Standard burdens vs modern electronic meter burdens for metering instrument transformers

Metering for billing department, HQ.

Benoît Garceau, ing.
29 août 2019

Hydro Québec

Summary

- Introduction;
- Burdens for current metering instrument transformer (Inductive CT);
- Burdens for voltage metering instrument transformer (Inductive VT);
- Impact of modern electronic meter voltage burden on accuracy;
- Conclusion.

Introduction

Introduction

- We (Hydro-Quebec) reviewed our internal standard for instrument transformer approval (F21-08), based on CSA 61869, IEEE C.57.13 and Measurement Canada S-E-07 standards.
- We introduced electronic burdens E-0.2, E-0.04, T and Q in our standard and type/routine test procedure.
- All our approved electronic meter that are meant to be used with instrument transformers are powered by the voltage transformer on one phase. We started to question whether this aspect was taken into account in international standards.

Burdens for metering current instrument transformer (Inductive CT)

Standard CT burdens for metering

IEEE StdC57.13-2016 – Table 10 / CSA 61869-2:14 Table 201C / SE-0-7 Table 1

Standard Burden	Resistance Ω	Inductance mH	Impedance Ω (60Hz)	Power VA (5A, 60Hz)	Power factor
E-0.04	0.04	0	0.04	1.0	1.0
E-0.2	0.20	0	0.20	5.0	1.0
B0.1	0.09	0.116	0.10	2.5	0.9
B0.2	0.18	0.232	0.20	5.0	0.9
B0.5	0.45	0.580	0.50	12.5	0.9
B0.9	0.81	1.044	0.90	22.5	0.9
B1.8	1.62	2.088	1.80	45.0	0.9

CT burden technical specifications

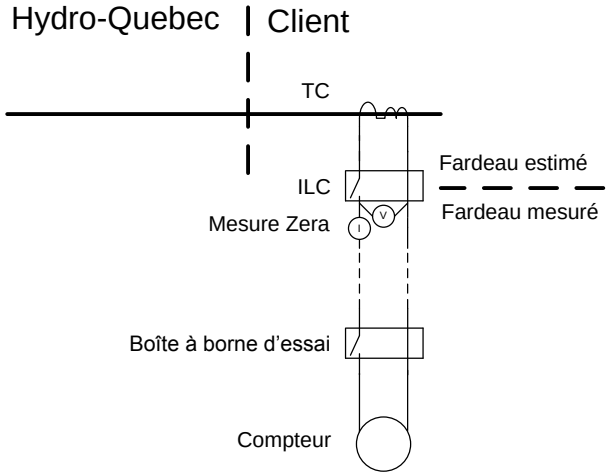
Technical specifications of analysed electronic meters :

Meter model	Current input resistance (Ω)*
A	0.002
B	0.00384
C	0.00008
D	0.0001
E	0.001
F	0.002

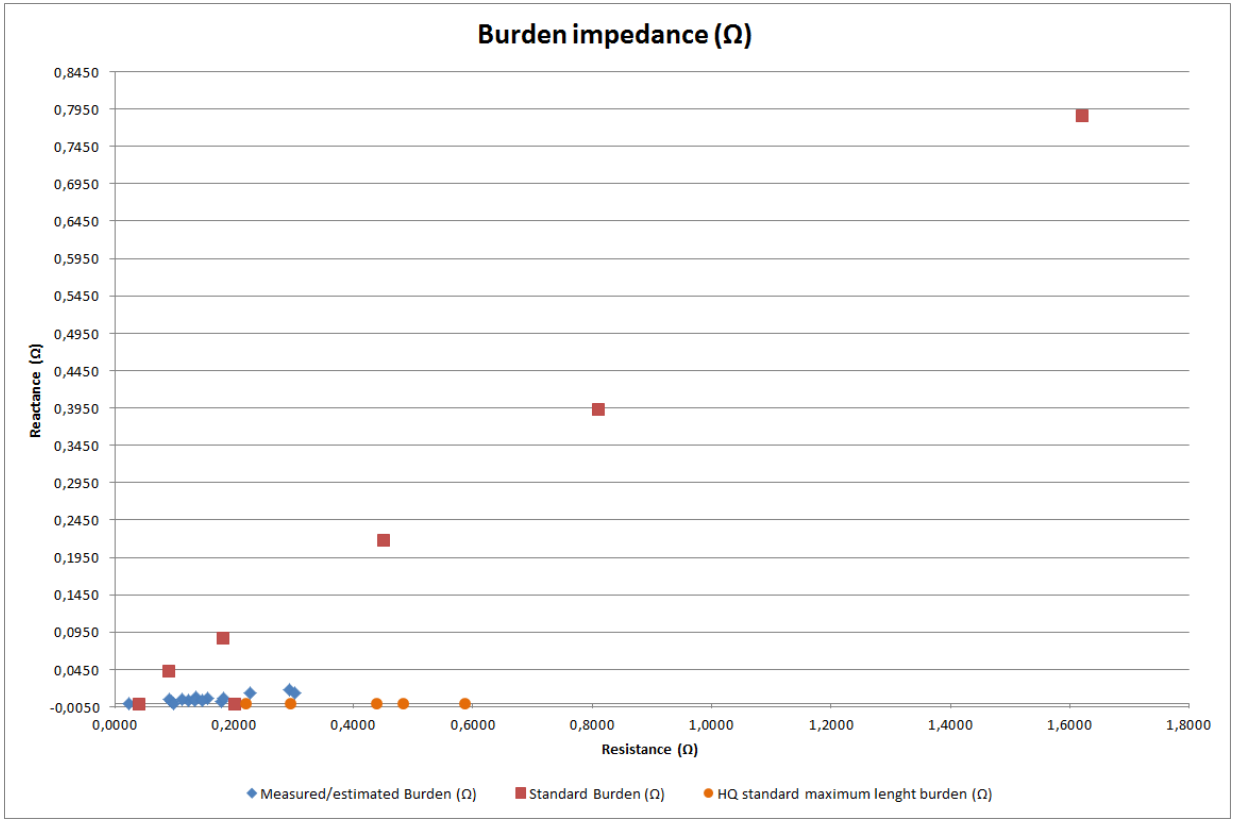
*Validated with micro-ohm meter

CT burden measurements

The burden comes mainly from the wiring. We conducted a study in 15 installations with different wiring length. To avoid customer measurement interruption, we measured at the first accessible terminal (ILC) after the CT with a portable burden meter and estimated the wiring part between CT and terminal (ILC).



CT burden measurements



CT burden measurements vs standard

- E-0.2 burden cover most of measured installations.
- Electronic Standard burdens impedance are similar to measured/estimated burdens in the field.

Burdens for metering voltage instrument transformer (Inductive VT)

Standard VT burdens for metering

IEEE StdC57.13-2016 – Table 19

Standard Burden	Resistance Ω	Inductance mH	Impedance Ω (60Hz)	Power VA (120V, 60Hz)	Power factor
W	115.2	3.0400	1152	12.5	0.10
X	403.2	1.0900	576	25.0	0.70
M	82.3	1.0700	411	35.0	0.20
Y	163.2	0.2680	192	75.0	0.85
Z	61.2	0.1010	72	200.0	0.85
ZZ	30.6	0.05040	36	400.0	0.85

CSA 61869-3 :14 Table 301C / SE-0-7:2016 Table 3

Standard Burden	Resistance Ω	Inductance mH	Impedance Ω (60Hz)	Power VA (120V, 60Hz)	Power factor
Q	14400.0	0.0000	14400	1.0	1.00
T	5760.0	0.0000	5760	2.5	1.00
W	115.2	3.0420	1152	12.5	0.10
X	403.2	1.0920	576	25.0	0.70
Y	163.2	0.2680	192	75.0	0.85
Z	61.2	0.1010	72	200.0	0.85
ZZ	30.6	0.0504	36	400.0	0.85

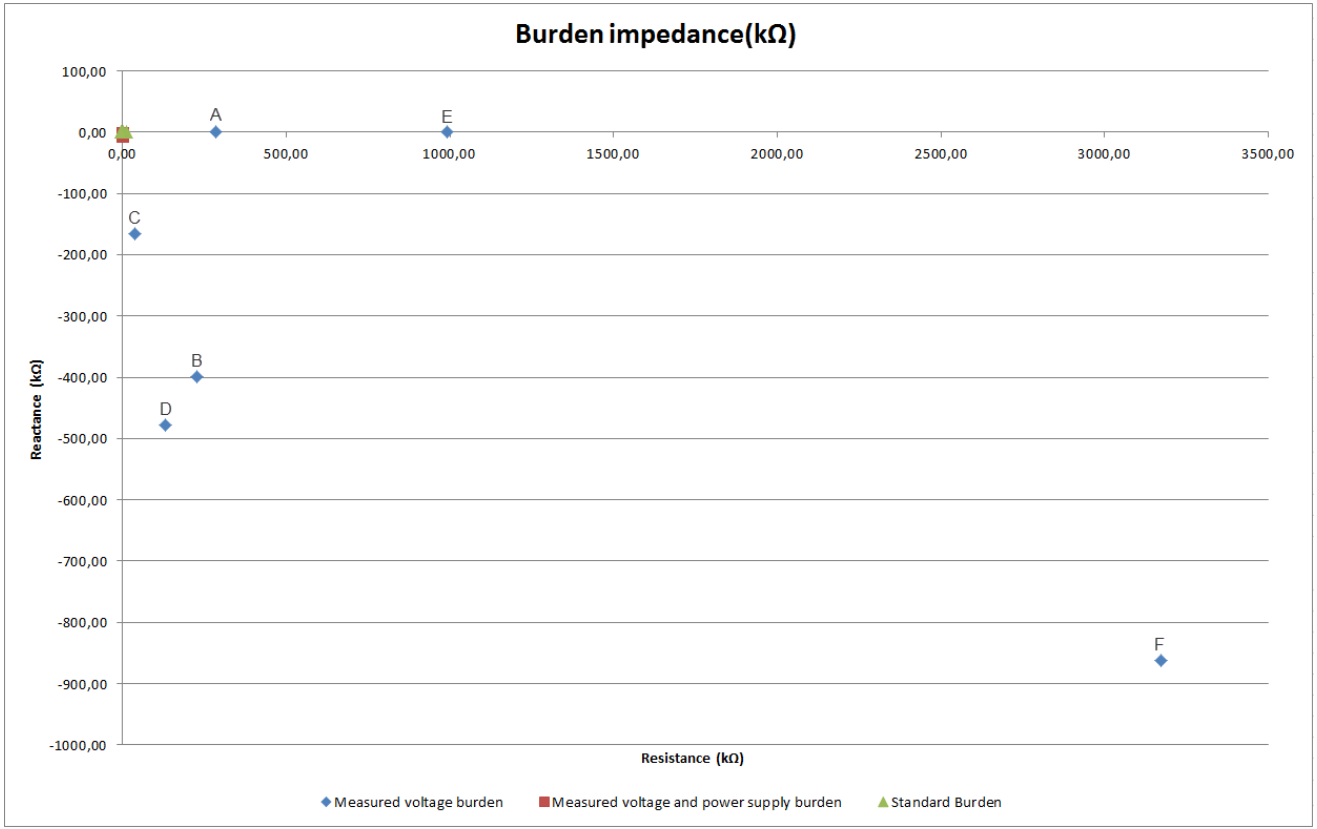
VT burden measurements

- We measured the burden of several meter models with a Radian measurement standard :
  - Phase with voltage input only;
  - Phase with voltage and power supply input.
- Burden related to wiring is considered negligible because:
  - impedance is in the order of Ω/km;
  - HQ meters are often very close to the metering instrument transformer.

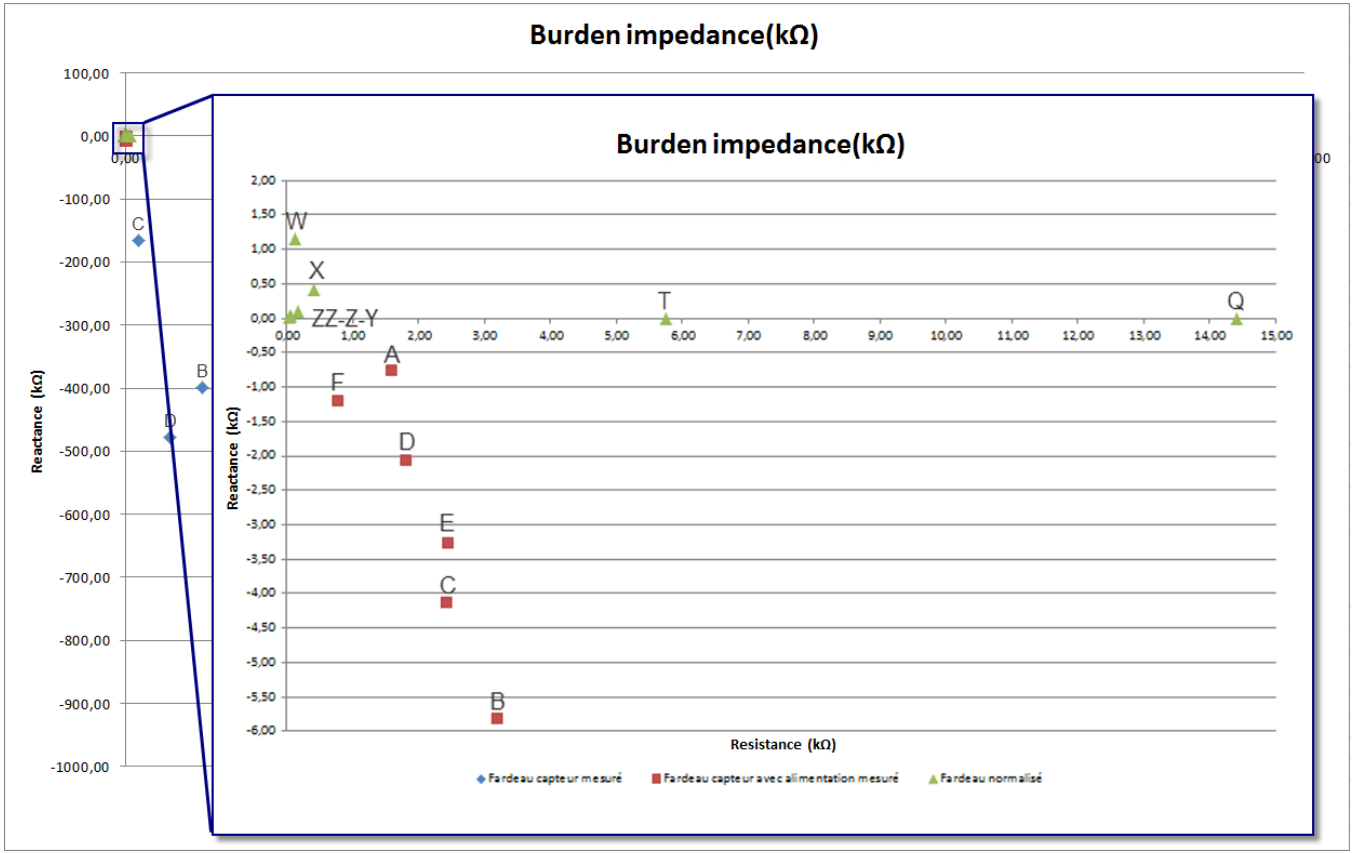
	Voltage input impedance		Voltage and power supply input impedance*	
Meter model	Resistance (kΩ)	Reactance (kΩ)	Resistance (kΩ)	Reactance (kΩ)
A	288,46	0,00	1,57	-0,73
B	230,81	-398,72	3,18	-5,81
C	40,78	-165,70	2,40	-4,12
D	133,79	-477,12	1,80	-2,05
E	993,62	0,00	2,43	-3,25
F	3174,34	-862,66	0,75	-1,19

*Active load, values might change over time

VT burden measurements – voltage input only



VT burden measurements – voltage and power supply input



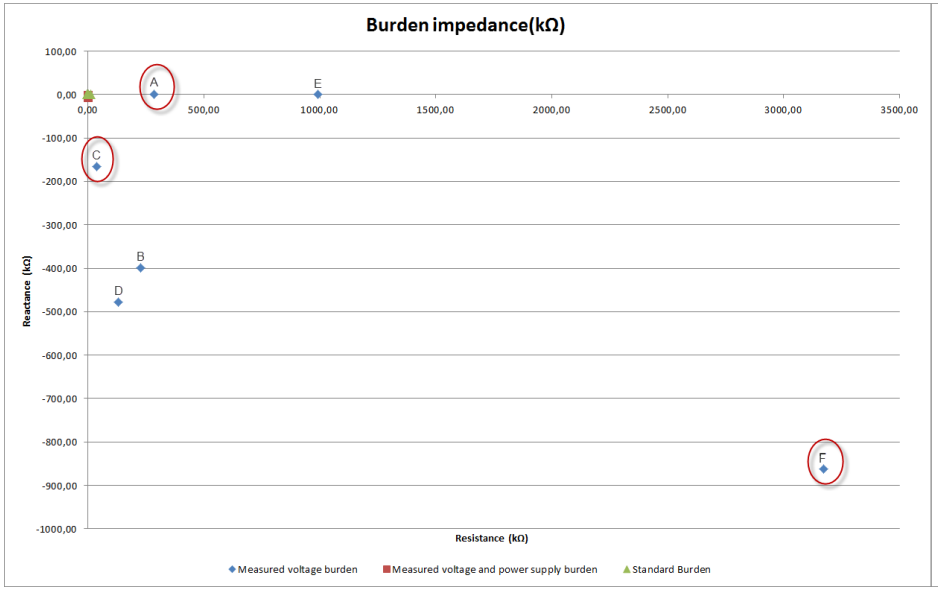
VT burden measurements vs standard

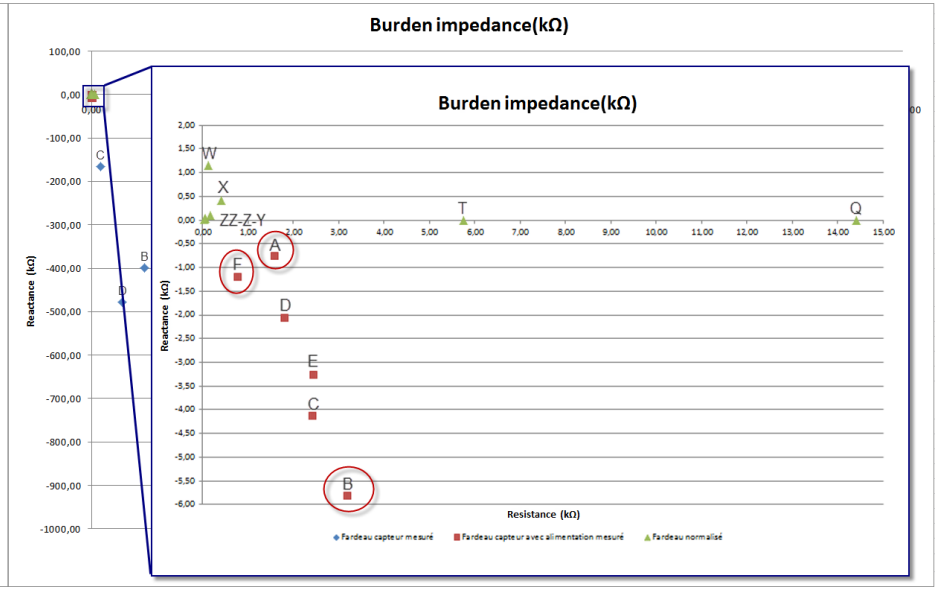
- Measured voltage input burdens have a much higher impedance value, and some have a capacitive power factor (4 on 6).
- Measured voltage and power supply input and standard burdens have a similar impedance amplitude, but with a capacitive power factor.

Impact of modern electronic meter voltage burdens on accuracy test

Impact of modern electronic meter voltage burdens on accuracy test

- We selected the extreme values of measured voltage burden to apply on VT accuracy test



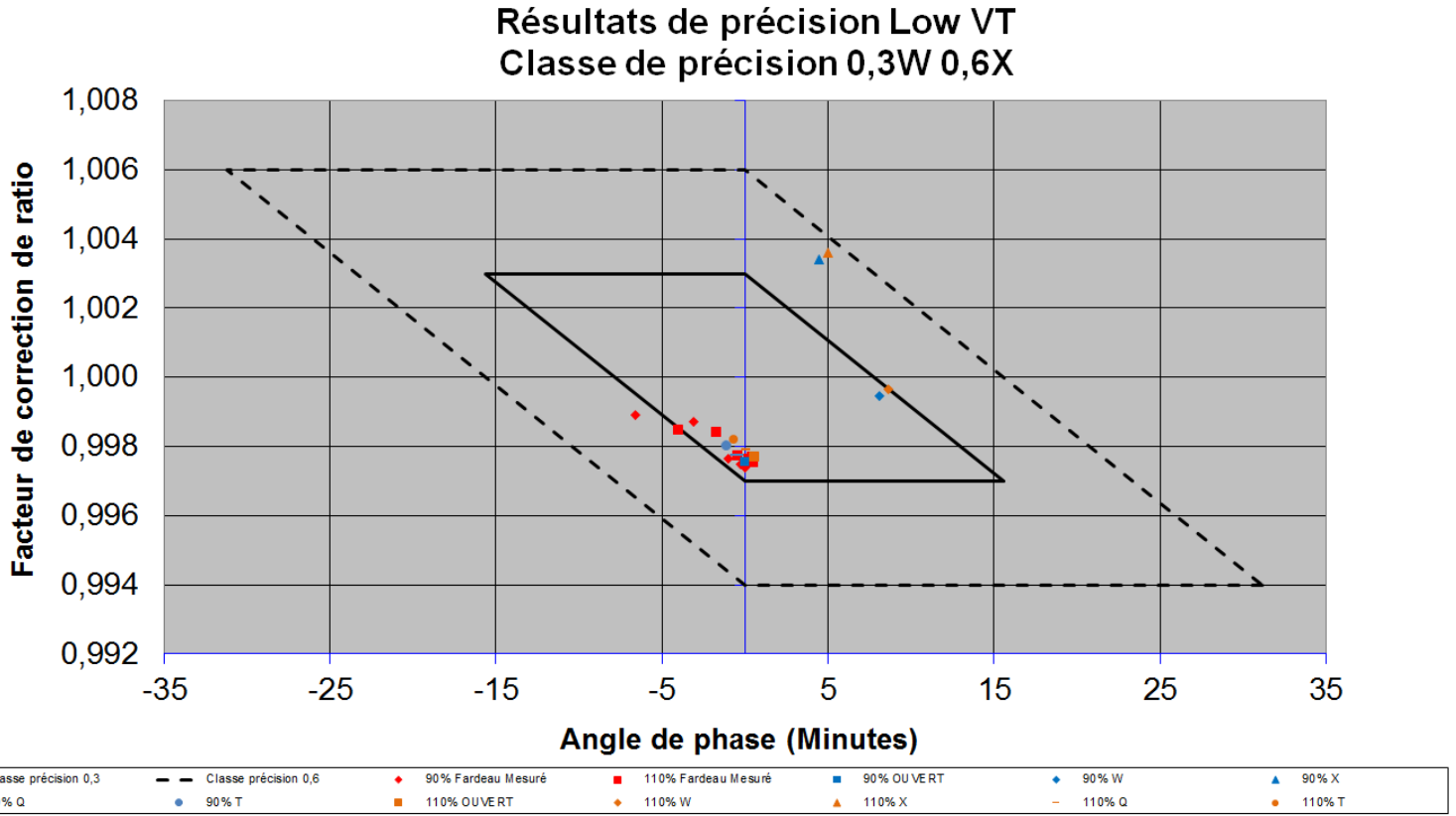


Impact of modern electronic meter voltage burdens on accuracy test

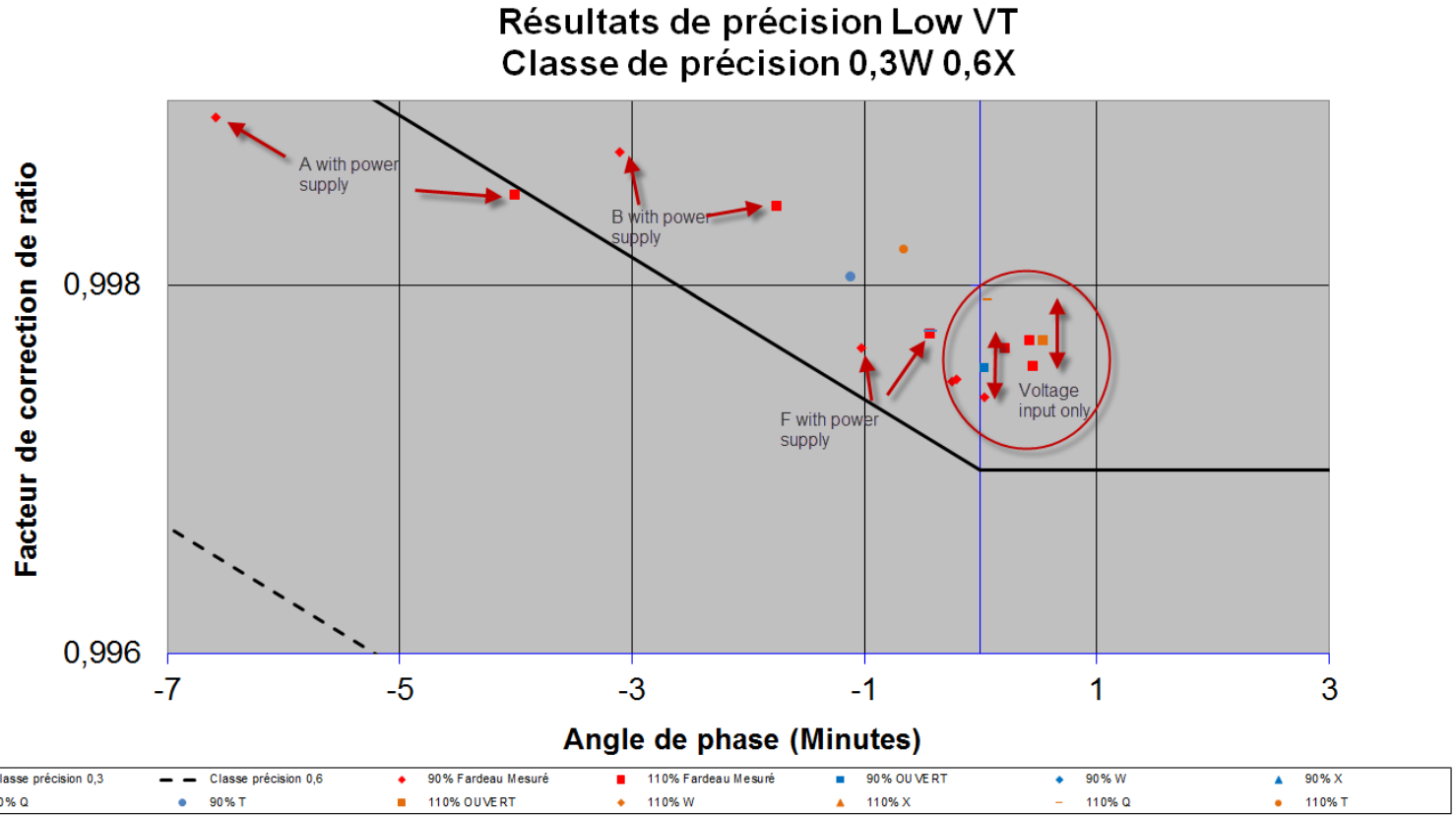
- We programmed the selected burdens in a programmable electronic burden reference on our bench test.

- We tested measured burdens vs standards burdens on 2 inductive VT :
  - 1 x Low voltage (360:120V);
  - 1 x Medium voltage (14400:120V).

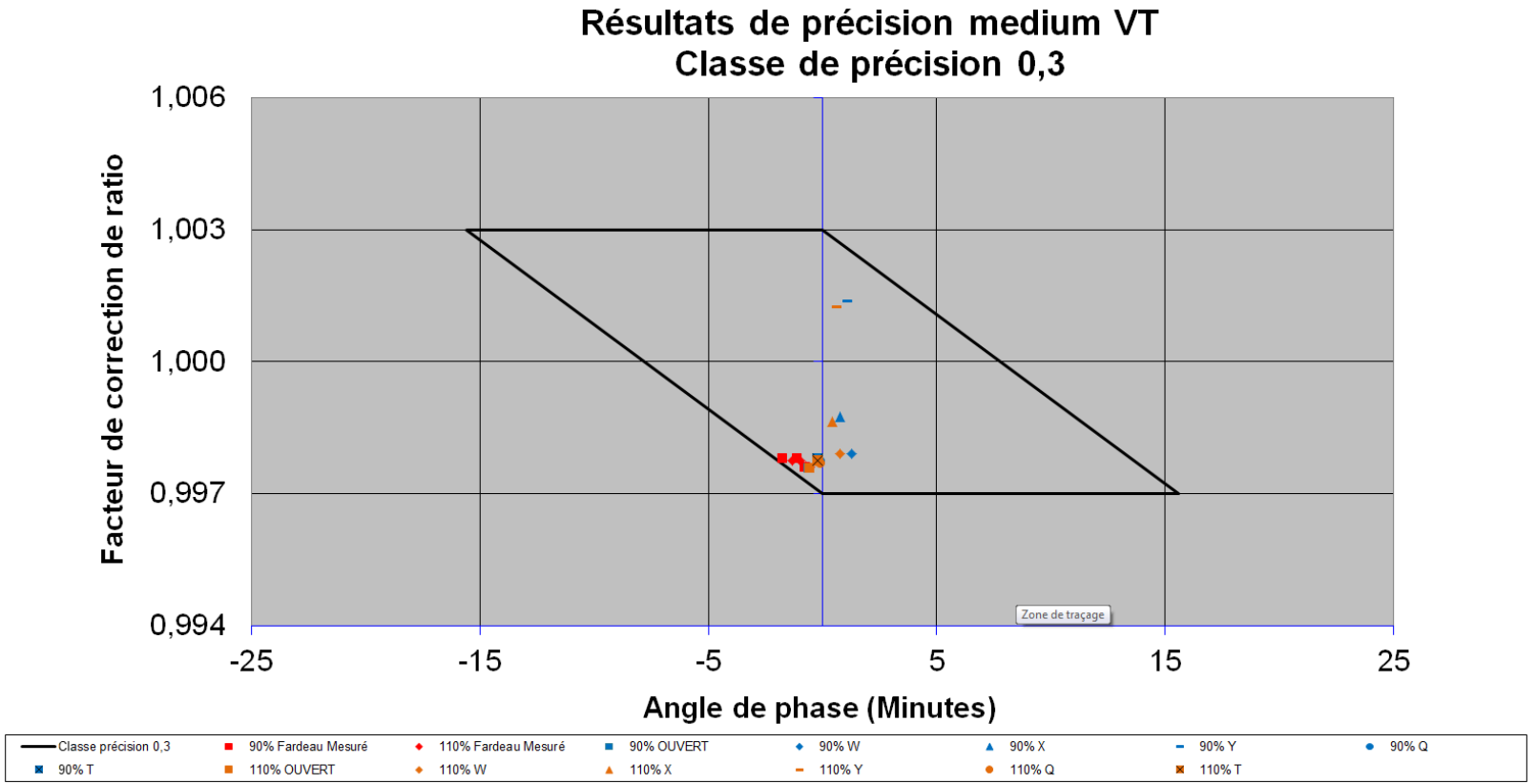
Impact of modern electronic meter voltage burdens on accuracy test – Low VT



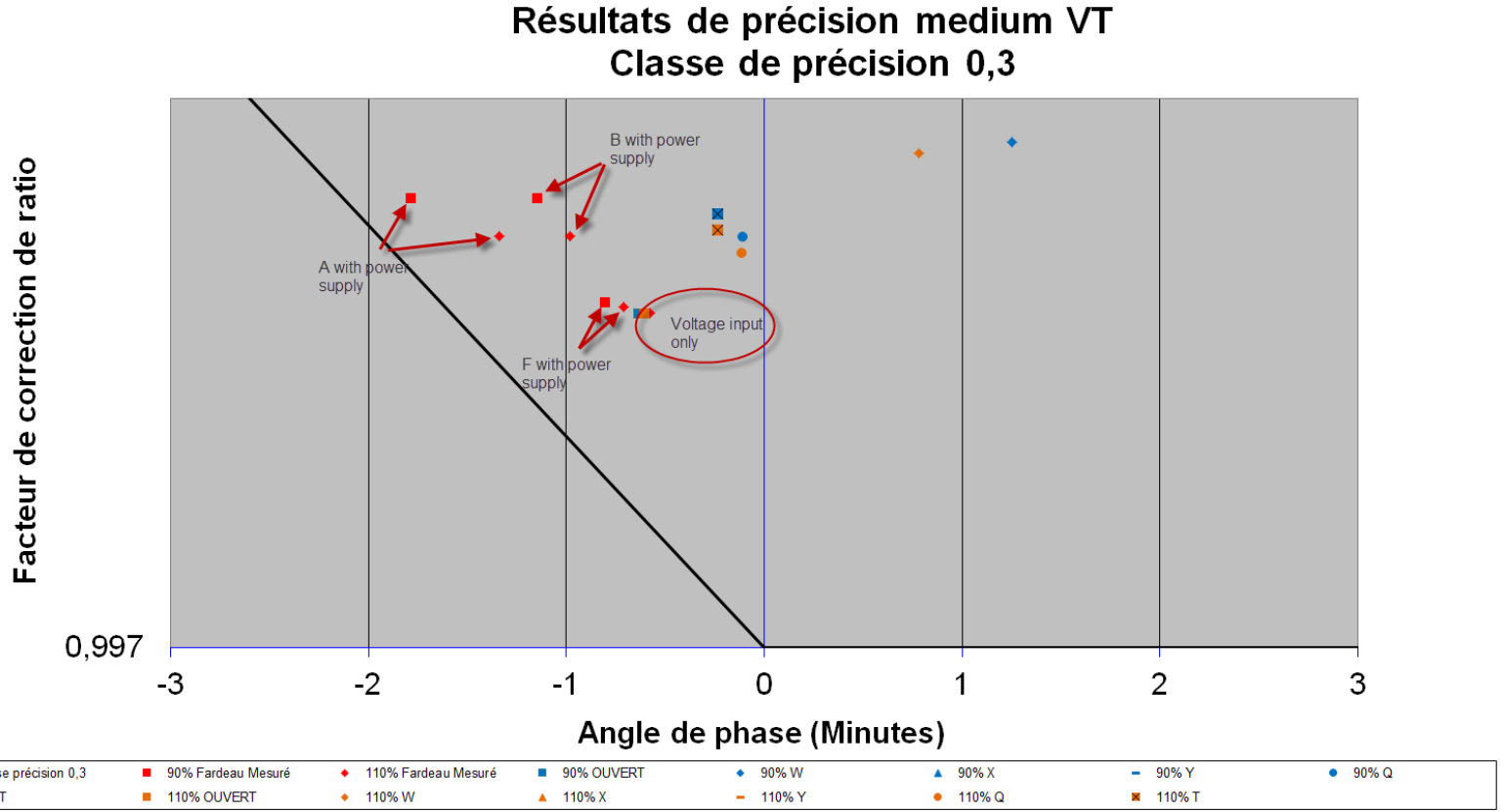
Impact of modern electronic meter voltage burdens on accuracy test – Low VT



Impact of modern electronic meter voltage burdens on accuracy test – Medium VT



Impact of modern electronic meter voltage burdens on accuracy test – Medium VT



Impact of modern electronic meter voltage burdens on accuracy test

- The application of modern electronic meter burdens on accuracy test with 1 low VT and 1 medium VT demonstrate that :
  - Accuracy response with “voltage input and power supply” are more restrictive :
    - Results tend to be more negative in phase compared to standard burdens;
    - Low VT did not pass accuracy test *meter model A* voltage input with power supply burden.
  - Accuracy response with “voltage input” are more restrictive :
    - Results tend to be lower in ratio correction factor (RCF) compared to standard electronic burdens.

Conclusion

Conclusion

- Standard burdens for CT represent field installations.
- Standard burdens for VT does not represent modern electronic meter :
  - Voltage input burdens are higher in impedance and for some meters, capacitive.
  - The majority of electronic meters are powered by one phase, supplied by the VT. These burdens are capacitive, in the same amplitude range of standard burdens.

Conclusion

- Standard burdens should represent the field to ensure the validity of type/routine accuracy tests. This analysis demonstrate a difference between standard burdens and modern burdens for VT.
- This analysis demonstrate that the difference between standard burdens and modern burdens have an impact on accuracy.
- It is recommended to revise the standard burdens for VT.