Inženýrsko-výrobní elektrotechnický podnik, a.s.
619 00 Brno, Vídeňská 117, Czech Republic

ZKUŠEBNA E-51

CZECH TESTING LABORATORIES ASSOCIATION – SDRUŽENÍ ČESKÝCH ZKUŠEBEN A LABORATOŘÍ

ČLEN ASOCIACE ZKUŠEBEN VYSOKÉHO NAPĚTÍ

TEST REPORT No.: 80-12981

CTSO 38 Current Instrument Transformer of Outdoor Design

Ing. Jaromír Mudra, CSc.

Brno, on: February 1, 2000

ivep®	**TEST REPORT No.: 80-12981** **Tested Device: Current Instrument Transformer of Outdoor Design**	**Page No.: 1** **No. of pages: 7**

Type:

CTSO 38

Kind of the test:

Type test

Testing carried out in conformity with the following standards and provisions:
ČSN 35 1301;
IEC 44-1; IEC 60-1; IEC 185+A1/1990

Rated values:

Rated primary current	10 A;	200 A;	1250 A
Rated secondary current	5 A;	1 A;	5 A
Accuracy class	0.5/10P	0.5/10P	0.5/5P
Instrument security factor (FS)	< 5	<10	< 10
Accuracy limit factor	5	10	10
Highest voltage of the system		38.5 kV	
Rated frequency		50 Hz	
Insulation class		E	

Test ordered by:
the company
KPB INTRA, s.r.o.
Fučíkova 860
685 01 Bučovice, Czech Republic

Order No.:

KPB 199/0297, as of Nov. 01, 1999

Tested specimen reg. No. :
399-401/99
prod. No. KPB 003668, 003669, 003670

Atmospheric conditions:

Air temperature:	21.0°C
Air pressure:	1022.7 hPa
Air humidity:	52% (100%)

Manufacturer of the products:
KPB INTRA, s.r.o.
Fučíkova 860
685 01 Bučovice
Czech Republic

Specimens for testing delivered on:
Nov. 01, 1999

The test report does include:

Text pages:	7
Charts/tables:	5
Diagrammes:	
Drawings:	
Pictures:	
Appendices:	

Distribution list:

IVEP ŘZ	1x
KPB	2x
IVEP-archives:	1x

Test results:

The CTSO 38 type, current instrument transformers of outdoor design, manufactured by the company KPB INTRA, s.r.o., Czech Republic

have satisfied

to the type test provisions as defined by the ČSN 35 1301/1997 and IEC 185+A1/1990 standards.

ZKUŠEBNÍ LABORATOŘE S ČINNOSTÍ AUTORIZOVANOU SCHVÁLENOU ivep akciová společnost BRNO Zkušebny a laboratoře 016

Date of the test: Nov. 04, 1999 to Jan. 10, 2000	**Testing personnel:** Ing. Vlastimil Rada Ing. Hana Mašková	**Manager of the test laboratory:** Ing. Jaromír Mudra, CSc.

Based on order No. 199/0297, issued by the company KPB INTRA s.r.o, type test of 3 pcs of outdoor current instrument transformers of CTSO 38 type designation was carried out at the IVEP a.s. Brno State Metrology Centre, in accordance with the provisions of the ČSN 35 1301 and IEC 185+A1/1990 standards and recommendations.

The transformers tested were manufactured in consistency with the No. 0104001 set of drawings, and in accordance with the P 364, P 365 and P 366 winding instructions. The tests were carried through at the IVEP SMS State Metrology Centre, at the IVEP HV test shop and the IVEP short-circuit laboratory.

The following instrument transformers were subjected to the type test:

The CTSO 38 transformer – specimen No. 399/99 – > prod. No. 003668
10//5/5 A; 15 VA – accuracy class 0.5 – instrument security factor FS 5
15 VA - accuracy class 10 P- accuracy limit factor n = 5

The CTSO 38 transformer – specimen No. 400/99 –> prod. No. 003669
200//1/1 A; 10 VA – accuracy class 0.5 – instrument security factor FS10
30 VA - accuracy class 10 P – accuracy limit factor n = 10

The CTSO 38 transformer – specimen No. 401/99 – > prod. No. 003670
1250//5/5 A; 15 VA – accuracy class 0.5 – instrument security factor FS10
15 VA - accuracy class 5 P – accuracy limit factor n = 10

Scope of the type test

1. Short circuit tests
2. Temperature rise test
3. Lightning impulse test
4. Wet test
5. Power frequency voltage insulation test on secondary windings
6. Power frequency voltage insulation test of dielectric strength between the secondary windings
7. Inter-turn insulation test
8. Power frequency voltage insulation test on primary winding
9. Partial discharge measurement
10. Verification of terminal marking correctness
11. Measurement of errors
12. Measurement of instrument security factor
13. Measurement of composite error

1. Short circuit tests

This kind of testing was carried through at the short-circuit test laboratory of IVEP a.s. Brno (see the test report No. 88-0196). Based on the evaluation of oscillographic curves of the primary and secondary currents, based on the error measurement results after demagnetization of magnetic circuits (see par. 11), and by virtue of repeated insulation tests using power frequency test voltage and the measurement of partial discharges, and also on the basis of the visual inspection of the transformer surface the test result was declared as **satisfactory**.
The short circuit tests were conducted with the following short-circuit currents:

The CTSO 38 transformer, specimen No. 399/99 –> transformation ratio 10//5/5 A

I_{th} = 6.3 kA_{rms}
I_{dyn} = 16 kA_{max}

The CTSO 38 transformer, specimen No. 400/99 –> transformation ratio 200//1/1 A

I_{th} = 25 kA_{rms}
I_{dyn} = 63 kA_{max}

The CTSO 38 transformer, specimen No. 401/99 –> transformation ratio 1250//5/5 A

I_{th} = 31.5 kA_{rms}
I_{dyn} = 66 kA_{max}

(i.e. the highest achievable dynamic inrush current of the IVEP a.s. short-circuit test shop)

The CTSO 38 outdoor design, current instrument transformers have passed the short current test to ČSN 35 1301, par. 12 and IEC 185+A1/1990, par. 12.

2. The temperature rise tests

The tests were carried through on specimens No. 400/99 – 200//1/1 A and 401/99 – 1250//5/5 A, at 120 % of rated primary testing currents, and at rated secondary burdens of 10/30 VA, or 15/15 VA.

The value of temperature rise on the secondary windings was calculated from the winding resistance increase. The temperature of primary terminals was measured using the Thermophil electronic thermometer.

Following temperature values and temperature rise differences were identified:

Specimen No. 400/99 –> transformation ratio 200//1/1 A

Temperature rise value: the 1S1 – 1S2 terminals -> 14.8 K
the 2S1 – 2S2 terminals -> 14.6 K

Temperature of primary winding - 37° C
Surrounding temperature during the test: t_{ok} - 22° C

Specimen No. 401/99 –> transformation ratio 1250//5/5 A

Temperature rise value: the 1S1 – 1S2 terminals -> 59.3 K
the 2S1 – 2S2 terminals -> 60.2 K

Temperature of primary winding: - 85° C
Surrounding temperature during the test: t_{ok} - 15° C

The temperature rise values measured and the temperatures of the secondary and primary windings of the CTSO 38 current instrument transformers **have passed** the requirements of the ČSN 35 1301, par. 9 and IEC 185+A1/1990, par. 9 and 13 standards and recommendations that apply to the E insulation class.

3. The lightning impulse test

The test procedures used are based on the ČSN 35 1301 and IEC 185+A1/1990 standards. The tested specimens No. 399/99; 400/999 and 401/99 coming under the CTSO 38 type series **have satisfied** the test consisting of 15 impulses of positive and negative polarity of 180 kV impulse test voltage, without flashover.

The specification and the detailed results of the test are shown in the IVEP a.s. Brno No. 82-0679 test report.

4. The wet test

The transformer was subjected to one-minute short time power frequency voltage test of 80 kV/50 Hz, with **satisfactory result**. The detailed test results are shown in the IVEP a.s. Brno No. 82-0879 test report.

5. Th power frequency voltage insulation test on the secondary winding

This test was carried out using the 3 kV/50 Hz test voltage during 1 minute. Test result: **satisfactory**. The detailed test results are shown in the IVEP a.s. Brno No. 82-0679 test report.

6. Power frequency voltage insulation test of dielectric strength between the secondary windings

This test was carried out using the 3 kV/50 Hz test voltage during 1 minute, applied in between the measuring and protective secondary windings. Test result: **satisfactory.**
The detailed test results are shown in the IVEP a.s. Brno No. 82-0679 test report.

7. The inter-turn insulation test

The specimens No. 399 to 401/99 were subjected to insulation testing with the secondary winding opened and the primary applied to testing current of the rated increased value of 120 % I_N, during 1 minute test period. The voltage at the terminals of the opened secondary winding was measured using peak-to-peak V-meter, via the SME2 capacitive voltage divider.

The specimens **have passed** the requirements of the ČSN 35 1301, par. 10.5 and 19, and the IEC 185+A1/1990, par. 19 standards, as defined for the „A" procedure.

8. Power frequency voltage insulation test on primary winding

During this test the one-minute power frequency test voltage of 80 kV/50 Hz, at dry surrounding conditions, was applied in between the primary and the secondary windings. Test result: **satisfactory.**
The detailed test results are shown in the IVEP a.s. Brno No. 82-0679 test report.

9. Measurement of partial discharges

This measurement was conducted in accordance with the IEC 44-4 recommendations. The values measured satisfy to the highest operating voltage of 38.5 kV, in impedance earthed neutral power systems.

The results of partial discharge measurement on specimens No. 399 to 401/99, for test voltages specified, are shown in the IVEP a.s. Brno No. 82-0679 test report, and comply with the requirements of the ČSN 35 1301, par. 17 and IEC 185+A1/1990, par. 17 standards.

10. Verification of terminal marking correctness

The polarity check on the primary and secondary windings was carried out using polarity indication device, and conducted during the measurement of accuracy. The marking of both the primary and secondary terminals corresponds to the requirements of the ČSN 35 1301, par. 22 and IEC 185+A1/1999, par. 22 standards.

11. Measurement of errors

For this type of measurement the compensation method was used, with Hartmann & Brown measuring bridge of the Keller system, type MEWK, prod. No. 6406857, verification document No. 817/057/99.

Furthermore, the following measuring instruments and devices were utilized:

Current instrument transformer; manufactured by Tettex, type 4724, prod. No. 113033, verification certificate No. CM 114/1/128/95
Current instrument transformer; manufactured by Tettex, type 4764, prod. No. 135233, verification certificate No. CM 114/1/078/95
Current instrument transformer; manufactured by Tettex, type 4714, prod. No. 9546, verification certificate No. CM 114/1/097/95
Current burden, manufactured by Hartmann & Braun AG, type NBKa, prod. No. 3154031, verification certificate No. 817/057/99
Current burden, being a part of the No. 3154031 current burden, manufactured by IVEP a.s. Brno, verification certificate No. 817/J 233/98

The accuracy measurement took part in conformity with the ČSN 35 1301, par. 27, 37 and IEC 185+A1/1990, par. 27, 37 standards.

The error, current and phase displacement values measured with testing current of 5 to 120 % of I_N (or 100 % I_N) before and after the short-circuit test are shown in the following tables/charts.

Table No. 1 – The CTSO 38 current instrument transformer, specimen No. 399/99
transformation ratio 10//5/5 A; 15 VA -> accuracy class 0.5
15 VA -> accuracy class 10 P

	I_N	5%	20%	100 %	120%	PN VA
winding 1S1-1S2 (with the 2S1-2S2 winding short circuited)	ϵ_I [%]	+0.39	+0.39	+0.36	+0.36	3.75
	δ_I [']	+20.60	+15.90	+7.20	+6.60	
	ϵ_I [%]	-0.63	-0.39	-0.21	-0.34	15
	δ_I [']	+34.80	+15.60	+9.0	+16.70	
winding 1S1-2S2 (the 2S1-2S2 winding loaded with 15 VA burden)	ϵ_I [%]	+0.38	+0.34	+0.30	+0.31	3.75
	δ_I [']	+21.20	+15.80	+7.20	+6.40	
	ϵ_I [%]	-0.65	-0.42	-0.23	-0.36	15
	δ_I [']	+36.0	+16.80	+9.30	+17.30	
the 1S1-1S2 winding after the short-circuit test	ϵ_I [%]	+0.39	+0.35	+0.32	+0.32	3.75
	δ_I [']	+20.20	+15.0	+7.20	+6.40	
	ϵ_I [%]	-0.62	-0.39	-0.21	-0.34	15
	δ_I [']	+34.90	+15.70	+8.80	+16.80	
The 2S1 – 2S2 winding	ϵ_I [%]			-0.56		15
	δ_I [']			+0.50		
after short-circuit testing	ϵ_I [%]			-0.48		15
	δ_I [']			-0.40		

Table No. 2 – The CTSO 38 current instrument transformer, specimen No. 400/99
transformation ratio 200//5/5 A; 10 VA -> accuracy class 0.5
30 VA -> accuracy class 10 P

	I_N	5%	20%	100 %	120%	PN VA
winding 1S1-1S2 (with the 2S1-2S2 winding short circuited)	ϵ_I [%]	+0.21	+0.30	+0.36	+0.36	2.5
	δ_I [']	+21.0	+11.60	+5.90	+5.50	
	ϵ_I [%]	-0.45	-0.11	-0.11	+0.13	10
	δ_I [']	+20.40	+10.30	+3.20	+2.60	
winding 1S1-2S2 (the 2S1-2S2 winding loaded with 30 VA burden)	ϵ_I [%]	+0.21	+0.30	+0.36	+0.36	2.5
	δ_I [']	+22.0	+11.60	+6.0	+5.60	
	ϵ_I [%]	-0.44	-0.11	+0.11	+0.13	10
	δ_I [']	+20.0	+10.20	+3.20	+2.60	
the 1S1-1S2 winding after the short-circuit test	ϵ_I [%]	+0.22	+0.31	+0.36	+0.37	2.5
	δ_I [']	+20.90	+11.0	+15.70	-5.50	
	ϵ_I [%]	-0.43	-0.09	+0.13	+0.14	10
	δ_I [']	+20.20	+ 9.60	+3.0	+2.50	
The 2S1 – 2S2 winding	ϵ_I [%]			-0.19		30
	δ_I [']			+3.20		
after short-circuit testing	ϵ_I [%]			-0.17		30
	δ_I [']			+2.80		

Table No. 3 – The CTSO 38 current instrument transformer, specimen No. 401/99
transformation ratio 1250//5/5 A; 15 VA -> accuracy class 0.5
15 VA -> accuracy class 5 P

	I_N	5%	20%	100 %	120%	PN VA
winding 1S1-1S2 (with the 2S1-2S2 winding short circuited)	ϵ_I [%]	+0.05	+0.08	+0.10	+0.12	3.75
	δ_I [']	+15.50	+ 9.50	+5.0	+3.30	
	ϵ_I [%]	-0.42	-0.23	-0.10	-0.11	15
	δ_I [']	+17.0	+10.0	+3.50	+3.30	
winding 1S1-2S2 (the 2S1-2S2 winding loaded with 15 VA burden)	ϵ_I [%]	+0.07	+0.06	+0.10	+0.12	3.75
	δ_I [']	+15.30	+9.60	+5.0	+3.20	
	ϵ_I [%]	-0.43	-0.22	-0.11	-0.11	15
	δ_I [']	+16.90	+10.10	+3.60	+3.40	
the 1S1-1S2 winding after the short-circuit test	ϵ_I [%]	+0.06	+0.10	+0.12	+0.20	3.75
	δ_I [']	+12.80	+7.40	+3.80	+3.30	
	ϵ_I [%]	-0.32	-0.14	-0.02	-0.01	15
	δ_I [']	+14.0	+7.10	+2.20	+2.0	
The 2S1 – 2S2 winding	ϵ_I [%]			-0.19		15
	δ_I [']			+1.40		
after short-circuit testing	ϵ_I [%]			-0.13		15
	δ_I [']			+2.30		

The CTSO 38 current instrument transformers, specimen Nos. 399 to 401/99, **have passed** the requirements of the ČSN 35 1301 and IEC 185+A1/1990 standards, with secondary winding loaded with the class 0.5 and 5P or 10 P burdens, connected prior and after the short circuit test. The impact of protective windings on the accuracy of measuring windings was found as negligible for all the specimens.

Other combinations of secondary burdens and accuracy classes for the measuring windings have to meet the requirements of the ČSN 35 1301 and TPM 2272-99 standards.

12. Measurement of the instrument security factor (FS)

With regard to the transformer design this measurement carried out on measuring windings of the current instrument transformers was done with primary winding opened and with secondary winding connected to sine-shaped power frequency voltage. In order to make a comparison the direct measurement method was applied for the specimen No. 399/99 (with the 10//5/5 A transformation ratio).
Instrument security factor (FS) at rated burdens connected to the 1S1 and 1S2 terminals are shown in Table No. 4 hereunder.

Table No. 4

Transformer type	Specimen number	Secondary winding transformation ratio	Burden	Instrument security factor (FS)	
				Direct method	Indirect method
CTSO 38	399/99	10//5/5 A 1S1-1S2	15 VA	1.50	1.80
CTSO 38	400/99	200//1/1 A 1S1-1S2	10 VA		7.60
CTSO 38	401/99	1250//5/5 A 1S1-1S2	15 VA		7.40

The CTSO 38 current instrument transformers, specimen Nos. 399 to 401/99 **satisfied** the instrument security factor values specified on the nameplate ($n < 5$, or $n < 10$) and required by the ČSN 35 1301, par. 31, appendix A standard, as well as the IEC 185+A1/1990 standard, appendix A.

13. Measurement of total error

The same methods and the same scope of test parameters as used for the measurement of instrument security factor (see par. 12) were utilized for total error measurement on 2S1/2S2 secondary terminals. The total error values measured for rated burdens are shown in Table No. 5.

Table No. 5

Transformer type	Specimen number	Transformation ratio of secondary winding	Burden	Accuracy limit factor	Total error	
					Direct method	Indirect method
CTSO 38	399/99	10//5/5 A 2S1-2S2	15 VA	5	1.2 %	1.55 %
CTSO 38	400/99	200//1/1 A 2S1-2S2	30 VA	10		0.45 %
CTSO 38	401/99	1250//5/5 A 2S1-2S2	15 VA	10		0.068 %

The CTSO 38 current instrument transformers, specimen Nos. 399 to 401/99 **satisfied** the total error values as shown on the nameplate and specified by the ČSN 35 1301 standard, par. 39 and appendix A, and the IEC 185+A1/1990 standard, par. 39 and appendix A.