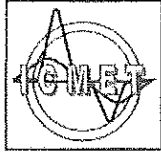


ПАПКА 7

ПРИЛОЖЕНИЕ 10 Други документи за  
Позиция 1 и Позиция 2

ПРИЛОЖЕНИЕ 10.1 БКТП

Приложение 4-4.9; 4.10; 4.11; 4.12; 4.13; 4.14; 4.15;  
4.16; 4.17; 4.18; 4.19



RESEARCH-DEVELOPMENT AND TESTING NATIONAL  
INSTITUTE FOR ELECTRICAL ENGINEERING

**ICMET CRAIOVA  
HIGH POWER DIVISION**

**HIGH POWER LABORATORY "Ovidiu Rarinca"**  
200746-CRAIOVA, Blvd. DECEBAL, No.118A, ROMANIA  
Old address 200515-CRAIOVA Calea Bucuresti Nr. 144 ROMANIA)  
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INCERCARE



SR EN ISO / CEI 17025: 2005  
CERTIFICAT DE ACREDITARE  
nr. LI 004 / 2007

**TEST REPORT**

**No. 11239**

**CUSTOMER:** "PAVEL and SONS" Electric Ltd.  
12 Madara Blvd. Shumen Bulgaria

**MANUFACTURER:** "PAVEL and SONS" Electric Ltd.  
12 Madara Blvd. Shumen Bulgaria

**TESTED PRODUCT:** 20 / 0.4 kV, 1250 kVA Prefabricated Transformer Substation

**REFERENCE STANDARD:** IEC 62271-202 / 2006 clause 6.3

**TEST PERFORMED:** Temperature-rise test and determination of thermal class

**TEST DATE:** 22.09.2011

**TEST RESULT:** Passed the tests

Report has 14 pages and it is edited in 4 copies from which copy 1 for laboratory and copies 2, 3 and 4 for customer.

На основание чл. 2  
от ЗЗЛД

**DATE OF ISSUE:** 25.09.2011

1. Results refer to test product only.
2. Publication or reproduction of the contents of this report in any other form unless its complete photocopying is not allowed without writing approval of division to which laboratory belongs to.
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**TEST REPORT No 11239**

**PAGE 2**

	page
1. Identification of the test product	3
2. Technical characteristics established by manufacturer	3
3. Tests program	3
4. Responsible for tests	3
5. Present at the tests	3
6. Test report documentation	3
7. Temperature – rise test	4
8. Thermal class determination	7
9. Remarks	7
10. Test result	7
10.1 Annexes	8
- Photo	8
- Technical specification	9
- Drawing	11

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ВЯРНО С  
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**1. IDENTIFICATION OF TEST PRODUCT**

	Prefabricated Substation	MV Switchgear	Transformer
Type	CCTS 20/0.4kV 1x1250kVA	8DJHRRT	TM 1250/20/0.4
Serial number/year	11319 / 2011	-/2010	142377
Technical specification /Drawing	See page 9,10 / See pages 11 to 14		
Contract no:	705.2/8547/17.08.2011		
Product receiving date:	22.08.2011		
Product condition at receiving:	New		

**2. TECHNICAL CHARACTERISTICS ESTABLISHED BY MANUFACTURER**

	Substation	MV Switchgear	LV Panel	Transformer
Rated power	1250 kVA			1250 kVA
Rated voltage	20/0.4kV	20kV	0.4 kV	20/0.4 kV
Rated current	-	630A	2500A	36.08/1804A
Rated frequency	50Hz	50Hz	50Hz	50Hz
Short-circuit voltage	-	-	-	5.47%
Connection	-	-	-	Dyn5
Total losses				14145W

**3. TESTS PROGRAM**

3.1 One test to check the temperature-rise test of the transformer inside of the substation and the low voltage panel.

- During the test the power transformer was supplied on the high voltage windings, at total losses P<sub>tot</sub> – 14145W, and the low voltage winding was short circuited.

- During the test the Low Voltage equipment was supplied through fuses other power supply at I= 1804A, and the shortcircuit was made at the end of the cables supply the transformer on low voltage windings.

3.2 Determination of thermal class of the substation.

**4. RESPONSIBLE FOR TESTS:** Eng. Sboru Ilie

**5. PRESENT AT THE TESTS:** Mr. Velimir Dimitrov from 'Pavel and Sons' Electric Ltd

**6. TEST REPORT DOCUMENTATION**

Diagrams - ; Tables 6 ;  
Photos 1 ; Drawings 4 .

7. TEMPERATURE-RISE TEST

7.1 Three-phase supply circuit for temperature rise test

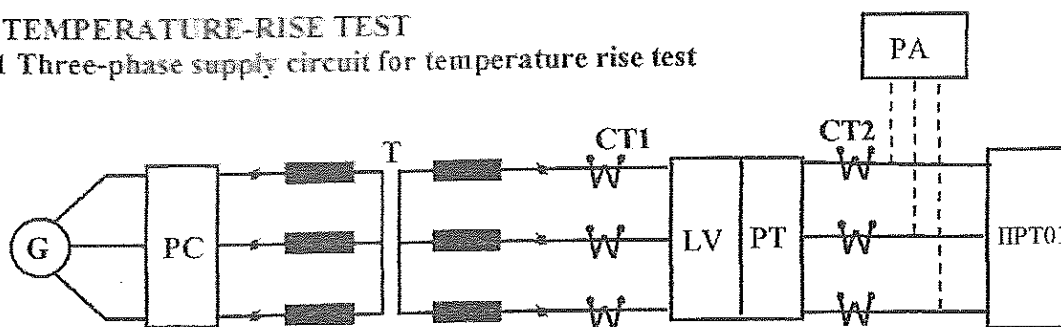


Fig. 1 – Test diagram for current paths temperature-rise test

- G - Generator type GSAM – 390 kVA, 400 V, 50 Hz
- PC - Connections panel
- T - Adapting transformer made of 3 single-phase transformers of 400 / 25V, 10 kA, 50 Hz
- CT1 - Current transformers type CIRSO – 2000 / 5 A
- CT2 - Current transformers type CIRSO – 2x50/5 A
- LV - Low Voltage equipment
- PT - Power Transformer tested
- PA - Power analysing device
- IPT - Substation test installation

7.2 TEST CONDITIONS AND CALCULATION RELATIONS OF TEMPERATURE-RISE

Table 1

Test stage	I	II
Loss (W)	14145	Current / period (A / minutes)
Load type		36.08/60

Calculation relations (IEC 60076-2:1993, clause 5.4):

$$\theta_2 = (R_2 / R_1) * (235 + \theta_1) - 235 - \text{for cooper winding}$$

$$\Delta\theta = \theta_2 - \theta_a$$

$$\Delta\theta_u = \theta_u - \theta_a$$

where:

- $\theta_2, \theta_2'$  - windings average temperature (inside the substation and outside the substation)
- $R_1, R_1'$  - windings resistance measured in cold condition (inside the substation and outside the substation)
- $R_2, R_2'$  - windings resistance measured at shutdown (inside the substation and outside the substation)
- $\theta_1, \theta_1'$  - environment temperature in cold condition (inside the substation and outside the substation)
- $\theta_a, \theta_a'$  - environment temperature at the end of temperature-rise test (inside the substation and outside the substation)
- $\Delta\theta, \Delta\theta'$  - windings temperature-rise (inside the substation and outside the substation)
- $\theta_u, \theta_u'$  - oil average temperature at the upper part (inside the substation and outside the substation)
- $\Delta\theta_u, \Delta\theta_u'$  - oil temperature-rise (inside the substation and outside the substation)

## 7.3 RESULTS OBTAINED AT TEST

## 7.3.1 Transformer's temperature-rise test inside the substation

Table 2

Windings	Determined values						Oil
	$R_1'$ ( $\Omega$ )	$\theta_1'$ ( $^{\circ}\text{C}$ )	$R_2'$ ( $\Omega$ )	$\theta_a'$ ( $^{\circ}\text{C}$ )	$\theta_2'$ ( $^{\circ}\text{C}$ )	$\Delta\theta'$ (K)	$\Delta\theta_u'$ (K)
HV	2.579	23	3.305	26	95.63	69.63	67
LV	$870.3 \times 10^{-6}$		$1110 \times 10^{-6}$		94.06	68.06	

Measurements were performed with expanded uncertainty of: 3 % for voltages; 3% for currents; 2.5% for time and the confidence level  $P = 95\%$ .

where:

HV - high voltage winding

LV - low voltage winding

Remarks: Values of the measured resistances, calculated temperatures are presented in pages 5, 6

## 7.3.2 Measured values of currents, losses and temperatures

Table 3

Time	Hour	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:01	21:01	
Current on phases	$I_1$	A	40.53	39.31	38.79	38.21	37.66	37.10	36.50	36.15	36.07
	$I_2$	A	40.73	39.46	38.93	38.32	37.80	37.18	36.72	36.06	36.09
	$I_3$	A	40.90	39.61	39.13	38.44	37.97	37.32	36.89	36.09	36.08
Average current	$I_m$	A	40.72	39.46	38.95	38.32	37.81	37.20	36.70	36.08	36.09
Measured loss	$P_1$	W	3810	3870	3930	3860	3910	3900	3970	3629	3634
	$P_2$	W	6150	6130	5950	5780	5900	5920	5942	5380	5372
	$P_3$	W	4260	4250	4310	4400	4342	4338	4240	3841	3834
Total loss	$P_m$	W	14220	14250	14190	14200	14152	14158	14152	12850	12840
Environment temperature	$\theta_{a1}$	$^{\circ}\text{C}$	24.1	24.4	24.5	24.8	25.0	25.4	25.7	25.7	25.7
	$\theta_{a2}$	$^{\circ}\text{C}$	24.2	24.4	24.7	24.8	24.9	25.2	25.3	25.4	25.4
	$\theta_{a3}$	$^{\circ}\text{C}$	24.6	25.0	25.5	25.7	26.0	26.5	26.7	26.9	26.9
	$\theta_a$	$^{\circ}\text{C}$	24.3	24.6	24.9	25.1	25.3	25.7	25.9	26.0	26.0
Oil temperature	$\theta_u$	$^{\circ}\text{C}$	47.2	65.8	77.2	85.8	89.8	91.2	92.3	93.5	93.0
Oil temperature-rise	$\Delta\theta_u$	$^{\circ}\text{C}$	22.9	41.2	51.3	60.7	64.5	65.5	66.4	67.5	67.0

Measurements were performed with expanded uncertainty of: 5 % for powers; 3% for currents; 2.5% for time and the confidence level  $P = 95\%$ .

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7.3.3 Values of the high and low voltage windings resistance measured after shutdown inside the substation  
 The resistances of high and low voltage windings were measured in direct current for 10 minutes (one reading at each minute) using the ammeter-voltmeter method. The windings resistances determination at the time of shutdown ( $t_0$ ).

Table 4

t [min]	R <sub>HV</sub> [Ω]	R <sub>LV</sub> [mΩ]
1	3.30	1.105
2	3.29	1.10
3	3.28	1.08
4	3.27	1.075
5	3.26	1.06
6	3.255	1.05
7	3.25	1.04
8	3.24	1.035
9	3.23	1.02
10	3.22	1.015

Measurements were performed with expanded uncertainty of: 2.5 % for resistances and the confidence level  $P = 95\%$ .

\* The windings resistances determination at the time of shutdown ( $t_0$ )

$R_1 = 3.305 \Omega$  HV - high voltage winding;  $R_2 = 1.11 \cdot 10^{-3} \Omega$  LV - low voltage winding

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7.3.4 Temperature-rise of the low voltage equipment

Table 5

No.	Elements and temperature measuring points	Temperature-rise [°K]			Admitted
		Calculated			
		R	S	T	
1	Circuit breaker terminals				80
	-Input	73.47	74.38	73.62	
	-Output	74.33	75.12	75.24	
2	Terminal connection of fuses	64.32	65.47	65.58	70
3	Bus bar low voltage compartment in upper part	68.59	67.81	67.20	
	Bus bar low voltage compartment in lower part	65.56	66.47	67.30	
4	Fuse handler	12.94			25
5	Environment temperature	26.00			-

The measurements were performed with expanded uncertainty of: 1.1% for temperature and the confidence level P = 95%.

\* Temperature-rise of the low voltage equipment did not exceed the specified limits (see table 5)

8. THERMAL CLASS DETERMINATION

To assess the thermal class the following relations (IEC 62271-202:2006, clause 6.3) will be applied:

$$\Delta t_1 = t_{t1} - t_{a1},$$

$$\Delta t_2 = t_{t2} - t_{a2},$$

$$\Delta t = \Delta t_2 - \Delta t_1$$

where:

$t_{t1}$  = - temperature of the transformer windings outside the substation,

$t_{a1}$  = -environment temperature at the end of transformer temperature-rise test outside the substation

$\Delta t_1$  = - temperature-rise of the transformer windings outside the substation

$t_{t2}$  = - temperature of the transformer windings inside the substation

$t_{a2}$  = - environment temperature at the end of transformer temperature-rise test inside the substation

$\Delta t_2$  = - temperature-rise of the transformer windings inside the substation.

Table 6

	$\Delta t_1$ [°C]	$t_{t1}$ [°C]	$t_{a1}$ [°C]	$\Delta t_2$ [°C]	$t_{t2}$ [°C]	$t_{a2}$ [°C]	$\Delta t$ [°C]
HV winding	50.11	75.11	25.00	69.62	95.63	26.00	19.52
LV winding	48.86	73.86		68.06	94.06		19.20
Oil	49.80	74.80		67.00	93.00		17.20
* Remarks	* These data are according to technical records made by ELPROM TRAF0 test report no.T П - 161			These data are according to table 2 of this Test Report			

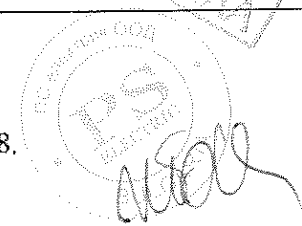
Thermal class: because  $15 K < \Delta t < 20 K \Rightarrow$  Class 20

\* Thermal class is 20 (see table 6).

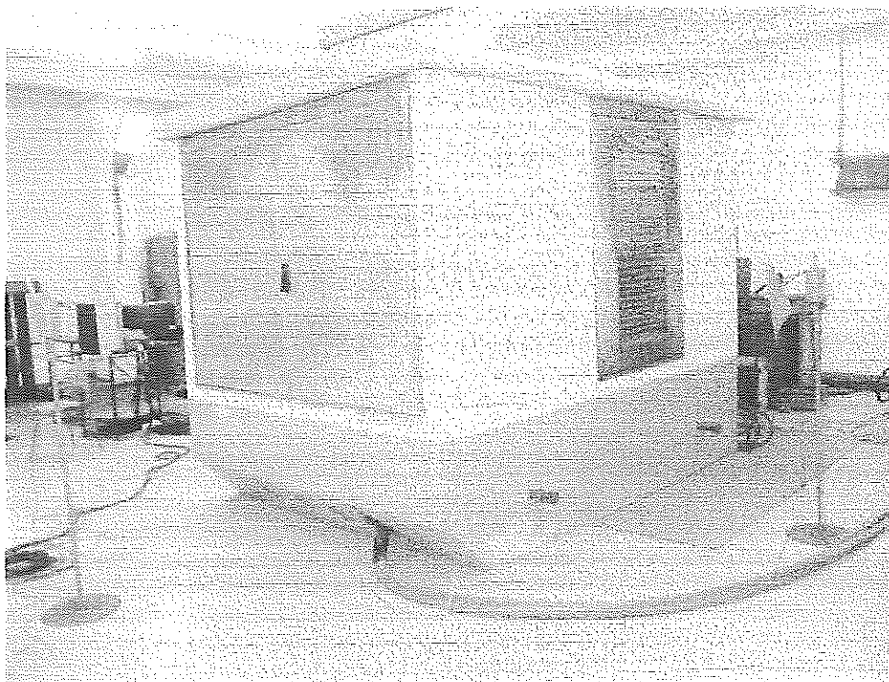
9. REMARK

Aspect of the substation in the test circuit is presented in photo from page 8.

10. TEST RESULT: PASSED THE TEST



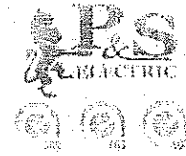




Aspect of Transformer Substation in the test circuit

ВЯРНО С  
ОРИГИНАЛА

ICMET  
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### TECHNICAL SPECIFICATION

PREFABRICATED TRANSFORMER SUBSTATION MADE OF REINFORCED CONCRETE

TYPE: CCTS 20/0.4kV 1x1250kVA  
PRODUCER: "PAVEL & SONS ELECTRIC" LTD., SHUMEN, BULGARIA  
FACTORY NUMBER: 11319

CASING: THE CASING OF THE CONCRETE PREFABRICATED SUBSTATION IS MADE OF WATER -TIGHT REINFORCED CONCRETE B45;

1.1. MEASUREMENTS ( ROOF INCLUDED ) :  
L= 3300MM;B=2600MM;H=2750MM;  
WEIGHT WITH TRANSFORMERS: 15 100KG;

EQUIPMENT:

2.1. EQUIPMENT ON THE MIDDLE VOLTAGE SIDE:  
COMPLETE DISTRIBUTING DEVICE - 8DJ20.10 SIEMENS, WHICH CONSISTS OF CABLE "IN" 20kV, CABLE "OUT" AND "TRANSFORMER PROTECTION".  
2.2. INTERCONNECTIONS 20 kV FROM MV SWITCHBOARD TO TRANSFORMERS NA2X(F)2Y 3x1x50MM<sup>2</sup>.

2.3. TRANSFORMER:  
TRANSFORMER 20/0.4KV 1250 KVA  
DIMENSIONS:  
L=1680MM.  
W=1010MM.  
H=1700MM.

2.4. CONNECTING CABLE FROM TRANSFORMERS TO LV SWITCHBOARD -  
NYY 3x(6x240MM<sup>2</sup>)+3x240MM<sup>2</sup>.

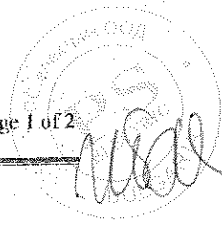
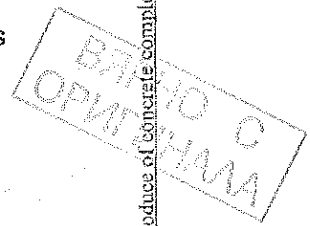
2.5. MAIN CIRCUIT - BREAKERS OF LV SWITCHBOARD - AUTOMATIC CIRCUIT - BREAKERS NS 2000A.

2.6. TERMINALS OF LV SWITCHBOARD - VERTICAL SWITCH DISCONNECTOR WITH FUSES MULTIVERT 400A - 5 PSC. "M.SCHNEIDER" AUSTRIA

2.7. COPPER BARS' SYSTEM:  
DISTRIBUTING RIMS - COPPER BARS 120X10MM.  
CONNECTION BETWEEN MAIN CIRCUIT - BREAKER AND DISTRIBUTING RIMS - COPPER BARS 120X10MM.

CURRENT TRANSFORMER:  
BH-0.66 120 2000/5A  
5VA GRADE OF FIT 0.5  
ITH MAX 50KA.

Produce of concrete complete transformer substation, distribution panels and equipment for the power engineering



Page 1 of 2

Main office address: 9700 Shumen, Blvd 13 Mladara; tel: +359 54 07 44 99; fax: +359 54 07 45 00  
Sofia office address: 1000 Sofia Blvd 129 Vitosha; tel: +359 2 952 24 05; fax: +359 2 952 67 20  
e-mail: office@pavel-sons.com web: www.pavel-sons.com



3. EARTHING INSTALATION:

INTERNAL CONNECTIONS- CONDUCTOR H07V-K 1x50MM2.

CONNECTION BETWEEN NEUTRAL COPPER BAR AND POTENTIAL COPPER BAR – CONDUCTOR H07V-K 1x150MM2.

CONNECTION TO EXTERNAL EARTHING CONTOUR –H07V-K 1x50MM2.

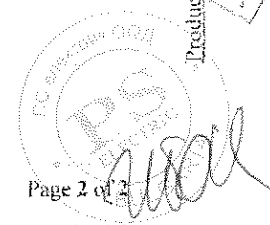
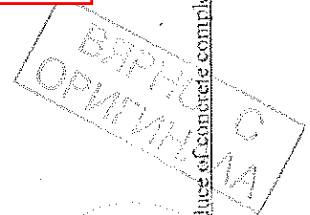
RATINGS OF PREFABRICATED SUBSTATION:

- RATED VOLTAGE ON MV SIDE – 24kV;
- OPERATED VOLTAGE ON MV SIDE – 20kV;
- RATED INSULATION LEVEL ON MV SIDE -50kV;
- RATED LIGHTNING IMPULSE WITHSTAND VOLTAGE ON MV SIDE-125kV;
- RATED VOLTAGE ON LV SIDE – 0.4kV;
- RATED INSULATION LEVEL ON LV SIDE -2,5kV;
- RATED NORMAL CURRENT OF MV BUSBAR-400A;
- RATED LIGHTNING IMPULSE WITHSTAND VOLTAGE ON LV SIDE- 5kV;
- RATED FEEDER CURRENT -630A;
- RATED FEEDER CURRENT FOR TRANSFORMER PANELS – 200A;
- MAIN CIRCUIT BREAKERS ON LV SWITCHBOARD-1250A;
- RATED SHORT TIME WITHSTAND CURRENT ON MV SIDE -20kA/1s;
- PEAK WITHSTAND RATED CURRENT – ON MV SIDE-50KA;
- SHORT TIME WITHSTAND CURRENT ON EARTHING CIRCUIT -16KA

DATE:19.09.2011  
SHUMEN

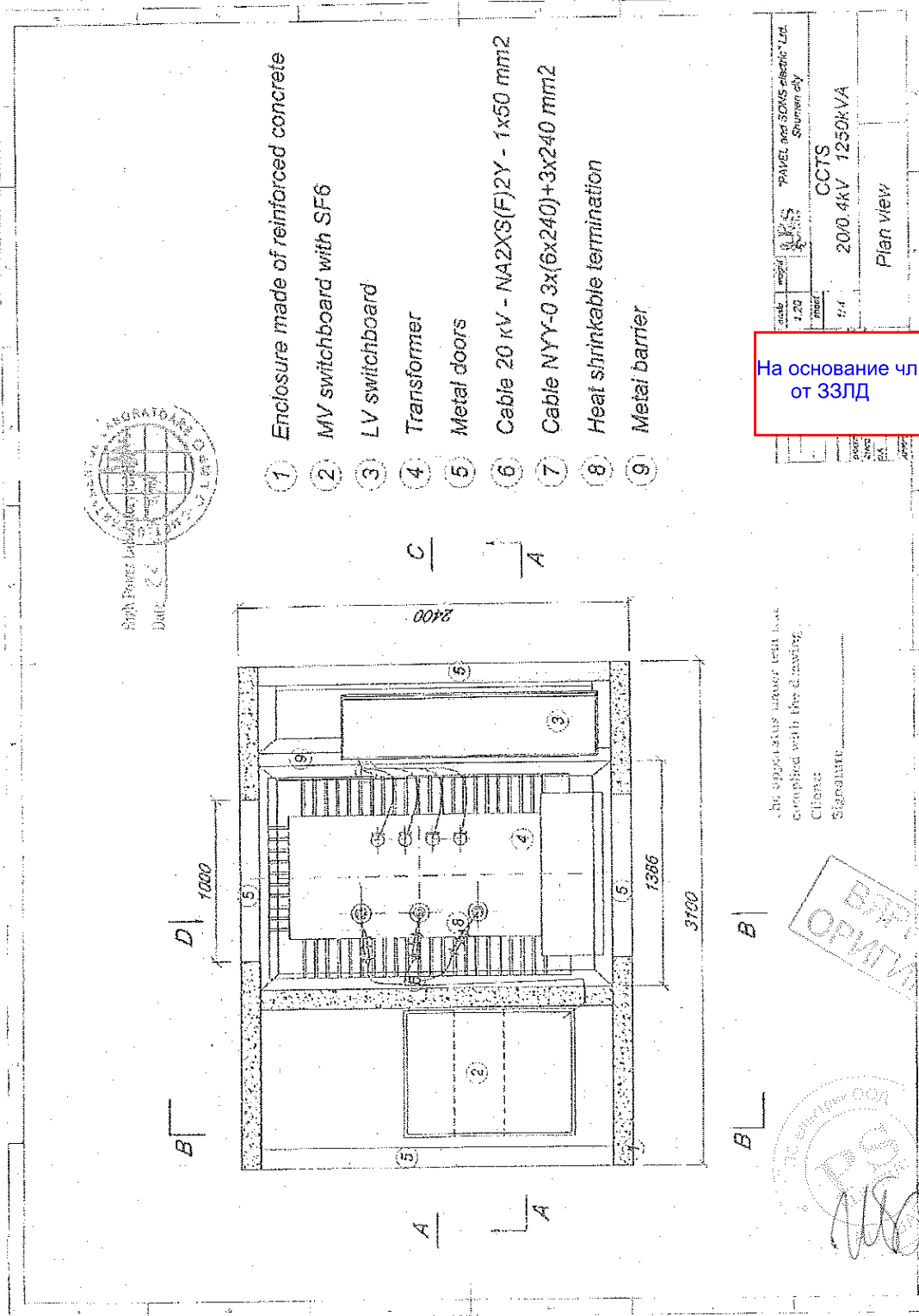
PREPARED:  
CHECKED:

На основание чл. 2  
от ЗЗЛД



Produce of concrete complete transformer substation, distribution panels and equipment for the power engineering

Page 2 of 2



- ① Enclosure made of reinforced concrete
- ② MV switchboard with SF6
- ③ LV switchboard
- ④ Transformer
- ⑤ Metal doors
- ⑥ Cable 20 kV - NA2XS(F)2Y - 1x50 mm2
- ⑦ Cable NYY-0 3x(6x240)+3x240 mm2
- ⑧ Heat shrinkable termination
- ⑨ Metal barrier

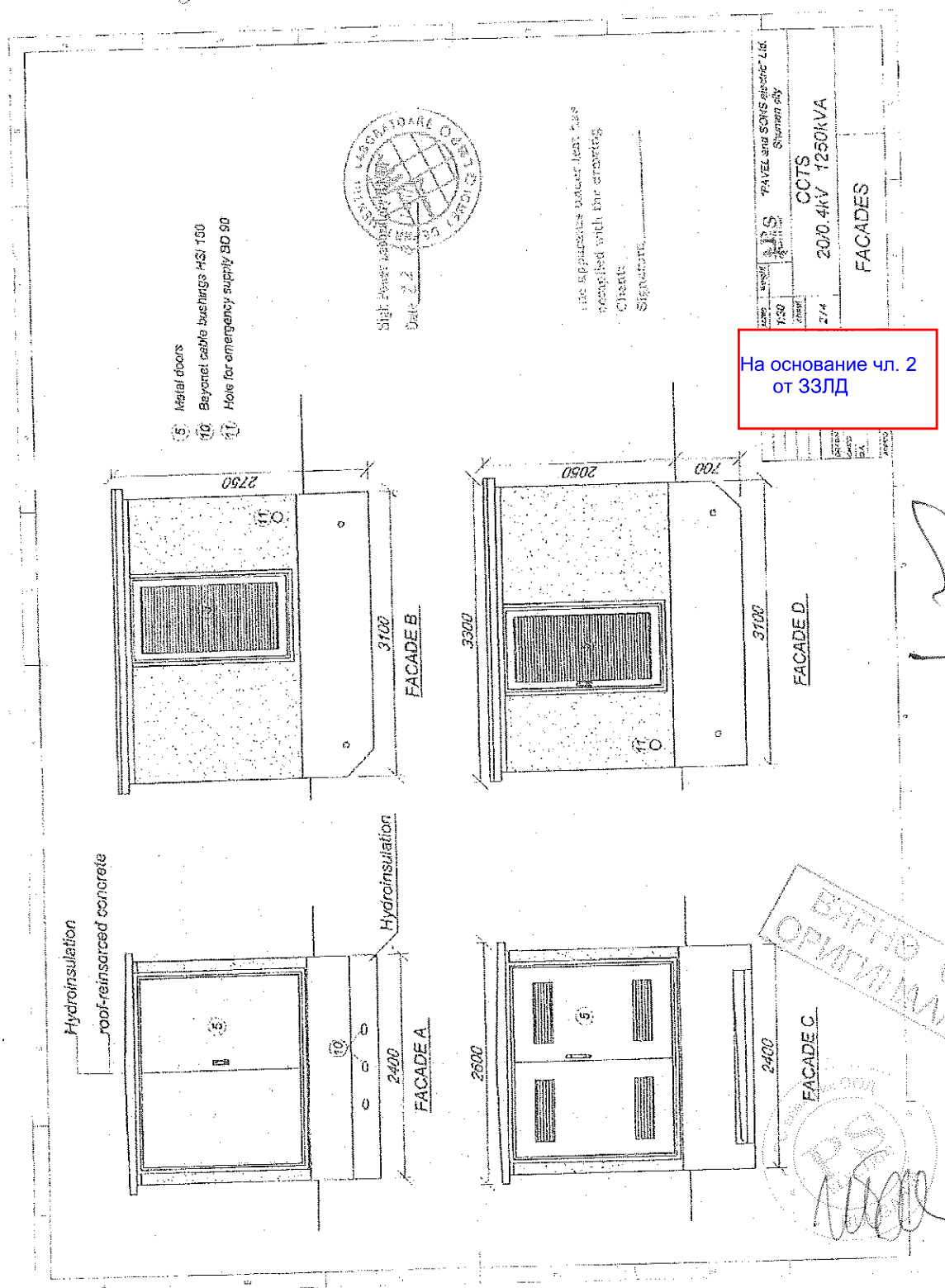
Model	2.20	Client	PHIET, and SIKAS electric Ltd. Shumen city
Year	2011	Contract	CCTS
Scale	1:1	Voltage	20/0.4KV 1250kVA
Plan view			

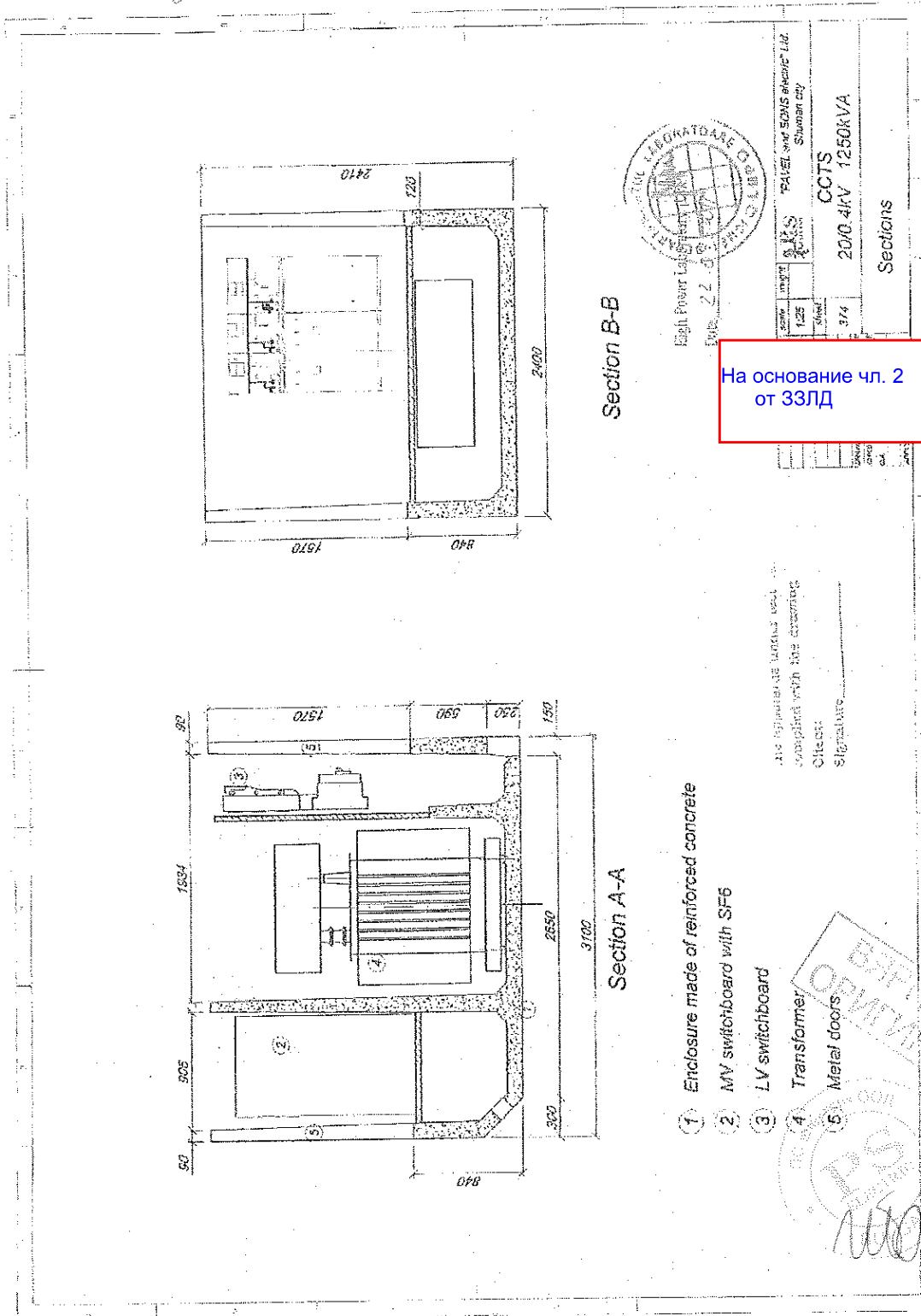
На основание чл. 2 от ЗЗЛД

The apparatus under test has been checked with the drawing.  
 Client: \_\_\_\_\_  
 Signature: \_\_\_\_\_

ВАРНО С ОРБИТРАНА

INTEGRATED LABORATORY

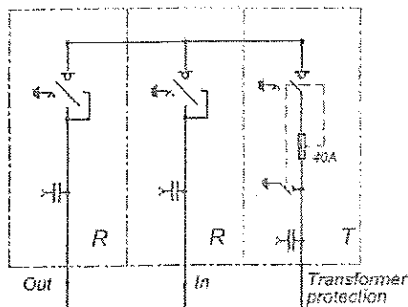




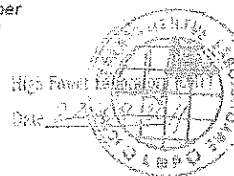
На основание чл. 2 от ЗЗЛД

- 1 Enclosure made of reinforced concrete
- 2 MV switchboard with SF6
- 3 LV switchboard
- 4 Transformer
- 5 Metal doors

RMU 8DJH RRT



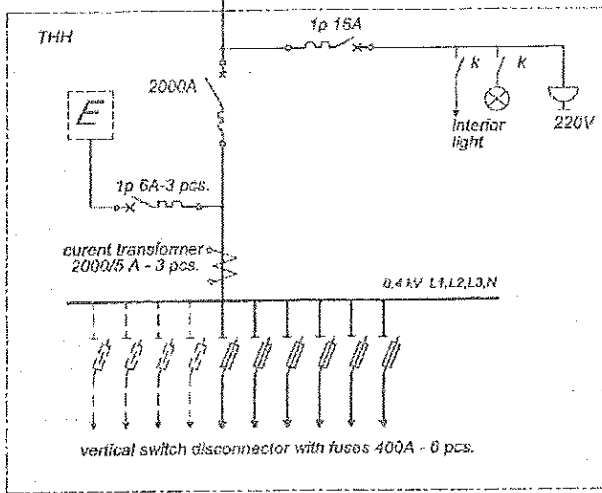
The apparatus under test has  
 complied with the drawing  
 Client: \_\_\_\_\_  
 Signature: \_\_\_\_\_



HA2XS(F)2Y 3x(1x50)mm<sup>2</sup>

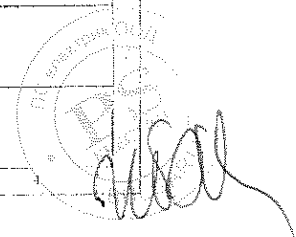
Oil Transformer 1250 kVA  
 20/0.4 kV

NYY 0 3x(6x(1x240))+3x(1x240)mm<sup>2</sup>



ВЪРХО С  
 ОПИВНА

scale	weight	"PAVEL and SONS electric" Ltd. Shumen city
sheet		
CCTS 20/0.4kV 1250kVA		Circuit diagram
DRAWN	На основание чл. 2 от ЗЗЛД	
CHKD		
QA		
APPROV		





RESEARCH-DEVELOPMENT AND TESTING NATIONAL  
INSTITUTE FOR ELECTRICAL ENGINEERING

# ICMET CRAIOVA HIGH POWER DIVISION

HIGH POWER LABORATORY

“Ovidiu Rarinca”

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acreditat pentru  
INCERCARE



SR EN ISO/CEI 17025:2005  
CERTIFICAT DE ACREDITARE  
nr. LI 004/2010

## TEST REPORT No. 11188

**CUSTOMER:** “PAVEL and SONS electric” Ltd  
12 Madara Blvd. 9700 Shumen, Bulgaria

**MANUFACTURER:** “PAVEL and SONS electric” Ltd  
12 Madara Blvd. 9700 Shumen, Bulgaria

**TESTED PRODUCT:** 20/0.4 kV, 800 kVA Prefabricated Transformer  
Substation

**REFERENCE STANDARD:** IEC 62271-202/2006 Annex A

**TEST PERFORMED:** Internal arc test

**TEST DATE:** 18.07.2011

**TEST RESULT:** Passed the test for IAC - A



Report has 15 pages and it is edited in 4 copies from which copy 1 for laboratory and copies 2, 3 and 4 for customer.

**HEAD OF HIGH POWER DIVISION:**

**HEAD OF LABORATORY:**

Dr. Eng.

На основание чл. 2  
от ЗЗЛД

**DATE OF ISSUE:** 04.08.2011

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**Content**

1.	Identification of the test product	3
2.	Technical characteristics established by producer	3
3.	Tests program	3
4.	Responsible for tests	3
5.	Present at the tests	3
6.	Test report documentation	3
7.	Data of testing and measuring circuit	4
8.	Values obtained on test	4
9.	Test results	5
	Photos	6
	Technical specification	8
	Drawings	10
	Oscillograms	14

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BAPHO · C  
CRAIOVA

PS  
ELECTRIC  
BUL  
*Handwritten signature*

*Handwritten scribble*

**1. IDENTIFICATION OF APPARATUS**

Type	Substation	MV Switchgear (RMU Siemens)
Serial number/year	CCTS 20/0.4 kV/1x800 kVA	8DJH RRT
Technical specification/Drawing	11320/2011	CV 815242-00006/001/2011
Contract No.:	See page 8 and 9 / See pages 10 to 13	
Product receiving date:	705.2/8521/03.05.2011	
Product condition at receiving:	18.07.2011	
	New	

**2. TECHNICAL CHARACTERISTICS ESTABLISHED BY PRODUCER**

	Substation	MV Switchgear
Rated power	800 kVA	-
Rated voltage	20/0.4 kV	24 kV
Rated current	23.09/1154.7 A	630 A
Rated frequency	50 Hz	50 Hz
Rated short - time withstand current:		
- peak value	40 kA	40 kA
- r.m.s. value	16 kA	16 kA
Rated duration of short-circuit (t <sub>k</sub> )	1 s	1 s
IAC Classification	A	AF
Internal fault current	16 kA	16 kA
Rated duration of internal fault current	1 s	1 s

**3. TESTS PROGRAM**

The internal arc test was performed on MV Switchgear (RMU Siemens) containing:

- Cell 1 Incoming / Outgoing;
- Cell 2 Incoming / Outgoing;
- Cell 3 Transformer protection.

3.1 Current calibration test.

3.2 Internal arc test with arc initiation point between R and S phases on input terminals of cell 2.

Arcing point was initiated by means of a copper wire having 0.5 mm diameter.

Test parameters were:  $I_p = 40 \times 0.87 = 34.8$  kA,  $I_k = 16 \times 0.87 = 13.92$  kA,  $t_k = 1$  s and three-phase applied voltage on the input terminals of cell 1.

The combined vertical and horizontal indicators were placed in front of the MV Switchgear at 300 mm distance with doors of MV compartment opened, in front of the closed doors and windows of the transformers compartments at 100 mm distance.

Tests are performed according to own procedure PT 03.07.

**4. RESPONSIBLE FOR TESTS:**

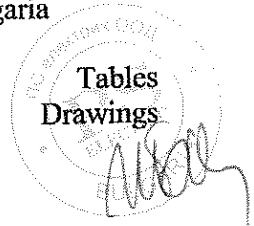
Eng. Ilie Sboru

**5. PRESENT AT THE TESTS:**

Eng. Dimitar Dimitrov from "PAVEL and SONS electric" Ltd., Bulgaria

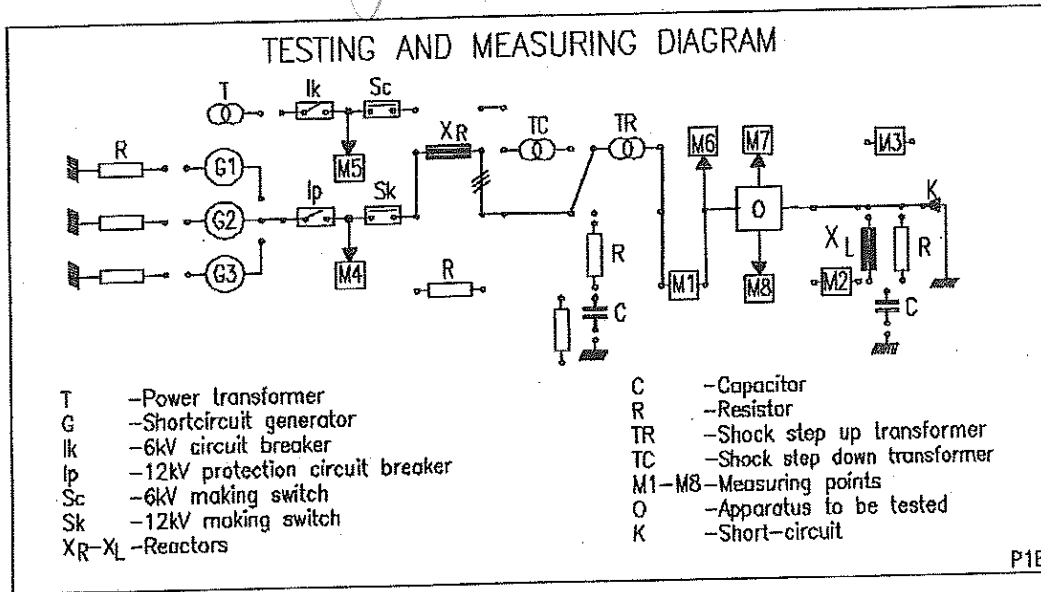
**6. TEST REPORT DOCUMENTATION**

Oscillograms	2 ;	Tables	3 ;
Photos	3 ;	Drawings	4 .



*Ilie*

7. DATA OF TESTING AND MEASURING CIRCUIT



P1E

Table 1

Number of phases	3	
Power supply / Connection	G1 / Δ	
Transformer / Ratio	TR 7, 8, 9 / 1.07	
Earthing	Power supply	-
	Apparatus	Net earthing connection
Reactor [Ω]	0.133	
Power factor	<0.15	
M1 - Test current - Rogowski coils 30 kA/V		
M4 - Power supply voltage - Voltage transformer 15000 V/100 V		
M6 - Test voltage - Voltage divider 120 kV/60 V		
M8 - Data acquisition system TRAS 1 - 16 bit, 16 channels		

8. INTERNAL ARC TEST

The test results are presented in table 2.

Table 2

Oscillogram No.	URS	I <sub>pR</sub>	I <sub>tR</sub>	t <sub>t</sub> [sec.]	I <sub>t med</sub> [kA]	DURS	Remarks
	UST	I <sub>pS</sub>	I <sub>tR</sub>			DUST	
	UTR	I <sub>pT</sub>	I <sub>tT</sub>			DUTR	
	[kV]	[kA]	[kA]			[V]	
80891/2011	6.3	35.2	14.3	0.17	14.3	-	Current calibration
	6.3	35.2	14.3			-	
	6.3	-	-			-	
80892/2011	6.4	33.7	14.3	1	14.3	630	Internal arc test for IAC-AF
	6.4	33.7	14.3			-	
	6.4	-	-			-	

Measurements were performed with extended uncertainty of: 1% for voltage; 1.5% for current; 0.5% for time and the confidence level P = 95 %.

**8.1. Symbols used in tables and oscillograms**

- $I_R I_S I_T$  = Short-circuit current
- $I_{pR} I_{pS} I_{pT}$  = Peak values of short-time withstand currents on the phases R, S, T.
- $I_{tR} I_{tS} I_{tT}$  = R.m.s. values of short - time withstand currents on the phases R, S, T.
- $t_t$  = The duration of short - circuit
- $I_t \text{ med}$  = Effective current mean value
- DURS, DUST, DUTR = Voltage drop on arc
- URS, UST, UTR = No-load applied voltage

**8.2 Opinions and interpretations**

1. Aspect of the prefabricated transformer substation and indicators in the test circuit before test are presented in photo 1 and 2.
2. Aspect of the prefabricated transformer substation and indicators in the test circuit after test are presented in photo 3.
3. The indicators for IAC-AF were made of black cretonne ( $140\text{g/m}^2$ )
4. During the test:
  - the doors of MV Switchgear and the doors Power Transformer compartment didn't open ;
  - parts from the Substation and MV Switchgear didn't fly off;
  - the indicators didn't ignite;
  - the earthing connections are effective.

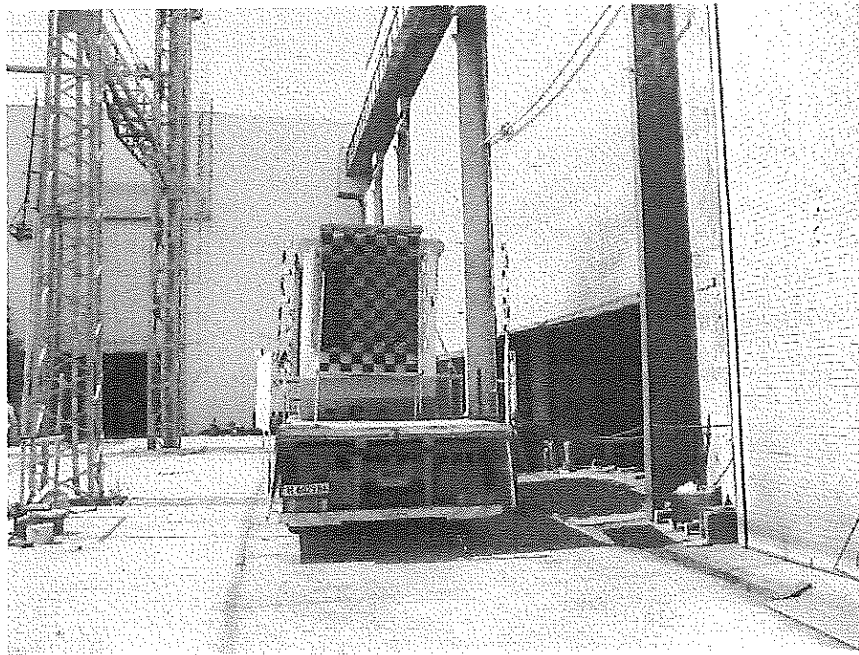
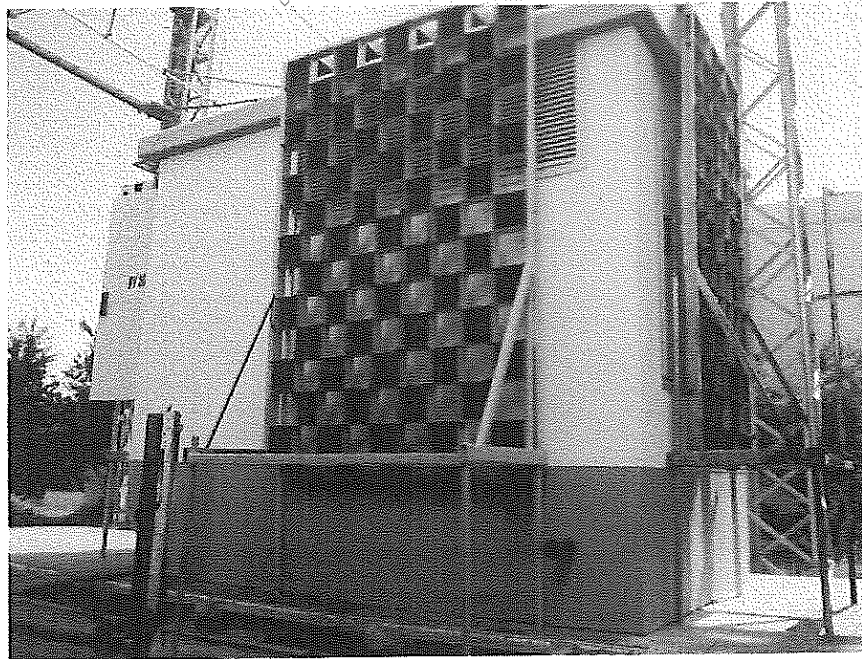
**8.3 Assessment of the test result**

Criterion	Result
1. The doors, covers etc. correctly secured do not open	Fulfilled
2. No fragmentation of the enclosure occurs during test	Fulfilled
3. Arcing does not cause holes in the roof and in the accessible sides up to a height of 2 m	Fulfilled
4. Indicators do not ignite due to the effect of hot gases	Fulfilled
5. The enclosure remains connected to its earthing point	Fulfilled

**9. TEST RESULT: PASSED THE TEST**

ВЕРНО  
ОПЫТНИКА





ВЯРНО С  
ОРИГИНАЛА

Photos 1, 2 - Aspect of the prefabricated transformer substation and indicators  
in the test circuit before test

ICMET Craiova  
2011/11/18  
[Signature]

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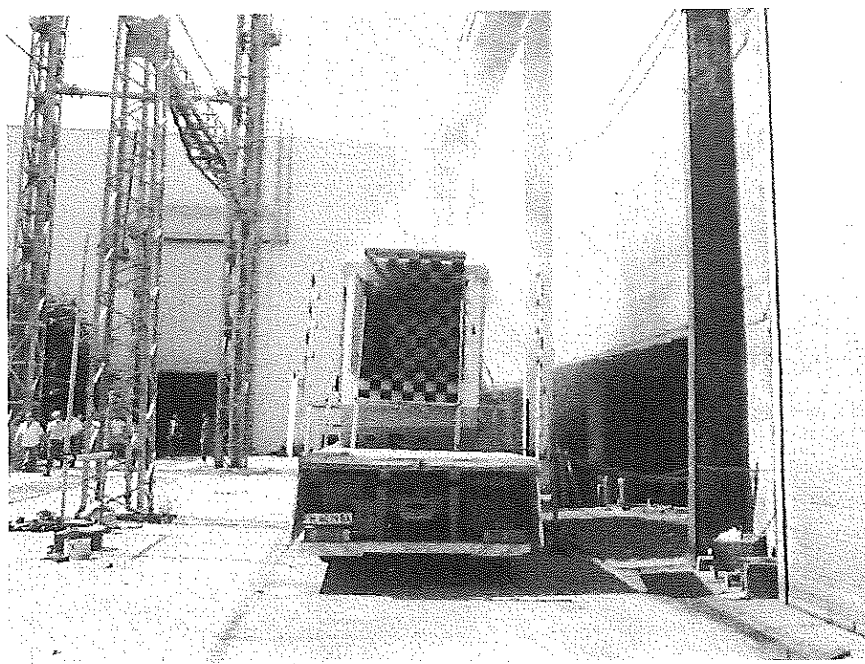


Photo 3 - Aspect of the prefabricated transformer substation and indicators in the test circuit after test

B

BRPHO C  
OPRATYVANA

ICMET Craiova  
[Signature]

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## TECHNICAL SPECIFICATION

PREFABRICATED TRANSFORMER SUBSTATION MADE OF REINFORCED CONCRETE

TYPE: CCTS 20/0.4KV 1x800KVA  
 PRODUCER: "PAVEL & SONS ELECTRIC" LTD. , SHUMEN, BULGARIA  
 FACTORY NUMBER: 11320

CASING: THE CASING OF THE CONCRETE PREFABRICATED SUBSTATION IS MADE OF WATER -TIGHT REINFORCED CONCRETE B45;

1.1. MEASUREMENTS ( ROOF INCLUDED ) :

L= 3200MM;B=2100MM;H=2600MM;

WEIGHT WITH TRANSFORMERS: 12 100KG;

EQUIPMENT:

2.1. EQUIPMENT ON THE MIDDLE VOLTAGE SIDE:

COMPLETE DISTRIBUTING DEVICE - 8DJH RRT SIEMENS, WHICH CONSISTS OF CABLE "IN" 20KV, CABLE "OUT" AND "TRANSFORMER PROTECTION".

2.2. INTERCONNECTIONS 20 KV FROM MV SWITCHBOARD TO TRANSFORMERS NA2X(F)2Y 3x1x50MM<sup>2</sup>.

2.3. TRANSFORMER:

TRANSFORMER 20/0.4KV 800 KVA

DIMENSIONS:

L=1600MM.

W=920MM.

H=1520MM.

2.4. CONNECTING CABLE FROM TRANSFORMERS TO LV SWITCHBOARD - NYY 3x(4x240MM<sup>2</sup>)+2x240MM<sup>2</sup>.

2.5. MAIN CIRCUIT - BREAKERS OF LV SWITCHBOARD - AUTOMATIC CIRCUIT - BREAKERS SIEMENS 1250A.

2.6. TERMINALS OF LV SWITCHBOARD - VERTICAL SWITCH DISCONNECTOR WITH FUSES MULTIVERT 400A - 6 PSC. "M.SCHNEIDER" AUSTRIA

2.7. COPPER BARS' SYSTEM:

DISTRIBUTING RIMS - COPPER BARS 80x10MM.

CONNECTION BETWEEN MAIN CIRCUIT - BREAKER AND DISTRIBUTING RIMS - COPPER BARS 50x15MM.

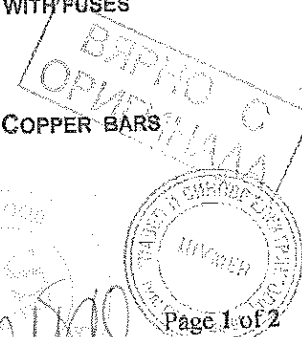
CURRENT TRANSFORMER:

CT-4 1250/5A

5VA GRADE OF FIT 0.5

ITH MAX 50KA.

Produce of concrete complete transformer substation, distribution panels and equipment for the power engineering



Main office address: 9700 Shumen, Blvd 12 Madara; tel: +359 54 87 44 99; fax: +359 54 87 45 00

Sofia office address: 1000 Sofia Blvd 129 Vitoshka; tel: +359 2 952 24 05; fax: +359 2 952 67 20

e-mail: office@pavel-sons.com web: www.pavel-sons.com



3. EARTHING INSTALATION:

INTERNAL CONNECTIONS- CONDUCTOR H07V-K 1x50MM2.

CONNECTION BETWEEN NEUTRAL COPPER BAR AND POTENTIAL COPPER BAR – CONDUCTOR H07V-K 1x150MM2.

CONNECTION TO EXTERNAL EARTHING CONTOUR –H07V-K 1x50MM2.

RATINGS OF PREFABRICATED SUBSTATION:

- RATED VOLTAGE ON MV SIDE – 24kV;
- OPERATED VOLTAGE ON MV SIDE – 20kV;
- RATED INSULATION LEVEL ON MV SIDE -50kV;
- RATED LIGHTNING IMPULSE WITHSTAND VOLTAGE ON MV SIDE-125kV;
- RATED VOLTAGE ON LV SIDE – 0.4kV;
- RATED INSULATION LEVEL ON LV SIDE -2,5kV;
- RATED NORMAL CURRENT OF MV BUSBAR-400A;
- RATED LIGHTNING IMPULSE WITHSTAND VOLTAGE ON LV SIDE- 5kV;
- RATED FEEDER CURRENT -630A;
- RATED FEEDER CURRENT FOR TRANSFORMER PANELS – 200A;
- MAIN CIRCUIT BREAKERS ON LV SWITCHBOARD-1250A;
- RATED SHORT TIME WITHSTAND CURRENT ON MV SIDE -20KA/1s;
- PEAK WITHSTAND RATED CURRENT – ON MV SIDE-50KA;
- SHORT TIME WITHSTAND CURRENT ON EARTHING CIRCUIT -16KA

DATE: 11.07.2011  
SHUMEN

PREPARED: ENG.  
CHECKED: ENG.

На основание чл. 2  
от ЗЗЛД

ВАРНО С  
ОРИГИНАЛ

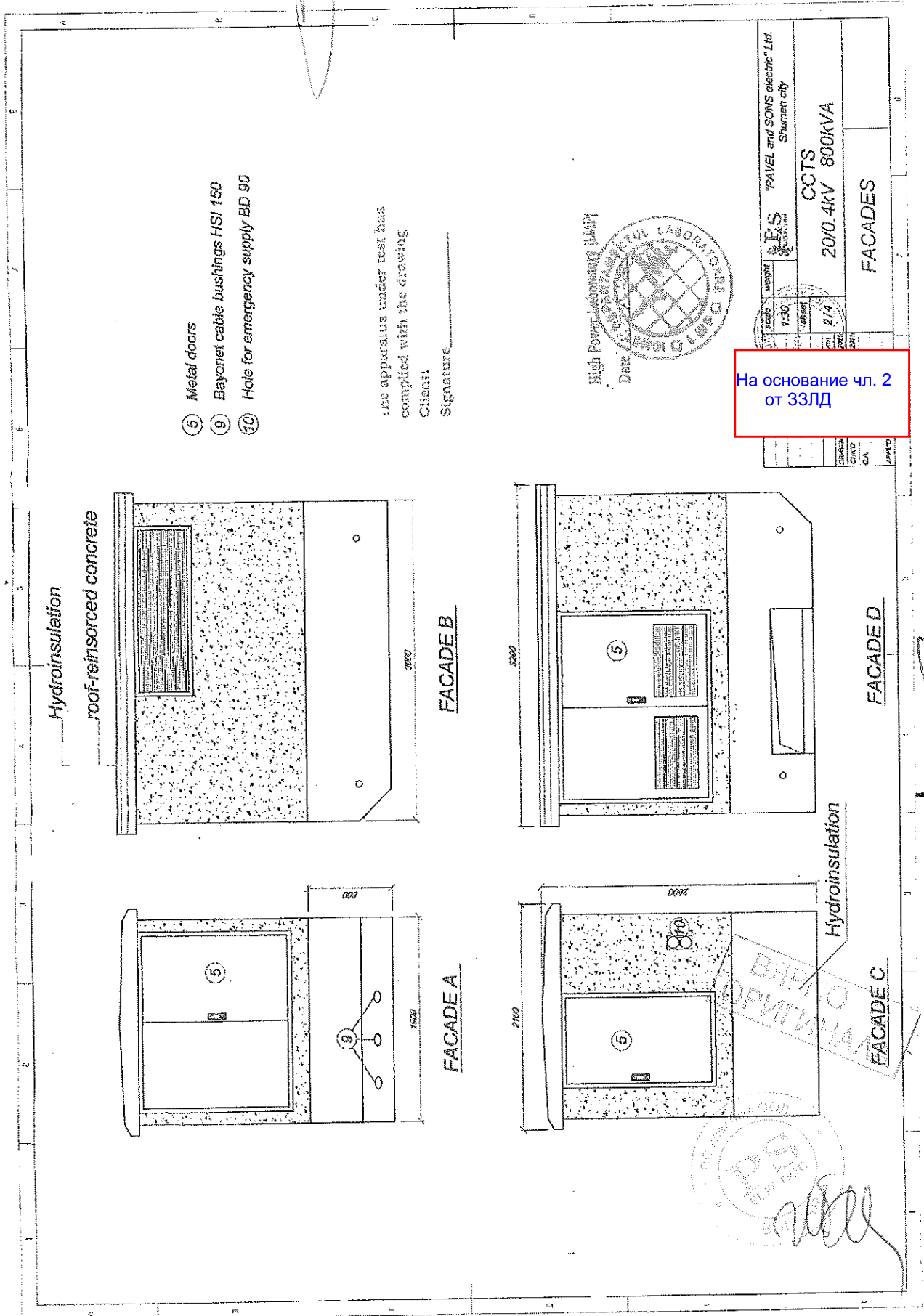


Page 2 of 2

Produce of concrete complete transformer substation, distribution panels and equipment for the power engineering

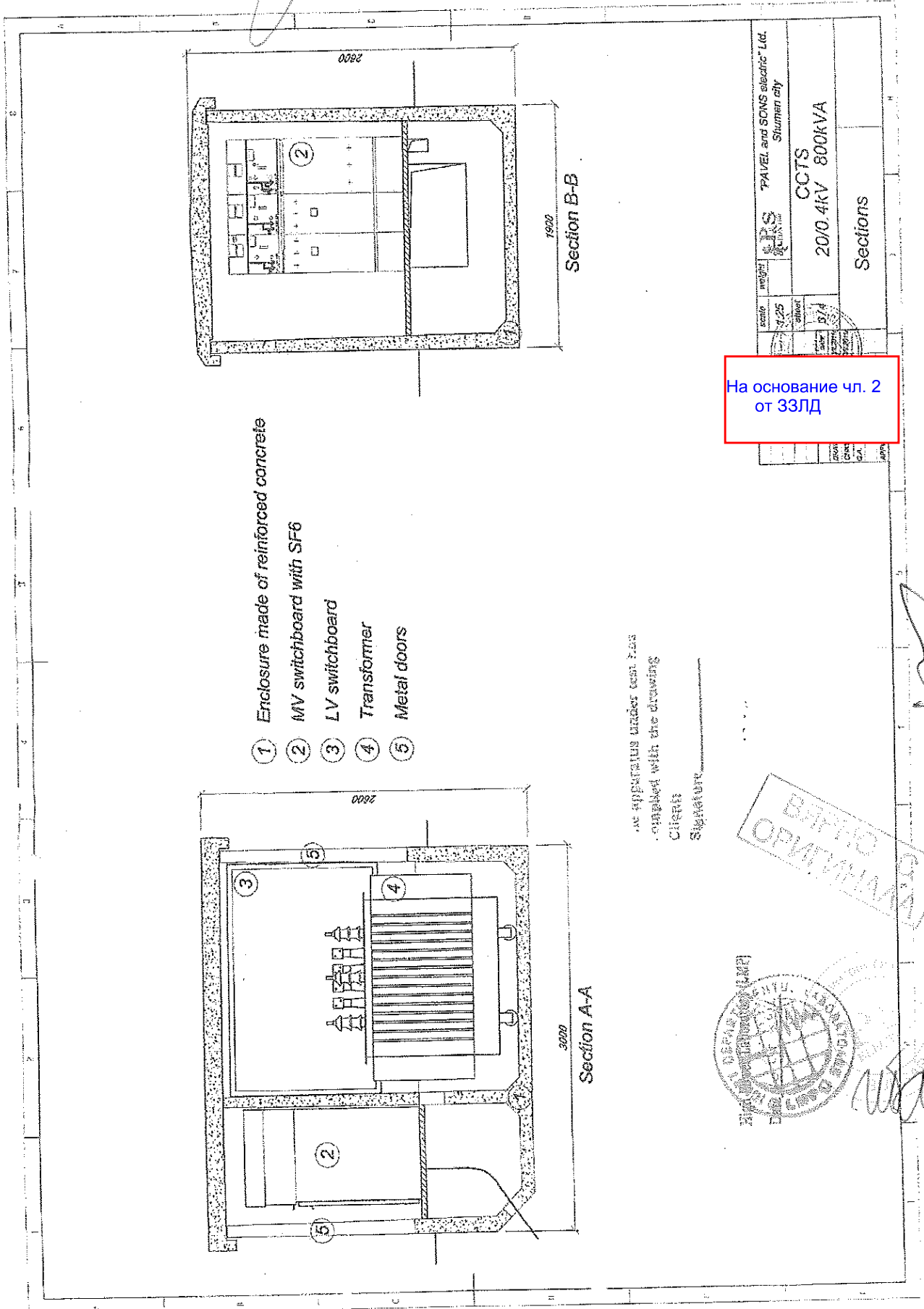






На основание чл. 2 от ЗЗЛД

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are appearing under test has  
 equipped with the drawing  
 Client: \_\_\_\_\_  
 Signature: \_\_\_\_\_

На основание чл. 2  
 от ЗЗЛД

Stamp: ВАРНО ОРИГИНАЛ

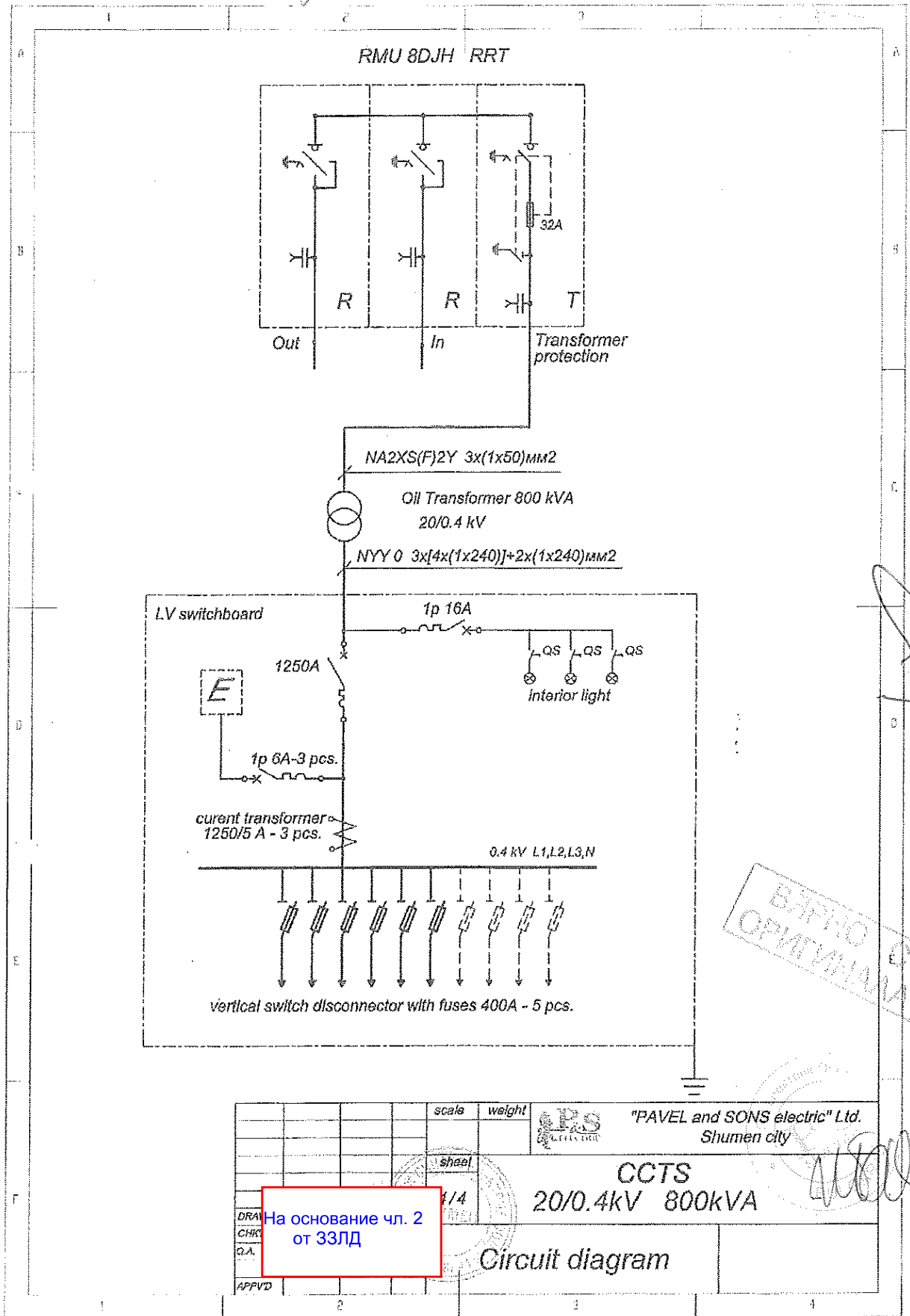
Stamp: LABORATORY FOR TESTING OF ELECTRICAL EQUIPMENT


Stamp: PAVEL and SONS electric Ltd. Shumen city

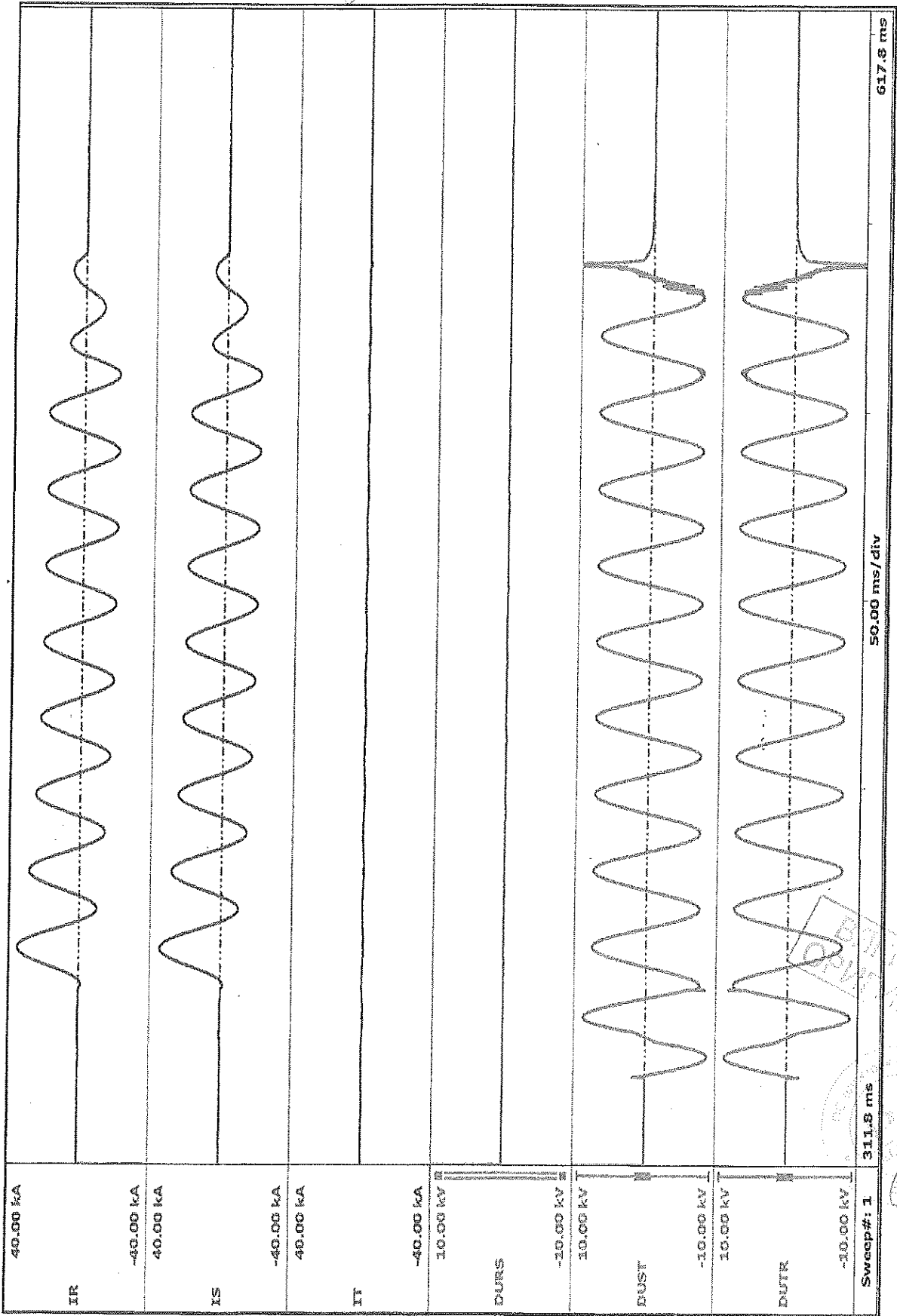
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Stamp: Sections

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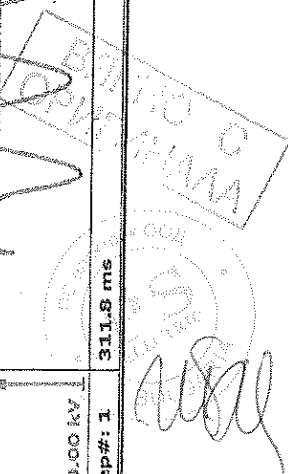


		scale	weight	 "PAVEL and SONS electric" Ltd. Shumen city
		sheet	1/4	
DRAW CHK Q.A. APPVD	На основание чл. 2 от ЗЗЛД	<b>CCTS</b> 20/0.4KV 800kVA		Circuit diagram

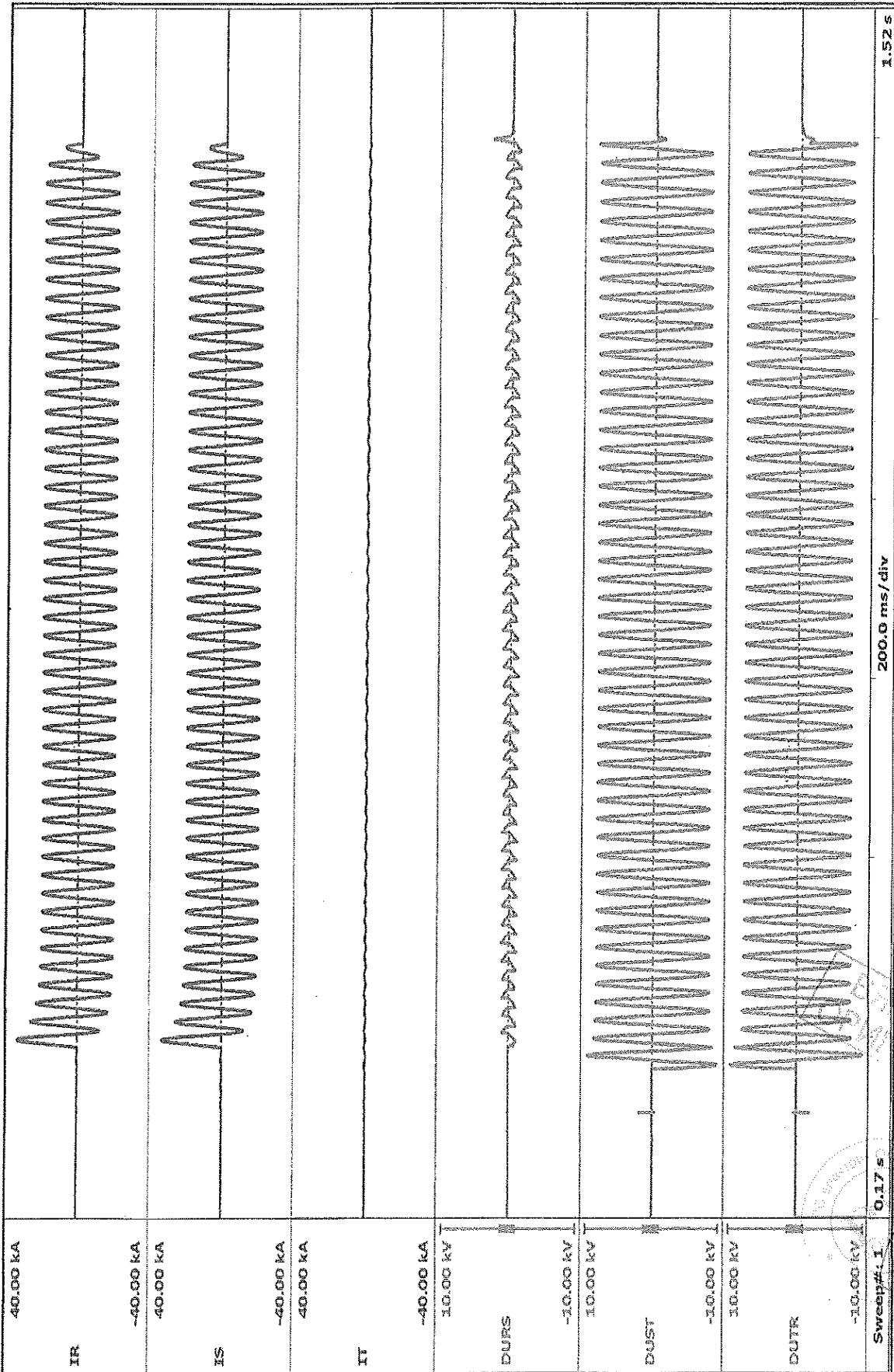


Oscillogram No. 80891 / 2011

*BB*



*www*



Oscillogram No. 80892 / 2011

200.0 ms/div

1.52 s

0.17 s



RESEARCH-DEVELOPMENT AND TESTING NATIONAL  
INSTITUTE FOR ELECTRICAL ENGINEERING

**ICMET CRAIOVA  
ROMANIA**

**"Ovidiu Rarinca" HIGH POWER LABORATORY- LMP** INCERCARE  
200515-CRAIOVA Calea Bucuresti Nr. 144 ROMANIA  
Phone: +40 351 402427; Fax: +40 351 404 890; +40 251 415 482  
E-mail: imp@icmet.ro



SR EN ISO/CEI 17025:2001  
CERTIFICAT DE ACREDITARE  
Nr. 004 - L

**TEST REPORT  
No. 9912 / June 22, 2007**

**Tested product:** 20/0.4 kV, 800 kVA Complete transformer substation

**Test:** Internal arc test

**Test method:** According to IEC 62271-202/2006, Annex A

**Test date:** June 22, 2007

**Test result:** Passed the test.

**Head of LMP:** Responsible for quality assurance: Responsible for test group:

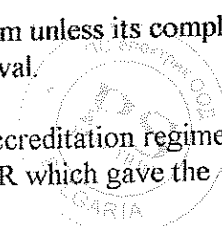
На основание чл. 2  
от ЗЗЛД

**Test witness:** Eng. Velimir Dimitrov and Eng. Dimitar Donchev from Pavel & Sons

Report has 15 pages and it is edited in 4 copies from which 3 copies for customer.

**Note:**

1. Publication or reproduction of the contents of this report in any other form unless its complete photocopying is not allowed without laboratory and RENAR writing approval.
2. Results refer to test product only.
3. Accreditation of the laboratory or any of its Test Reports issued under accreditation regime do not constitute or do not imply themselves an approval of the product by RENAR which gave the accreditation or any other body.



P101-01ae

**CUSTOMER:** PAVEL & SONS  
Central office: 9700, Shumen BULGARIA

**MANUFACTURER:** PAVEL & SONS  
Central office: 9700, Shumen BULGARIA

**IDENTIFICATION OF APPARATUS**

	Substation	MV switchboard (Siemens)	LV Switchboard
Type	BM 01A31	8DJ20	
Serial number/Year	07057 /2007	CV766249000020/001/ 2007	
Technical documentation	-		
Drawing	BM 01A31		
Order no.:	Contract No. 5021/ 11.06.2007		
Product receiving date:	April, 2007		
Product condition at receiving:	New		

**PERFORMANCES ESTABLISHED BY PRODUCER**

	Substation	MV switchboard	LV Switchboard
Rated voltage	24 kV	24 kV	400 V
Rated power	800 KVA	-	-
Rated current	-	400 A	1250 A
Rated frequency	50 Hz	50 Hz	50 Hz
Rated short-time withstand current			
- peak value (Ip)	40 kA	40 kA	84 kA
- r.m.s. value (Ik)	16 kA	16 kA	40 kA
Rated duration of short-circuit (tk)	1 s	1 s	1 s
Classification IAC	B	B	B

**TEST PROGRAM**

1. One three phase current calibration test.
2. One internal arc test on MV switchboard type 8DJ20 with two phases (RS) arc initiation point on input terminals by means of a copper wire having 0.5 mm diameter at parameters: Ip = 40 kA, Ik = 16 kA, tk = 1 s and 6 kV three-phase applied voltage on output terminals of MV switchboard type 8DJ20. Supply was made with cooper cables of 1x180 mm<sup>2</sup> brought by customer.

Test circuit is presented at page 7.

The combined vertical and horizontal indicators were placed in front of the door of MV compartment and in front of the door and the window of power transformer compartment and in front of LV compartment at 100 mm distance corresponding to accessibility class B.

The tests were performed according to own technical procedure PT – 03.07.

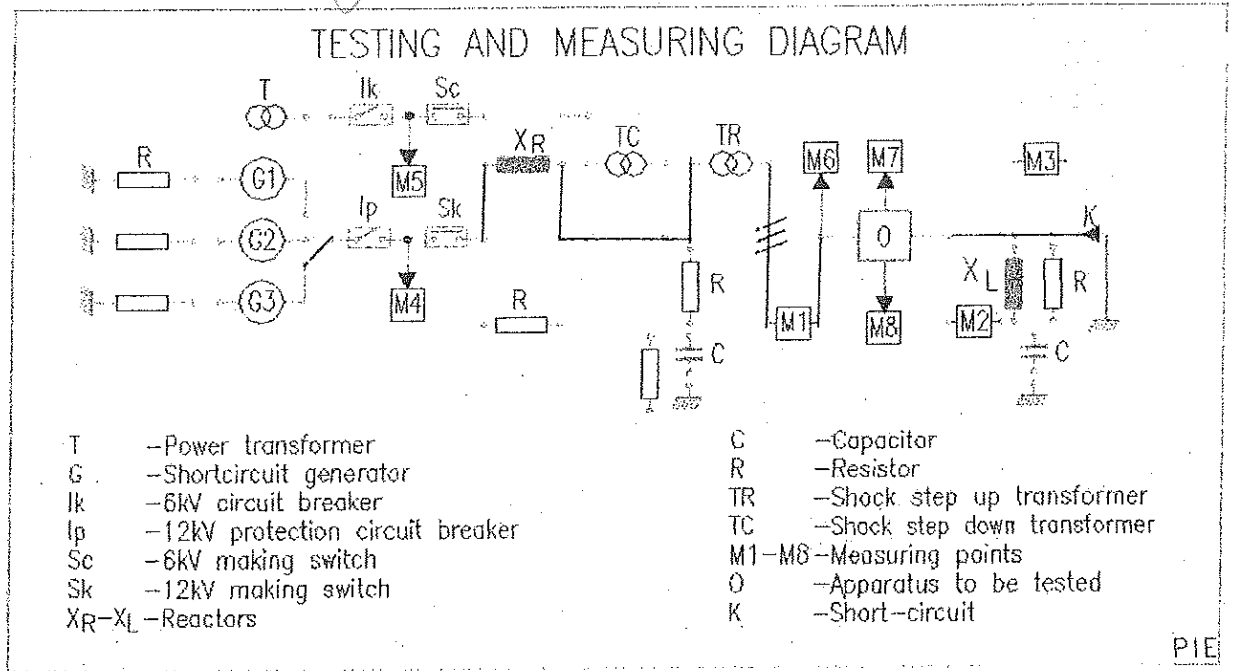
**TEST REPORT DOCUMENTATION:** Oscillograms 2 ; Tables  
Photos 3 ; Drawings

p102-01E



W





### DATA OF TESTING AND MEASURING CIRCUIT

Table 1

Test duty	Internal arc test on MV compartment	
Phases number	3	
Source/ connection	G3 / Δ	
Transformer/report	TR 4, 5, 6 / 1.07	
Earthing	Source	-
	Apparatus	Net earthing connection
Reactor	[mΩ]	133, 133, 133
Power	factor	< 0.15
M1 - Apparatus current - Rogowski coil 70 kA		
M4 - Supply source voltage - Voltage transformer 15000 V/100 V		
M6 - Apparatus voltage - Voltage transformer 35000 V / 100 V		

ВЯРНО С  
 ОПРИТНАТА



## VALUES OBTAINED ON TESTS

Table 2

Oscillogram No.	$U_{RS}$	$I_{pR}$	$I_{rR}$	$I_{t,med.}$	$t_t$	$DU_{RS}$	Remarks
	$U_{ST}$	$I_{pS}$	$I_{rS}$			$DU_{ST}$	
	$U_{TR}$ [kV]	$I_{pT}$ [kA]	$I_{rT}$ [kA]	[kA]	[s]	$DU_{TR}$ [V]	
69404/2007	3	20.23	8	8	0.235	-	Current calibration
	3	20.23	8			-	
	3	-	-			-	
69406/2007	6.2	40.7	17	17	1	660	Internal arc test on Medium voltage compartment
	6.2	-	17			-	
	6.2	-	-			-	

The measurements were performed with uncertainty of: 3 % for voltages-; 3% for currents; 2.5% for time and the confidence level  $P = 95\%$ .

## SIMBOLS USED IN TABLES AND OSCILLOGRAMS

- $I_{pR}$   $I_{pS}$   $I_{pT}$  = Peak values of currents on the phases R, S, T.  
 $I_{rR}$   $I_{rS}$   $I_{rT}$  = R.m.s. values of currents on the phases R, S, T.  
 $t_t$  = The duration of short - circuit  
 $I_{t,med}$  = R.m.s. current mean value  
 $DU_{RS}$ ,  $DU_{ST}$ ,  $DU_{TR}$  = Voltage drop on arc  
 $U_{RS}$ ,  $U_{ST}$ ,  $U_{TR}$  = No-load applied voltage

## REMARKS:

- Aspect of the Concrete Transformer Substation and the indicators in test circuit is presented in photos 1 and 2..
- Aspect of the Concrete Transformer Substation after test is presented in photo 3.
- For accessibility class B, the indicators were made of black cotton ( $55 \text{ g/m}^2$ ).

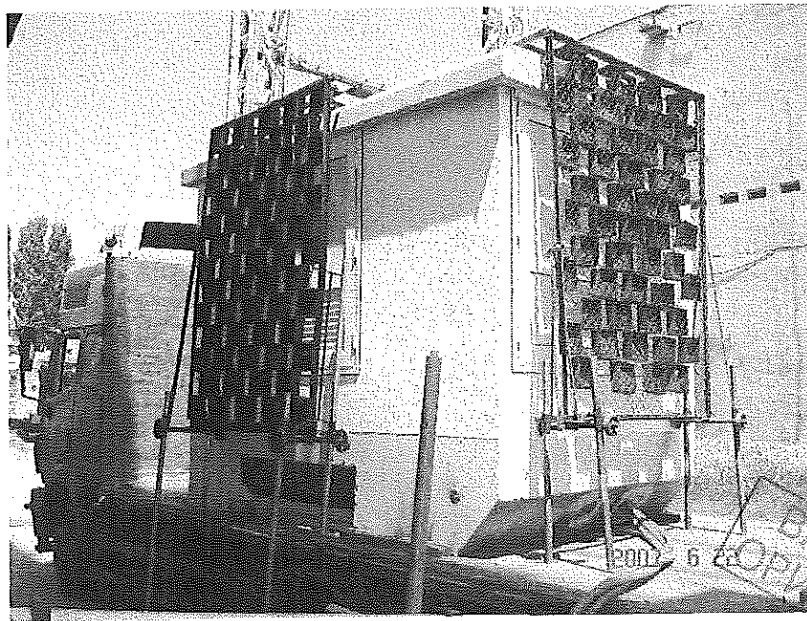
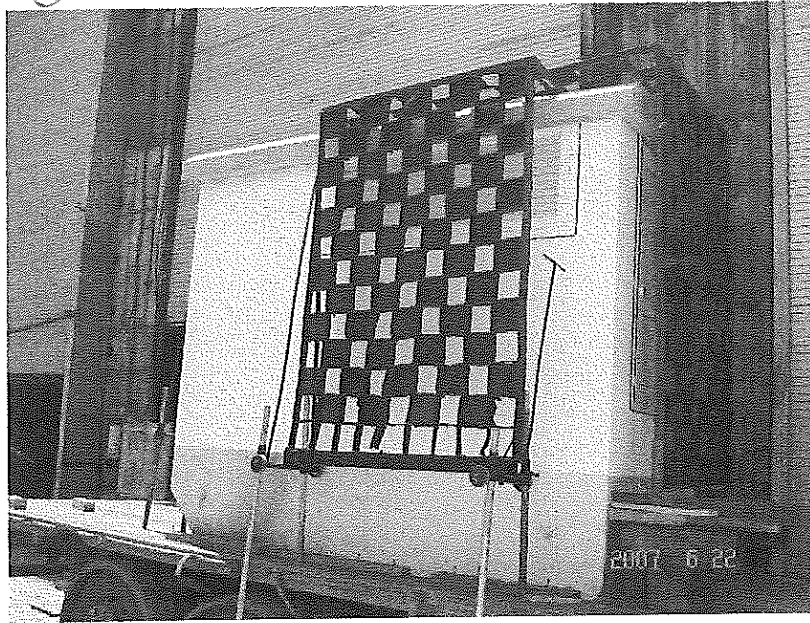
## ASSESSMENT OF THE TESTS

Table 3

Criterion	Result
1. The doors*, covers etc. correctly secured do not open	Fulfilled
2. Parts which may cause a hazard do not fly off	Fulfilled
3. Arcing does not cause holes to develop in the freely accessible external parts of the enclosure as a result of burning or other effects	Fulfilled
4. The indicators arranged vertically do not ignite	Fulfilled
5. The indicators arranged horizontally do not ignite	Fulfilled
6. All earthing connections are still effective	Fulfilled

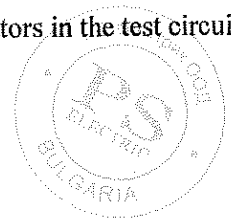
\* The doors belong to the prefabricated substation and cubicles.





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Photos 1 and 2 – Aspect of the complete transformer substation and indicators in the test circuit



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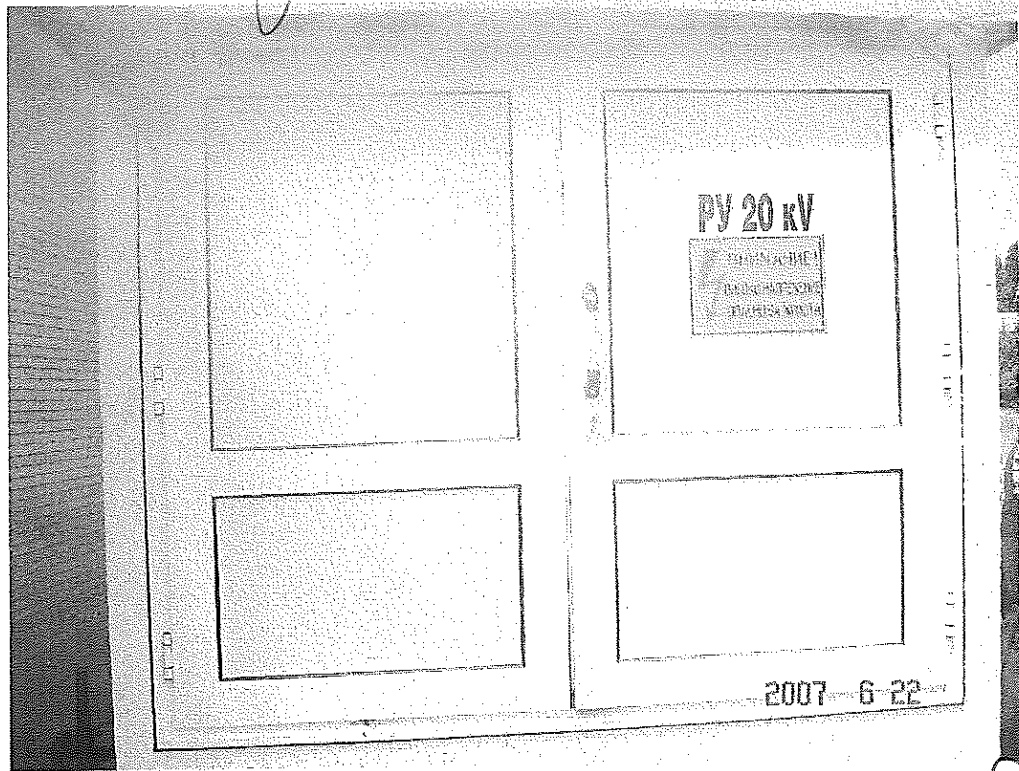
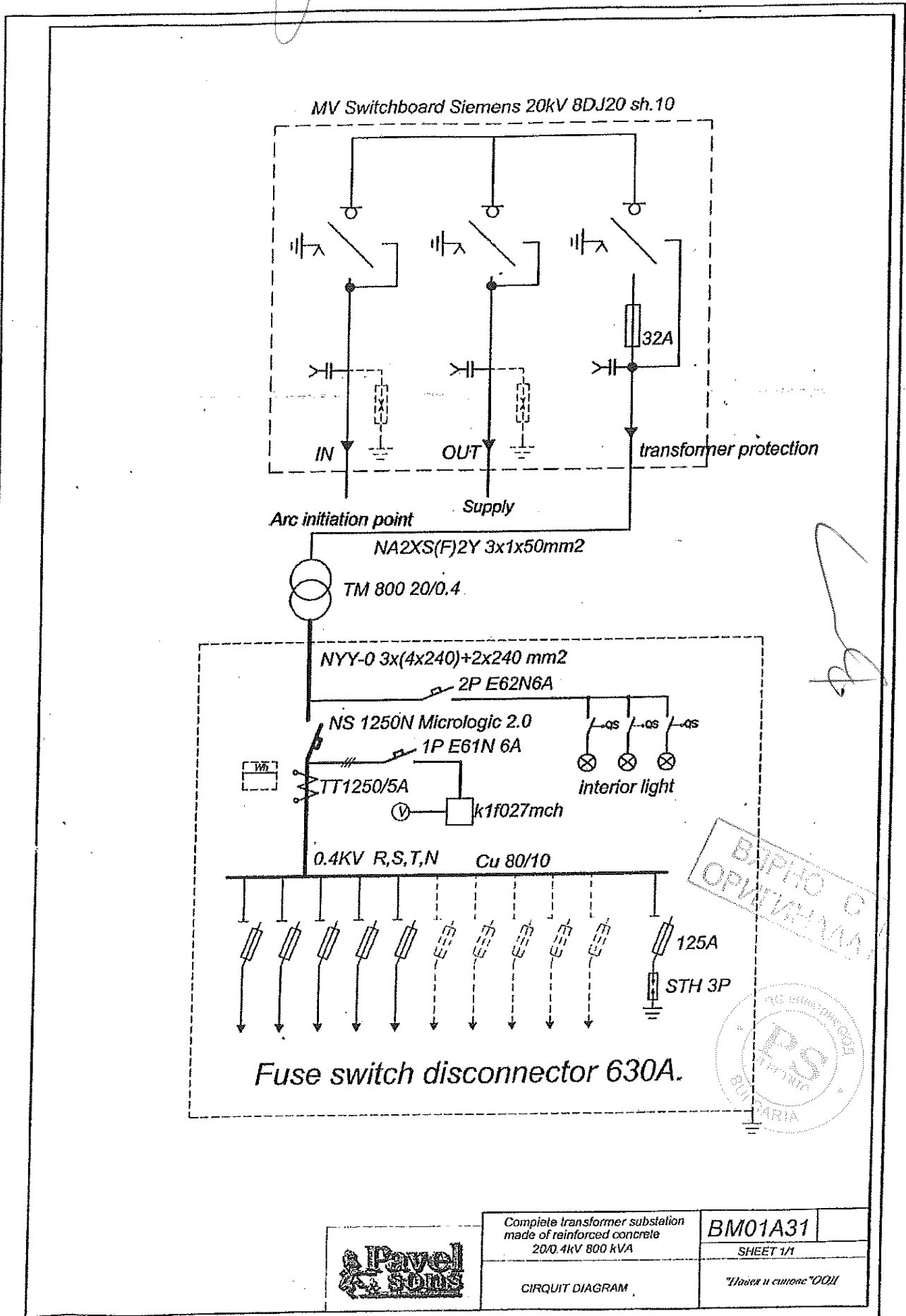



Photo 3 -- Aspect of the complete transformer substation after test

ВЯРНО С  
ОРИГИНАЛА



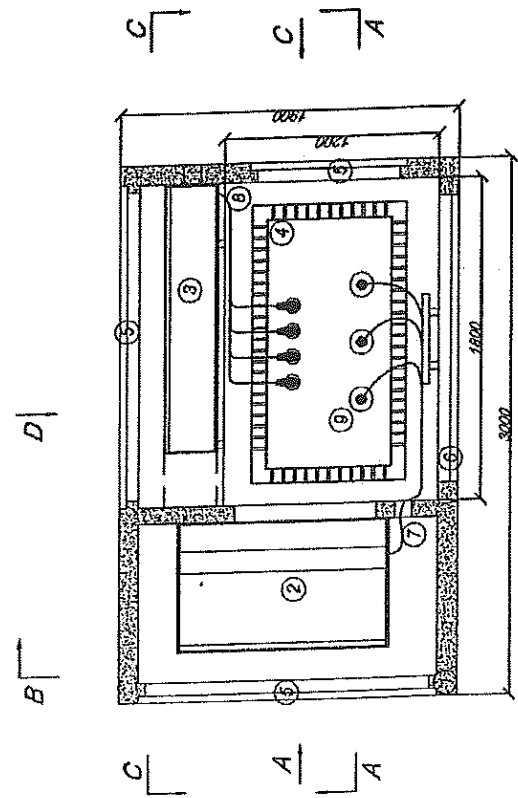
my



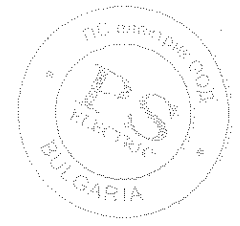
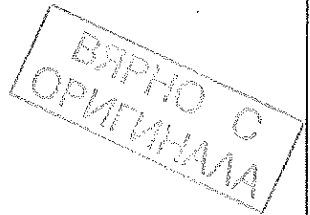
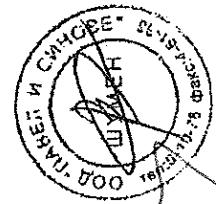
	Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA	<b>BM01A31</b> SHEET 1/1
	CIRCUIT DIAGRAM	<i>"Дявола и чукача" 0011</i>

*key*

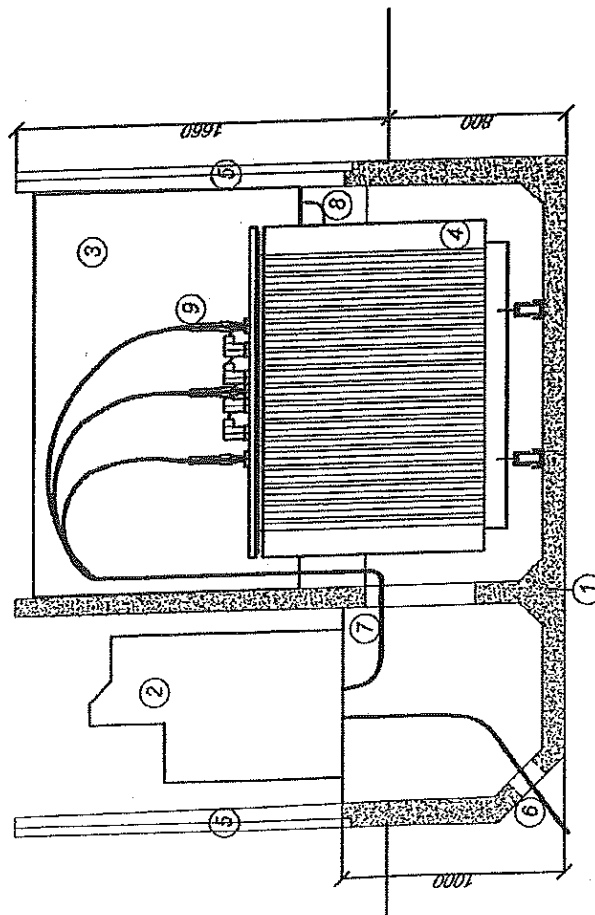
- ① Corpus made of reinforced concrete B45
- ② MV switchboard with SF6 Merlin Gerin RIM6 NE IQI
- ③ LV Switchboard
- ④ Transformer hermetic 20/0.4kV 800kVA
- ⑤ Aluminium door
- ⑥ Ventilation grille
- ⑦ Cabel 20 kV - 3x1x50mm<sup>2</sup> NA2XS(F)2Y
- ⑧ Cabel 0.4kV - NYY 3x(4x240mm<sup>2</sup>)+2x240mm<sup>2</sup>
- ⑨ Cable ends 20kV Raychem RSSS 5225



Complete transformer substation made of reinforced concrete	BM01A31/2L/800	BM01A31 01 1:25
part/electrical		лист 2 от 12/2017
		Тема и номер *001



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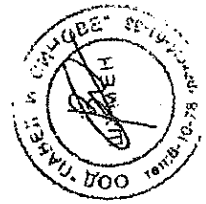


A - A

- ① Corpus made of reinforced concrete B45
- ② MV switchboard with SF6 Merlin Gerin RM6 NE IQI
- ③ LV Switchboard
- ④ Transformer hermetic 20/0.4kV 800kVA
- ⑤ Aluminium door
- ⑥ Cable bushings BKD 150
- ⑦ Cabel 20 kV - 3x1x50mm2 NA2XS(F)2Y
- ⑧ Cabel 0.4kV - NY 3x(4x240mm2)+2x240mm2
- ⑨ Cable ends 20kV Raychem RSSS 5225

Complete transformer substation made of reinforced concrete <b>BM01A31/2L/800</b>	BM01A31 01	1:25
	Лист 3	ср-11/10/07
Section A-A		

Табела 4. каталог "ООД"

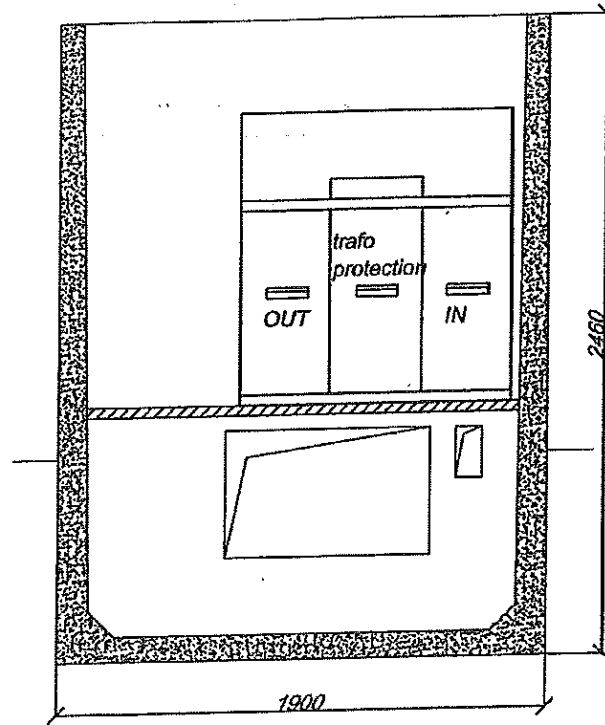


ВЯРНО С  
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*B*



B-B

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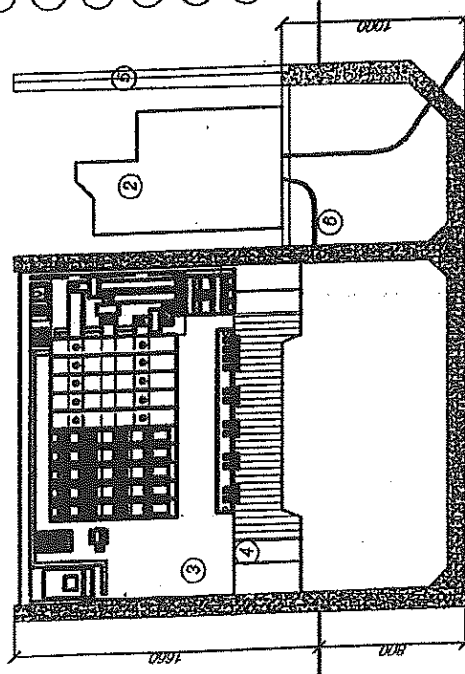


Complete transformer substation made of reinforced concrete <b>BM01A31/2L/800</b> section B-B	<b>BM01A31 01</b>	<b>1:20</b>
	лист 4	вс. листа 7
<i>"Павел и Сичев" ООД</i>		

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- ① Corpus made of reinforced concrete B45
- ② MV switchboard with SF6 Merlin Gerin RM6 NE IQI
- ③ LV Switchboard
- ④ Transformer hermetic 20/0.4kV 800kVA
- ⑤ Aluminium door
- ⑦ Cable 20 kV - 3x1x50mm<sup>2</sup> NA2XS(F)2Y



C-C

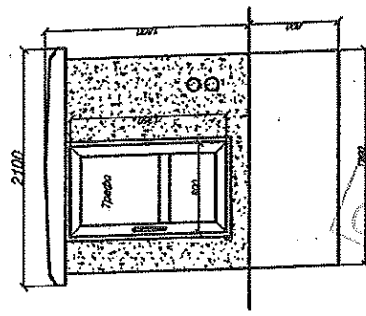
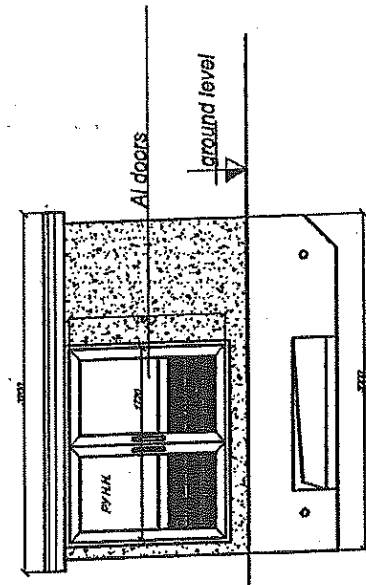
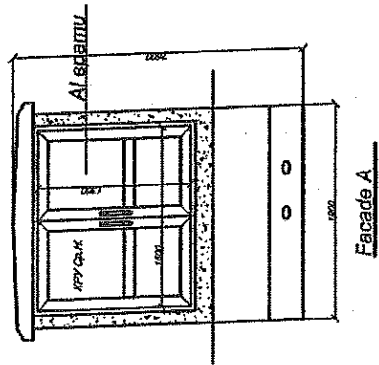
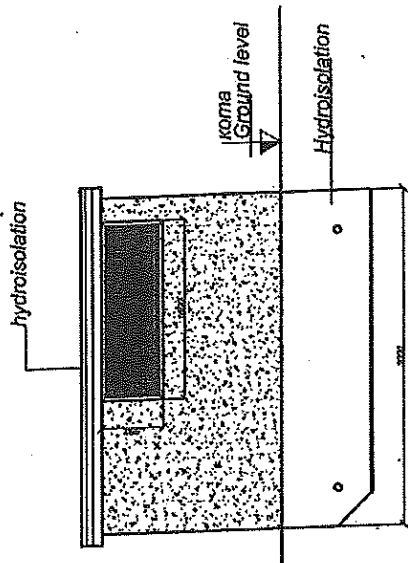
Complete transformer substation made of reinforced concrete	BM01A31 01 1:25
BM01A31/2L/800	лист 5
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Товар и стикер "ООД"	



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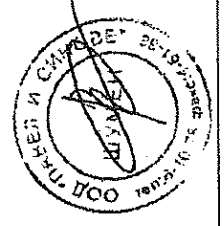
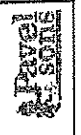


PAVEL  
ELEKTRO



Complete transformer substation made of reinforced concrete	BM01A31 01 1:40
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Технически проект

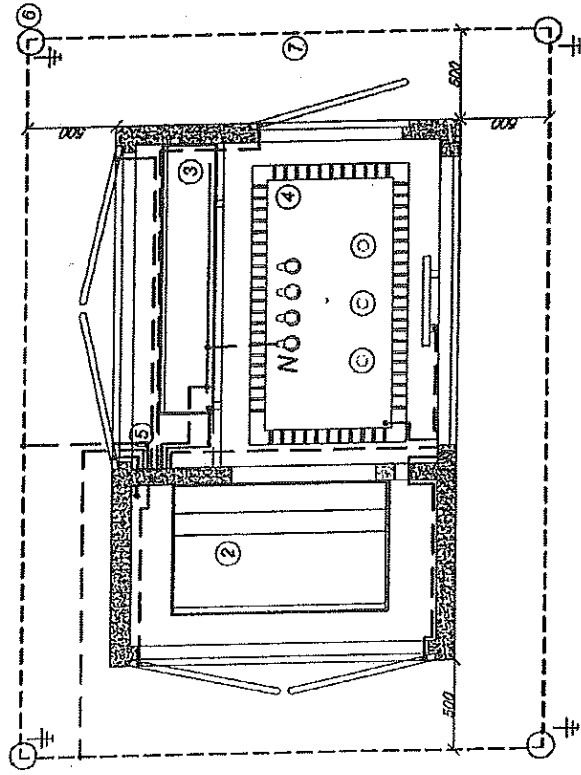


ДИПЛОМ  
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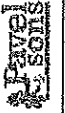
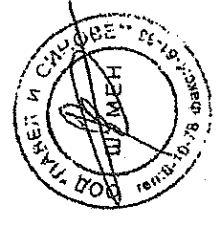


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- ① Corpus made of reinforced concrete B45
- ② MV switchboard with SF6 Siemens 8DJ20 -10
- ③ LV Switchboard
- ④ Transformer hermetic 20/0.4kV 800kVA
- ⑤ HO5V - K - 1x50mm<sup>2</sup>



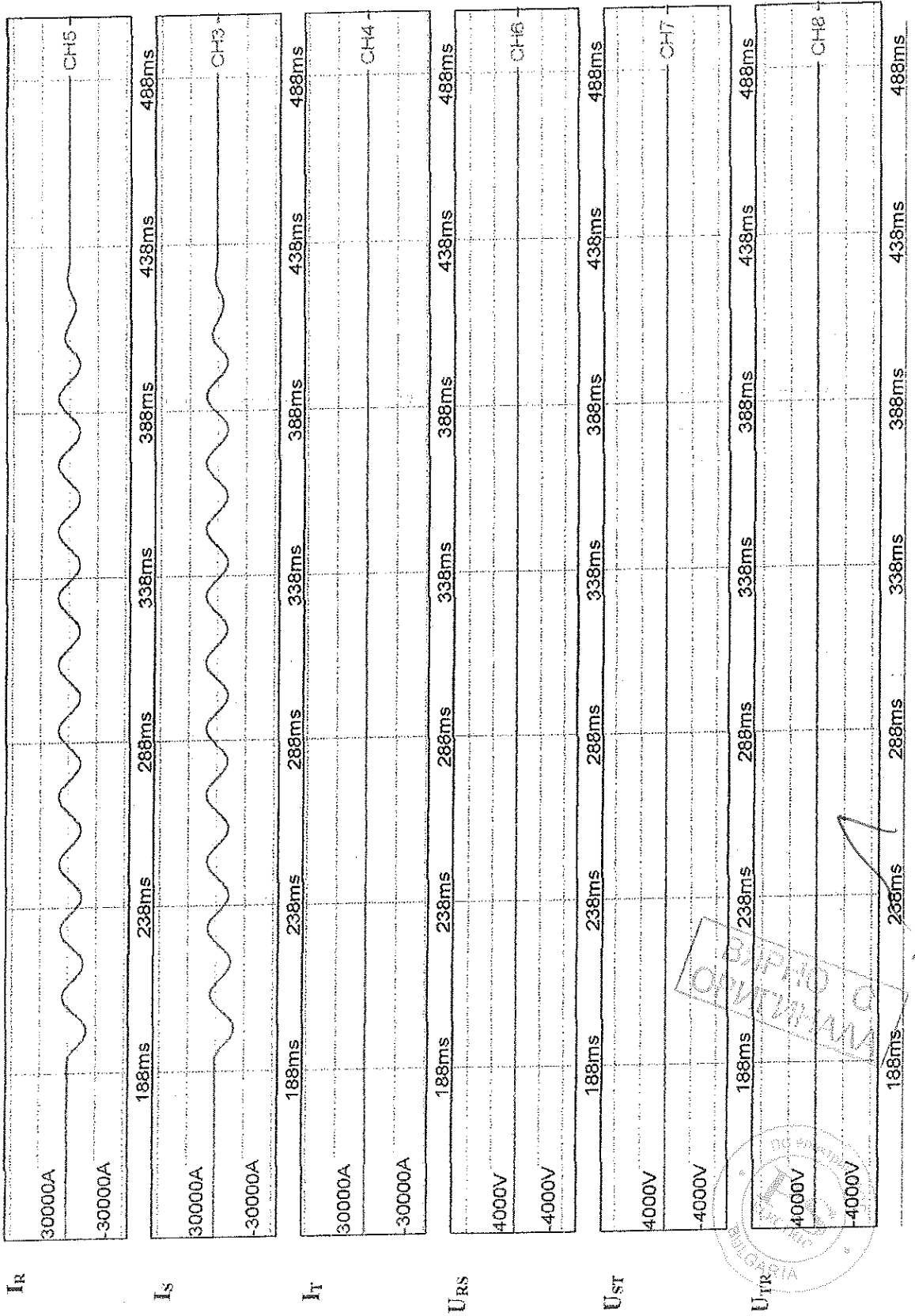
Complete transformer substation made of reinforced concrete	BM01A31 01 1:25
BM01A31/2L/800	лист 7 от 8
Землемерна инсталация	КС-БУДБИЗ 7
	Телев и стикер "ООД"



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$I_R$

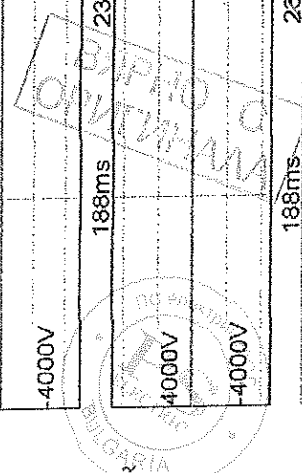
$I_S$

$I_T$

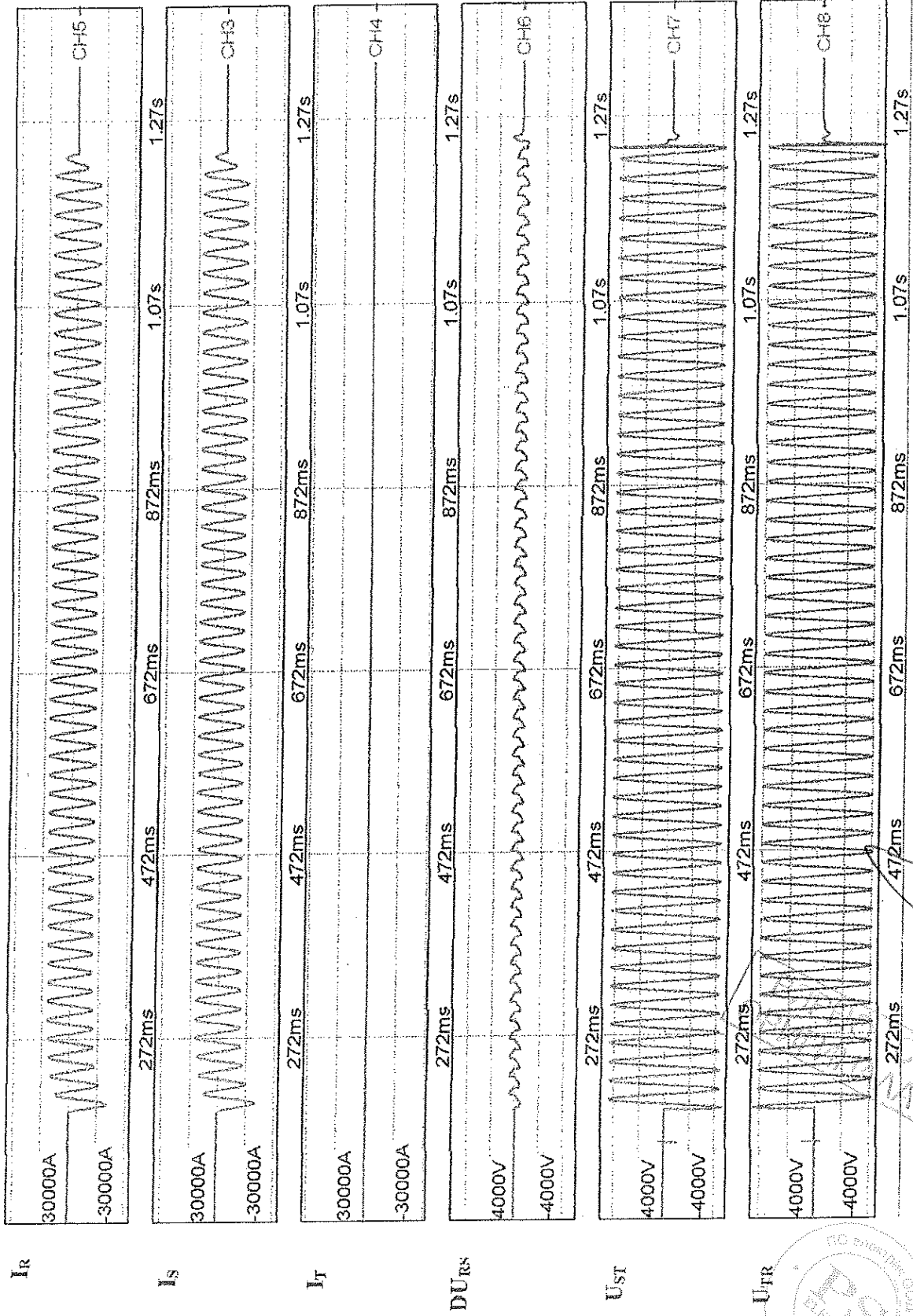
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$U_{ST}$

$U_{TR}$



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I<sub>r</sub>

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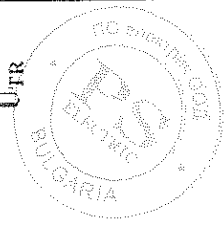
I<sub>r</sub>

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Oscillogram No. 69406 / 2007



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RESEARCH-DEVELOPMENT AND TESTING NATIONAL  
INSTITUTE FOR ELECTRICAL ENGINEERING

**ICMET CRAIOVA  
HIGH POWER DIVISION**

**HIGH POWER LABORATORY**

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INCERCARE



SR EN ISO / CEI 17025:2005  
CERTIFICAT DE ACREDITARE  
nr. LI 004 / 2007

**TEST REPORT**

**No. 10732**

**CUSTOMER:** "PAVEL and SONS" Ltd.  
12 Madara Blvd. Shumen Bulgaria

**MANUFACTURER:** "PAVEL and SONS" Ltd. 12 Madara Blvd.  
12 Madara Blvd. Shumen Bulgaria

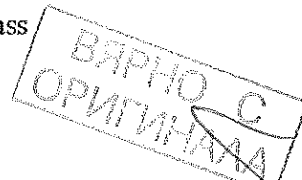
**TESTED PRODUCT:** 20/0.4 kV, 1000kVA- Prefabricated Transformer Substation  
made of reinforced concrete

**REFERENCE STANDARD:** IEC 62271-202 / 2006 clause 6.3

**TEST PERFORMED:** Temperature-rise test and determination of thermal class

**TEST DATE:** 12.02.2010

**TEST RESULT:** Passed the tests



Report has 15 pages and it is edited in 4 copies from which copy 1 for laboratory and copies 2, 3 and 4 for customer.

**HEAD OF HIGH POWER DIVISION:**

**HEAD OF LABORATORY:**

На основание чл. 2  
от ЗЗЛД

**DATE OF ISSUE:** 08.03.2010

1. Results refer to test product only.
2. Publication or reproduction of the contents of this report in any other form unless its complete photocopying is not allowed without writing approval of division to which laboratory belong to.
3. Accreditation of the laboratory or any of its Test Reports issued under accreditation regime do not constitute or do not imply themselves an approval of the product by the accreditation body.

**TEST REPORT No 10732**

**PAGE 2**

1.	Identification of the test product	3
2.	Technical characteristics established by manufacturer	3
3.	Tests program	3
4.	Responsible for tests	3
5.	Present at the tests	3
6.	Test report documentation	3
7.	Temperature – rise test	4
8.	Thermal class determination	8
9.	Remarks	8
10	Test result	8
10.1	Annexes	8
	- Photo	9
	- Technical specification	10
	- Drawing	12

ВЯРНО С  
ОРИГИНАЛА



1. IDENTIFICATION OF TEST PRODUCT

Type	Substation CCTS 20/0.4kV/1x1000kVA	MV Switchgear (RMU Siemens) 8DJH RRH	Transformer TM 1000/20 LEMI TRAF0 EOOD- Bulgaria 110869/2009
Serial number/year	10001/2010	CV 792414-000070/001	
Technical specification /Drawing	See pages 10,11 / see pages 12 to 15		
Contract no:	705.2/2312/29.12.2009		
Product receiving date:	12.02.2010		
Product condition at receiving:	New		

2. TECHNICAL CHARACTERISTICS ESTABLISHED BY MANUFACTURER

	Substation	MV Switchgear	LV Panel	Transformer
Rated power	1000 kVA			1000 kVA
Rated voltage	20/0.4kV	24kV	0.4 kV	20/0.4 kV
Rated current	-	630A	1600A	28.87/1443A
Rated frequency	50Hz	50Hz	50Hz	50Hz
Short-circuit voltage	-	-	-	6.2%
Vector group	-	-	-	Dyn5
Total losses	-	-	-	16431 W

3. TESTS PROGRAM

3.1 One test to check the temperature-rise limits of the transformer and the low voltage panel of substation.

The temperature rise test was performed at total losses of 16431 W up to the oil temperature stabilisation, followed by the heating at rated current  $I_n = 1443$  A for one hour.

Supply was made through copper flexible cables with  $S = 3 \times (5 \times 240)$  mm<sup>2</sup> in low voltage panel on terminal connection of fuses and high voltage windings were short-circuited.

3.2 The temperature-rise test of the transformer outside of the substation was performed by supply the low voltage winding and short-circuit the high voltage winding at total losses 16431 W up to the oil temperature stabilisation, followed by the heating at rated current  $I_n = 1443$  A for one hour.

3.3 Determination of thermal class of the substation.

4. RESPONSIBLE FOR TESTS: Eng. Ilie Sborna

5. PRESENT AT THE TESTS: Mr. Velimir Dimitrov from 'Pavel and Sons' Ltd.

6. TEST REPORT DOCUMENTATION

Diagrams - ; Tables 8;  
Photos 1 ; Drawings 4.



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7. TEMPERATURE-RISE TEST

7.1 Three-phase supply circuit for temperature rise test

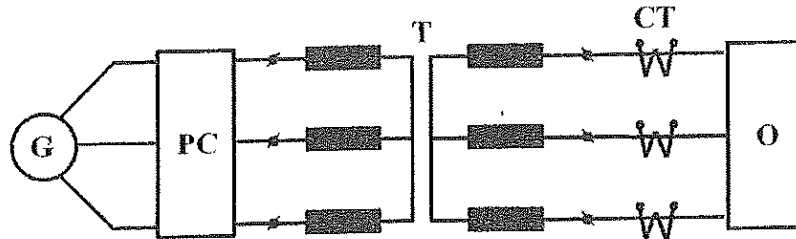


Fig. 1 – Test diagram for current paths temperature-rise test

- G - Generator type GSAM – 390 kVA, 400 V, 50 Hz
- PC - Connections panel
- T - Adapting transformer made of 3 single-phase transformers of 400 / 25V, 10 kA, 50 Hz
- CT - Current transformers type CIRSO – 2000 / 5 A
- O - Object to be tested

7.2 TEST CONDITIONS AND CALCULATION RELATIONS OF TEMPERATURE-RISE

Table 1

Test stage	I	II
Loss (W)	16431	1443/60
Current / period (A / minutes)		

Calculation relations (IEC 60076-2:1993, clause 5.4):

$$\theta_2 = (R_2 / R_1) * (235 + \theta_1) - 235 - \text{for cooper winding}$$

$$\Delta\theta = \theta_2 - \theta_a$$

$$\Delta\theta_u = \theta_u - \theta_a$$

where:

- $\theta_2, \theta_2'$  - windings average temperature (inside the substation and outside the substation)
- $R_1, R_1'$  - windings resistance measured in cold condition (inside the substation and outside the substation)
- $R_2, R_2'$  - windings resistance measured at shutdown (inside the substation and outside the substation)
- $\theta_1, \theta_1'$  - environment temperature in cold condition (inside the substation and outside the substation)
- $\theta_a, \theta_a'$  - environment temperature at the end of temperature-rise test (inside the substation and outside the substation)
- $\Delta\theta, \Delta\theta'$  - windings temperature-rise (inside the substation and outside the substation)
- $\theta_u, \theta_u'$  - oil average temperature at the upper part (inside the substation and outside the substation)
- $\Delta\theta_u, \Delta\theta_u'$  - oil temperature-rise (inside the substation and outside the substation)

ВЕРНО С  
ОРИГИНАЛА

## 7.3 RESULTS OBTAINED AT TEST

## 7.3.1 Transformer's temperature-rise test outside the substation

Table 2

Windings	Determined values						
	$R_1'$ ( $\Omega$ )	$\theta_1'$ ( $^{\circ}\text{C}$ )	$R_2'$ ( $\Omega$ )	$\theta_a'$ ( $^{\circ}\text{C}$ )	$\theta_2'$ (K)	$\Delta\theta'$ (K)	$\Delta\theta_u'$ (K)
HV	4.62	10.0	5.775	10.1	71.25	61.15	58.1
LV	$1.506 \times 10^{-3}$		$1.898 \times 10^{-3}$		73.77	63.67	

Measurements were performed with expanded uncertainty of: 3 % for voltages; 3% for currents;

2.5% for time and the confidence level  $P = 95\%$ .

where:

HV - high voltage winding

LV - low voltage winding

## 7.3.2 Transformer's temperature-rise test inside the substation

Table 3

Windings	Determined values						
	$R_1$ ( $\Omega$ )	$\theta_1$ ( $^{\circ}\text{C}$ )	$R_2$ ( $\Omega$ )	$\theta_a$ ( $^{\circ}\text{C}$ )	$\theta_2$ (K)	$\Delta\theta$ (K)	$\Delta\theta_u$ (K)
HV	4.62	10.0	6.138	10.2	90.50	80.30	76.8
LV	$1.506 \times 10^{-3}$		$2.015 \times 10^{-3}$		92.80	82.60	

Measurements were performed with expanded uncertainty of: 3 % for voltages; 3% for currents;

2.5% for time and the confidence level  $P = 95\%$ .

where:

HV - high voltage winding

LV - low voltage winding

Remarks: Values of the measured resistances, calculated temperatures are presented in pages 5, 6, 7

## 7.3.3 Measured values of currents, losses and temperatures

Table 4

Time	Hour	13:20	14:20	15:20	16:20	17:20	18:20	19:20	19:21	20:21	
Current on phases	$I_1$	A	1534	1488	1475	1471	1469	1449	1448	1443	1443
	$I_2$	A	1532	1495	1478	1470	1462	1458	1456	1444	1444
	$I_3$	A	1547	1489	1480	1465	1465	1458	1444	1443	1443
Average current	$I_m$	A	1538	1491	1478	1469	1465	1455	1449	1443	1443
Measured loss	$P_1$	W	5305	5360	5310	5360	5365	5277	5354	5209	5211
	$P_2$	W	5815	5850	5854	5851	5823	5876	5844	5847	5768
	$P_3$	W	5312	5220	5267	5220	5246	5278	5233	5228	5233
Total loss	$P_m$	W	16431	16430	16431	16431	16431	16431	16431	16284	16212
Environment temperature	$\theta_{a1}$	$^{\circ}\text{C}$	10.07	10.09	10.11	10.12	10.14	10.16	10.16	10.18	10.21
	$\theta_{a2}$	$^{\circ}\text{C}$	10.04	10.05	10.05	10.09	10.10	10.14	10.15	10.17	10.19
	$\theta_{a3}$	$^{\circ}\text{C}$	10.07	10.10	10.07	10.11	10.12	10.17	10.18	10.17	10.20
	$\theta_a$	$^{\circ}\text{C}$	10.06	10.08	10.08	10.11	10.12	10.16	10.16	10.17	10.20
Oil temperature	$\theta_o$	$^{\circ}\text{C}$	59.85	76.59	81.37	83.74	84.62	85.50	86.42	86.44	87.00
Oil temperature-rise	$\Delta\theta_o$	$^{\circ}\text{C}$	49.25	66.51	71.29	73.63	74.50	75.34	76.26	76.27	76.8

Measurements were performed with expanded uncertainty of: 5 % for powers; 3% for currents; 2.5% for time and the confidence level  $P = 95\%$ .

**7.3.4 Symbols used in table 4 :** $\theta_{a1}$  ;  $\theta_{a2}$  ;  $\theta_{a3}$  - environment temperature in 3 measuring points $\theta_a$  - environment average temperature:  $\theta_a = (\theta_{a1} + \theta_{a2} + \theta_{a3})/3$  $I_1, I_2, I_3$  -phase current $P_1, P_2, P_3$  -phase power $P_m$  - total loss**7.3.5 Values of the high and low voltage windings resistance measured after shutdown on transformer outside the substation**

The resistances of high and low voltage windings were measured in direct current for 10 minutes (one reading at each minute) using the ammeter-voltmeter method. The windings resistances determination at the time of shutdown ( $t_0$ )

Table 5

Time t [min]	High voltage winding			Low voltage winding		
	$U_{HV}$ [V]	$I_{HV}$ [A]	$R_{HV}$ [ $\Omega$ ]	$U_{LV}$ [mV]	$I_{LV}$ [A]	$R_{LV}$ [m $\Omega$ ]
1	11.5	6.091	1.888	1.229	0.2137	5.751
2	11.4	6.070	1.878	1.224	0.2137	5.728
3	11.3	6.052	1.867	1.220	0.2137	5.710
4	11.2	6.028	1.858	1.215	0.2137	5.686
5	11.1	6.006	1.848	1.212	0.2137	5.672
6	11.1	6.033	1.840	1.208	0.2137	5.653
7	11.0	6.011	1.830	1.208	0.2137	5.634
8	11.0	6.041	1.821	1.201	0.2137	5.620
9	11.0	6.007	1.813	1.198	0.2137	5.606
10	11.0	6.086	1.807	1.195	0.2137	5.592

Measurements were performed with expanded uncertainty of: 2.5 % for resistances and the confidence level  $P = 95\%$ .

\* The windings resistances determination at the time of shutdown ( $t_0$ )

$R_2 = 5.77 \Omega$  HV - high voltage winding

$R_2 = 1.898 \cdot 10^{-3} \Omega$  LV - low voltage winding

ВЯРНО С  
ОРИГИНАЛА



### 7.3.6 Values of the high and low voltage windings resistance measured after shutdown on transformer inside the substation

The resistances of high and low voltage windings were measured in direct current for 10 minutes (one reading at each minute) using the ammeter-voltmeter method. The windings resistances determination at the time of shutdown ( $t_0$ )

Table 6

Time t [min]	High voltage winding			Low voltage winding		
	$U_{HV}$ [V]	$I_{HV}$ [A]	$R_{HV}$ [ $\Omega$ ]	$U_{LV}$ [mV]	$I_{LV}$ [A]	$R_{LV}$ [m $\Omega$ ]
1	1.298	0.2131	6.091	12.100	6.035	2.005
2	1.293	0.2131	6.067	12.065	6.038	1.998
3	1.286	0.2132	6.034	12.033	6.040	1.986
4	1.281	0.2132	6.000	11.960	6.049	1.980
5	1.276	0.2173	5.980	11.910	6.058	1.970
6	1.272	0.2134	5.960	11.880	6.065	1.960
7	1.269	0.2134	5.946	11.840	6.075	1.951
8	1.265	0.2134	5.928	11.810	6.082	1.942
9	1.261	0.2135	5.906	11.780	6.087	1.938
10	1.258	0.2135	5.892	11.770	6.096	1.930

\* The windings resistances determination at the time of shutdown ( $t_0$ )

$R_2 = 6.138 \Omega$  HV - high voltage winding

$R_2 = 2.015 \cdot 10^{-3} \Omega$  LV - low voltage winding

ВЯРНО С  
ОРИГИНАЛА



## 7.3.3 Temperature-rise of the low voltage equipment

Table 7

No.	Elements and temperature measuring points	Temperature-rise [°K]			Admitted
		Calculated			
		R	S	T	
1	Circuit breaker terminals				70
	-Input	65.48	66.87	67.19	
	-Output	64.12	65.33	67.89	
2	Terminal connection of fuses	32.78	30.02	31.24	
3	Bus bar low voltage compartment	62.23	61.48	62.36	
4	Fuse handler	14.45			
5	Environment temperature	10.2			

The measurements were performed with expanded uncertainty of: 1.1% for temperature and the confidence level P = 95%.

## 8. THERMAL CLASS DETERMINATION

To assess the thermal class the following relations (IEC 62271-202:2006, clause 6.3) will be applied:

$$\Delta t_1 = t_{t1} - t_{a1},$$

$$\Delta t_2 = t_{t2} - t_{a2},$$

$$\Delta t = \Delta t_2 - \Delta t_1$$

where:

$t_{t1}$  = - temperature of the transformer windings outside the substation,

$t_{a1}$  = -environment temperature at the end of transformer temperature-rise test outside the substation

$\Delta t_1$  = - temperature-rise of the transformer windings outside the substation

$t_{t2}$  = - temperature of the transformer windings inside the substation

$t_{a2}$  = - environment temperature at the end of transformer temperature-rise test inside the substation

$\Delta t_2$  = - temperature-rise of the transformer windings inside the substation.

Table 8

	$\Delta t_1$ [°C]	$t_{t1}$ [°C]	$t_{a1}$ [°C]	$\Delta t_2$ [°C]	$t_{t2}$ [°C]	$t_{a2}$ [°C]	$\Delta t$ [°C]
HV winding	61.15	71.25	10.1	80.30	90.50	10.2	19.15
LV winding	63.67	73.77		82.60	92.8		18.93
Oil	58.10	68.20		76.80	87.00		18.70

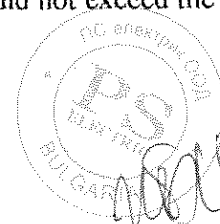
Thermal class: because  $15 \text{ K} < \Delta t < 20 \text{ K} \Rightarrow \text{Class 20}$

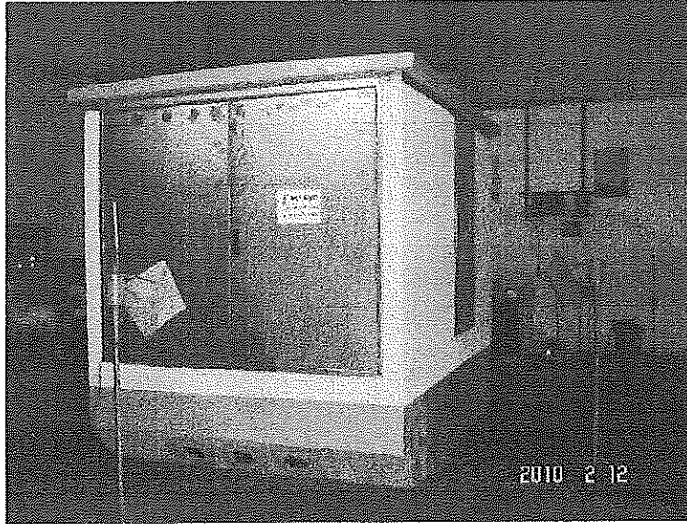
## 9. REMARK

Aspect of the substation in the test circuit is presented in photo from page 9.

**10. TEST RESULT:** Temperature-rise of the low voltage equipment did not exceed the specified limits (see table 7) and thermal class is 20 (see table 8).

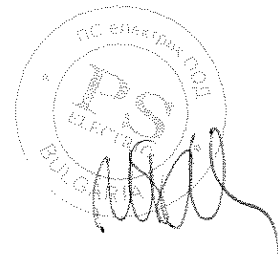
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Aspect of Prefabricated Substation in the test circuit

ВЯРНО С  
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### Technical specification

Prefabricated transformer substation made of reinforced concrete

Type: CCTS 20/0.4kV 1x1000kVA  
 Producer: "Pavel & sons" Ltd. , Shumen, Bulgaria  
 Factory number: 10001

Casing: The casing of the Concrete Prefabricated Substation is made of water-tight reinforced concrete B45;

1.1 Measurements ( roof included ) :

L= 3100mm;B=2400mm;H=2750mm;

Weight with transformers: 13 350kg;

Equipment:

2.1.Equipment on the Middle Voltage side:

Complete distributing device - 8DJH RRT Siemens, which consists of cable "IN" 20kV, cable "OUT" and "Transformer protection".

2.2.Interconnections 20 kV from MV switchboard to transformers NA2X(F)2Y 3 x 1 x 50mm<sup>2</sup>.

2.3.Transformer:

transformer 20/0.4kV 1000 kVA

Dimensions:

L=1860mm.

W=1100mm.

H=1830mm.

2.4.Connecting cable from transformers to LV switchboard -  
 NYY 3x(4x240mm<sup>2</sup>)+2x240mm<sup>2</sup>.

2.5.Main circuit -breakers of LV switchboard - automatic circuit-breakers  
 NS1600N Micrologic 2.0.

2.6.Terminals of LV switchboard - vertical switch disconnecter with fuses  
 MULTIVERT 400A - 6 psc. "m.schneider" Austria

2.7. Copper bars' system:

Distributing rims - Copper bars 60x15mm.

Connection between main circuit - breaker and distributing rims - Copper bars  
 50x15mm.

Current transformer:

CT-4 1500/5A

5VA grade of fit 0.5

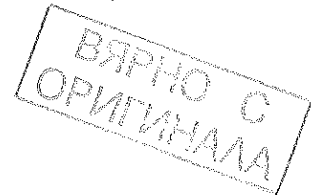
Ith max 50kA.

3.Earthing instalation:

Internal connections- steel bar 40x4mm.

Ratings of prefabricated substation:

- Rated voltage on MV side - 24kV;
- Operated voltage on MV side - 20kV;
- Rated insulation level on MV side -50kV;
- Rated lightning impulse withstand voltage on MV side-125kV;
- Rated voltage on LV side - 0.4kV;
- Rated insulation level on LV side -2,5kV;



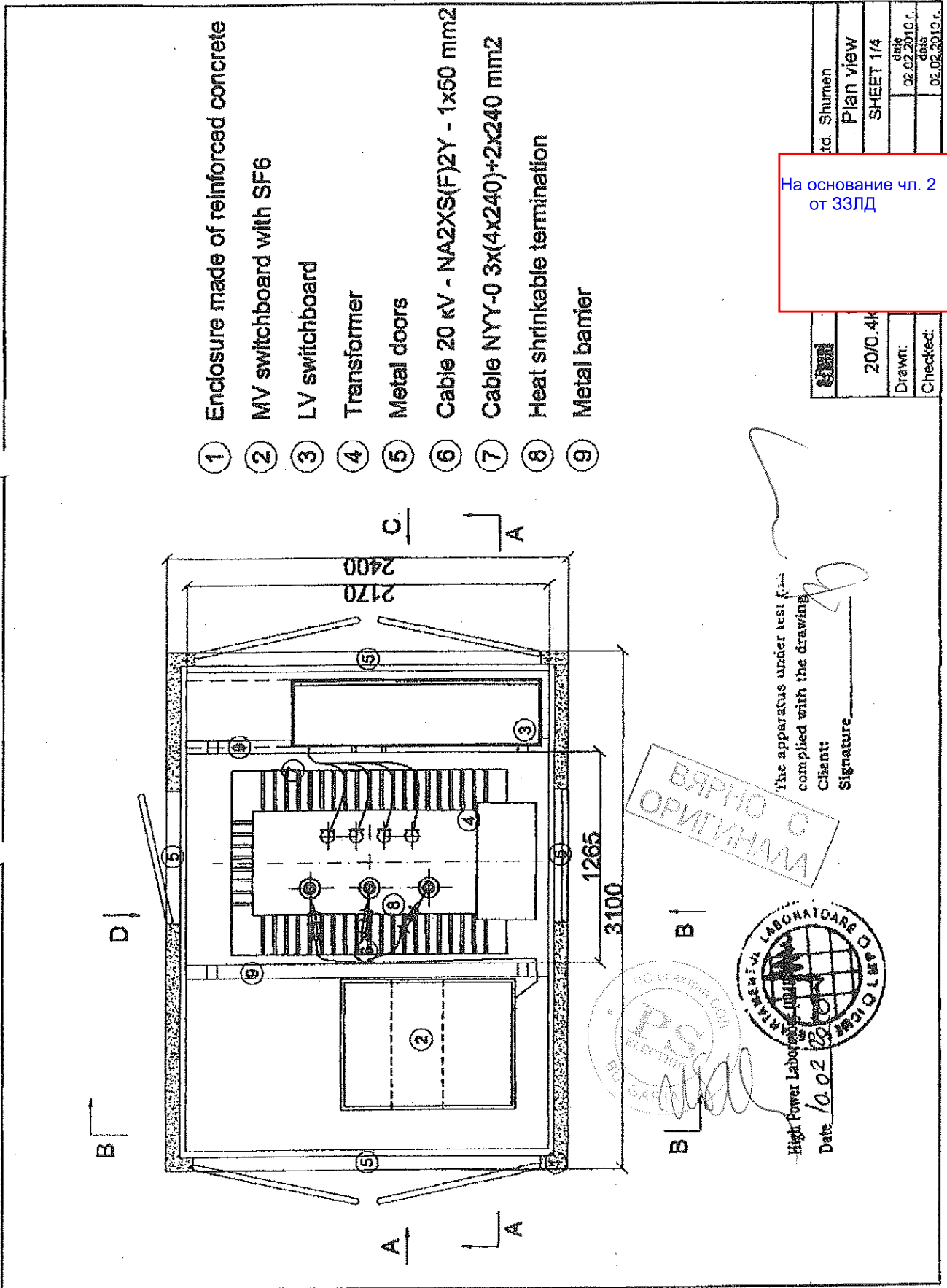
- Rated normal current of MV busbar-400A;
- Rated lightning impulse withstand voltage on LV side- 5kV;
- Rated feeder current -400A;
- Rated feeder current for transformer panels – 200A;
- Main circuit breakers on LV switchboard-1600A;
- rated short time withstand current on MV side -16kA/1s;
- peak withstand rated current – on MV side-40kA;
- Short time withstand current on earthing circuit -16kA

Date: 02.02.2010  
Shumen

Prepared: На основание чл. 2  
Checked: от ЗЗЛД

ВЯРНО С  
ОРИГИНАЛ

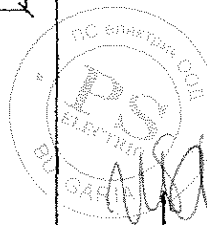




На основание чл. 2  
от ЗЗЛД

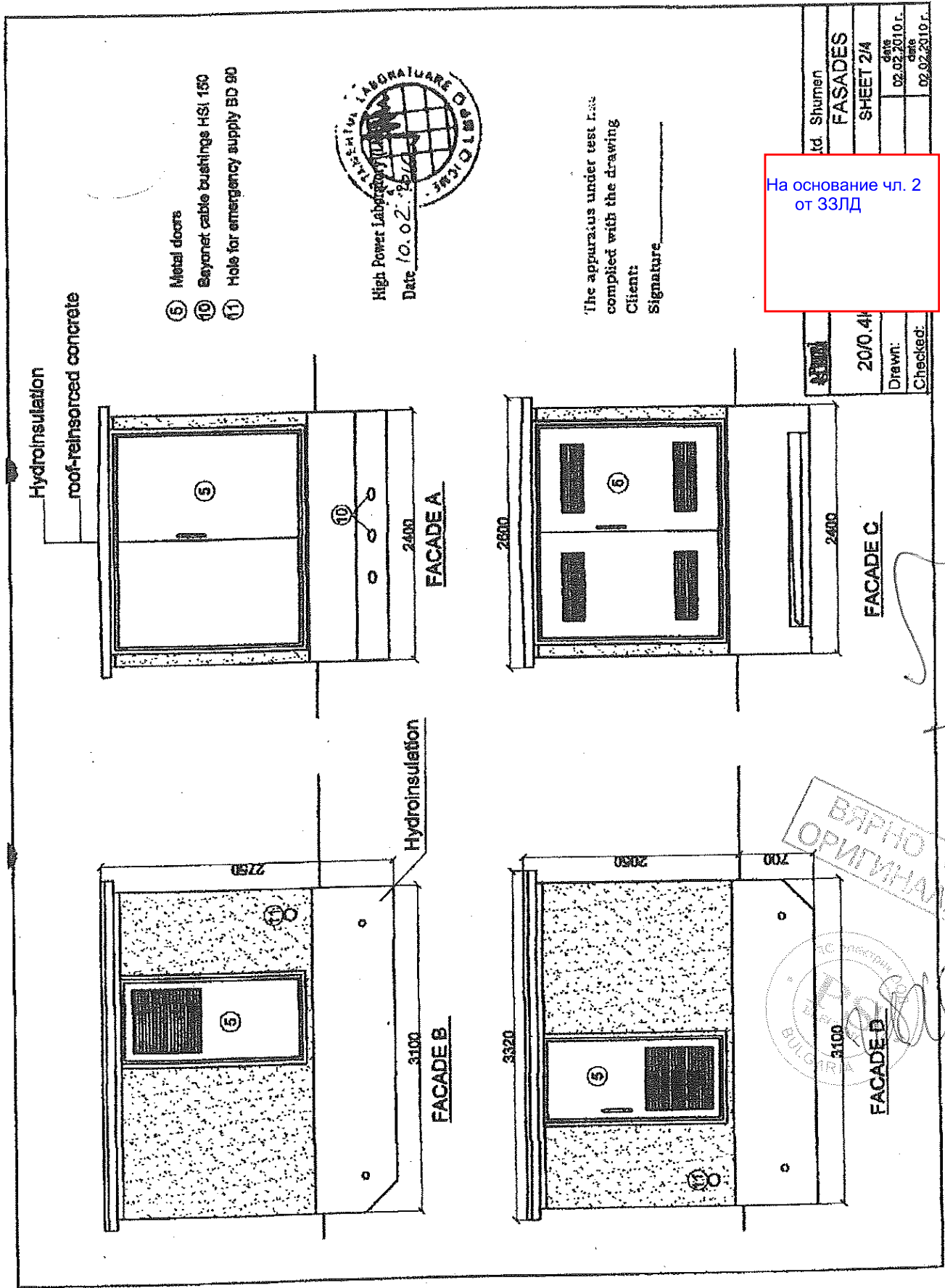
id. Shumen	Plan view
20/0.4kV	SHEET 1/4
Drawn:	class 02.02.2010.r.
Checked:	class 02.02.2010.r.

ВЯРНО С  
ОРИГИНАЛА

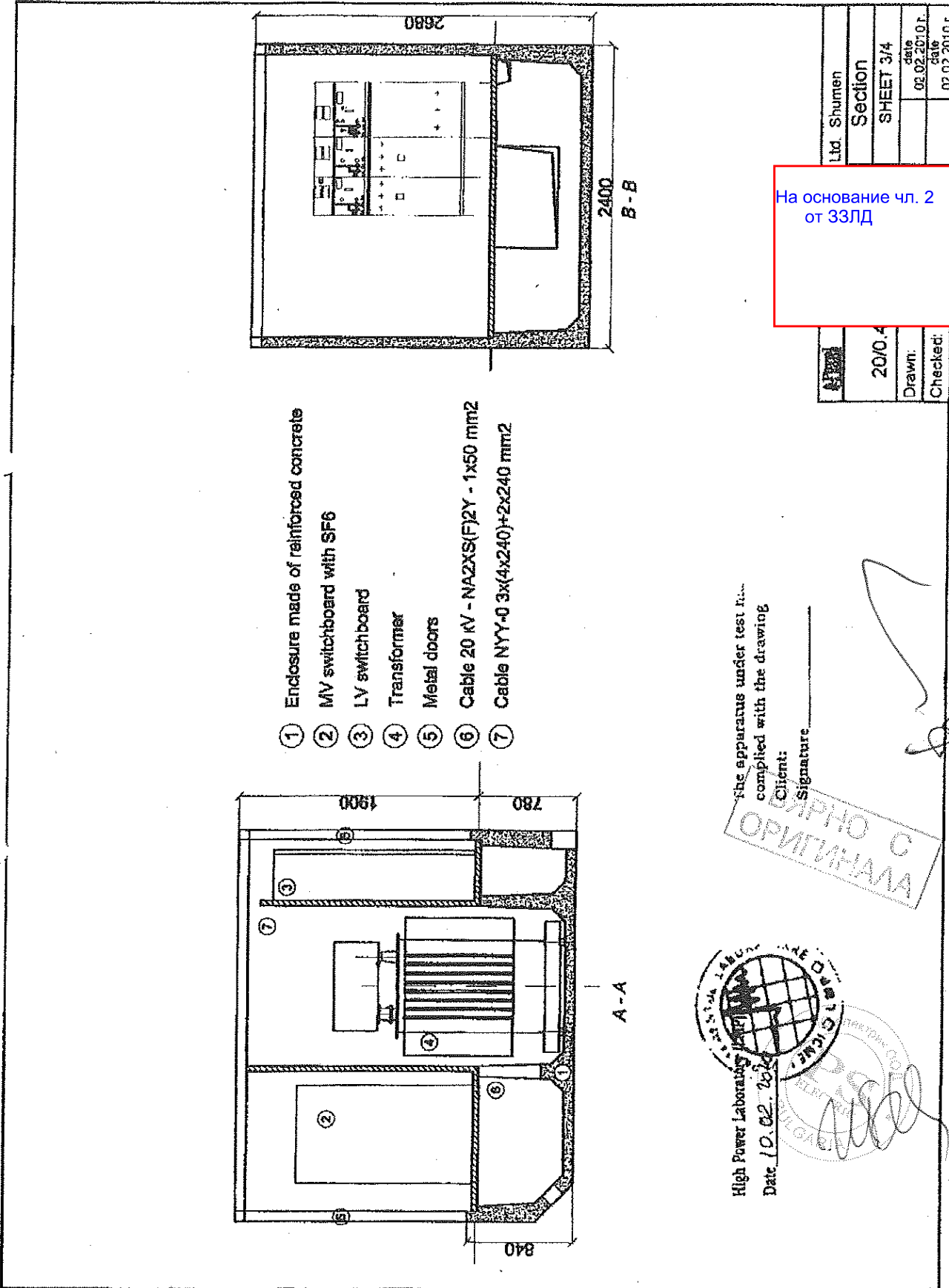


The apparatus under test has  
complied with the drawing  
Client: \_\_\_\_\_  
Signature: \_\_\_\_\_

Date 10.02.2010



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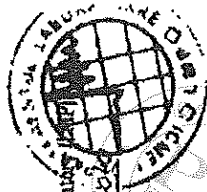


На основание чл. 2  
от ЗЗЛД

Ltd. Shumen	20/0.4
Section	Drawn:
SHEET 3/4	Checked:
Date: 02.02.2010г.	
Date: 02.02.2010г.	

The apparatus under test has  
complied with the drawing  
Client: \_\_\_\_\_  
Signature: \_\_\_\_\_

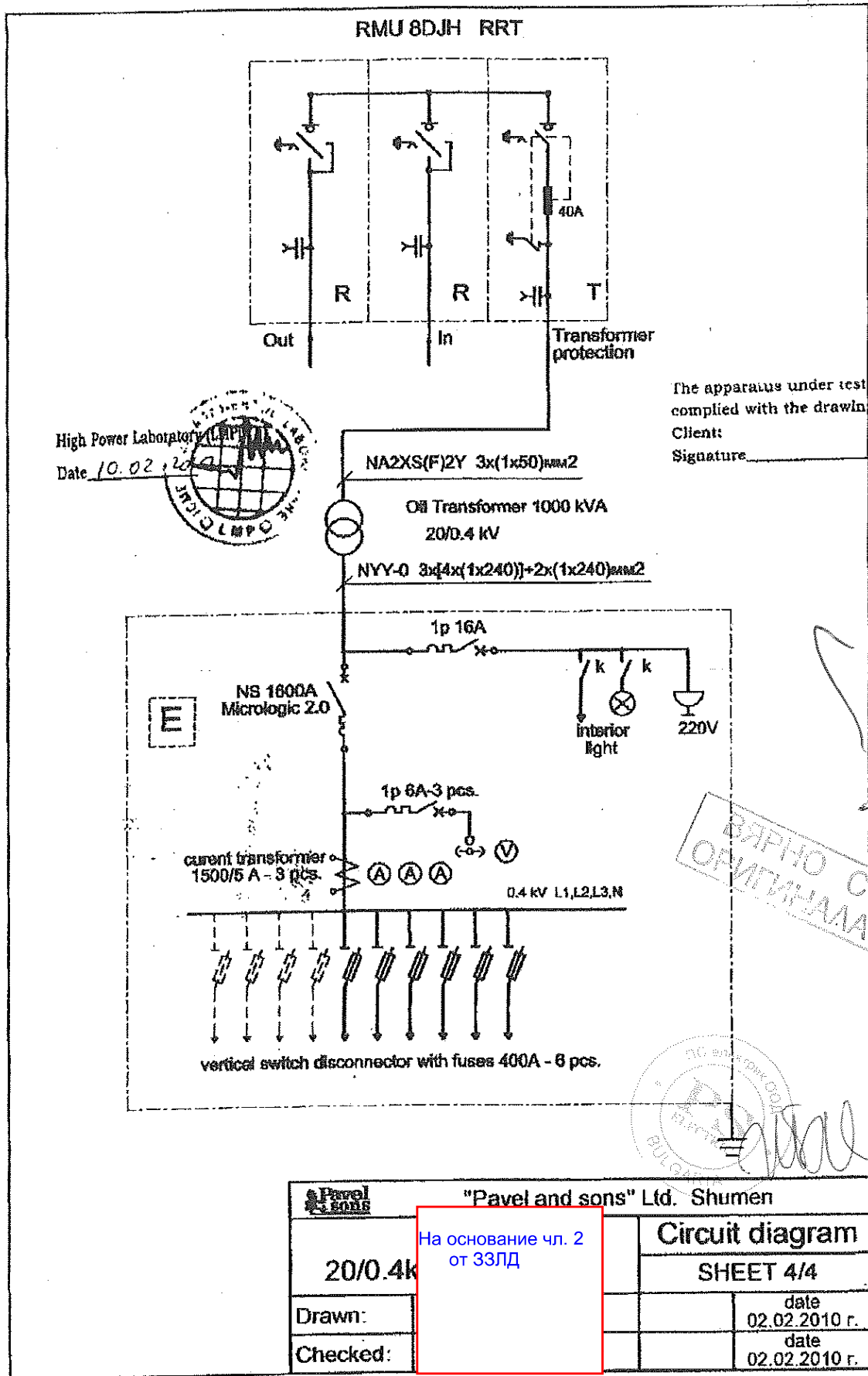
ВАРНО С  
ОРИГИНАЛ



High Power Laboratory Ltd.  
Date: 10.02.2010г.

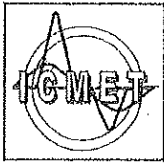
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*B*



		"Pavel and sons" Ltd. Shumen	
20/0.4kV		Circuit diagram	
Drawn:		SHEET 4/4	
Checked:		date 02.02.2010 г.	
		date 02.02.2010 г.	

*w*



RESEARCH-DEVELOPMENT AND TESTING NATIONAL  
INSTITUTE FOR ELECTRICAL ENGINEERING  
**ICMET CRAIOVA**  
**HIGH POWER DIVISION**

**HIGH POWER LABORATORY**  
**"Ovidiu Rarinca"**

200746-CRAIOVA, Blvd. DECEBAL No. 118A, ROMANIA  
Matriculation certificate: J16/312/1999, VAT number RO387 1599  
Phone: (351) 402 427; Fax: (251) 415482; (351) 404 890;  
E-mail: [imp@icmet.ro](mailto:imp@icmet.ro)

acreditat pentru  
INCERCARE



SREN ISO/CEI 17025:2005  
CERTIFICAT DE ACREDITARE  
nr. LI 004/2010

**TEST REPORT**  
**No. 11613**

**CUSTOMER:** "PAVEL and SONS electric" Ltd  
12 Madara Blvd. 9700 Shumen, Bulgaria

**MANUFACTURER:** "PAVEL and SONS electric" Ltd  
12 Madara Blvd. 9700 Shumen, Bulgaria

**TESTED PRODUCT:** 2x1000 kVA, 20/0,4 kV, Prefabricated Transformer  
Substation made of Reinforced Concrete

**REFERENCE STANDARD:** IEC 62271-202/2006 clause 6.8 and Annex A

**TEST PERFORMED:** Internal arc test in switching compartment

**TEST DATE:** 08.02.2013

**TEST RESULT:** Passed the test for IAC - AB

ВЯРНО С  
ОРИГИНАЛА

Test Report has 28 pages and it is edited in 4 copies from which copy 1 for laboratory and copies 2, 3 and 4 for customer.

**HEAD OF HIGH POWER DIVISION:**

**HEAD OF LABORATORY:**

На основание чл. 2  
от ЗЗЛД

**DATE OF ISSUE:** 12.02.2013

1. Results refer to test product only.
2. Publication or reproduction of the contents of this report in any other form unless its complete photocopying is not allowed without writing approval of division to which laboratory belongs to.
3. Accreditation of the laboratory or any of its Test Reports issued under accreditation regime do not constitute or do not imply themselves an approval of the product by the accreditation body.

B

**Content**

1.	Identification of the test product	3
2.	Technical characteristics established by producer	3
3.	Tests program	3
4.	Responsible for tests	3
5.	Present at the tests	3
6.	Test report documentation	3
7.	Data of testing and measuring circuit	4
8.	Values obtained on test	4
9.	Test results	5
	Photos	6
	Technical specification	10
	Drawings	12
	Oscillograms	26

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ВЯРНО С  
ОРИГИНАЛА



M

**1. IDENTIFICATION OF APPARATUS**

Type	Substation	MV Switchgear (RMU Siemens)
Serial number/year	CCTS 20/0.4 kV/2x1000 kVA	8DJH TRRT
	13002/2013	CV 825226-00020/001/2012
		CV 841392-00020/001/2013
Technical specification/Drawing	See page 10 and 11 / See pages 12 to 25	
Contract No.:	705.2/8658/21.01.2013	
Product receiving date:	08.02.2013	
Product condition at receiving:	New	

**2. TECHNICAL CHARACTERISTICS ESTABLISHED BY PRODUCER**

	Substation	MV Switchgear
Rated power	2x1000 kVA	-
Rated voltage	20/0.4 kV	24 kV
Rated current	23.09/1154.7 A	630 A
Rated frequency	50 Hz	50 Hz
Rated short - time withstand current:		
- peak value	40 kA	40 kA
- r.m.s. value	16 kA	20 kA
Rated duration of short-circuit ( $t_k$ )	1 s	1 s
IAC Classification	AB	AF
Internal fault current	16 kA	16 kA
Rated duration of internal fault current	1 s	1 s

**3. TESTS PROGRAM**

The internal arc tests were performed on MV Switchgears (RMU Siemens) containing:

- Cell 1 Transformer protection;
- Cell 2 Incoming / Outgoing;
- Cell 3 Incoming / Outgoing;
- Cell 4 Transformer protection .

3.1 Current calibration test.

3.2 Internal arc test for IAC B with three phase arc initiation point inside of tank of RMU serial no. 825226-00020/001/2012 from cell 1 and three phase applied voltage on the input terminals of cell 3 of RMU.

3.3 Internal arc test for IAC A with three phase arc initiation point inside of tank of RMU serial no. 841392-00020/001/2013 from cell 1 and three phase applied voltage on the input terminals of cell 3 of RMU.

Test parameters were:  $I_p = 40 \text{ kA}$ ,  $I_k = 16 \text{ kA}$ ,  $t_k = 1 \text{ s}$

Arcing point was initiated by means of a copper wire having 0.5 mm diameter.

Supply was made with flexible copper cables of  $3 \times (1 \times 185 \text{ mm}^2)$ .

The combined vertical and horizontal indicators were placed:

- for IAC B: in front of the closed door of MV compartment, transformers compartment, LV compartment and windows at 100 mm distance ;
- for IAC A: in front of RMU (opened doors of MV compartment) at 300 mm distance and in front of closed doors of transformer compartment, LV compartment and windows at 100 mm distance.

**4. RESPONSIBLE FOR TESTS:**

**5. PRESENT AT THE TESTS:**

**6. TEST REPORT DOCUMENTATION**

На основание чл. 2  
от ЗЗЛД

ВЯРНО. С  
ОРИГИНАЛА

Photos 8 ; Drawings

3 ;  
14.

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7. DATA OF TESTING AND MEASURING CIRCUIT

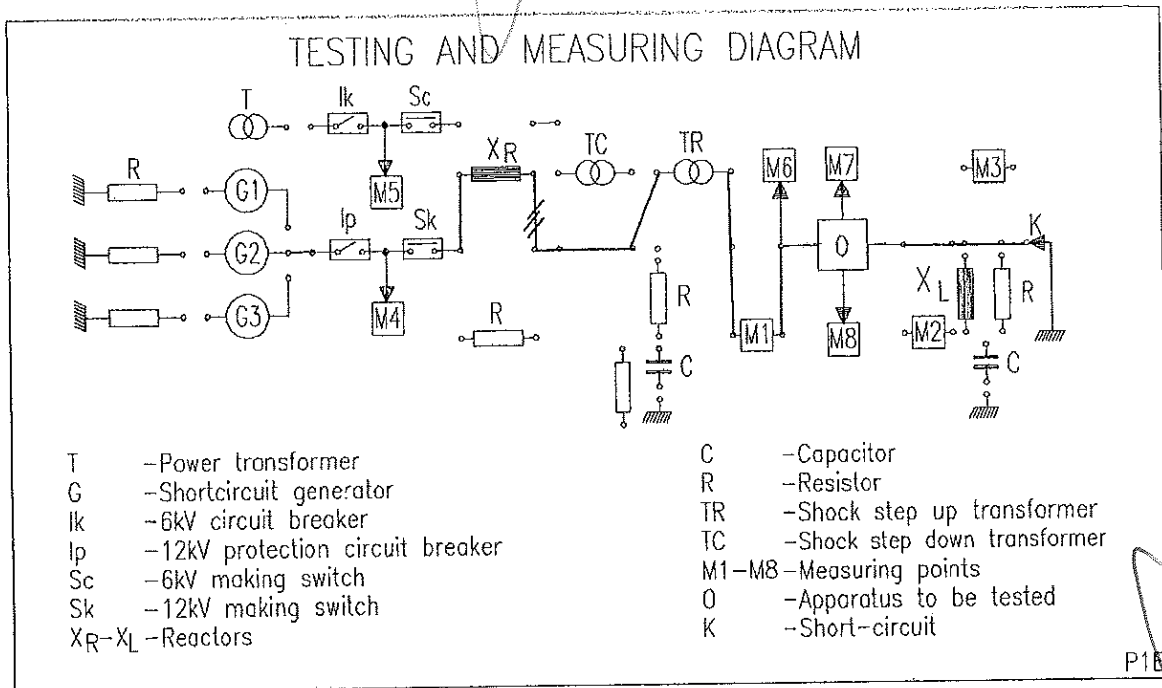


Table 1

Number of phases	3	
Power supply / Connection	G1 / Δ	
Transformer / Ratio	TR 4, 5, 6 / 1.07	
Earthing	Power supply	-
	Apparatus	Net earthing connection
Reactor [Ω]	0.133	
Power factor	<0.15	
M1 - Test current – Rogowski coils 30 kA/V		
M4 - Power supply voltage - Voltage transformer 15000 V/100 V		
M6 - Test voltage – Voltage divider 120 kV/60 V		
M8 - Data acquisition system TRAS 1 - 16 bit, 16 channels		

8. INTERNAL ARC TEST

The test results are presented in table 2.

Table 2

Oscillogram No.	URS UST UTR [kV]	I <sub>pR</sub> I <sub>pS</sub> I <sub>pT</sub> [kA]	I <sub>tR</sub> I <sub>tR</sub> I <sub>tT</sub> [kA]	t <sub>t</sub> [sec.]	I <sub>t med</sub> [kA]	DURS DUST/ DUTR [V]	Remarks
84780/2013	6.1 6.1 6.1	42 - -	16.1 16.2 16.1	0.2	16.13	- - -	Current calibration
84781/2013	6.4 6.4 6.4	40 - -	16.2 16.1 16.1	1	16.13	775 715 710	Internal arc test for IAC-B
84782/2013	6.4 6.4 6.4	41.5 - -	16.1 16.2 16.2	1	16.16	672 708 608	Internal arc test for IAC-A

Measurements were performed with extended uncertainty of: 1% for voltage; 1.5% for current; 0.5% for time and the confidence level P = 95 %.



**8.1. Symbols used in tables and oscillograms**

- IR IS IT = Short-circuit current
- I<sub>pR</sub> I<sub>pS</sub> I<sub>pT</sub> = Peak values of short-time withstand currents on the phases R, S, T.
- I<sub>tR</sub> I<sub>tS</sub> I<sub>tT</sub> = R.m.s. values of short - time withstand currents on the phases R, S, T.
- t<sub>t</sub> = The duration of short – circuit
- I<sub>t med</sub> = Effective current mean value
- DURS, DUST, DUTR = Voltage drop on arc
- URS, UST, UTR = No-load applied voltage

**8.2 Opinions and interpretations**

1. Aspect of the prefabricated transformer substation and indicators in the test circuit before test from IAC B are presented in photos 1 and 2.
2. Aspect of the prefabricated transformer substation and indicators in the test circuit after test from IAC B are presented in photos 3 and 4.
3. Aspect of the prefabricated transformer substation and indicators in the test circuit before test from IAC A are presented in photos 5 and 6.
4. Aspect of the prefabricated transformer substation and indicators in the test circuit after test from IAC A are presented in photos 7 and 8.
5. During the test:
  - the doors of MV Switchgear , the doors of MV compartment, power transformer compartment, LV compartment didn't open ;
  - parts from the Substation didn't fly off;
  - arcing didn't make holes in the substation;
  - the indicators didn't ignite;
  - the earthing connections are effective.

**8.3 Assessment of the test result**

Table 3

Criterion	Result
1.The doors, covers etc. correctly secured do not open	Fulfilled
2. No fragmentation of the enclosure occurs during test	Fulfilled
3. Arcing does not cause holes in the roof and in the accessible sides up to a height of 2 m	Fulfilled
4. Indicators do not ignite due to the effect of hot gases	Fulfilled
5. The enclosure remains connected to its earthing point	Fulfilled

ВРНО С  
ОРИГИНАЛ

**9. TEST RESULT: PASSED THE TEST**

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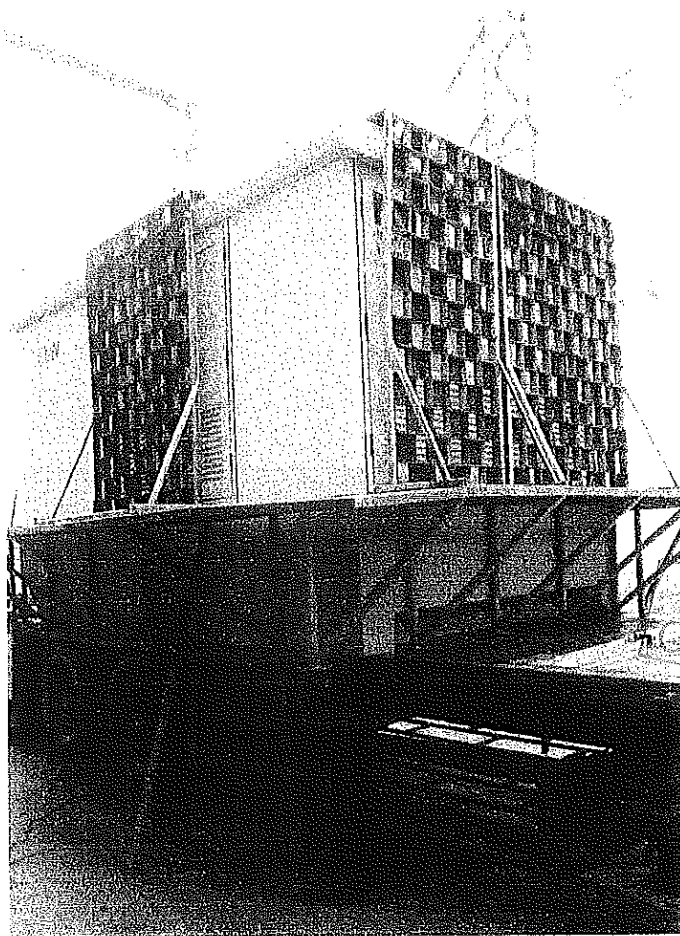
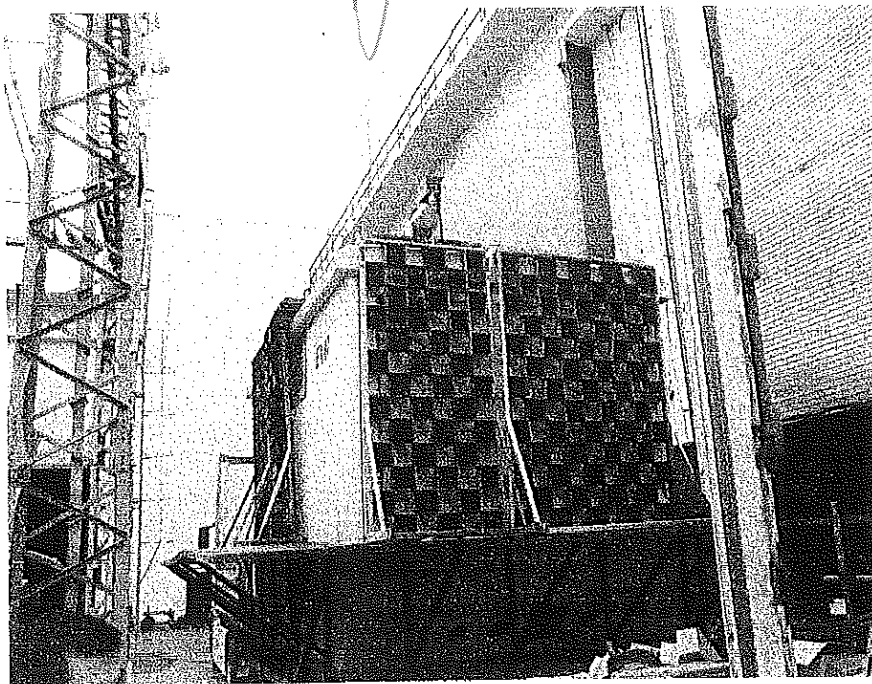


Photo 1 and photo 2 - Aspect of the prefabricated transformer substation and indicators in the test circuit before test from IAC B

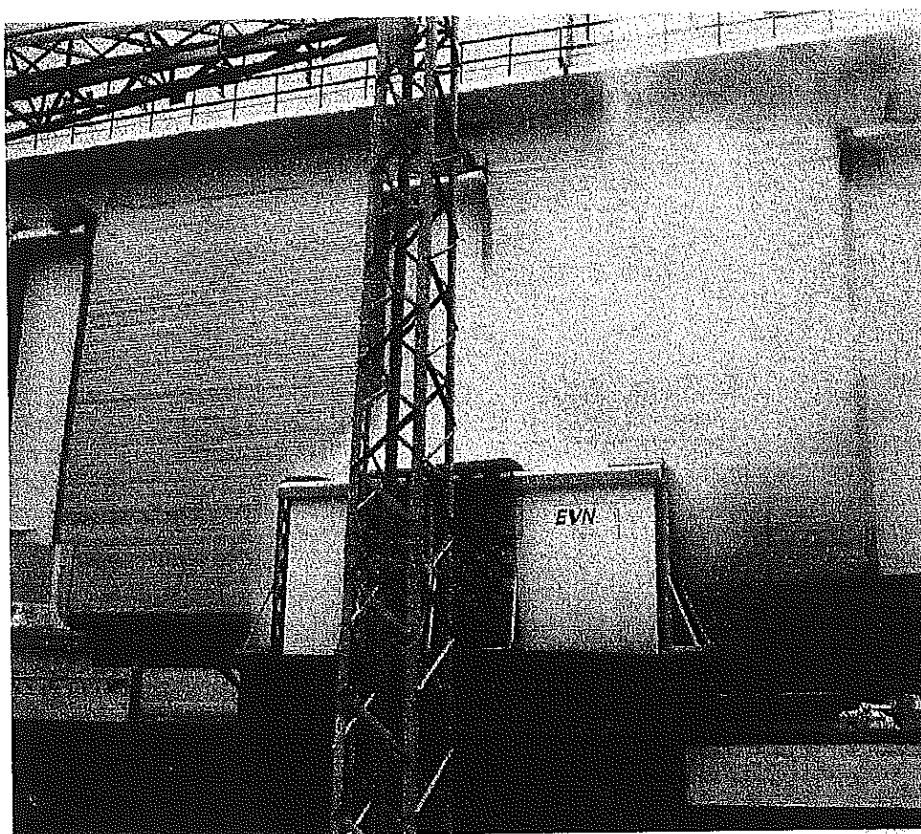
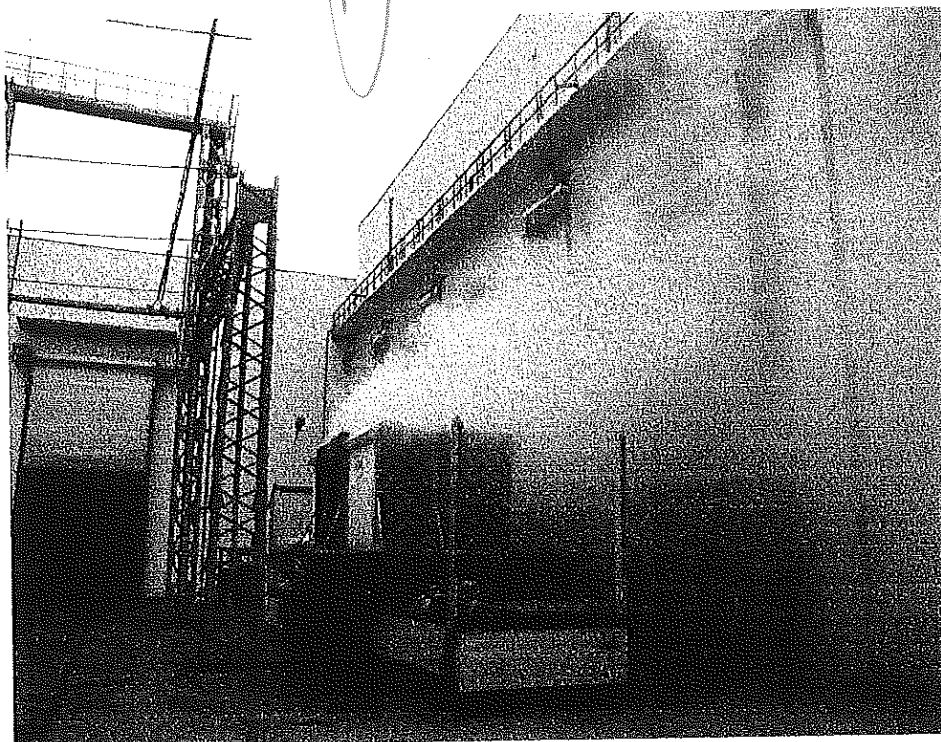


Photo 3 and photo 4 - Aspect of the prefabricated transformer substation and indicators in the test circuit after test from IAC B

Handwritten mark resembling the number '4'.

Handwritten mark resembling the number '10'.

Handwritten signature or initials.

Stamp: HO C / KHANA

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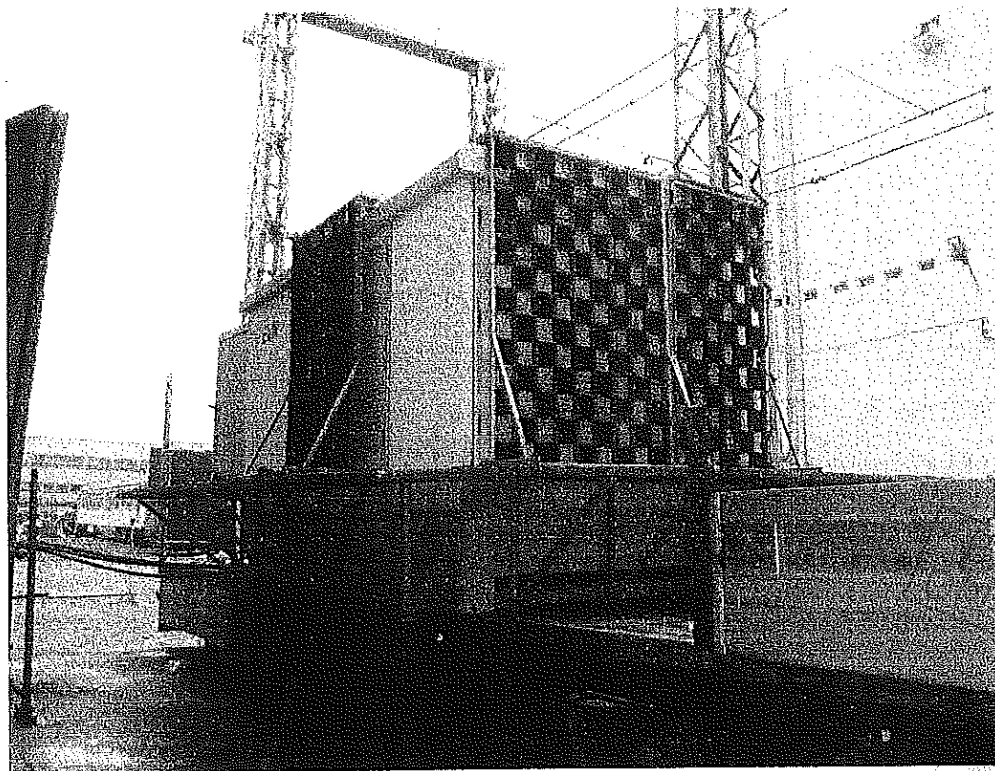
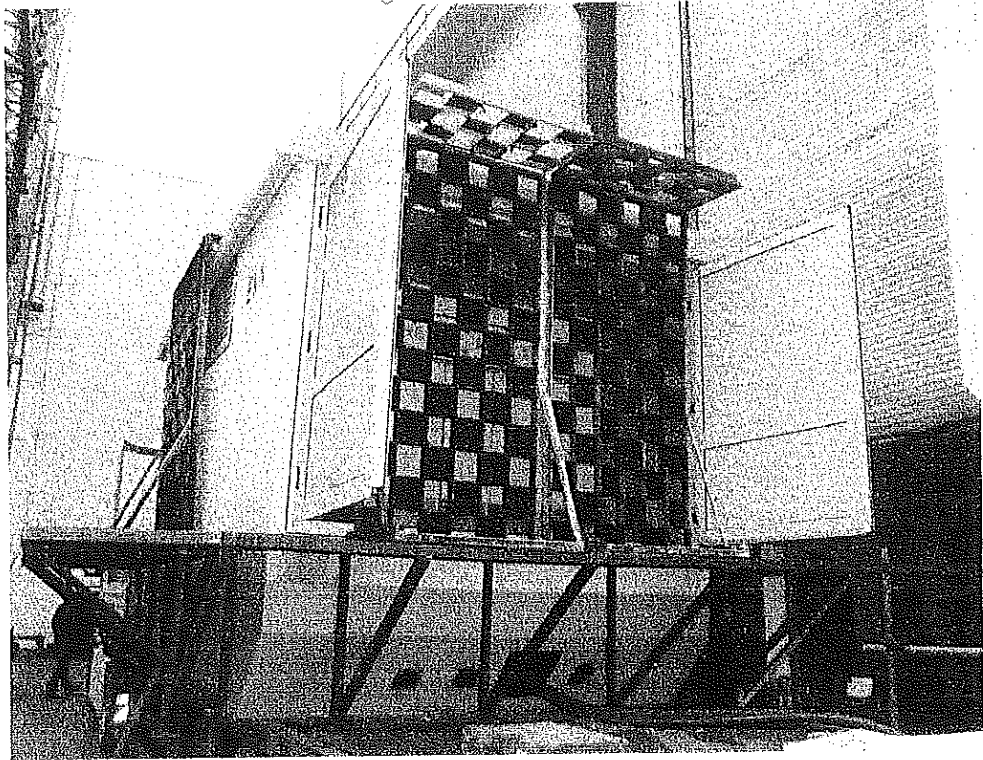


Photo 5 and photo 6 - Aspect of the prefabricated transformer substation and indicators in the test circuit before test from IAC A

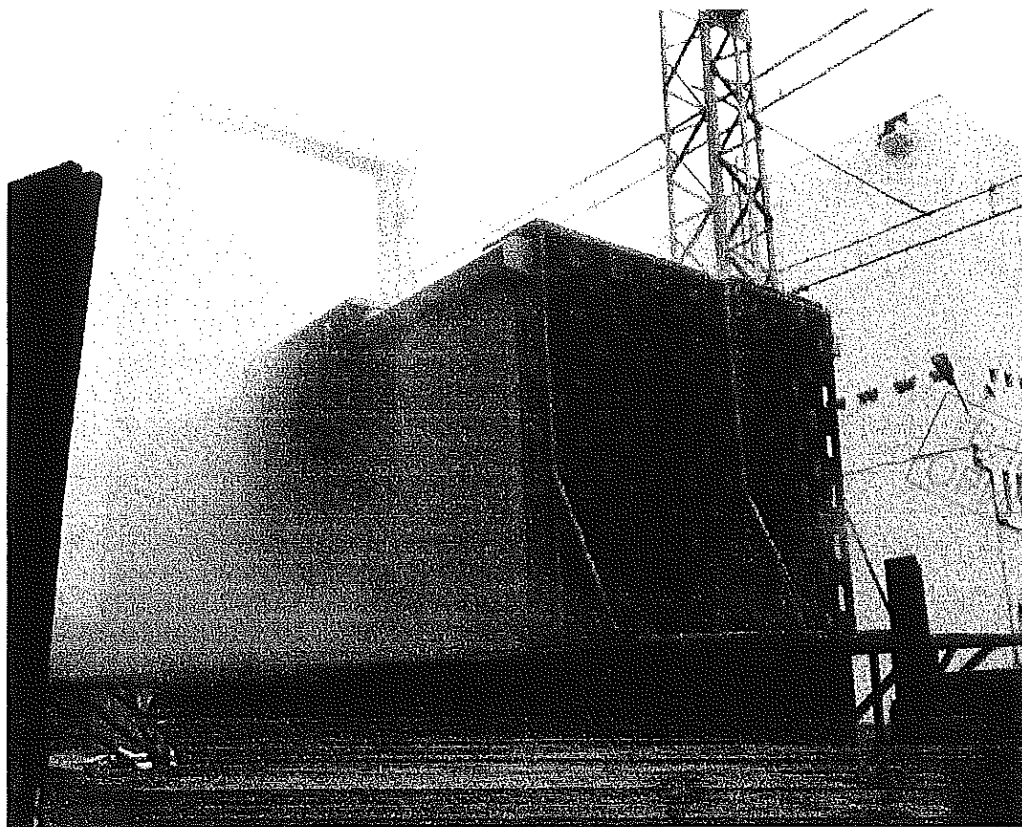
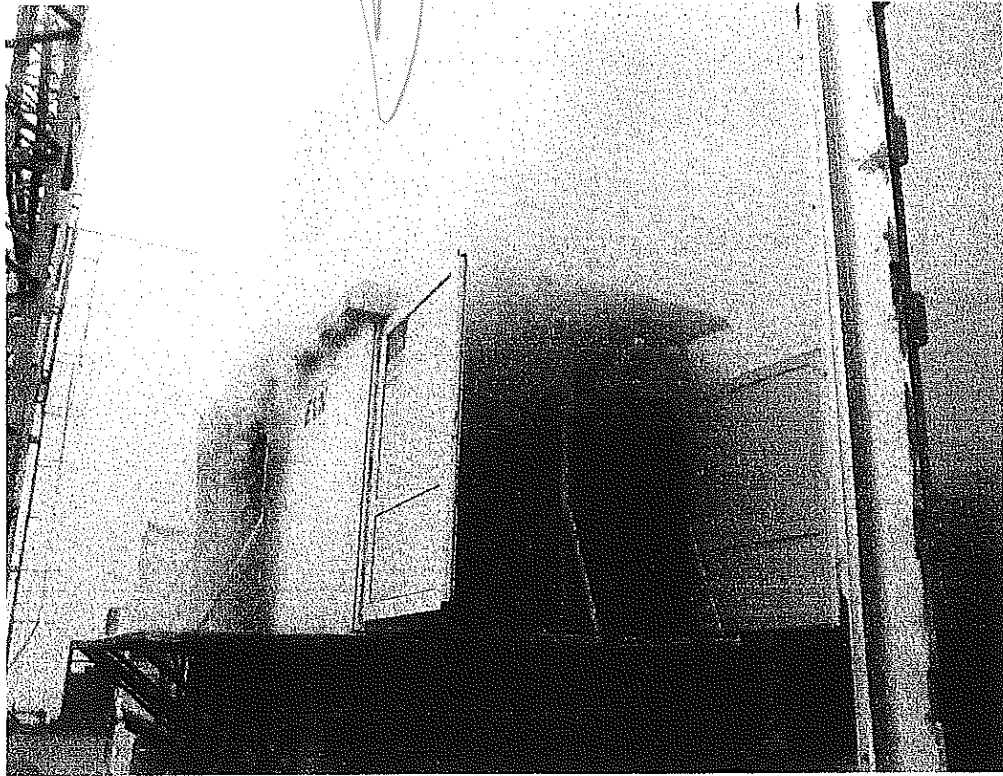


Photo 7 and photo 8 - Aspect of the prefabricated transformer substation and indicators in the test circuit after test from IAC A

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### TECHNICAL SPECIFICATION

PREFABRICATED TRANSFORMER SUBSTATION MADE OF REINFORCED CONCRETE

TYPE: CCTS 20/0.4kV 2x1000kVA  
PRODUCER: "PAVEL & SONS ELECTRIC" LTD., SHUMEN, BULGARIA  
FACTORY NUMBER: 13002

CASING: THE CASING OF THE CONCRETE PREFABRICATED SUBSTATION IS MADE OF WATER -TIGHT REINFORCED CONCRETE B45;

1.1. MEASUREMENTS ( ROOF INCLUDED) :

L= 4600MM;B=2800MM;H=2830MM;  
WEIGHT WITH TRANSFORMERS: 25 100KG;

EQUIPMENT:

2.1. EQUIPMENT ON THE MIDDLE VOLTAGE SIDE:  
COMPLETE DISTRIBUTING DEVICE - 8DJH TRRT SIEMENS, WHICH CONSISTS OF CABLE "IN", CABLE "OUT" AND "TRANSFORMER PROTECTION" - 2PCS.

2.2. INTERCONNECTIONS 20 kV FROM MV SWITCHBOARD TO TRANSFORMERS NA2XS(F)2Y 3X1X50MM<sup>2</sup>.

2.3. TRANSFORMER:  
TRANSFORMER 20/0.4KV 1000 KVA - 2PCS.

DIMENSIONS:  
L=1900MM.  
W=1100MM.  
H=1900MM.

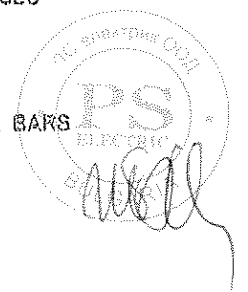
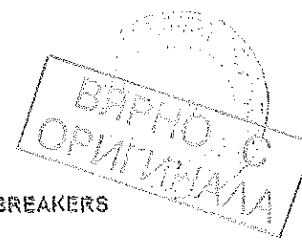
2.4. CONNECTING CABLE FROM TRANSFORMERS TO LV SWITCHBOARD - NYU-0 3X(4X300MM<sup>2</sup>)+2X300MM<sup>2</sup>.

2.5. MAIN CIRCUIT - BREAKERS OF LV SWITCHBOARD - AUTOMATIC CIRCUIT - BREAKERS NS 1600A "SCHNEIDER ELECTRIC".

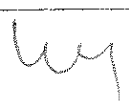
2.6. TERMINALS OF LV SWITCHBOARD - VERTICAL SWITCH DISCONNECTOR WITH FUSES MULTIVERT 630A - 5 PCS. "M.SCHNEIDER" AUSTRIA

2.7. COPPER BARS' SYSTEM:  
DISTRIBUTING RIMS - COPPER BARS 120X10MM.  
CONNECTION BETWEEN MAIN CIRCUIT - BREAKER AND DISTRIBUTING RIMS - COPPER BARS 2X(50X10MM).

3. EARTHING INSTALATION:  
INTERNAL CONNECTIONS- CONDUCTOR H07V-K 1X50MM<sup>2</sup>.



Product of concrete transformer substation, distribution panels and equipment for the power engineering







CONNECTION BETWEEN NEUTRAL COPPER BAR AND POTENTIAL COPPER BAR – CONDUCTOR H07V-K 1x150MM<sup>2</sup>.

CONNECTION TO EXTERNAL EARTHING CONTOUR –H07V-K 1x50MM<sup>2</sup>.

RATINGS OF PREFABRICATED SUBSTATION:

- RATED VOLTAGE ON MV SIDE – 24kV;
- OPERATED VOLTAGE ON MV SIDE – 20kV;
- RATED INSULATION LEVEL ON MV SIDE -50kV;
- RATED LIGHTNING IMPULSE WITHSTAND VOLTAGE ON MV SIDE-125kV;
- RATED VOLTAGE ON LV SIDE – 0.4kV;
- RATED INSULATION LEVEL ON LV SIDE -2,5kV;
- RATED NORMAL CURRENT OF MV BUSBAR-400A;
- RATED LIGHTNING IMPULSE WITHSTAND VOLTAGE ON LV SIDE- 5kV;
- RATED FEEDER CURRENT -630A;
- RATED FEEDER CURRENT FOR TRANSFORMER PANELS – 200A;
- MAIN CIRCUIT BREAKERS ON LV SWITCHBOARD-1250A;
- RATED SHORT TIME WITHSTAND CURRENT ON MV SIDE -20KA/1s;
- PEAK WITHSTAND RATED CURRENT – ON MV SIDE-50KA;
- SHORT TIME WITHSTAND CURRENT ON EARTHING CIRCUIT -16KA

DATE: 28.01.2013  
SHUMEN

PREPARED:  
CHECKED:

На основание чл. 2  
от ЗЗЛД

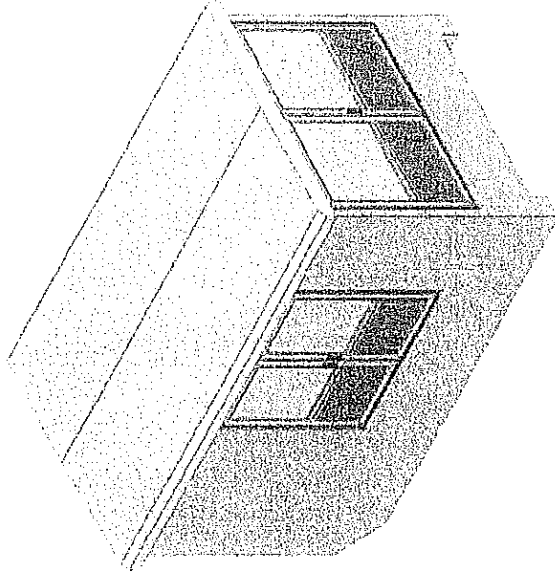
ВЯРНО С  
ОРИГИНАЛА



Page 2 of 2

Produce of concrete complete transformer substation, distribution panels and equipment for the power engineering

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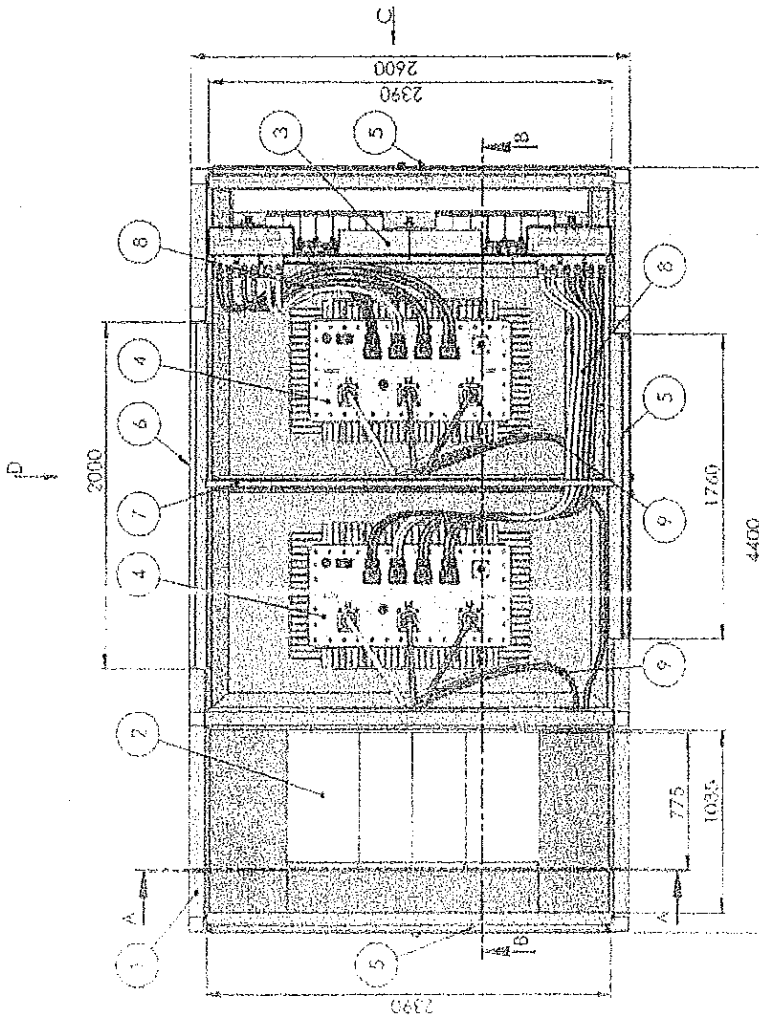


High Power Laboratory  
Date: 08.02

scale weight number  
1:50 24521.02313002  
sheet  
"PAVEL and SONS electric" Ltd.  
Shumen city, Bulgaria

1/14 CCTS 20/0.4KV 2x1000kVA

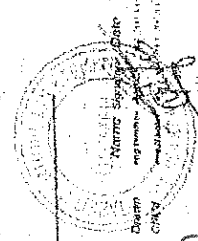
Plan view



The apparatus under test has complied with the drawing.

Client: Signature: \_\_\_\_\_

Signature: \_\_\_\_\_

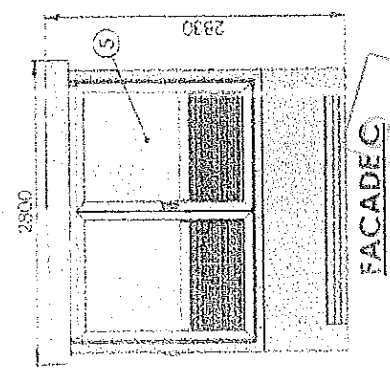
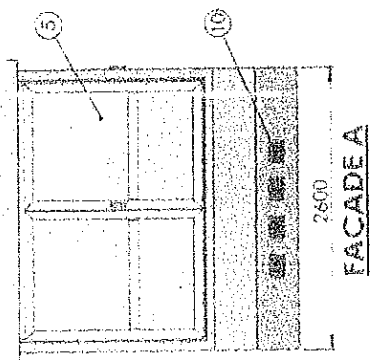
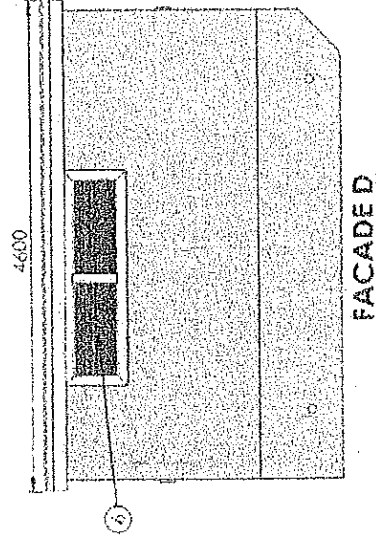
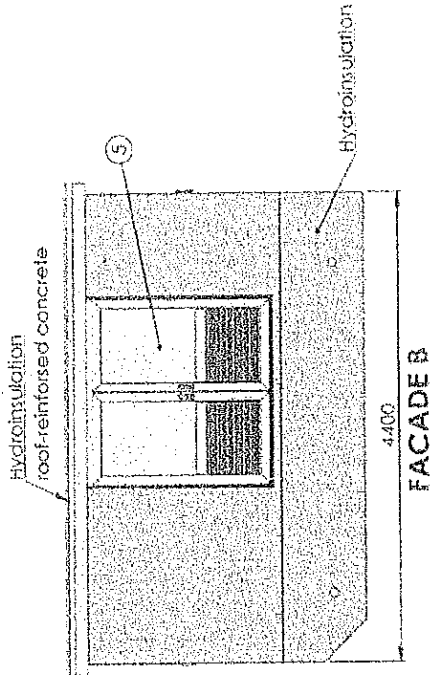


Approved



- 1. Enclosure made of reinforced concrete
- 2. MV switchboard with SF6
- 3. LV switchboard
- 4. Transformers
- 5. SF6 gas
- 6. Ventilation Grill
- 7. Metal barrier
- 8. Cable 0.4kV - NYI-0 3x(4x30mm<sup>2</sup>)+2x300mm<sup>2</sup>
- 9. Cable 20kV - NA2XS(F)Y 1x50mm<sup>2</sup>





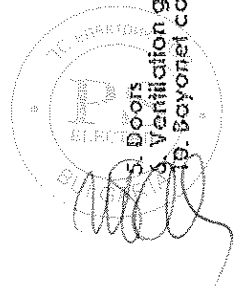
High Power Dept.  
Date: 28.02.2014

scale: 1:50  
weight number: 74521.02013002  
sheet: 2/14  
"PAVEL and SONS electric" Ltd.  
Shumen city, Bulgaria  
CCCTS 20/0.4KV 2x1000KVA

На основание чл. 2  
от ЗЗЛД

The apparatus under test has  
been completed and  
Client:  
Signature:

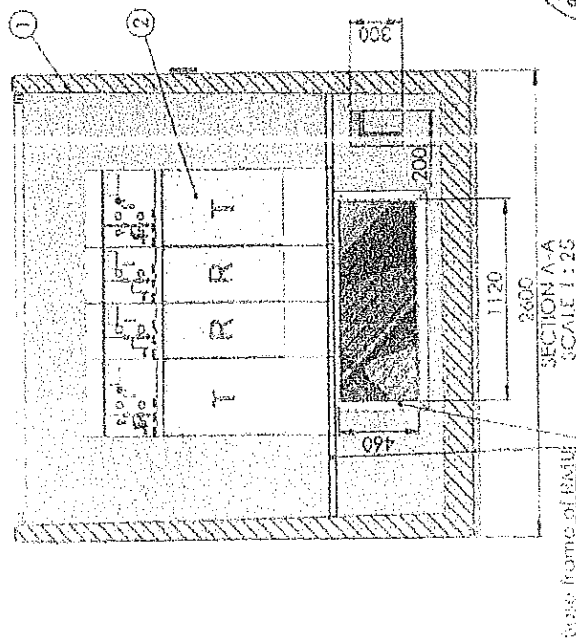
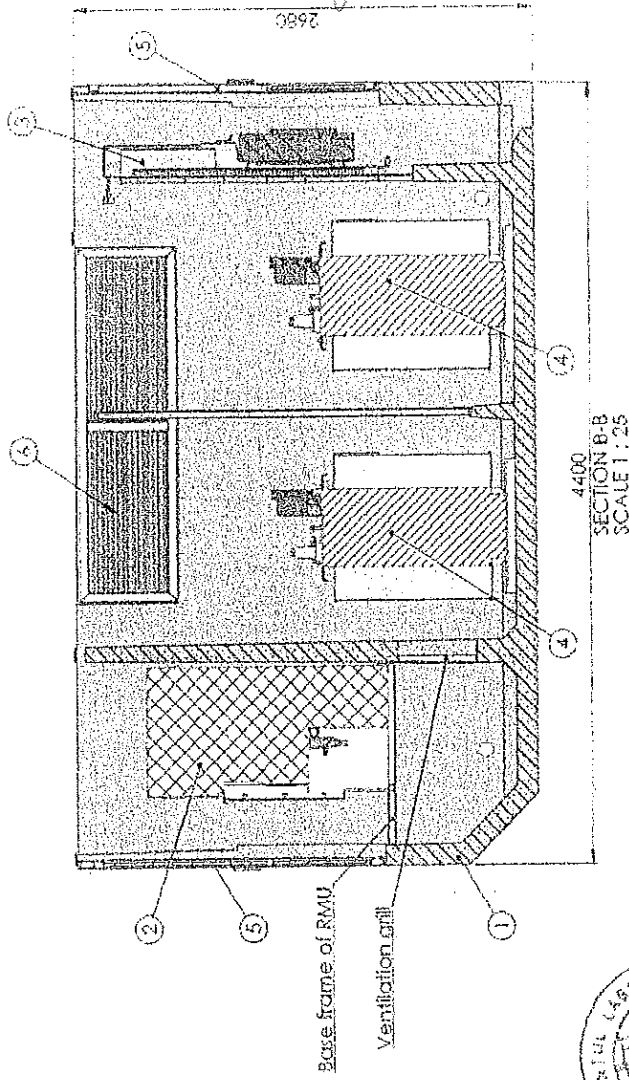
ВЯРНО  
РИГИНА



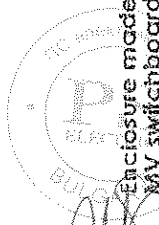
St. Doofs  
3, Ventilation grill  
19, Bayonet cable bushings 150

FACADES

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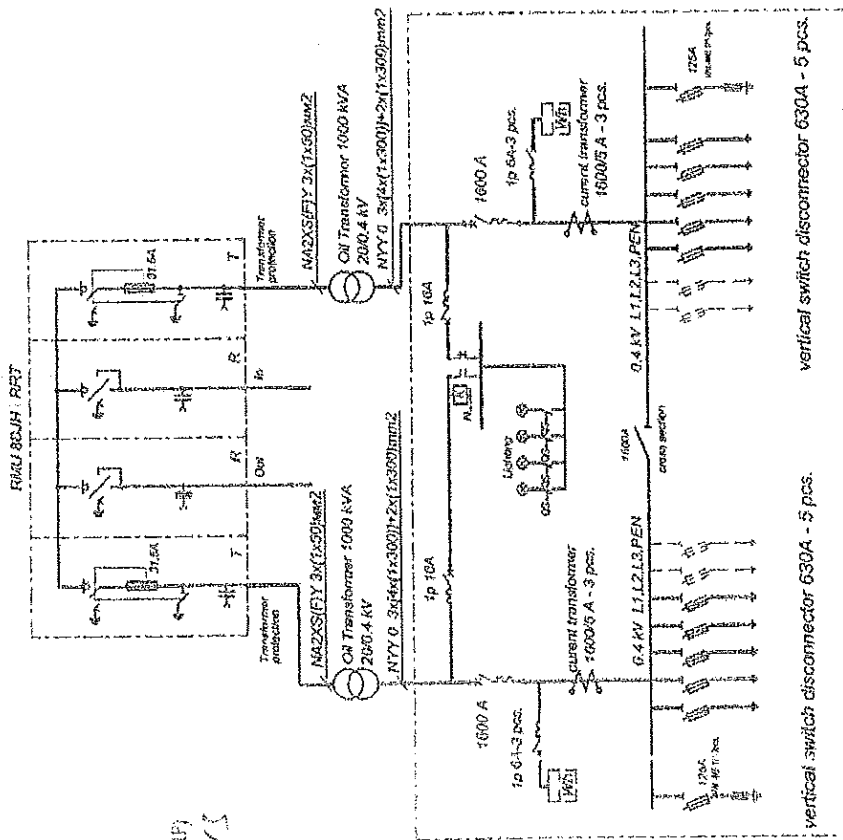
High-voltage Laboratory  
Date: 08.02.2010



- 1. Enclosure made of reinforced concrete
- 2. MV switchboard with SF6
- 3. MV switchboard
- 4. Transformers
- 5. Doors
- 6. Ventilation grill

The apparatus under test has  
 been completed  
 Client: "PAVEL and SONS electric" Ltd.  
 Signature: Shumen city, Bulgaria  
 scale: 1:50 weight number: 24521.02513002  
 sheet: 3/14  
**На основание чл. 2 от ЗЗЛД**

CCIS 20/0.4kV 2x1000kVA  
 Sections



scale	weight	number	"PAVEL and SONS electric" Ltd. Shumen city, Bulgaria
		13002	
sheet	CCTS 20/0.4kV 2x1000kVA		
4/12	Circuit diagram		

На основание чл. 2  
от ЗЗЛД

Line apparatus under test  
Client: Signature

ВАРНО С  
ОПРАТНИЦА

PS  
ELETRIC  
BULGARIA

Electrical Laboratory (ELMF)  
2013.02.20/3