present in the secondary circuit, that the manufacturer will guarantee their CT's will still accurately function, in regards to the ratio specification.

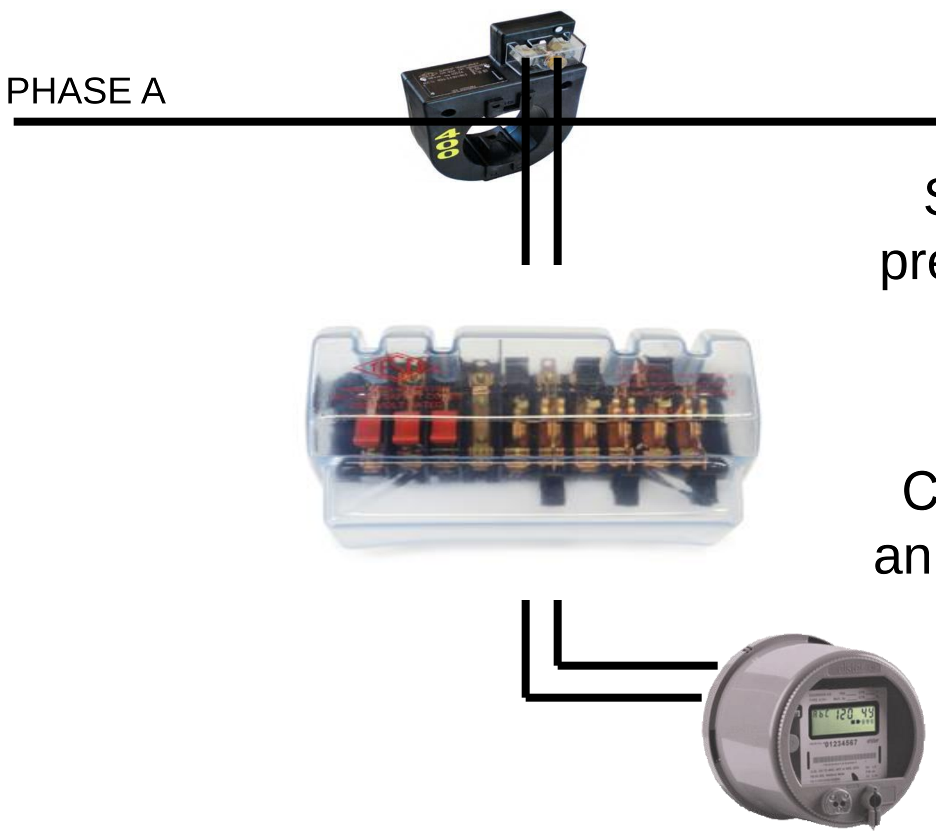
Ratio Testing

Ratio of Primary Current to Secondary Current



Burden Testing

Functionality with Burden Present on the Secondary Loop

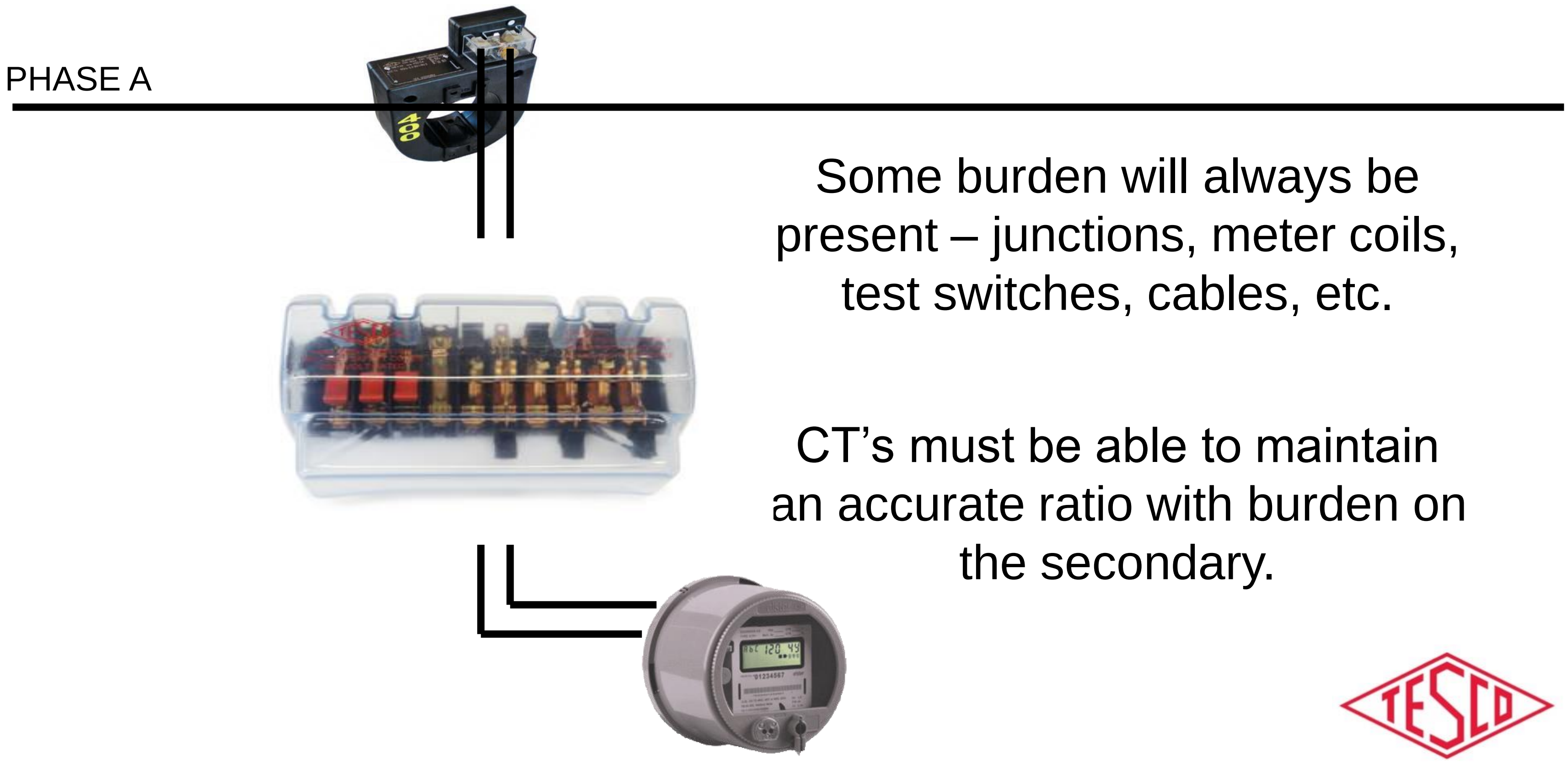


Some burden will always be present – junctions, meter coils, test switches, cables, etc.

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



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Burden Testing

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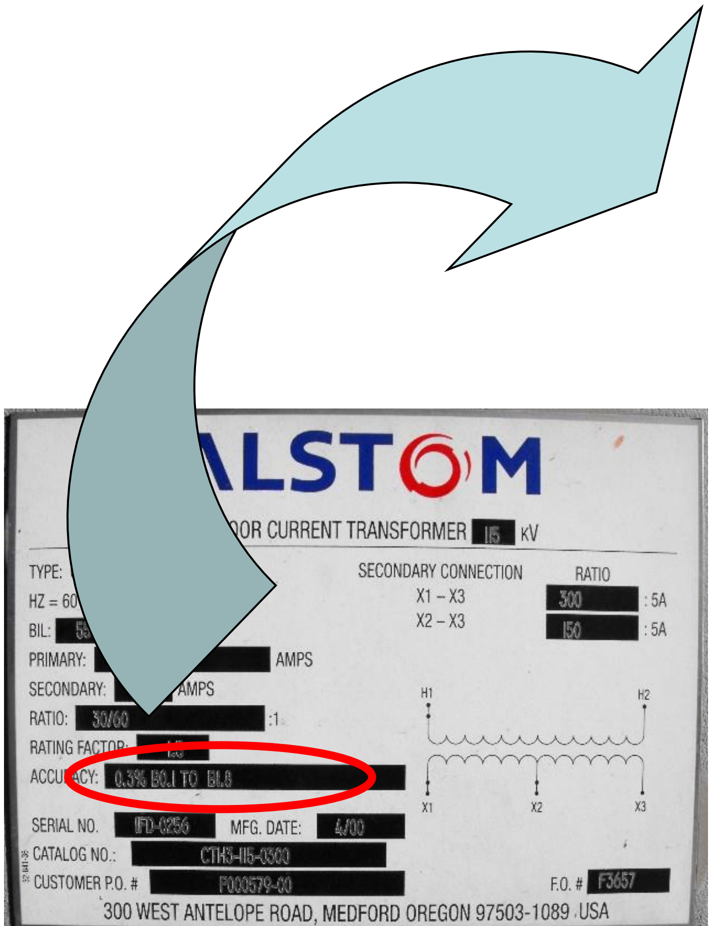


Example Burden Spec:

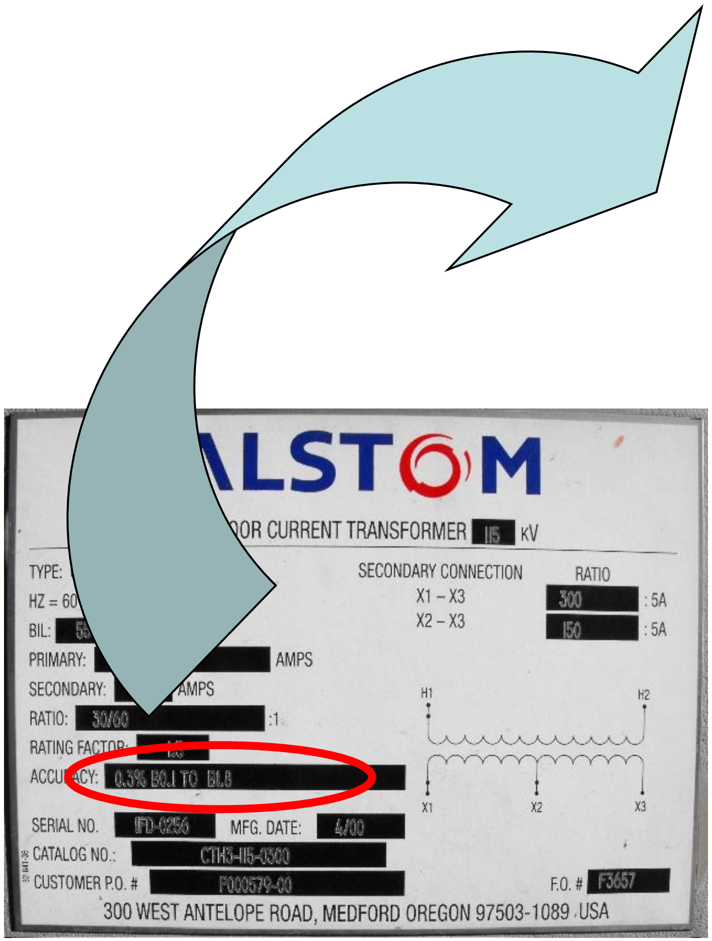
0.3% @ B0.1, B0.2, B0.5

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

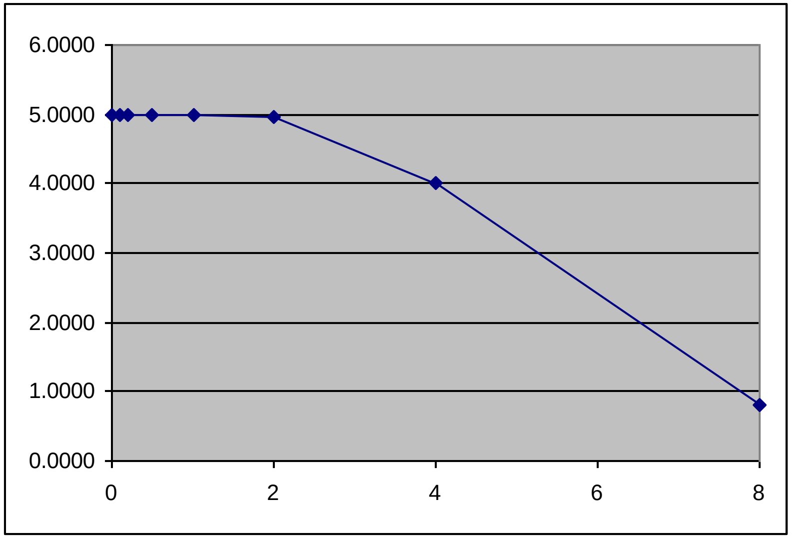
Burden Testing

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

Initial Reading = 5Amps

0.3% x 5A = 0.015A

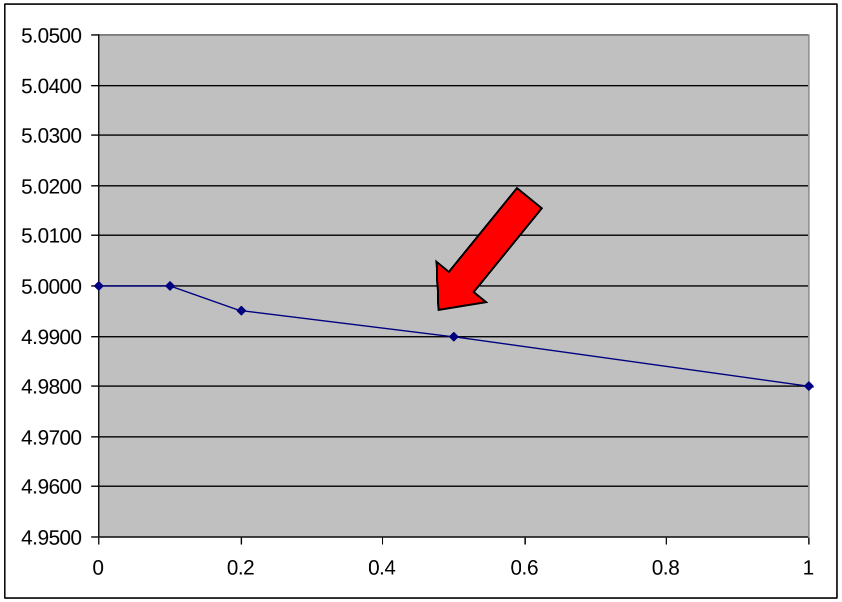
5A – 0.015 = 4.985A



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



At 0.5Ohms of Burden

the secondary current is still at 4.990A – Less than 0.3% change – Good CT!

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

Admittance Testing

- What is Admittance?
- Admittance testing measures the overall “health” of the secondary loop of the CT.
- 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

- Admittance test results are not immediately intuitive.
- Some analysis and interpretation is need.
- What do all these mS values mean?

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 demagnitized 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.

*Some information has been taken from Radian Research's Application Note 1109A: Admittance Testing Verifies CT Testing Integrity

Questions and Discussion

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