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SITE VERIFICATION AND SAFETY

Pennsylvania Rural Electric Association

PREA

March 4, 2025 1:30 PM – 2:45 PM

Perry Lawton

Site Verification: Why should we invest our limited meter service resources here

- These customers represent a disproportionately large amount of the overall revenue for every utility in North America.
- For some utilities, the ten percent of their customers who have transformer rated metering services can represent over 70% of their overall revenue.
- While these numbers will vary from utility to utility the basic premise should be the same for all utilities regarding where Meter Services should focus their efforts
- This is perhaps one of the larger benefits that AMI can provide for our Utilities – more time to spend on C&I metering and less on residential

Easy Answer: Money.

Potential list of tasks to be completed during a Site Verification of a Transformer Rated Metering Site

- Double check the meter number, the location the test result and the meter record
- Perform a visual safety inspection of the site. This includes utility and customer equipment. Things to look for include intact down ground on pole, properly attached enclosure, unwanted voltage on enclosure, proper trimming and site tidiness (absence of discarded seals, etc.)
- Visually inspect for energy diversions (intentional and not). This includes broken or missing wires, jumpers, open test switch, unconnected wires and foreign objects on meters or other metering equipment. Broken or missing wires can seriously cause the under measurement of energy. A simple broken wire on a CT or VT can cause the loss of 1/3 to 1/2 of the registration on either 3 element or 2 element metering, respectively.

Site Verification Checklist (cont)

- Visually check lightning arrestors and transformers for damage or leaks.
- Check for proper grounding and bonding of metering equipment. Poor grounding and bonding practices may result in inaccurate measurements that go undetected for long periods of time. Implementing a single point ground policy and practice can reduce or eliminate this issue.
- Burden test CTs and voltage check PTs.
- Verify service voltage. Stuck regulator or seasonal capacitor can impact service voltage.
- Verify condition of metering control wire. This includes looking for cracks in insulation, broken wires, loose connections, etc.
- Confirm we have a Blondel compliant metering set up
- Compare the test switch wiring with the wiring at the CTs and VTs. Verify CTs and VTs not cross wired. Be sure CTs are grounded in one location (test switch) only.

SITE VERIFICATION CHECKLIST (CONT)

- Check for bad test switch by examining voltage at the top and bottom of the switch. Also verify amps using amp probe on both sides of the test switch. Verify neutral connection to cabinet (voltage).

- Check rotation by closing in one phase at a time at the test switch and observing the phase meter for forward rotation. If forward rotation is not observed measurements may be significantly impacted as the phases are most likely cancelling each other out.

SITE VERIFICATION CHECKLIST (CONT)

- Test meter for accuracy. Verify demand if applicable with observed load. If meter is performing compensation (line and/or transformer losses) the compensation should be verified either through direct testing at the site or by examining recorded pulse data.

- Loss compensation is generally a very small percentage of the overall measurement and would not be caught under utilities normal high/low checks. However, the small percentages when applied to large loads or generation can really add up overtime. Billing adjustments can easily be in the $million range if not caught early.

SITE VERIFICATION CHECKLIST (CONT)

- Verify metering vectors. Traditionally this has been done using instruments such as a circuit analyzer. Many solid state meters today can provide vector diagrams along with volt/amp/pf and values using meter manufacturer software or meter displays. Many of these desired values are programmed into the meters Alternate/Utility display. Examining these values can provide much information about the metering integrity. It may also assist in determining if unbalanced loads are present and if CTs are sized properly. The vendor software generally has the ability to capture both diagnostic and vector information electronically. These electronic records should be kept in the meter shop for future comparisons.

- If metering is providing pulses/EOI pulse to customers, SCADA systems or other meters for totalization they also should be verified vs. the known load on the meter. If present test/inspect isolation relays/pulse splitters for things like blown fuses to ensure they are operating properly.

- Verify meter information including meter multiplier, serial number, dials/decimals, Mp, Ke, Primary Kh, Kr and Rate. Errors in this type of information can also cause a adverse impact on measured/reported values.

- Verify CT shunts are all opened.

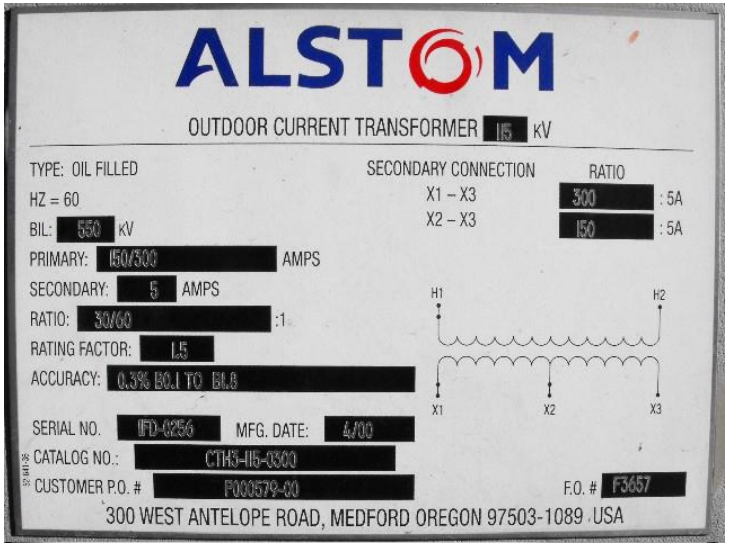
- Look for signs of excessive heat on the meter base e.g. melted plastic or discoloration related to heat

PERIODIC SITE INSPECTIONS.....

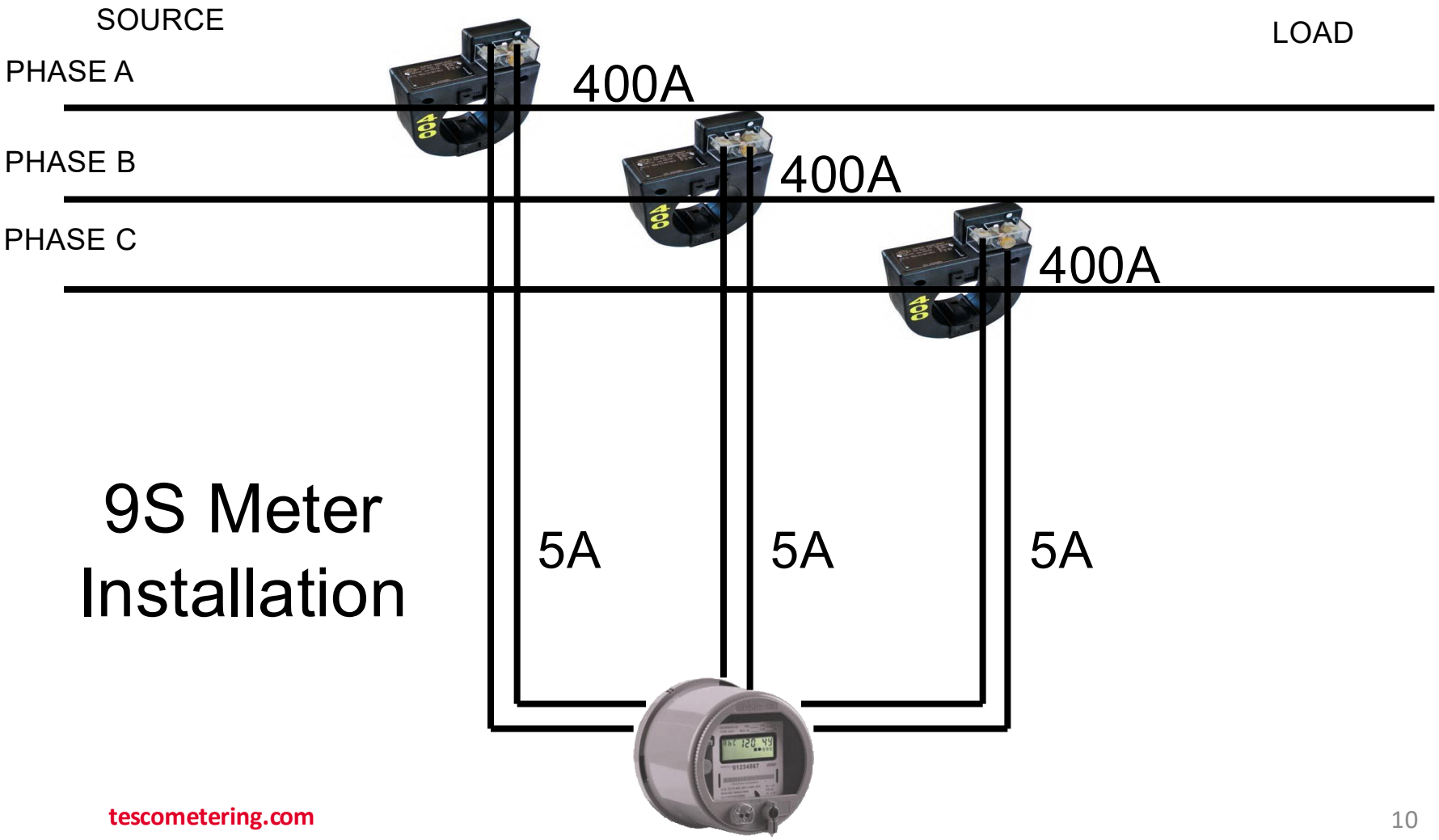
....Can Discover or Prevent:

- Billing Errors
- Bad Metering set-up
- Detect Current Diversion
- Identify Potential Safety Issues
- Metering Issues (issues not related to meter accuracy)
- AMR/AMI Communications Issues
- The need for Unscheduled Truck Rolls due to Undetected Field Related Issues
- Discrepancies between what is believed to be at a given site versus the actual setup and equipment at the site

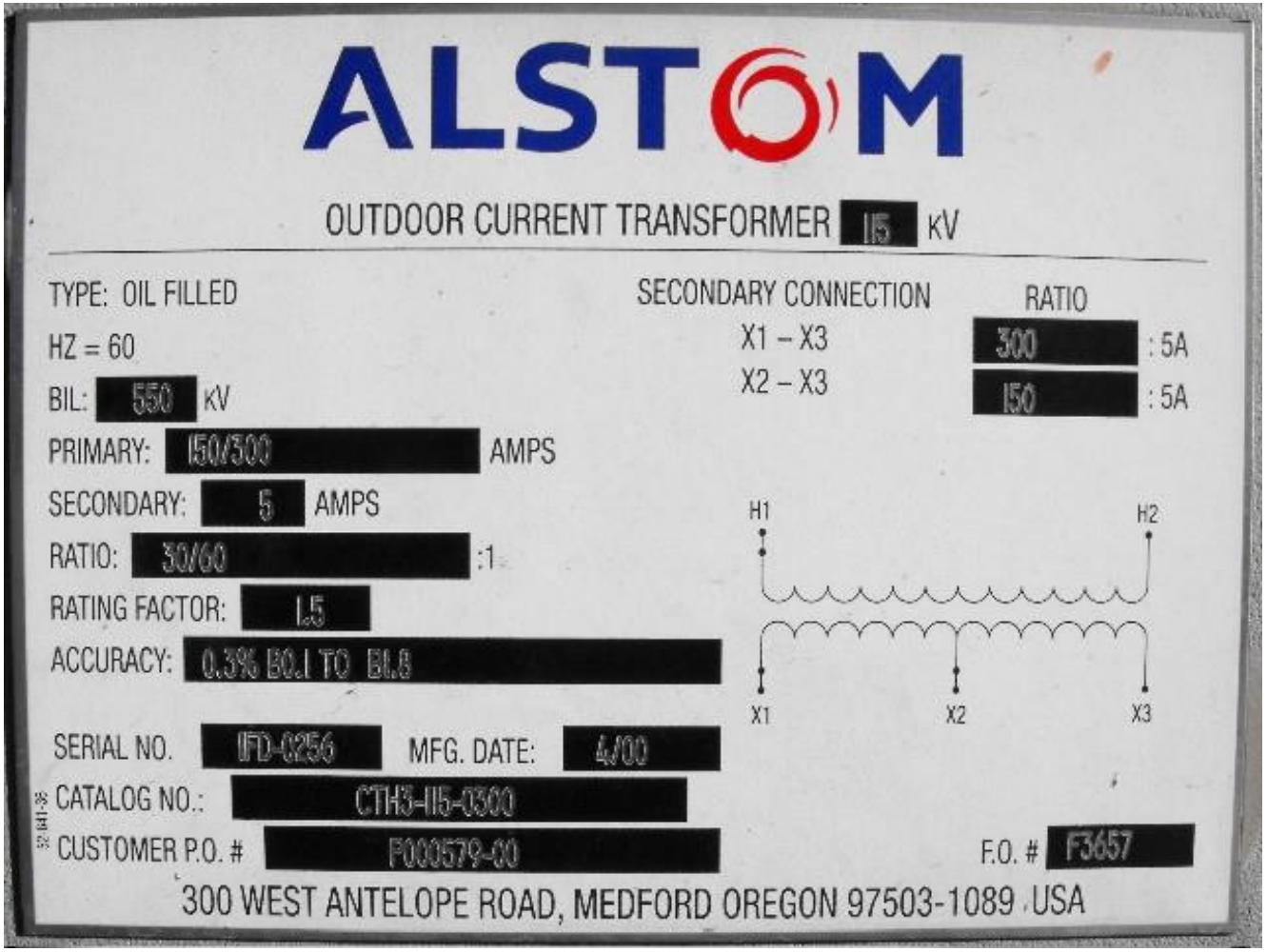
Ratio, Burden, and Admittance



EXAMPLE APPLICATION



FACEPLATE SPECIFICATIONS



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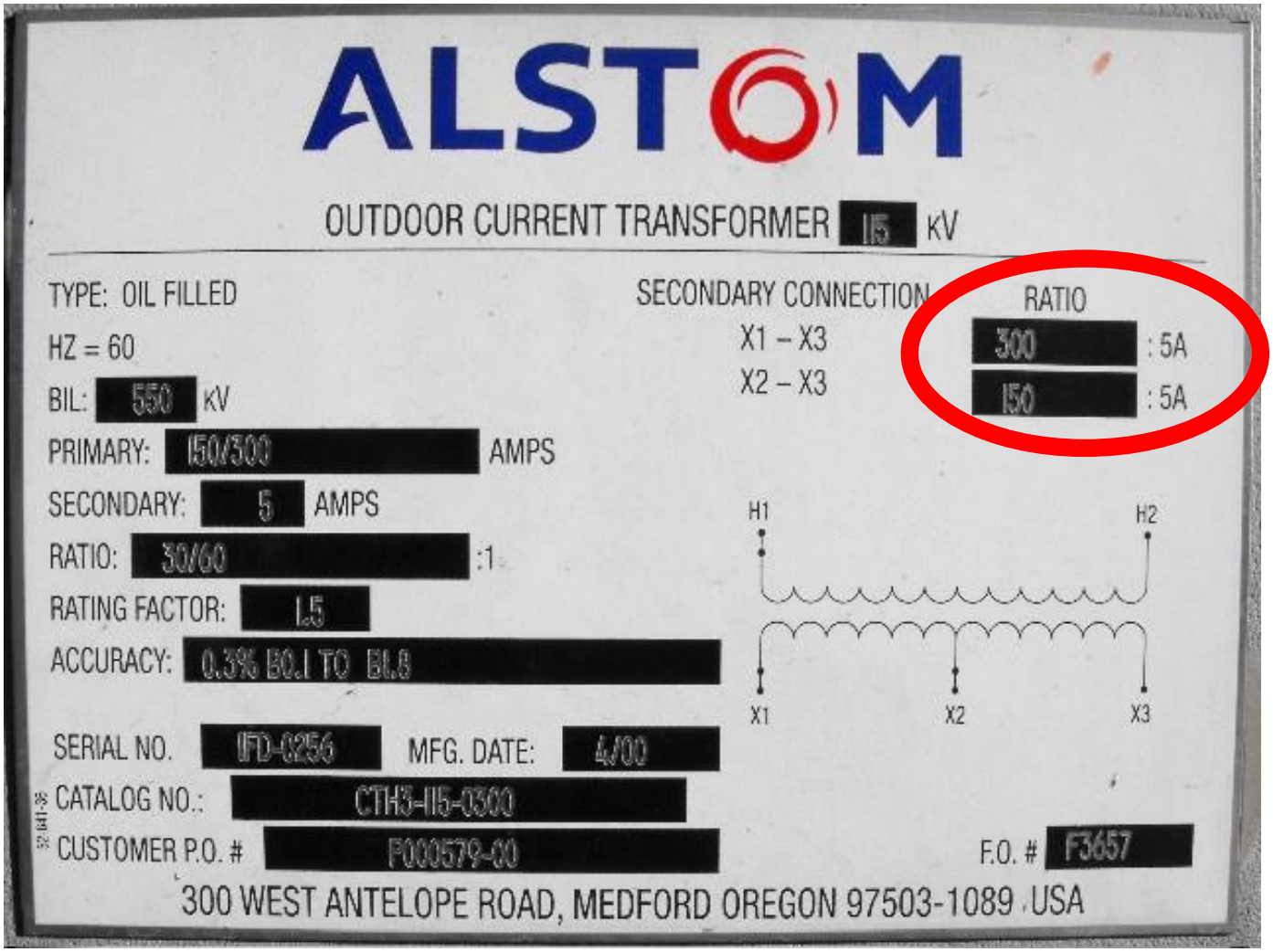
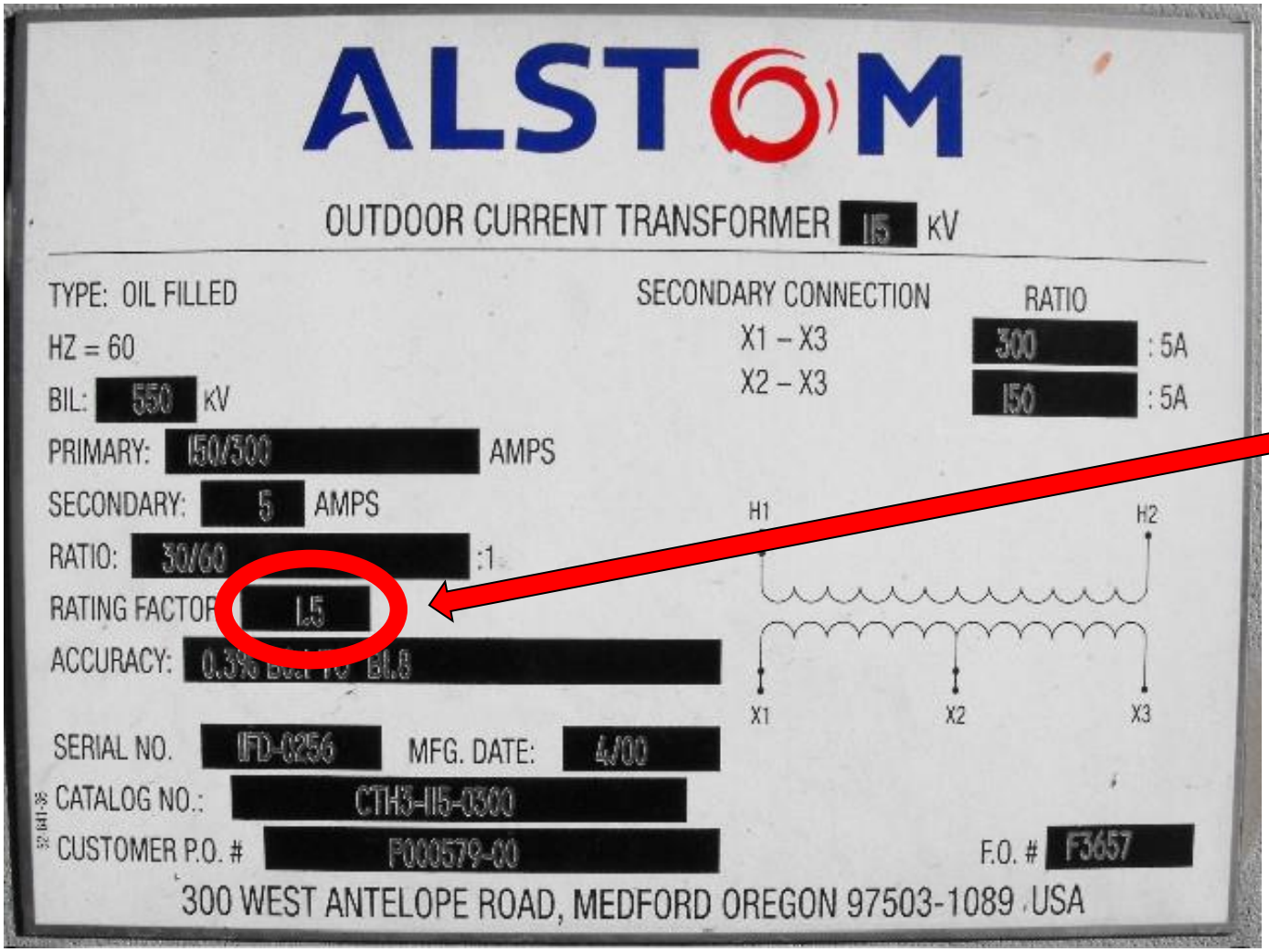


Ratio

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

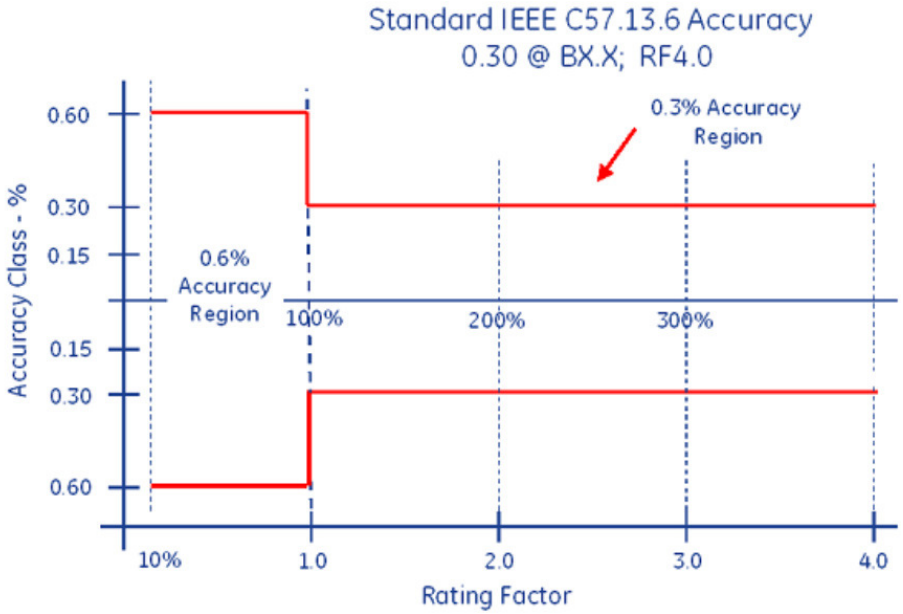
Thermal Rating factor

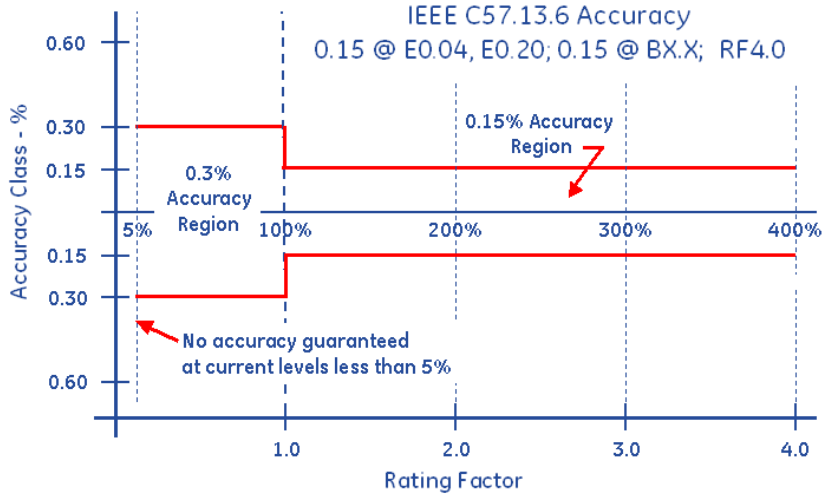
A value representing the amount by which the primary current can be increased without exceeding the allowable temperature rise. For instance, a RF of 4.0 at 30° ambient on a 400:5 ratio CT would allow for a primary current up to 1600A.

FACEPLATE SPECIFICATIONS

Accuracy Classifications

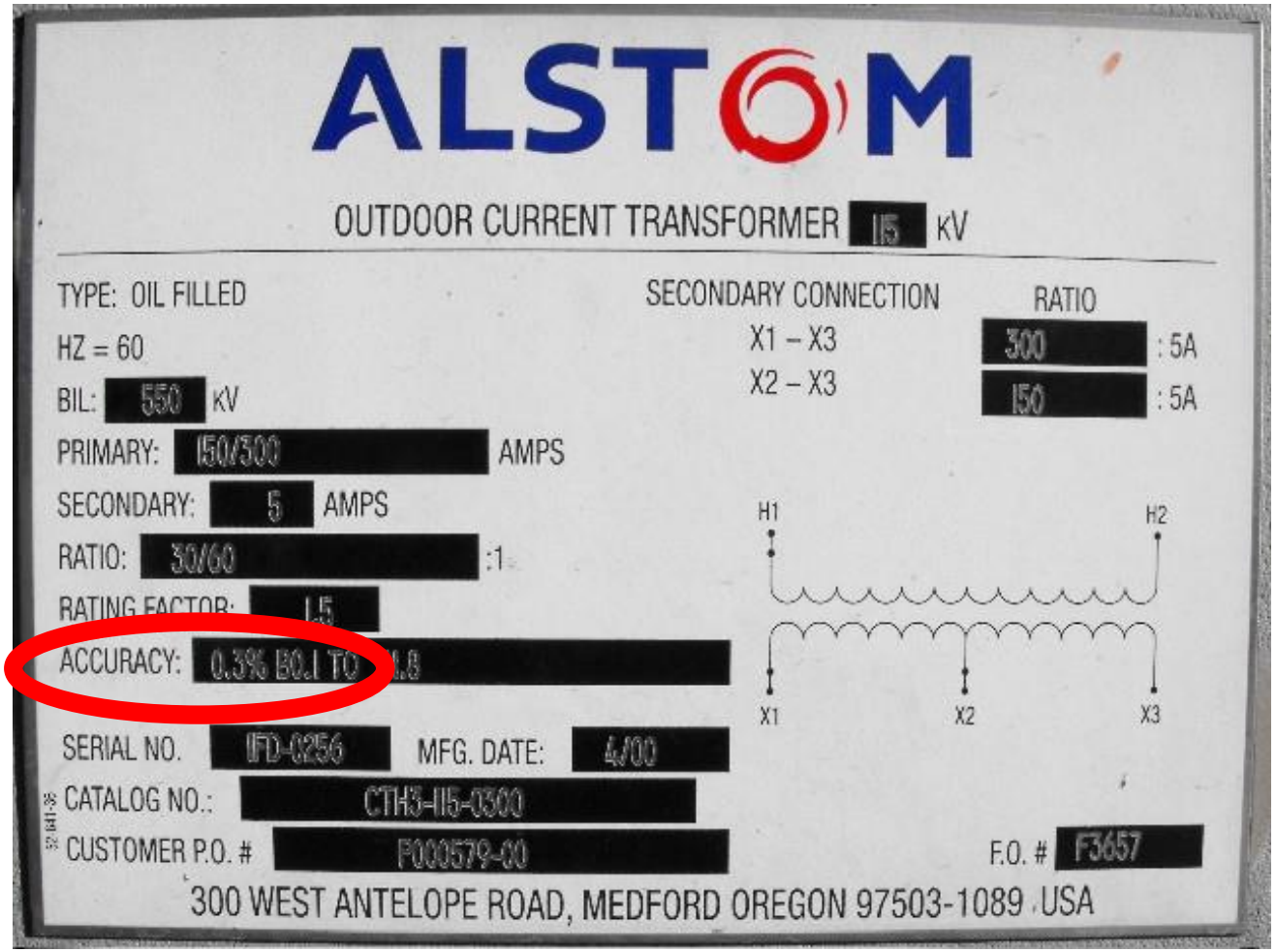
All CT's fall within an accuracy class.
IEEE Standards have defined accuracy classes.





FACEPLATE SPECIFICATIONS

Burden Rating

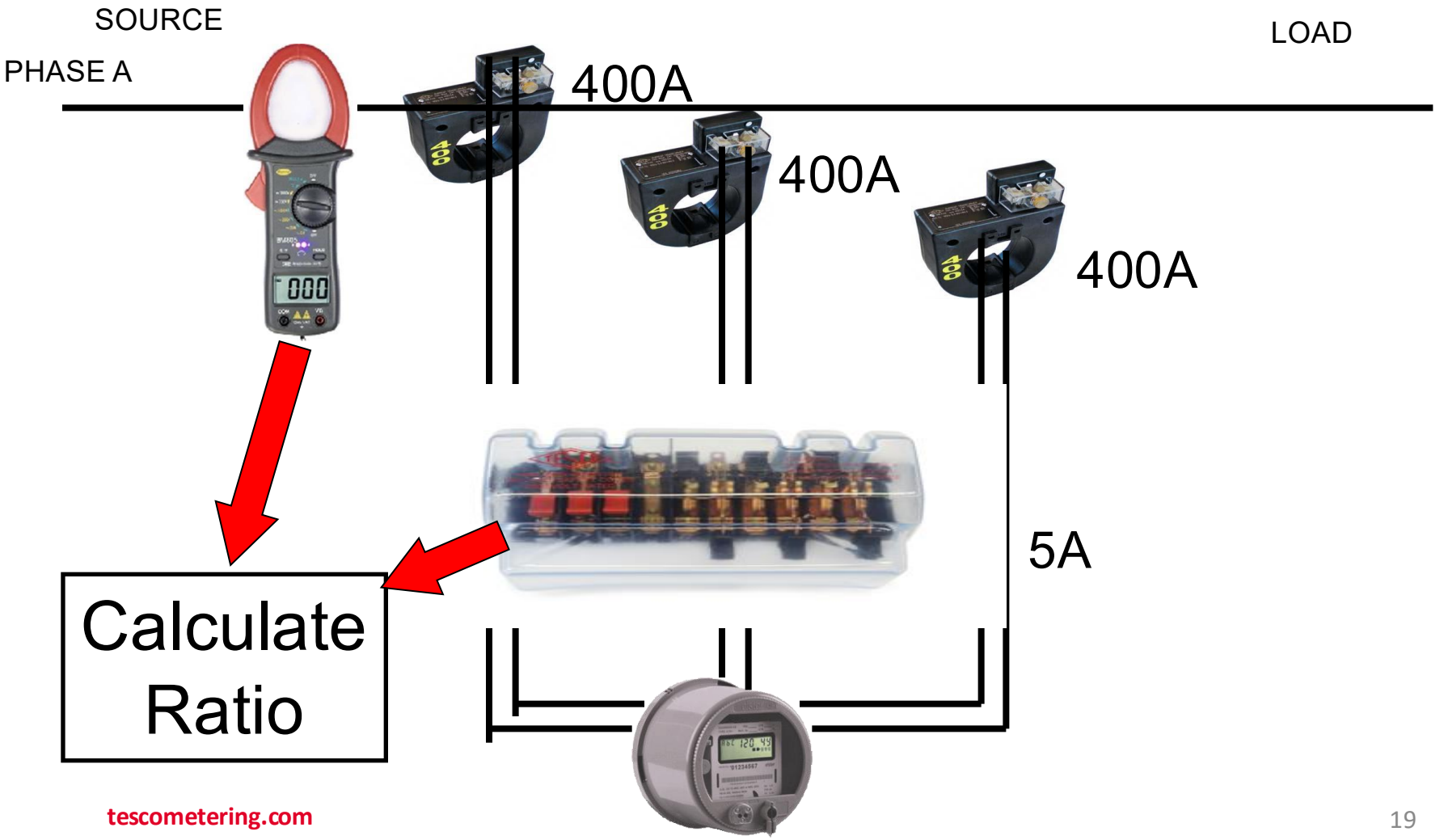


Burden Rating

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

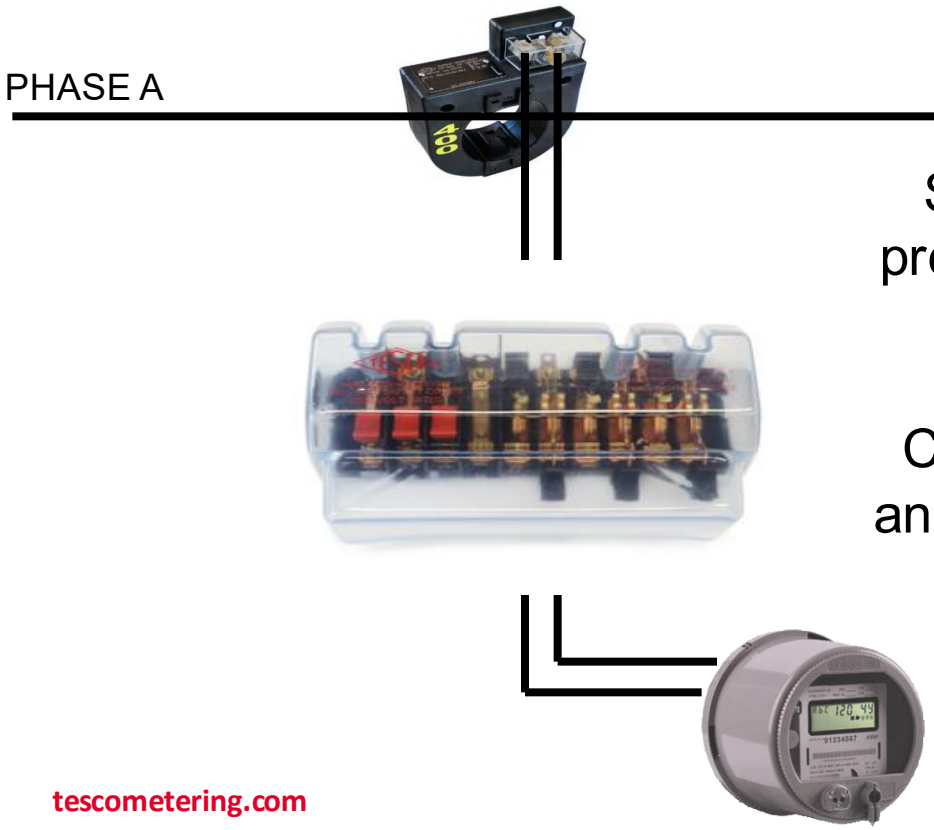
RATIO TESTING

Ratio of Primary Current to Secondary Current



BURDEN TESTING

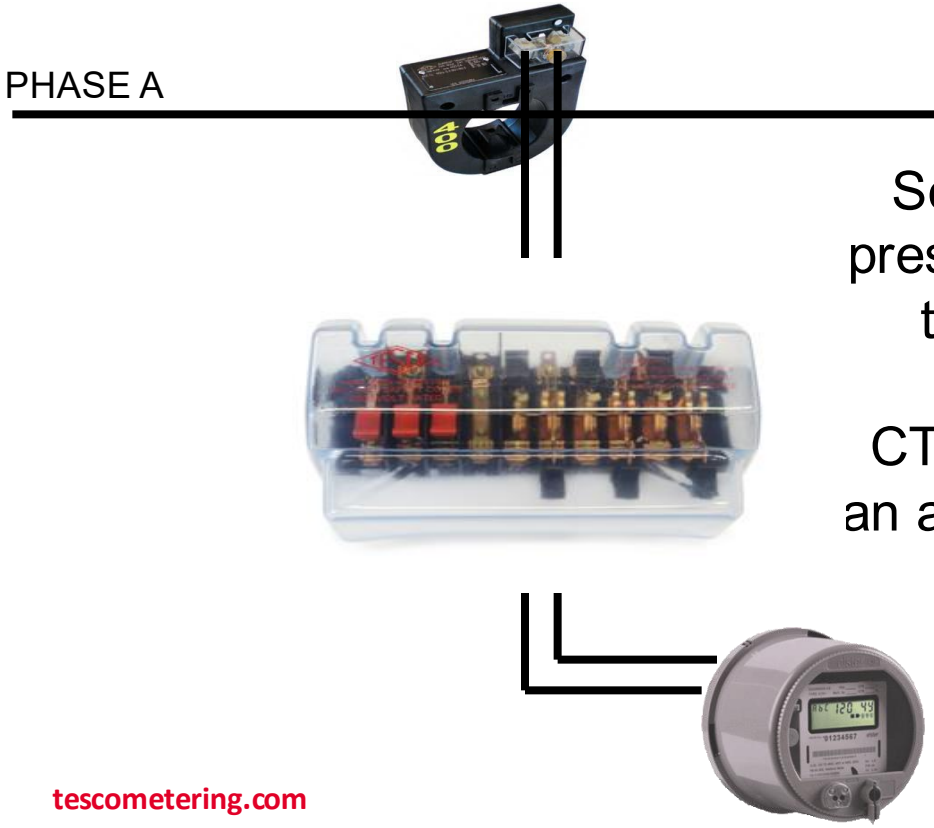
Functionality with Burden Present on the Secondary Loop



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.

Functionality with Burden Present on the Secondary Loop



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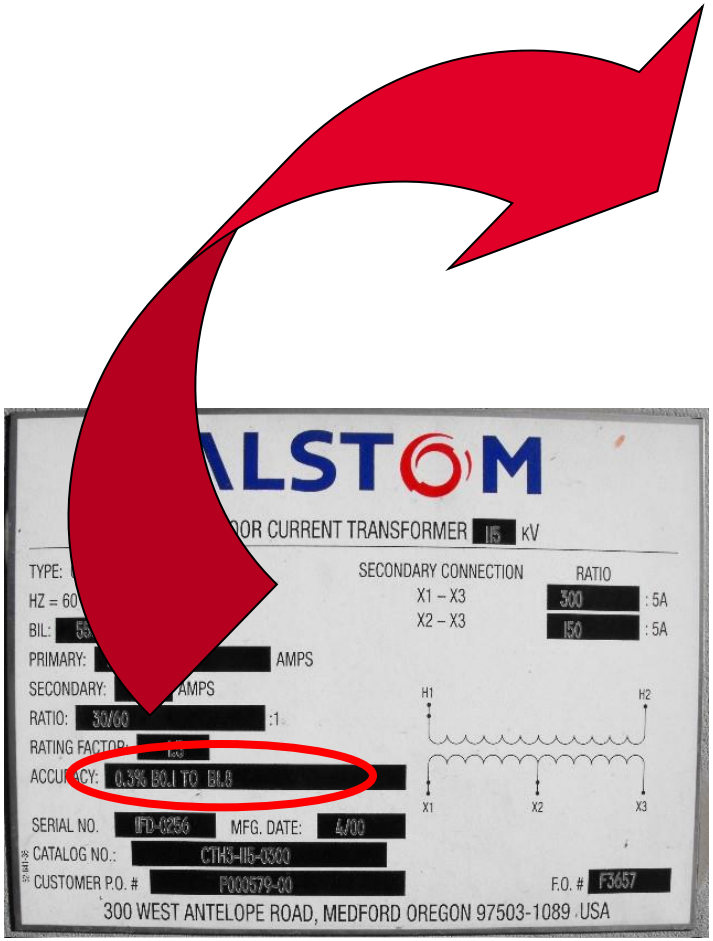

Example Burden Spec:
0.3% @ B0.1, B0.2, B0.5

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

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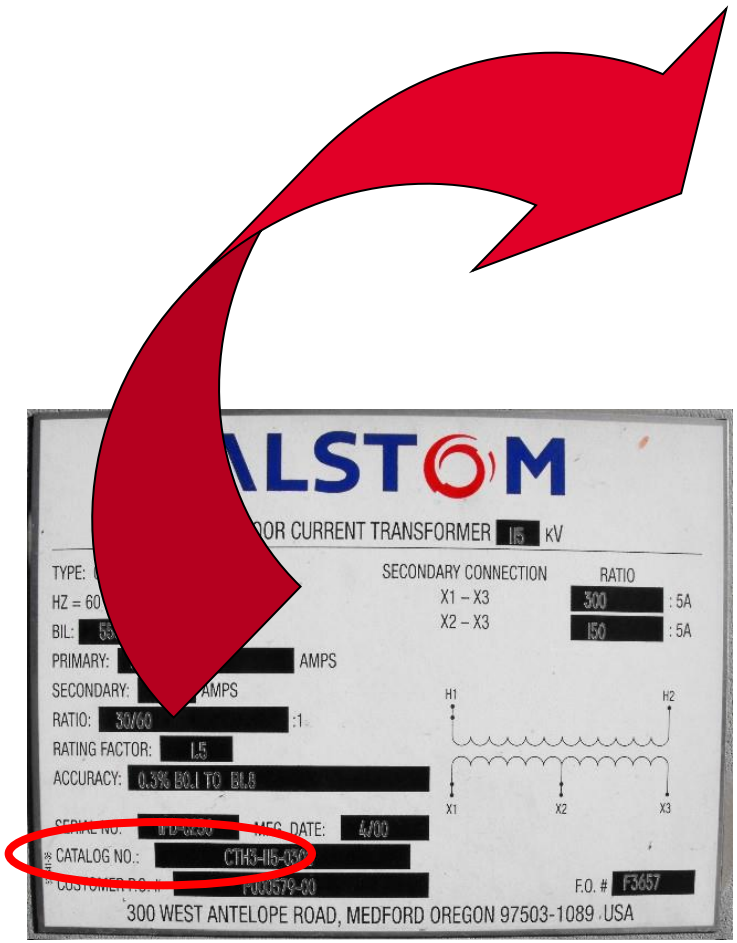
Functionality with Burden Present on the Secondary Loop

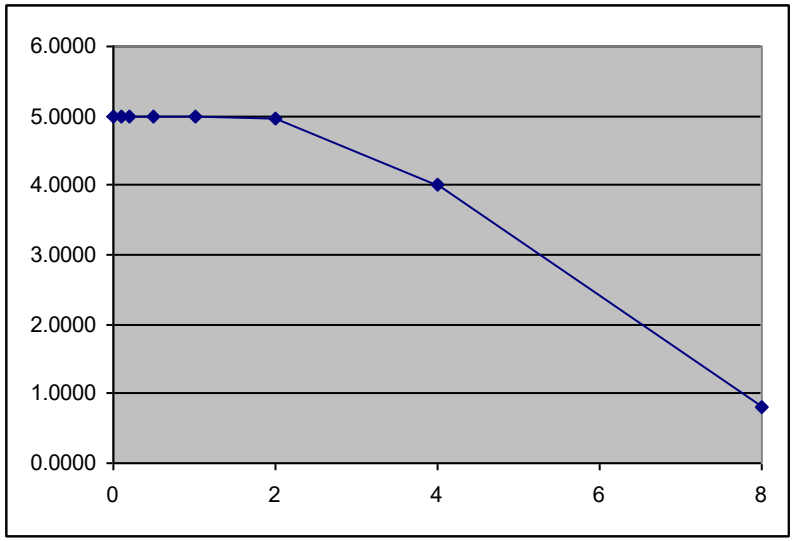


ANSI Burden Values

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

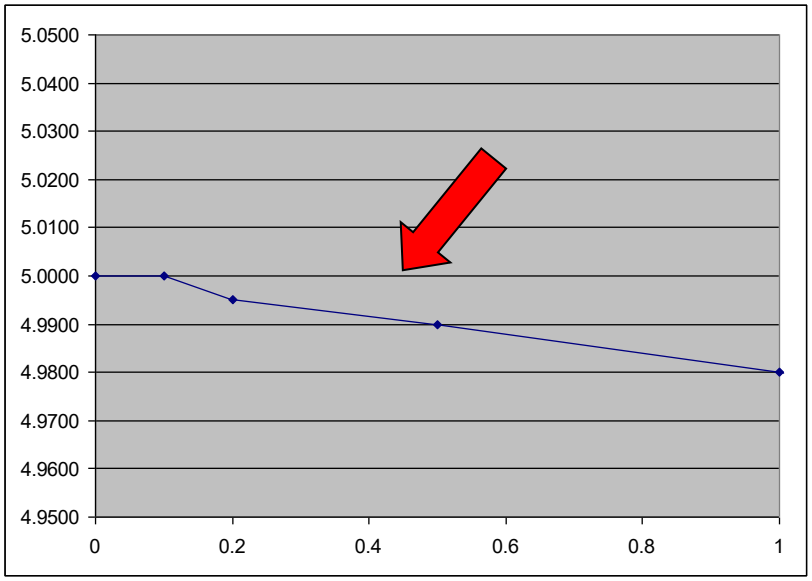


Initial Reading = 5Amps
0.3% x 5A = 0.015A
5A – 0.015 = 4.985A

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.

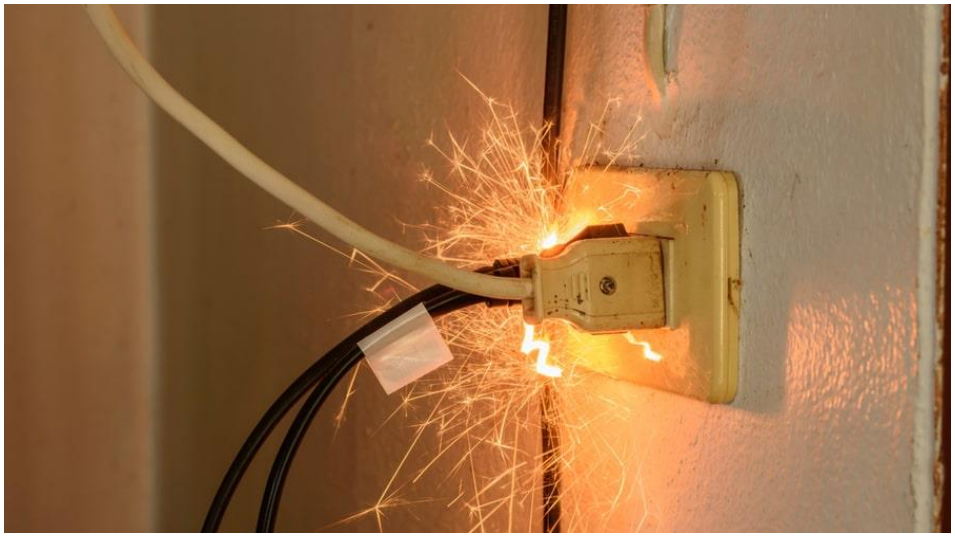
CT's can be demagnitized by slowly and smoothly increasing the secondary resistance until saturation occurs, and then slowly and smoothly decreasing the secondary resistance.

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

Fatal Electrical Injuries

- The highest rate of fatal electrical injury in 2019 occurred in the Construction industry (0.7/100,000), followed closely by the Utility industry (0.4/100,000).
- In 2019, there was one electrical fatality for every 33 fatalities from all causes. The long-term trend has declined from one electrical fatality for each 23 fatalities from all causes in 2003 to the 2019 level of one in 33.



Does Age Matter – Or Experience?

Fatal Electrical Injuries

- In 2019, 8% of all electrical injuries were fatal.
- By age group Fatalities tend to go down with age and experience (and perhaps a healthier respect for electricity).
    - 16 to 17 – 5.4 times as likely as the average worker to experience an electrical injury on the job site.
    - 18 to 19 years age group – 2.4 times
    - 20 to 24 years age group - 1.8 times
    - 25 to 34 years age group - 1.5 times
    - 35 to 44 years age group – 1.1 times, and;
    - those 45 years and up are at or below the average frequency of electrical injury.

Non-Fatal Electrical Injuries

- The median number of days away from work for nonfatal electrical injuries was 9 in 2019.
- Electrical injuries are typically classified as burn or shock. For non-fatal injuries, electrical shock injuries were nearly triple the electrical burn injuries in 2019.
- The Utility industry rate of nonfatal electrical injury involving days away from work (0.9/10,000) surpassed the Construction industry rate (0.7/10,000) in 2016.
- The Mining industry had rate of nonfatal electrical burn injury of 1.0/10,000 for 2016, followed by the Utility industry (0.9) followed by the construction industry (0.4). The rate for all of Private industry remained consistent at 0.1.

How Dangerous is Metering?

Electricity is Organized Lightning – George Carlin

Any Voltage without current will not kill you, but any voltage with current can kill you.

How Dangerous is Metering?

SAFETY FIRST - PPE

Personal Protective Equipment

- Leathers
- Rubber Gloves
- Face Shield
- FR Clothing
- Safety Shoes

ARC FLASH

What is Arc Flash?

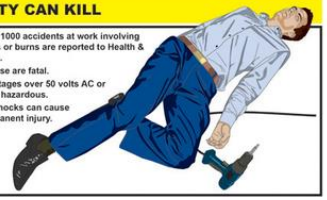
While an arc flash is sometimes used interchangeably with “arc fault”, an arc flash is more accurately defined as the light produced during an arc fault. An arc fault is a type of electrical fault that results from the breakdown of an insulating medium between two conductors where the energy is sufficient to sustain an arc across the insulator (often air) and can cause extreme amounts of light (arc flash), immense heat upwards of 19,000 degrees C, and a resulting explosive pressure wave (arc blast). These forces combine to create a hazardous condition that can vaporize metal, destroy equipment, and pose a significant hazard to anyone in the vicinity.

COVERING THE BASICS

More of the Basics

Electrical Safety

ELECTRICITY CAN KILL



- Each year about 1000 accidents at work involving electrical shocks or burns are reported to Health & Safety Executive.
- Around 30 of these are fatal.
- Shocks from voltages over 50 volts AC or 120 volts DC are hazardous.
- Even non-fatal shocks can cause severe and permanent injury.

WHAT DO THE REGULATIONS REQUIRE?

The Health and safety at Work Act 1974 states that:

- Employers are responsible for ensuring the safety and health of their employees and the public, if they are at risk from work activities.

The Electricity at Work Regulations 1989 states that:

- Electrical systems must be constructed in a way that prevents danger.
- Employers, employees and the self-employed must maintain electrical systems as necessary to prevent danger.
- Employers, employees and the self-employed should carry out work on electrical systems in a manner that prevents danger.
- Electrical equipment used in hazardous environments must be constructed or protected to prevent it becoming dangerous.
- Only those with competent knowledge or experience or under adequate supervision should work with, or on, electrical equipment that could cause danger or injury.

The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 requires employers, and other people who are in control of work premises, to report:

- Work-related deaths
- Major injuries
- Certain 'dangerous occurrences'

For example an injury resulting from an electric shock or electrical burn leading to unconsciousness, resuscitation or admittance to hospital for more than 24 hours must be reported.

If electrical short circuits or overloads causing a fire or explosion, which results in the stoppage of the plant for more than 24 hours or has the potential to cause death, the event must be reported.

How to report?

- Online at www.hse.gov.uk/riddor completing the appropriate online report form.
- By Telephone only in the case of fatal and major injuries only. Call the Incident Contact Centre on 0845 300 9923.

ASSESSING THE RISKS

Risk assessment consists of 5 steps:

01. Identifying the hazards.
02. Deciding who might be harmed and how.
03. Evaluating the risks and deciding on precautions.
04. Recording your findings and implementing them.
05. Reviewing your risk assessment and updating it if necessary.

Most common risks come from:

- Contact with live parts.
- Electrical faults, the risks are greatest where the equipment contains a heat source.
- Flammable or explosive atmospheres.
- Harsh conditions where unsuitable equipment can easily become live and make its surroundings live and dangerous.
- Confined spaces, where, if an electrical fault develops it will be difficult to avoid a shock.
- Equipment such as extension leads and flexible leads which are particularly liable to damage.

PORTABLE APPLIANCE TESTING (PAT)

PAT is the examination of electrical appliances and equipment to ensure they are safe to use as some types of defect can only be found by testing.

The Electricity at Work Regulations 1989 require that any electrical equipment that has the potential to cause injury is maintained in safe condition.

There are no specifications in the regulations on what needs to be done, by whom or how frequently. The frequency of inspection and testing depends upon the type of equipment and the environment it is used in.

Testing should be conducted by a competent person with appropriate equipment and the knowledge to carry out the tests and to understand the results.

Labeling equipment that has been inspected or tested as well as keeping records is not a legal requirement but can be a useful management tool for monitoring and reviewing the maintenance scheme.

REDUCING THE RISKS FOR EMPLOYERS

Ensure people working on or with electrical equipment or systems are 'competent' for the task.

Ensure the electrical installation

- Complies to BS 7671:2008 Requirements for electrical installations.
- Is maintained in a safe condition.

Enough socket outlets are provided.

Provide safe and suitable equipment

- Equipment must be suitable for its working environment.
- Consider using air, hydraulic or hand-powered tools in harsh conditions.
- Provide a switch near each fixed machine to cut off power in an emergency.
- Replace damaged sections of cable completely.
- Special electrical equipment should be used in potentially flammable or explosive atmospheres.
- Consider asking for specialist advice.

Reduce the voltage

- Temporary lighting can be run at lower voltages.
- Battery-operated tools are safest.
- Portable tools designed to be run from a 110 volt centre-tapped-to-earth supply are available.

Provide a safety device, such as a residual current device (an RCD), if equipment operating at 230 volts or higher is used. An RCD is a device which detects some faults in the electrical system and rapidly switches off the supply.

A competent person should carry out preventative maintenance periodically.

REDUCING THE RISKS FOR EMPLOYEES

Visual inspection should also be done by employees.

Work safely

- Suspect or faulty equipment must be taken out of use, labeled 'DO NOT USE' and kept secure until examined by a competent person.
- If possible, tools and power socket outlets should be switched off before plugging in or unplugging.
- Equipment should be switched off and/or unplugged before cleaning or making adjustments.

Always expect that cables will be present and live when digging in the street, pavement or near buildings.

Have overhead electric lines switched off if possible or maintain safe working distance from the lines.

The line or track operating company must be consulted before starting work near electrified railways or tramways.

The information contained in the poster is for guidance only and should not be used as a substitute for recognised training.

A623(V1)

How Bad Can Things Get?

Many thanks to Dominion Power

https://youtu.be/2Xoyb9M5-EA

Rubber Gloves and FR 4:10

Meter enclosure – shorted out 10:48

Thanks to Meter Grabber

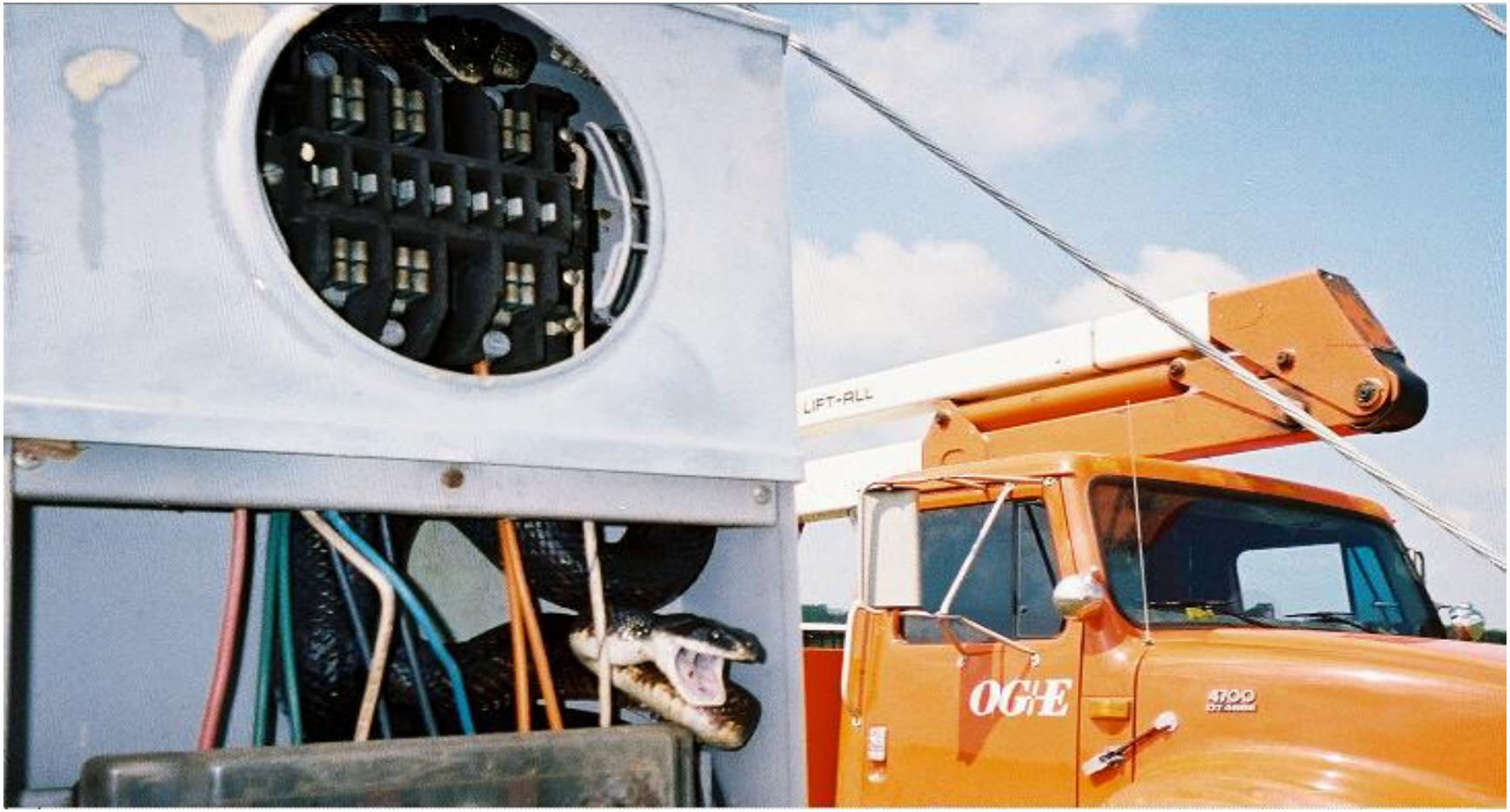
https://youtu.be/Azuu8VnM36g

Field Audits, Trouble Shooting and Testing

- Always approach an electrical service with caution and while wearing your full PPE. Why?
- Never stand directly in front of the meter when removing the meter
- Before you even open the box or get the cover off….
    - Live box
    - Bees
    - Other live animals
- Broken Seal
- Cover dropping off

Field Audits, Trouble Shooting and Testing 2

Field Audits, Trouble Shooting and Testing 3



Once the box is Open: Issues to Look For

- Open line – open line side connection to the meter socket.
- Missing neutral – missing neutral connection to the center lug in the meter socket
- Cross phase condition – cross wiring between the test block and the meter socket.
- Hidden jumpers line to load – diversion on both legs.
- Dead Short - dead short phase to ground on the load side of one leg of the socket.
- Partial Short - partial short phase to ground on the load side of one leg of the socket

Backfeed, Ground Fault and other Issues to Look For

- Back fed meter socket
- Ground fault
- Phase to phase fault
- Pulling a meter jaw with the meter

Tools

- Socket Pullers
- Volt meters
- Specialized tools

TOOLS

- Temporary Service Cover

SUMMARY

- Be Careful
- Assume the box is live
- Assume there is something live in the box
- Treat electricity with respect
- Treat all meter boxes with respect

AROUND THE ROOM

- Issues that you may have seen in your metering career already?
- Safety Issues not yet brought up?

Closing

- Are you not only following the rules but actively making suggestions?

MOST IMPORTANTLY…

We test and verify the sites to make sure we are not losing money and to make sure the sites are safe.

QUESTIONS AND DISCUSSION

Perry Lawton
Northeastern Regional Sales Manager
perry.lawton@tescometering.com

TESCO – The Eastern Specialty Company

Bristol, PA

215.228.0500

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

ISO 9001:2015 Certified Quality Company
ISO 17025:2017 Accredited Laboratory