Comparison protocol
EURAMET project

Bilateral three-phase AC power and energy comparison at power frequency

1. Introduction

This bilateral comparison was triggered by MIKES' need to get support for their planned extension electrical power and energy CMC claims to three phase calibrations.

SP will provide a travelling standard, which will be calibrated by both participants.

2. Travelling standard

The travelling standard is a precision three-phase reference electricity meter.

Manufacturer:	ZERA
Type:	TPZ303
SP reference:	96-610-12

Figure 1. Transfer reference, TPZ303

3. Quantities

The following quantities are relevant in the comparison:

Table 1 - Relevant quantities

Quantity	**Unit**
Active power	W
Reactive power	VAr
Active energy	Ws
Reactive energy	VArh

4. Organization

4.1. Contacts at MIKES:

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4.2. Contacts at SP:

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4.3. Time schedule

Estimated schedule is shown in Table 2.

Table 2 - Estimated time schedule

SP, Borås, Sweden	March-May, 2010
MIKES, Espoo, Finland	August-September, 2010
SP, Borås, Sweden	October-November, 2010

4.4. Transportation

Participants will be responsible for arranging transportation to the next participant. Transportation is each laboratory's own responsibility and cost. MIKES will inform SP by email when the transfer reference has arrived, and again when it will be sent back.

The transfer standard is packed in a metallic container with dimensions: height x width x depth [cm] = 50 x 50 x 50 cm. The weight of the standards with case is about 35 Kg. The container need not be transported personally.

4.5. Failure of the travelling standard

In case of failure of the traveling standard it will be sent back to SP. After the problem has been solved the comparison will start again.

4.6. Financial aspects, insurance

Each participating laboratory covers the costs of its measurements, transportation and possible customs charges as well as of any damage that may have occurred within its country. The pilot laboratory covers overall costs for the organization of the comparison.

5. Measurement instructions

5.1. Conditioning of the transfer standard

The transfer standard must be kept in the laboratory before the measurements for at least 2 hours so that it reaches stable temperature. It is recommended to keep the ambient temperature on the value 23°C ± 2°C.

The data of the ambient conditions during the measurements must be given in the calibration certificate.

5.2. Power comparison

On the TPZ303 display click on: “Funktioner” > “Ärvärden” to select the connection and measurement range;

Mätartt > 4L-Aktiv or 4L-Reaktiv
U-Omr > 240, 120, or 60
I-Omr > 10,5,2,1,500m,200m,100m,50m,20m,10m or 5m

To start the measurement first click on:
“Funktioner“ > “Kontrollmätning (U,I,P)“,

and then to get readings from the TPZ303 use the software “TPZ303 Reader”.

1) Use an RS232 cable to connect the COM port 1on the TPZ303 to the COM port on your computer.
2) Start the program “TPZ303 Reader”
3) In the program, select which of your computer’s COM ports you are using.
4) Choose an appropriate measuring time. (5000 ms)
5) Click on the  button to start a measurement.

To copy the average values to Excel for instance, triple-click in the *Average values* text field to select the text. Then CTRL+C to copy and then, in Excel, CTRL+V to paste.

5.3. Energy comparison

On the TPZ303 display go to “Funktioner” > “Ärvärden” to select the connection and measurement range

Mätartt > 4L-Aktiv or 4L-Reaktiv
U-Omr > 240, 120, or 60
I-Omr > 10,5,2,1,500m,200m,100m,50m,20m,10m or 5m

Use the frequents output f_{out} = 60000 i/s

Calculate the right pulse constant, i/kWh, by using the formula:

$$\frac{1000 * 3600 * 60000}{Urange * Irange * 3} = \frac{impuls}{kWh}$$

6. Uncertainty of measurement

All participants should provide their results with the associated uncertainty of measurement and a complete uncertainty budget.

The uncertainty of the measurement must be estimated according to the ISO Guide to the Expression of Uncertainty in Measurement (GUM).

7. Measurement report

Both participants will issue standard calibration certificate(s). SP will perform calibration before and after the travelling standard visits MIKES to control possible drift of the transfer reference. A short description of the measuring setup will be given as an annex.

The calibration certificates should be kept by the issuing laboratory until all three certificates have been signed.

8. Report of the comparison

After completion of all measurements the coordinator (MIKES) will prepare a first draft report and send it to SP for comments.

Annex 1

Table A-1 - Comparison points

Positive active energy, Y-connected, 4L-Active

TPZ Range		Test point				
		Phase-voltage U	Current I	Power factor cos(φ)	1-Phase L1	3-Phase
60 V	1 A	60 V	1 A	1,00		X
				0,87 ind		X
				0,87 cap		X
120 V	5 A	120 V	5 A	1,00		X
				0,87 ind		X
				0,87 cap		X
240 V	5 A	240 V	5 A	1,00		X
				0,87 ind		X
				0,87 cap		X

Positive reactive energy, Y-connected , 4L-Reactive

TPZ Range		Test point			Nominal TPZ readings			
		Phase voltage U	Phase current I	Power factor sin(φ)	Reactive power Q [VAr]	Active power P [W]	1-Phase L1	3-Phase
60 V	1 A	60 V	1 A	0,50 ind	450	-790		X
				0,50 cap	450	790		X
120 V	5 A	120 V	5 A	0,50 ind	900	-1570		X
				0,50 cap	900	1570		X
				1,00	1800	0		X
240 V	5 A	240 V	5 A	0,50 ind	1800	-3100		X
				0,50 cap	1800	3100		X

Positive active power, Y-connected, 4L-Active

TPZ Range		Test point				
		Phase-voltage U	Current I	Power factor cos(φ)	1-Phase L1	3-Phase
60 V	0,05 A	60 V	0,05 A	1,00		X
60 V	1 A	60 V	1 A	1,00	X	X
				0,87 ind		X
				0,50 ind		X
				0,25 ind		X
				0,87 cap		X
				0,50 cap		X
				0,25 cap	X	X
120 V	0,005 A	120 V	0,005 A	1,00	X	X
	0,01 A		0,01 A			X
	0,02 A		0,02 A			X
	0,05 A		0,05 A			X
	0,1 A		0,1 A			X
	0,2 A		0,2 A			X
	0,5 A		0,5 A			X
	1 A		1 A		X	X
	2 A		2 A			X
120 V	5 A	120 V	5 A	1,00	X	X
				0,87 ind		X
				0,50 ind		X
				0,25 ind		X
				0,87 cap		X
				0,50 cap		X
				0,25 cap		X
				0 ind	X	
				0 cap	X	
120 V	10 A	120 V	10 A	1,00	X	X
240 V	0,05 A	240 V	0,05 A	1,00		X
240 V	5 A	240 V	5 A	1,00	X	X
				0,87 ind		X
				0,50 ind		X
				0,25 ind		X
				0,87 cap		X
				0,50 cap		X
				0,25 cap	X	X
240 V	10 A	240 V	10 A	1,00		X

Positive reactive power, Y-connected, 4L-Reactive

TPZ Range		Test point			Nominal TPZ readings			
		Phase voltage	Phase current	Power factor	Reactive power	Active power	1-phase L1	3-Phase
		U	I	sin(φ)	Q [VAr]	P [W]		
60 V	1 A	60 V	1 A	0,50 ind	450	-790		X
				0,87 ind	790	-450		X
				1,00	900	0		X
				0,50 cap	450	790		X
				0,87 cap	790	450		X
120 V	5 A	120 V	5 A	0,50 ind	900	-1570		X
				0,87 ind	1570	-900		X
				1,00	1800	0		X
				0,50 cap	900	1570		X
				0,87 cap	1570	900		X
240 V	5 A	240 V	5 A	0,50 ind	1800	-3100		X
				0,87 ind	3100	-1800		X
				1,00	3600	0		X
				0,50 cap	1800	3100		X
				0,87 cap	3100	1800		X