TESCO METERING

The Benefit of High Accuracy, Extended Range CTs

TESCO's Meter School
TESCOOL
July 21-24, 2024

July 24, 2024
8:45 AM – 10:15 AM
Matt Green and Jonathan Clark

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WHERE WOULD YOU USE HIGH ACCURACY CT'S?

Inside of…

Generator

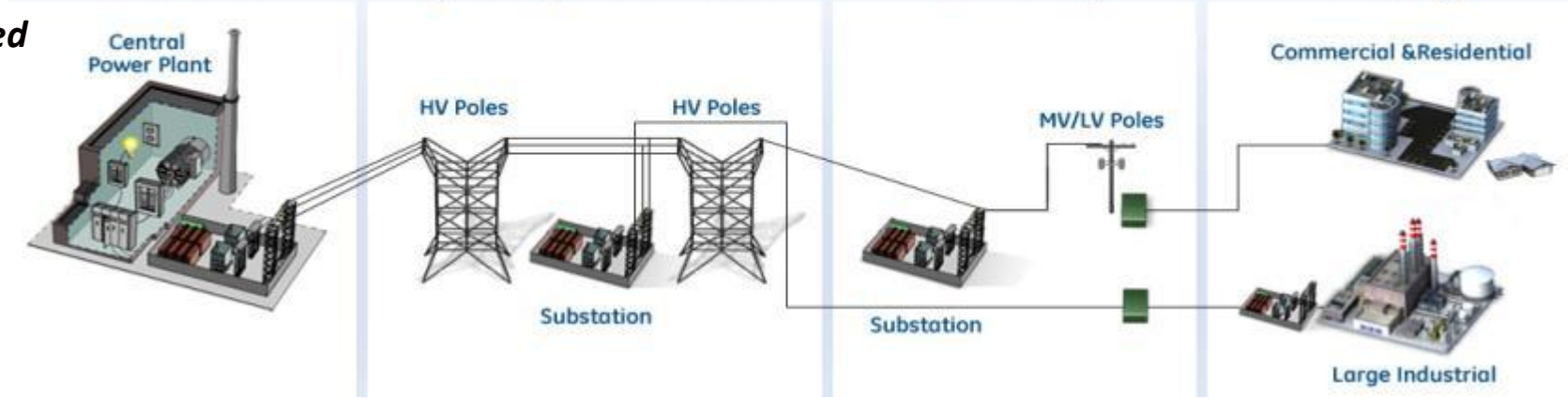
Transformers

Transformers

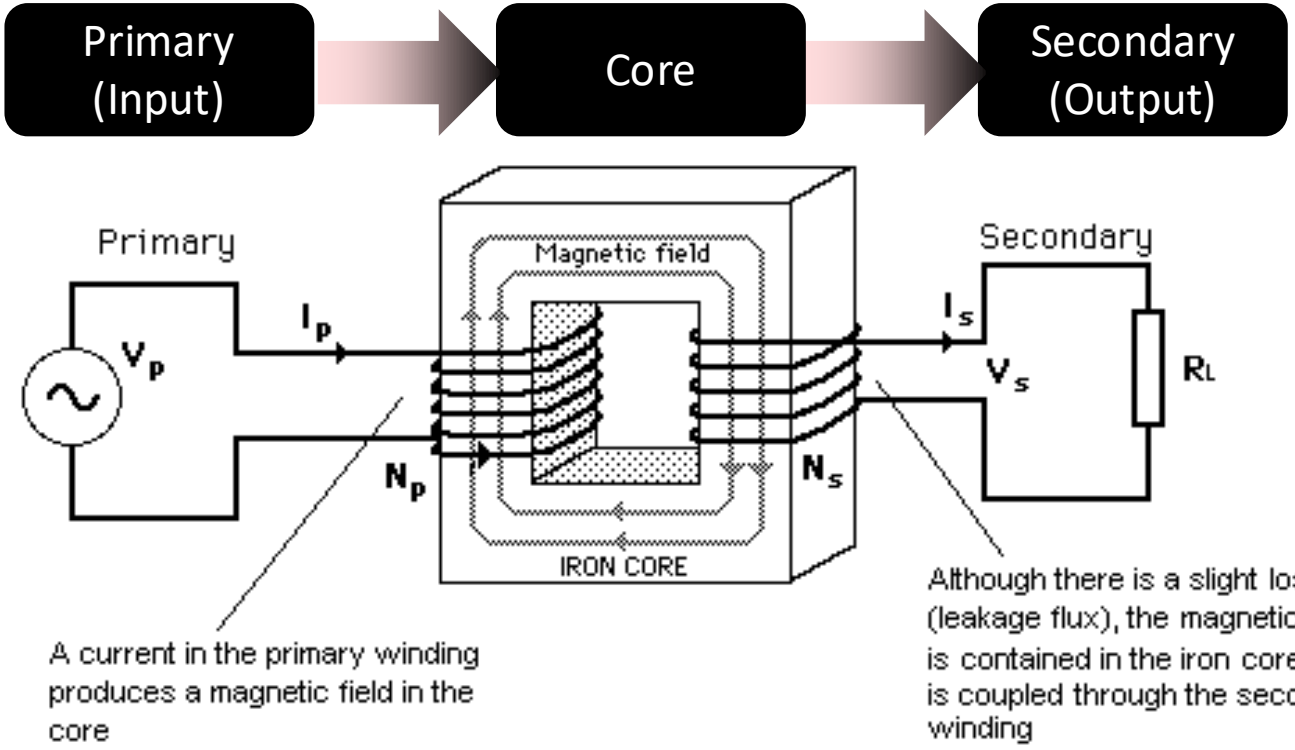
Switchgear

Metering Panels
LV Switchgear, MCC's

Installed at…



CURRENT TRANSFORMERS



Transform the voltage or current input into a standard 5 or 1 amp output

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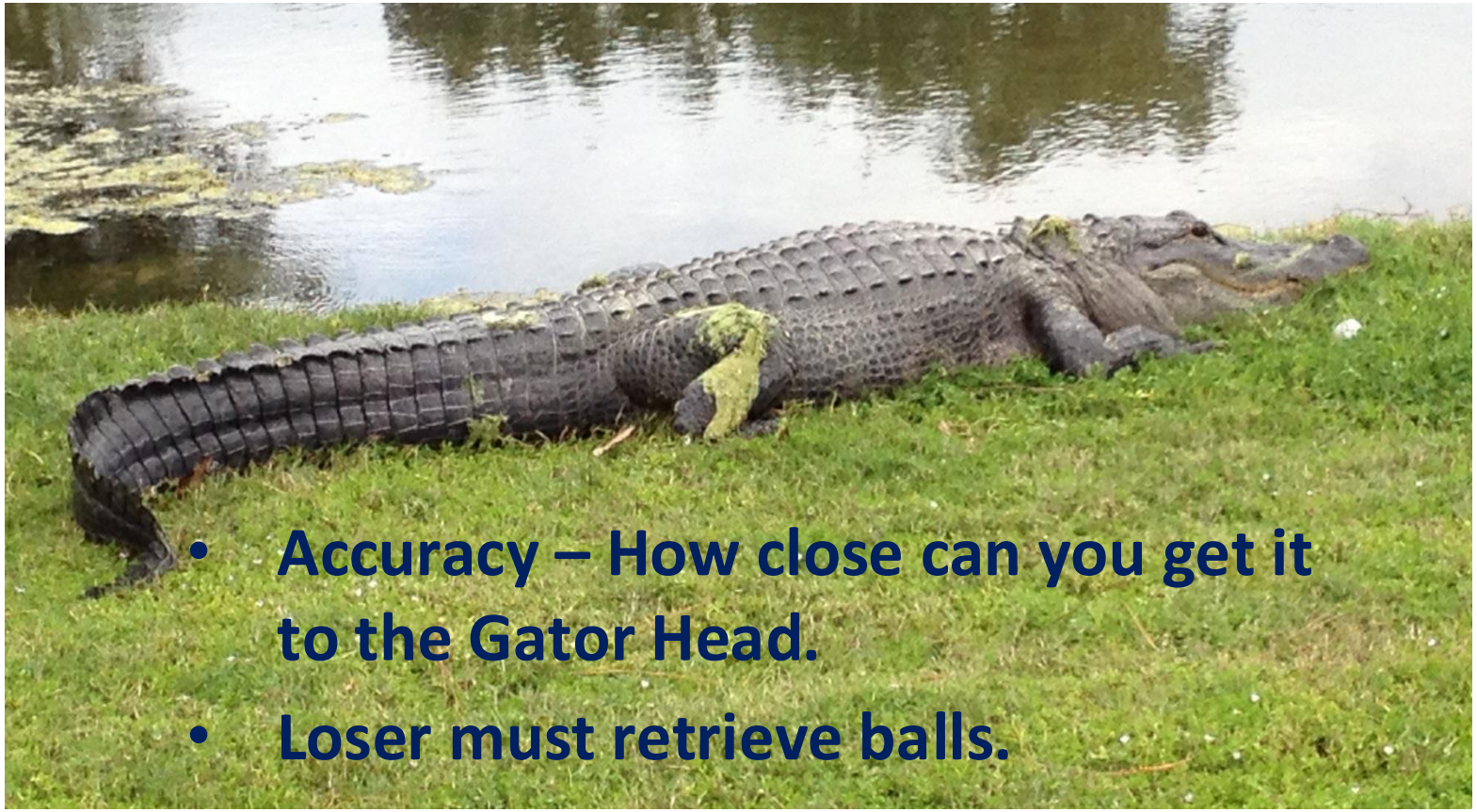

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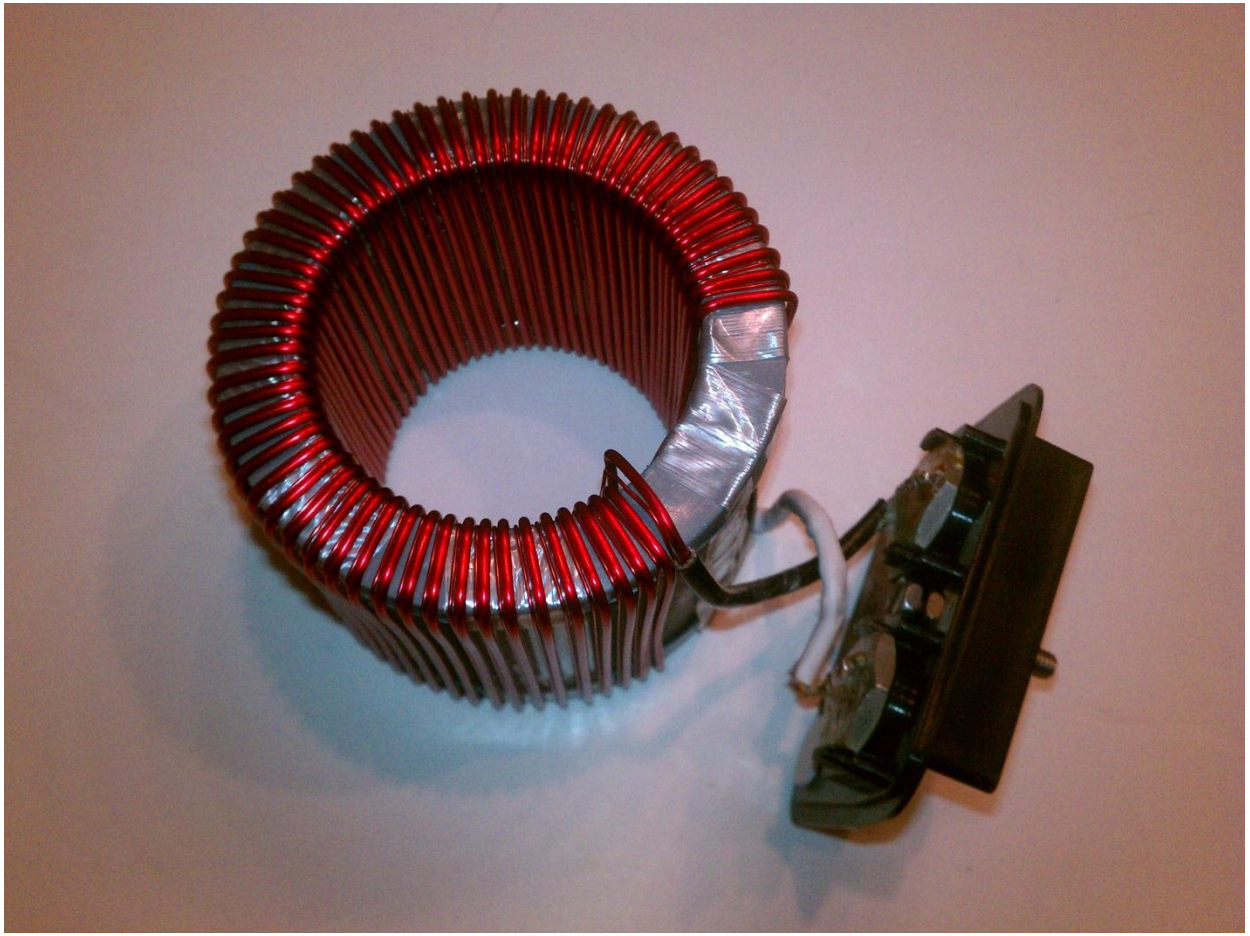
What Impacts Accuracy?



- Number of Secondary Turns
- Core material and/or cross section
- Secondary Burden

Energy Required to Energize the Core

$$\text{mmf} = \phi \Re = k_1 \left[\frac{Z_S I_S}{N_S f} \right] k_2 \left[\frac{\text{mmp}}{A_C \mu_C} \right] = k_1 k_2 \left[\frac{Z_S I_S \text{ mmp}}{N_S f A_C \mu_C} \right]$$

ϕ = flux in the core
$\Re$ = magnetic reluctance
k_1 = constant of proportionality
k_2 = constant of proportionality
Z_S = secondary impedance
mmp = core mean magnetic path
I_S = secondary current
A_C = core cross-sectional area
N_S = number of secondary turns
μ_C = permeability of core material
f = frequency, Hz

If ↑ Secondary turns or core cross section

↓ secondary impedance

Then ↓ energy required to energize core

Courtesy of Electric Power Transformer Handbook

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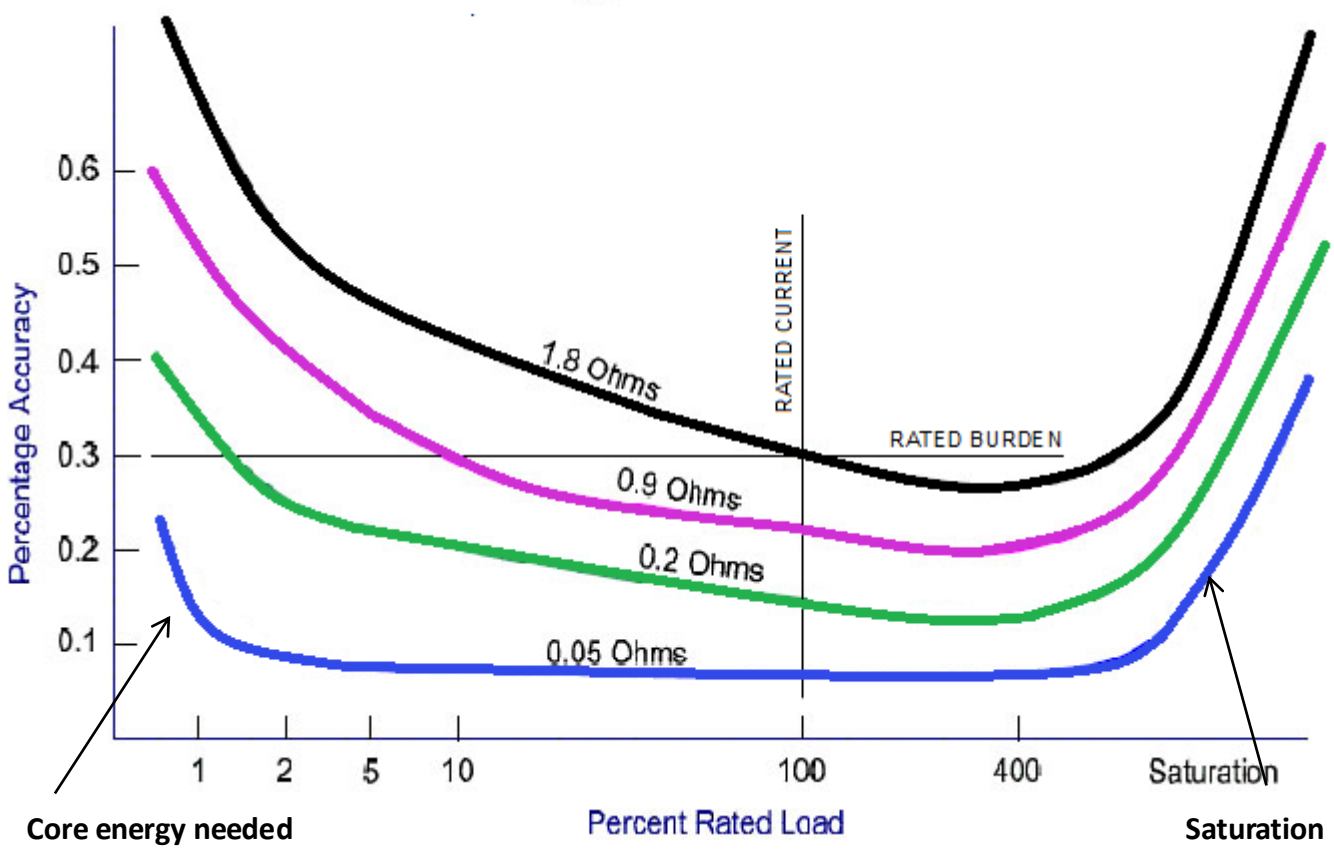
CT—ACCURACY—BURDEN — LOAD



Graph: Bill Hardy – TESCO

CT METERING ACCURACY

Actual secondary current ≠ **Rated** secondary current

Difference in % is known as the
"Accuracy"
of the CT

Definition: There are two sources of error in instrument transformers, namely ratio error and phase angle error. In a given transformer, the metering error is the combination of the two separate errors. This combination is called Transformer Correction Factor (TCF), IEEE has established accuracy classes for both current and potential transformers. The limit of permissible error in a potential transformer for a given accuracy class remains constant over a range of voltage from 10% below to 10% above rated voltage

Ratio Correction Factor (RCF)

IEEE C57.13 Terminology

RCF = True Ratio / Marked Ratio

Example: 500:5 CT

By test, CT Ratio = 100.1

RCF = 100.1 / 100 = 1.0010

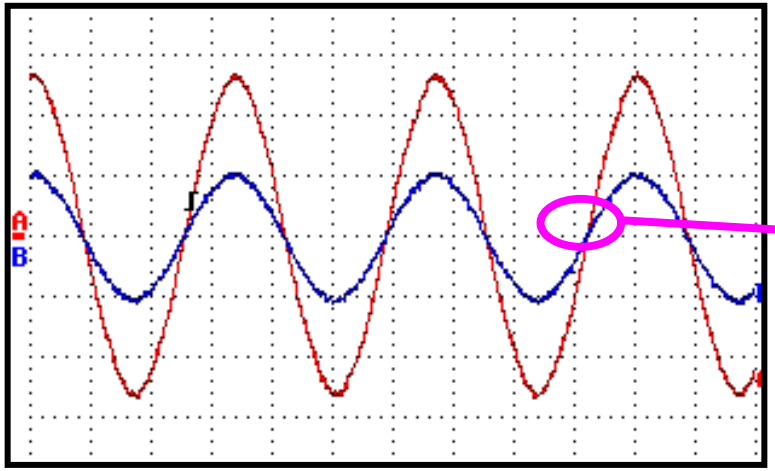
What does this mean? How many amps is the meter seeing?

A. – With 500A through primary, only 4.995A is flowing on the secondary 4.995 x 1.001 = 5A. (Negative current error due to losses)

RATIO CORRECTION FACTOR (RCF)

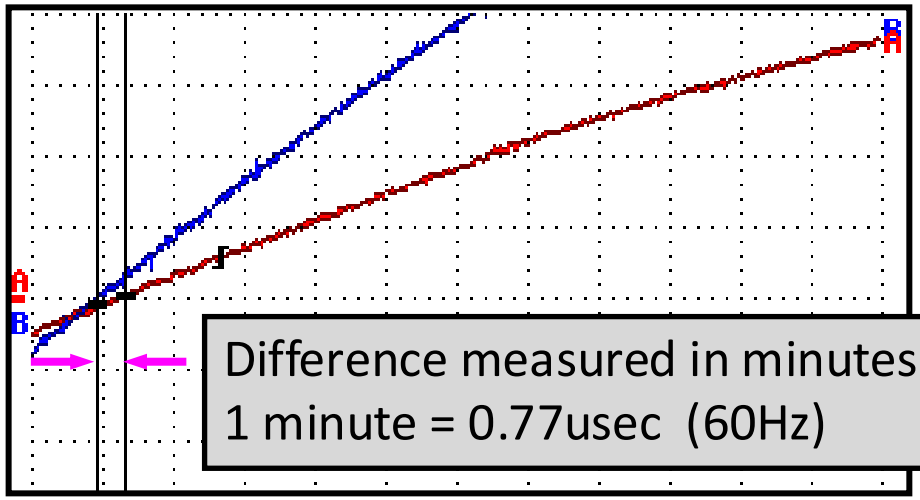
RCF on Knopp Comparator

Phase Error



Red = Primary Current
Blue = Secondary Current

When Secondary Current (blue) **leads** the Primary Current (red), Phase Error (⍰) is defined as **Positive**.



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PHASE ERROR

Phase Error on Knopp Comparator

CT PARALLELOGRAM

IEEE STD. C57.13 LIMITS OF ACCURACY CLASS FOR CURRENT TRANSFORMERS FOR METERING 0.3 ACCURACY CLASS

Recall the Knopp Comparator

The values were:

- Ratio Error = 1.00278
- Φ Angle Error = 5.2

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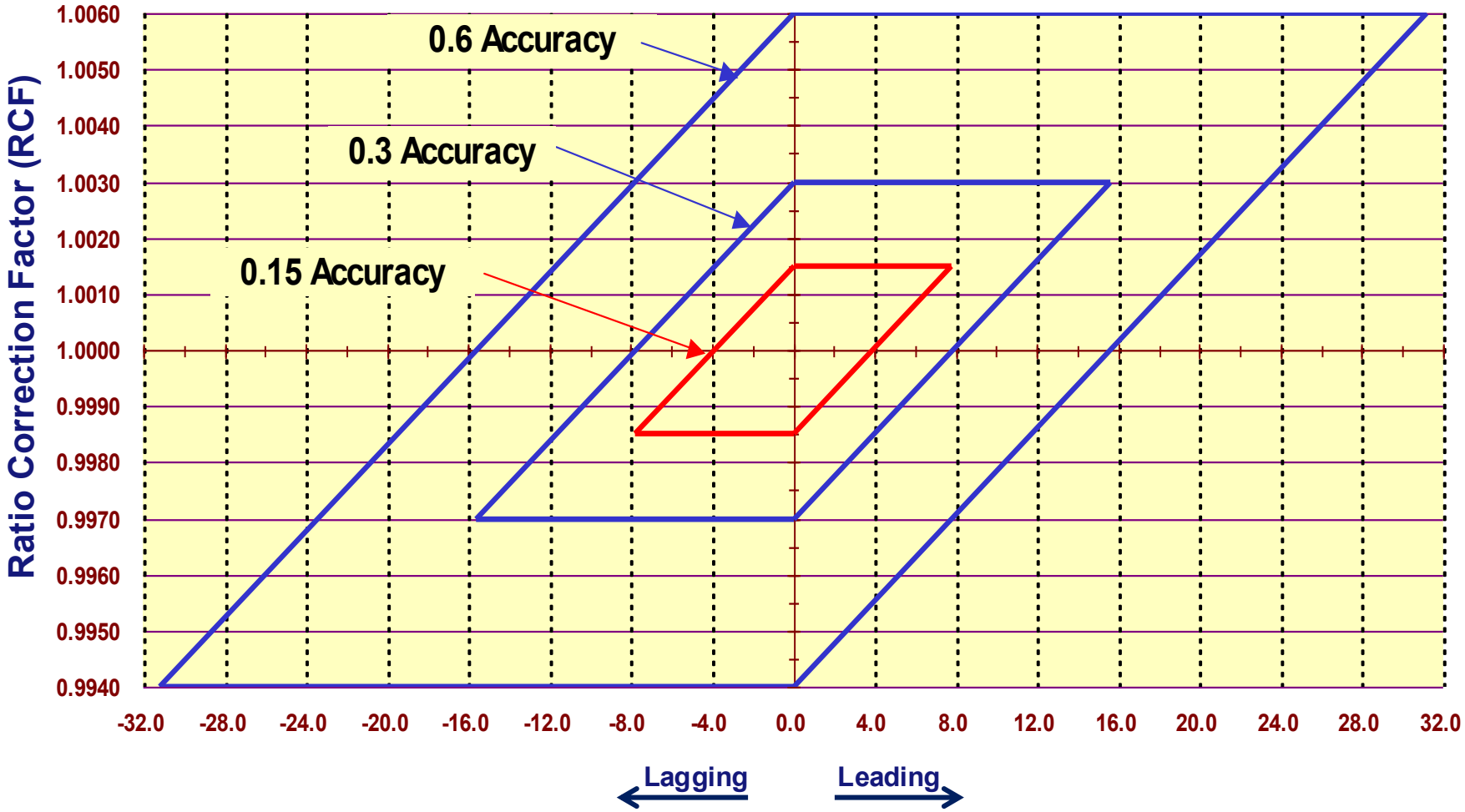
CT PARALLELOGRAM
IEEE C57.13 – ACCURACY LIMITS



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Accuracy Class Definitions

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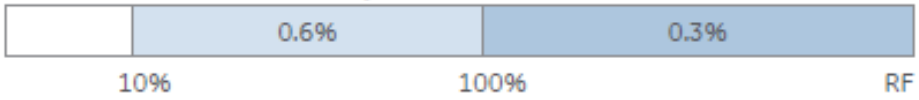
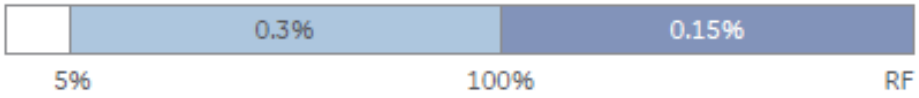
IEEE Metering Class

There are three revenue grade metering classes defined by IEEE C57.13-2008 and C57.13.6-2004. These are illustrated below, with limits shown as a percent of rated CT current:

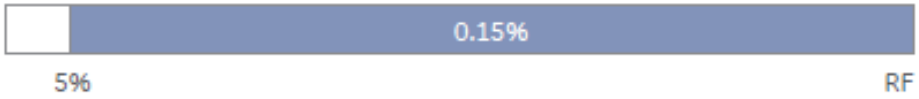
0.3 Class - Standard Accuracy



0.15 Class – High Accuracy



0.15S Class – Special High Accuracy

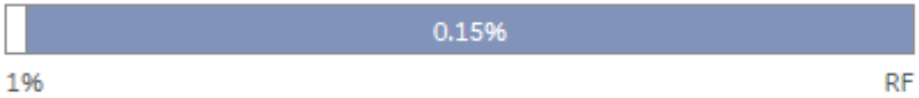


Encompass & RevenueSense Exceed IEEE Standards

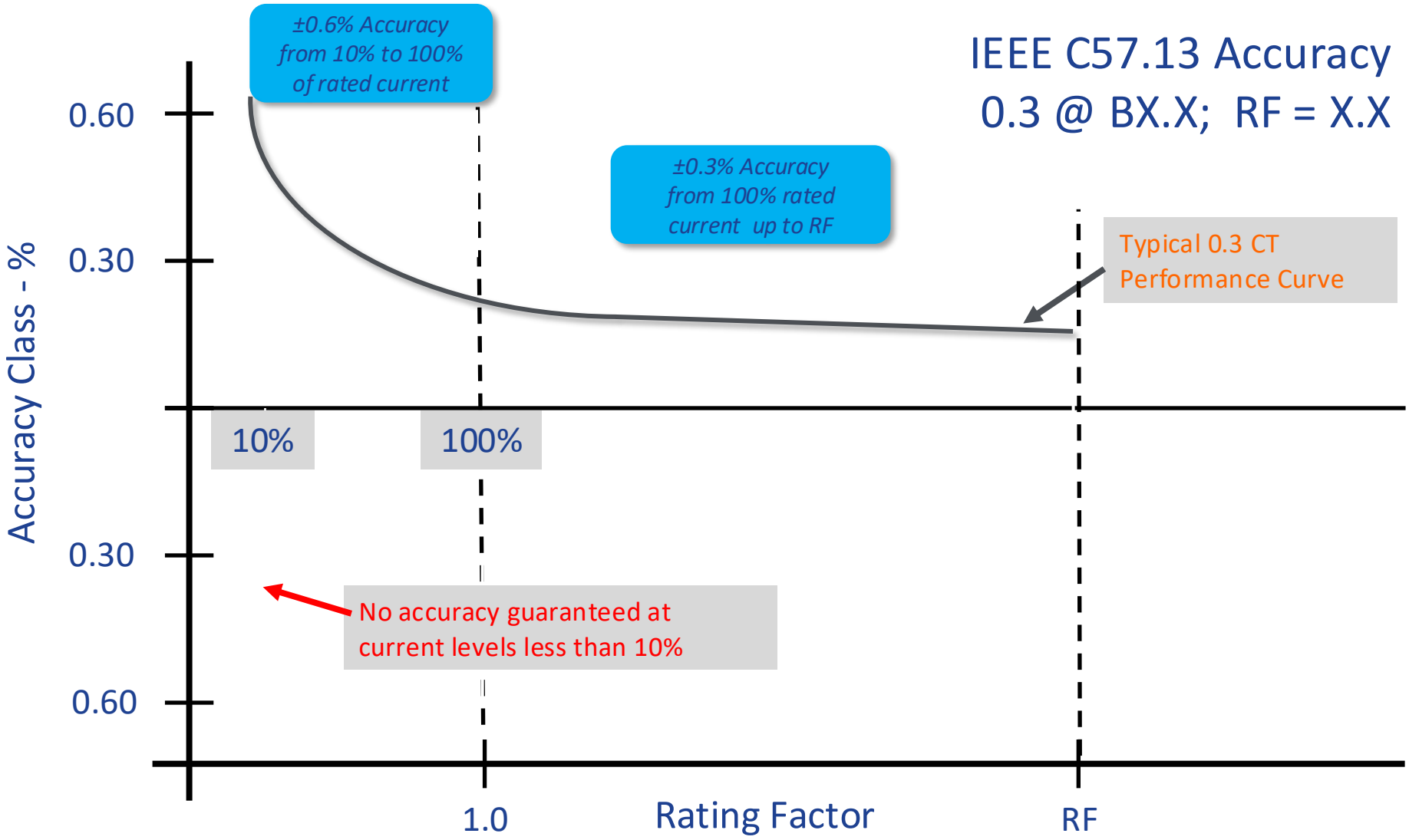
Encompass and RevenueSense redefine CT performance by exceeding the operating range within their respective IEEE accuracy classes, offering utilities additional flexibility to reduce inventory, part numbers, and billing multipliers. RevenueSense also allows for a further reduction of metering losses by extending high accuracy performance down to 1% of rated current.

GE Encompass – Standard Accuracy with Extended Range

GE RevenueSense – Special High Accuracy with Extended Range



STANDARD 0.3 ACCURACY CLASS



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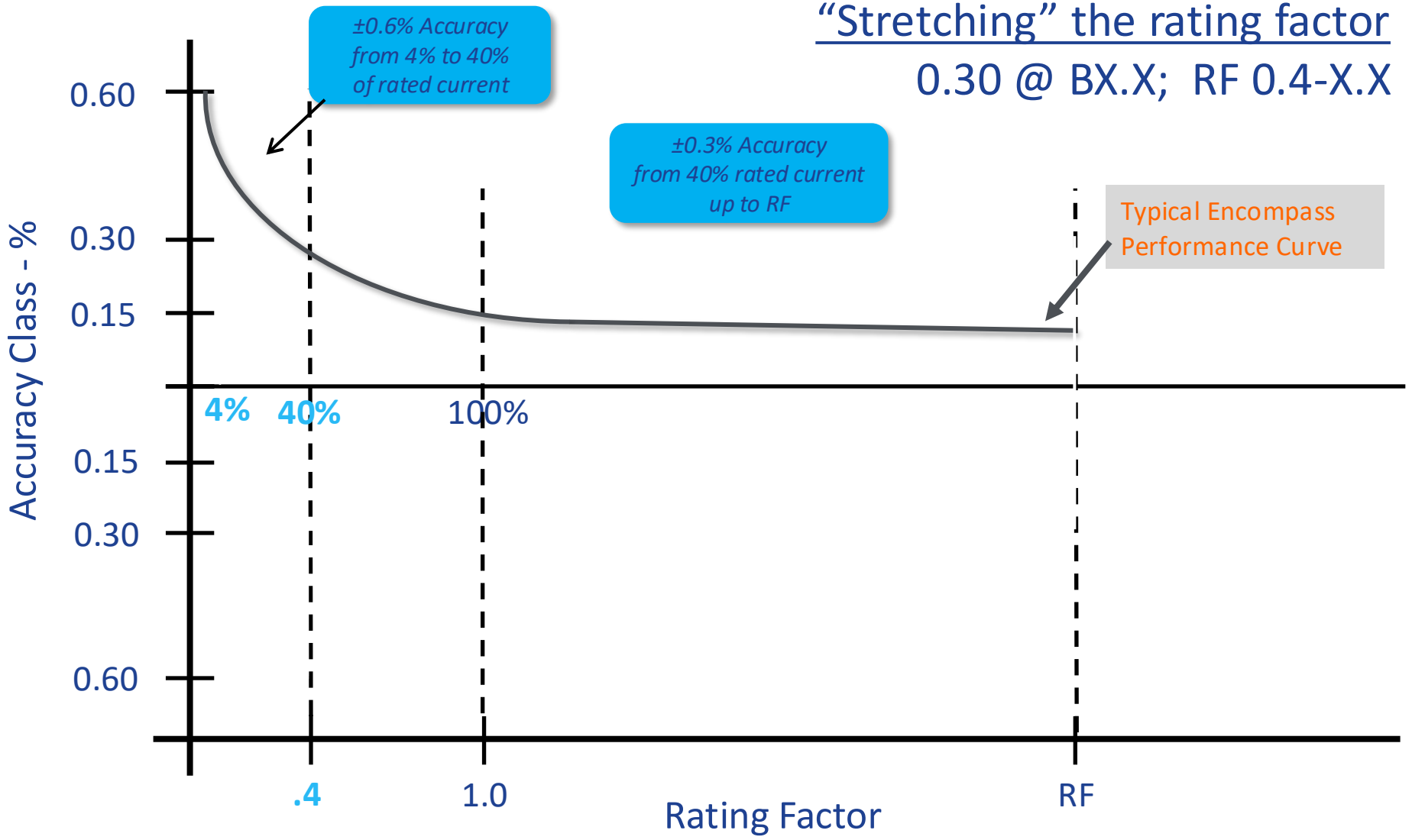
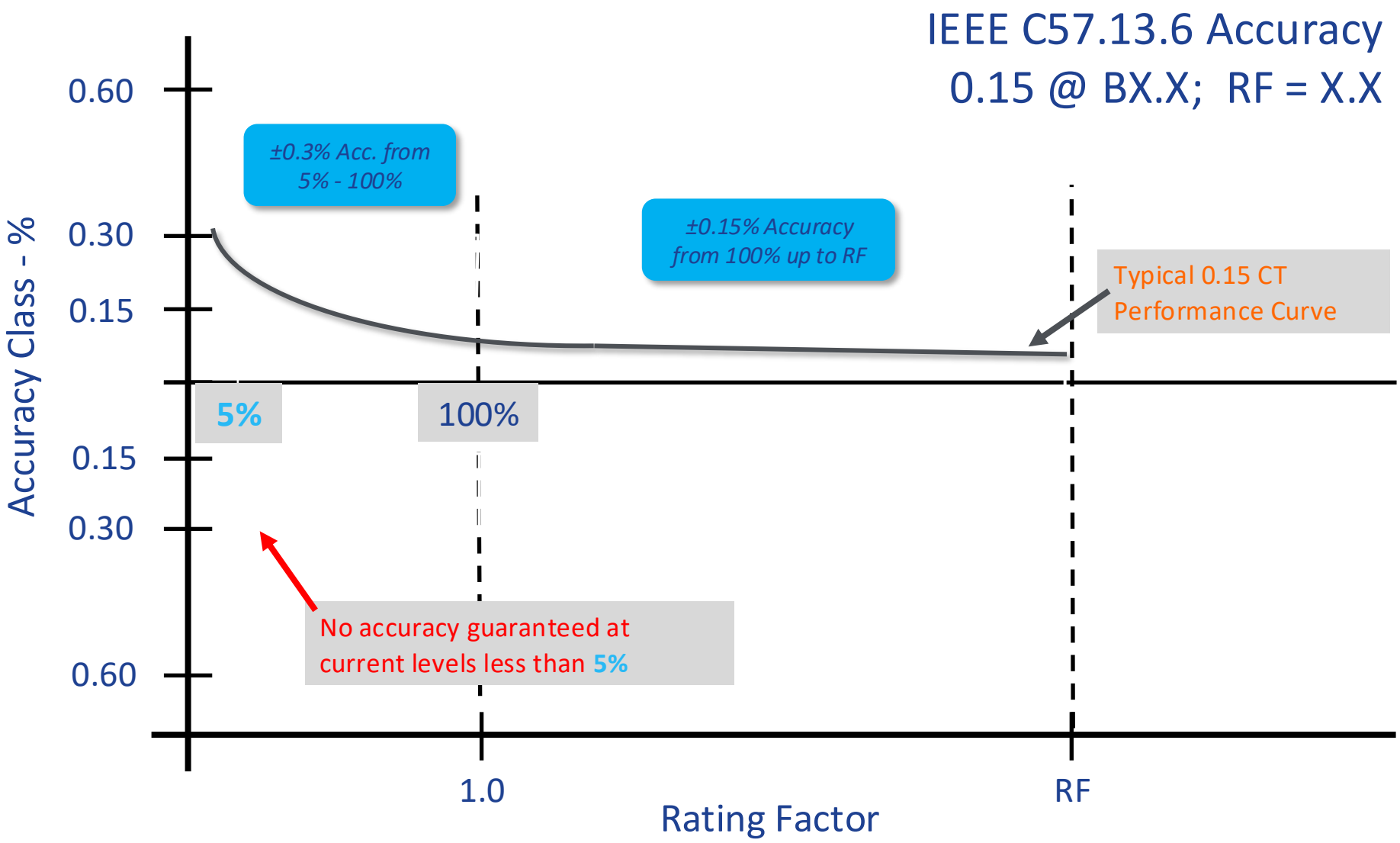
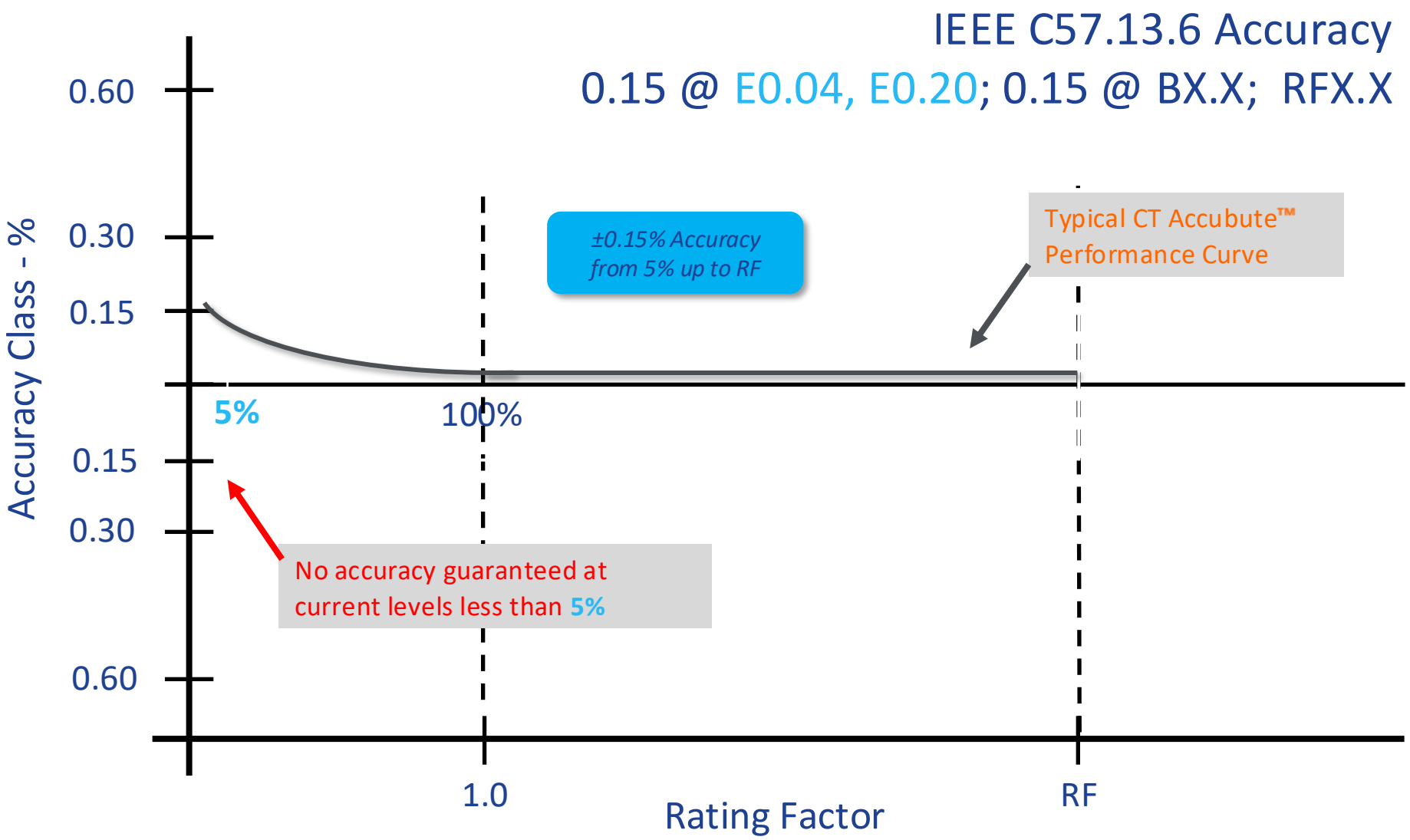
ITI ENCOMPASS



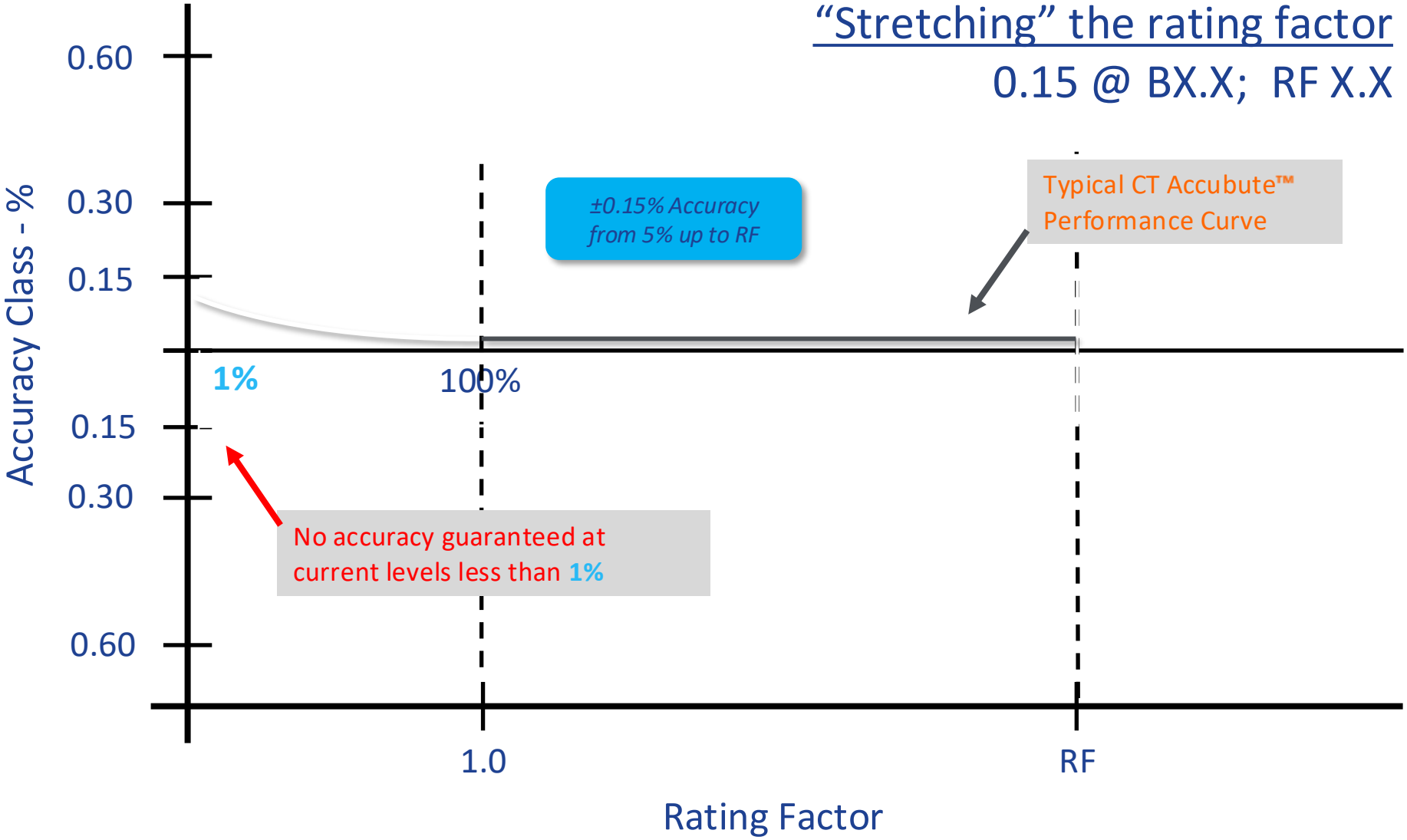
0.15 High Accuracy Class



0.15S Special High Accuracy (Accubute)



0.15S High Accuracy Extended Range



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DEFINITIONS

•Standard Revenue Metering Accuracy (IEEE 0.3 Accuracy Class)

•± 0.3% accurate from 100% Nameplate Rating, up to Rating Factor

•± 0.6% accurate below 100% Nameplate Rating, down to 10% of Nameplate Rating

•GE ITI Encompass CT's

•± 0.3% accurate from 40% of Nameplate Rating, up to Rating Factor

•± 0.6% accurate below 40% Nameplate Rating down to 4% of Nameplate Rating

•High Accuracy (IEEE 0.15 Accuracy Class)

•± 0.15% accurate from 100% Nameplate Rating, up to Rating Factor

•± 0.3% accurate below 100% Nameplate Rating, down to 5% of Nameplate Rating

•GE Somersworth Accubute™ (IEEE 0.15S Accuracy Class)

•± 0.15% accurate from down to 5% of Nameplate Rating, up to Rating Factor

•GE RevenueSense High Accuracy Extended Range (IEEE 0.15S Accuracy Class)

•± 0.15% accurate from down to 1% of Nameplate Rating, up to Rating Factor

UTILITY METERING CTS: WHAT DO I NEED TO KNOW

B - Burden

R - Ratio

A - Accuracy

V – voltage class

E – Etc (window size, special requirements)

R – Rating Factor

Revenue metering application

NAME PLATE INFORMATION: BURDEN

Definition: Load connected to CT secondary

- Includes devices & connecting leads
- Expressed in ohms
- Standard values = B0.1, B0.2, B0.5, B0.9, B1.8
  E0.04, E0.2

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STANDARD CT BURDENS

Standard IEEE CT Burdens (5 Amp)
(Per IEEE Std. C57.13-1993 & C57.13.6)

Application	Burden Designation	Impedance (Ohms)	VA @ 5 amps	Power Factor
Metering	B0.1	0.1	2.5	0.9
	B0.2	0.2	5	0.9
	B0.5	0.5	12.5	0.9
	B0.9	0.9	22.5	0.9
	B1.8	1.8	45	0.9
	E0.2	0.2	5	1.0
	E0.04	0.04	1	1.0

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STANDARD ACCURACY
EXTENDED RANGE

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LOW VOLTAGE ENCOMPASS™ SERIES

System Current	20A	40A	60A	80A	100A	200A	400A	600A	800A	1000A	1200A	1400A	1600A	1800A	2000A
200:5 JAK-0C (Rating Factor 4.0)	±0.6% Accuracy					±0.3% Accuracy									
400:5 JAK-0C (Rating Factor 4.0)			±0.6% Accuracy				±0.3% Accuracy								
1000:5 JAK-0C (Rating Factor 2.0)						±0.6% Accuracy				±0.3% Accuracy					
500:5 JAK-0W Encompass™ (4% to 400%)	±0.6% Accuracy					±0.3% Accuracy									

One Encompass CT offers equal to, or better accuracy class over the range of multiple legacy CT's

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HIGH ACCURACY EXTENDED RANGE

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LOW VOLTAGE REVENUESENSE™ SERIES

System Current	6A	20A	40A	60A	80A	100A	200A	400A	600A	800A	1000A	1200A	1400A	1600A	1800A	2000A
200:5 JAK-0C (Rating Factor 4.0)		±0.6% Accuracy					±0.3% Accuracy									
400:5 JAK-0C (Rating Factor 4.0)			±0.6% Accuracy					±0.3% Accuracy								
1200:5 JAK-0C (Rating Factor 1.5)								±0.6% Accuracy				±0.3% Accuracy				
600:5 JAK-0S High Revenue Sense (1% to 300%)	**±0.15% Accuracy**															

- One RevenueSense™ CT improves accuracy over the range of multiple legacy CT's, with significant improvement at low currents

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PRODUCT LINE SUMMARY

Encompass

Size	Mini	Intermediate	Padmount*	Large
Model	JCR-0W	JAK-0W	JAB-0W	JAD-0W
Ratio	250:5 or 500:5	500:5	500:5 or 1500:5	1000:5 or 1500:5

**Hi Temp available*

RevenueSense


Size	Mini	Intermediate	Padmount*	Large
Model	JCT-0S	JAK-0S	JAB-0S	JAD-0S
Ratio	600:5	600:5 or 1000:5	600:5, 1000:5 or 2000:5	1200:5 or 3000:5

**Hi Temp available*

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FACTORS INFLUENCING CT ACCURACY

Current Ratio

"Low ratio" and "high accuracy" are not friends!!

Burden

"High burden" and "High Accuracy" are not friends!!

Physical Size

"Large windows, small cross-section"
and "High accuracy" are not friends!!

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SIZING CTS FOR METERING

- Use as low of a ratio as possible with the RF covering the maximum current level
- CT error is **almost** always negative
- Using a more accurate metering class will almost always result in higher revenue levels
- Burden adversely affects accuracy, the lower the applied burden, the better the accuracy performance

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THANK YOU FOR YOUR TIME

Questions and Discussion

Matt Green

Jonathan Clark

Alabama Power

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