PS ELECTRIC®

ПАПКА 6

ПРИЛОЖЕНИЕ 10 Други документи за Позиция1 и Позиция 2

ПРИЛОЖЕНИЕ 10.1 БКТП

Приложение 4-4.1; 4.2; 4.3; 4.4; 4.5; 4.6; 4.7; 4.8

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Офис София адрес: 1000 София, бул. Витоша 129; тел: +359 2 952 24 05; факс: +359 2 952 67 20
e-mail: office@pselectric.bg web: www.pselectric.bg

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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: lmp@icmet.ro

acreditat pentru
ÎNCERCARE
RO LI RELAB
SR EN ISO/CEI 17025:2005
CERTIFICAT DE ACREDITARE
nr. LI 004/2010

TEST REPORT
No. 11400

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 made of Reinforced Concrete

REFERENCE STANDARD: IEC 62271-202/2006 Annex A

TEST PERFORMED: Internal arc test

TEST DATE: 09.04.2012

TEST RESULT: Passed the test for IAC - B

ВЯРНО С ОРИГИНАЛА

Test Report has 23 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

DIVISION:

ATORUL PUTERE "RARINCA" OVA .2012

На основание чл. 2 от ЗЗЛД

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.

Content

ВЯРНО С
ОРИГИНАЛА

1. IDENTIFICATION OF APPARATUS

	Substation	MV Switchgear (RMU Siemens)
Type	CCTS 20/0.4 kV/1x800 kVA	8DJH RRT
Serial number/year	12119/2012	CV 826345-00020/001/2012
Technical specification/Drawing	See page 8 and 9 / See pages 10 to 21	
Contract No.:	705.2/8595/21.03.2012	
Product receiving date:	09.04.2012	
Product condition at receiving:	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_k)	1 s	1 s
IAC Classification	B	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 three phase arc initiation point inside of tank on terminals of Load Break Switch from cell 1

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

Test parameters were: Ip = 40 kA, Ik = 16 kA, tk = 1 s and three-phase applied voltage on the input terminals of cell 2.

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

Tests are performed according to own procedure PT 03.07.

ВЯРНО С ОРИГИНАЛА

4. RESPONSIBLE FOR TESTS: Eng. Ilie Sbora

5. PRESENT AT THE TESTS: Mrs. Mile Dabeski, Oliver Mirchevski from EVN Macedonia
Mr. Krasimir Kalaydziev from EVN Bulgaria
Mr. Dimitar Dimitrov from "PAVEL and SONS electric" Ltd., Bulgaria

6. TEST REPORT DOCUMENTATION Oscillograms 2 ; Tables 3 ;
Photos 4 ; Drawings 12.

7. DATA OF TESTING AND MEASURING CIRCUIT

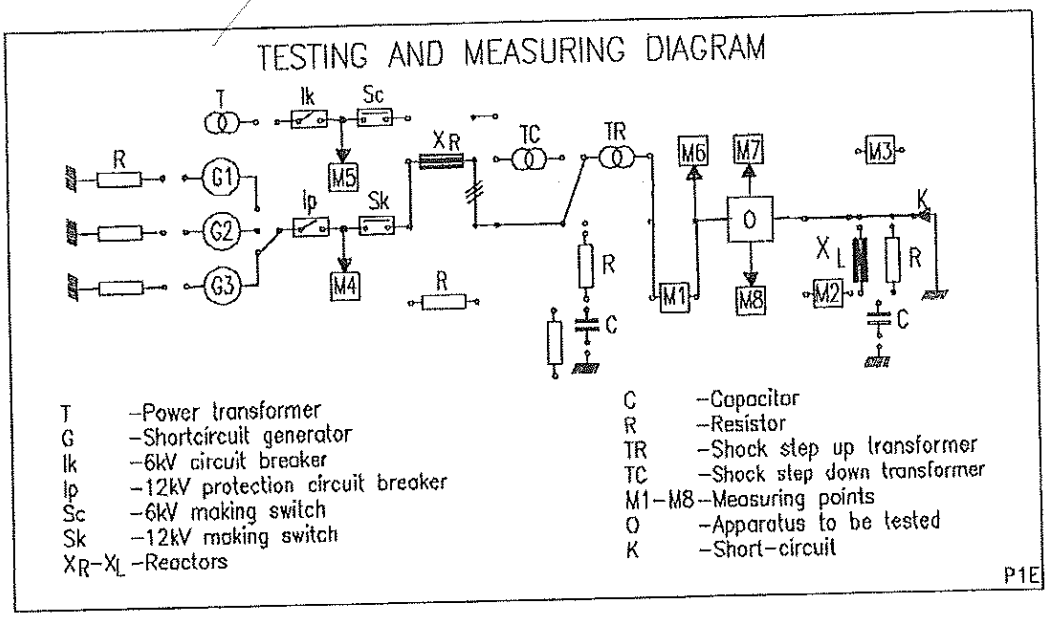


Table 1

Number of phases		3
Power supply / Connection		G3 /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.	U_{RS} U_{ST} U_{TR} [kV]	I_{pR} I_{pS} I_{pT} [kA]	I_{tR} I_{tR} I_{tT} [kA]	t_t [sec.]	I_t med [kA]	DU_{RS} DU_{ST} DU_{TR} [V]	Remarks
82579/2012	6.1 6.1 6.1	40.5 - -	16.0 16.2 16.2	0.2	16.13	- - -	Current calibration
82580/2012	6.4 6.4 6.4	40.6 - -	16.6 16.1 16.4	1	16.36	450 552 510	Internal arc test for IAC-B

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

$I_{t\,med}$ = Effective current mean value

DU_{RS}, DU_{ST}, DU_{TR} = Voltage drop on arc

U_{RS}, U_{ST}, U_{TR} = 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 and 4.
3. The indicators for IAC-B were made of black cotton – interlining lawn (45 g/m^2)
4. During the test:

- the doors of MV Switchgear and the doors Power Transformer compartment, LV compartment didn't open ;
- parts from the Substation didn't fly off;
- the indicators didn't ignite;
- the earthing connections are effective.

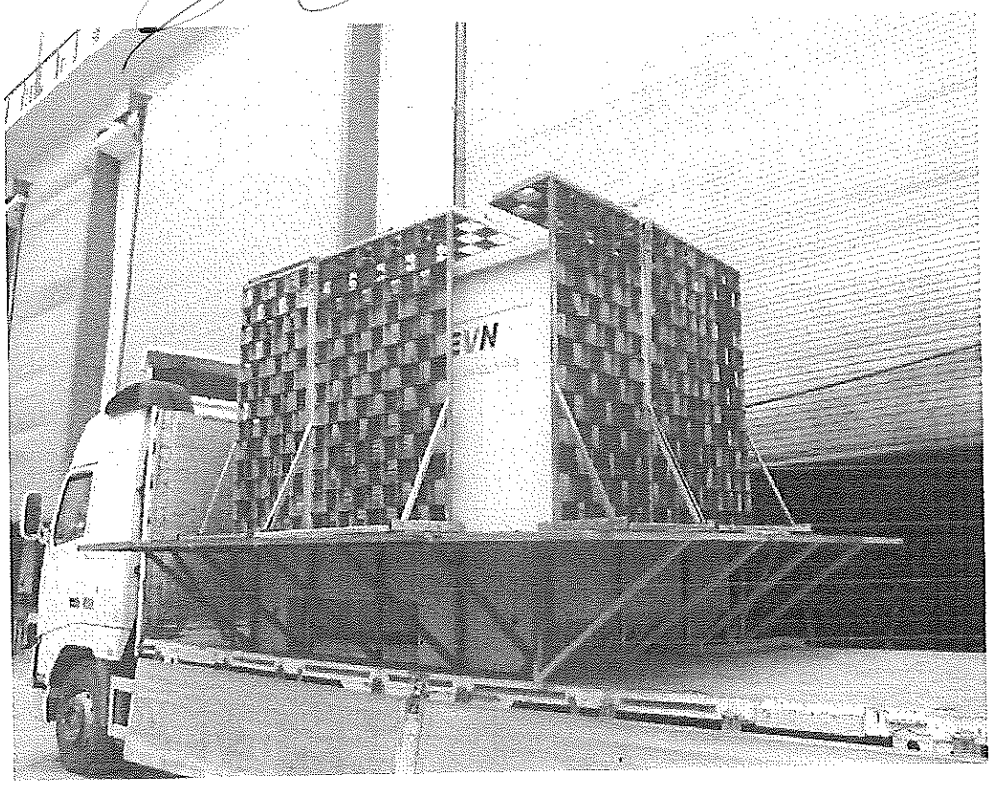
8.3 Assessment of the test result

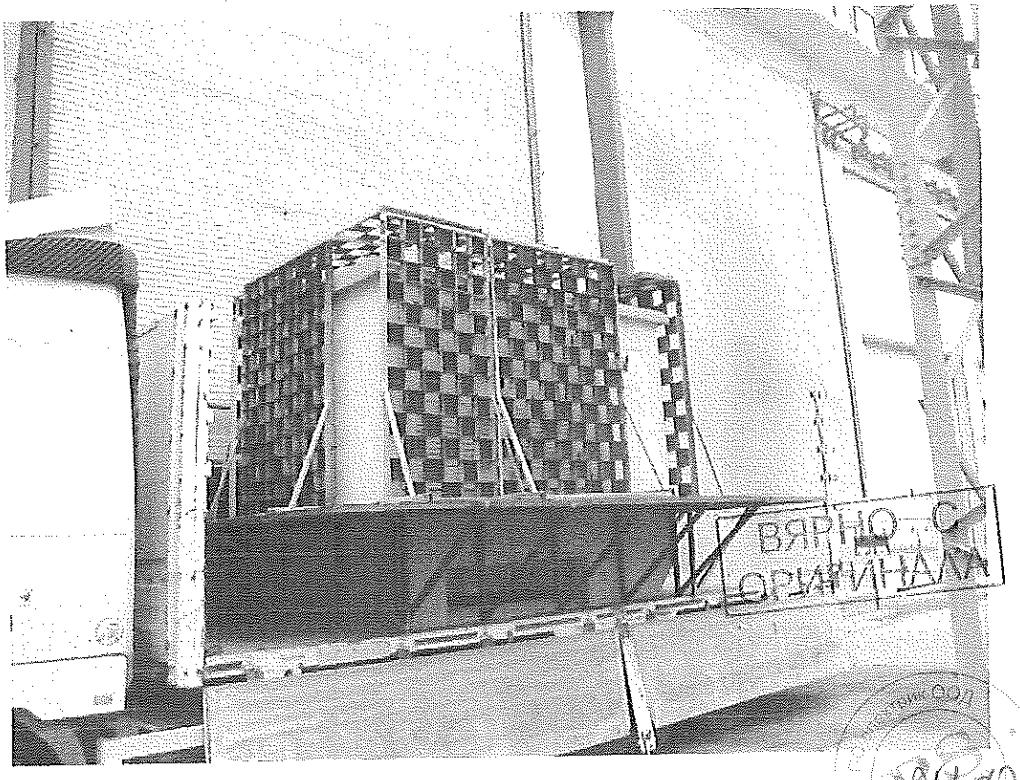
Table 3

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

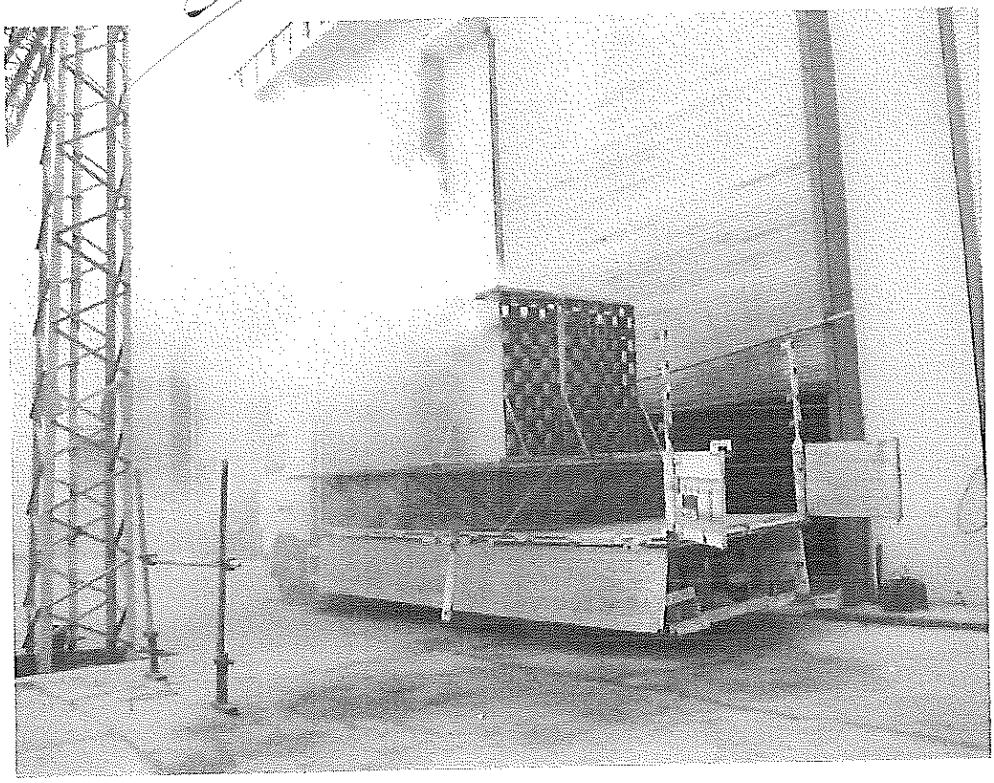
9. TEST RESULT: PASSED THE TEST

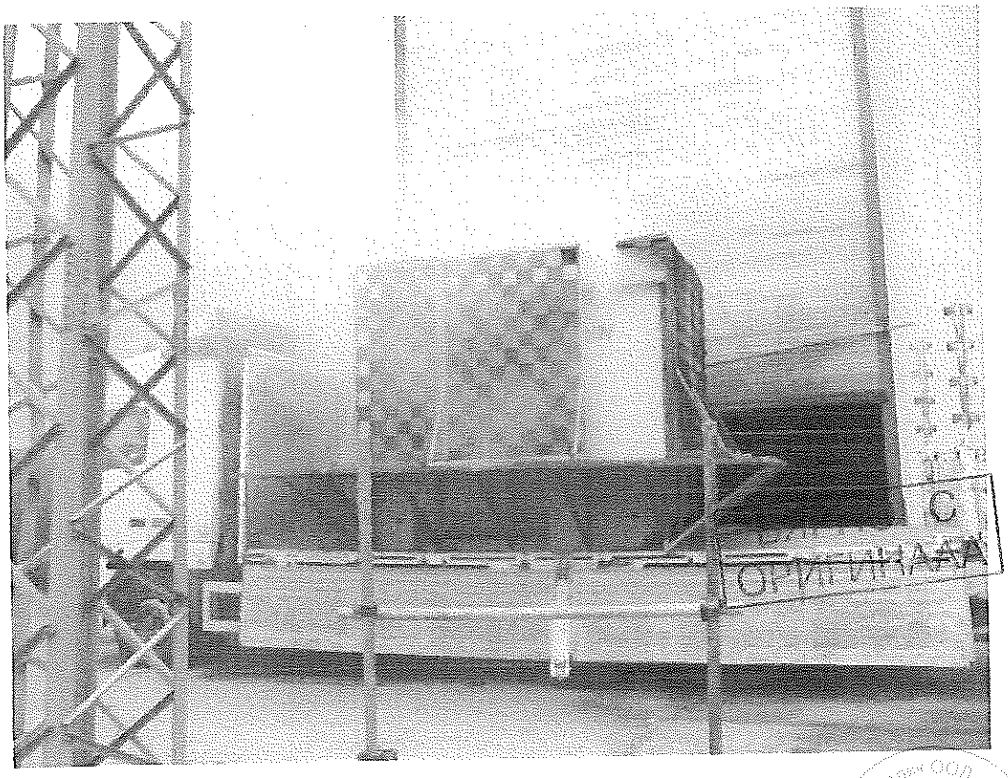
ВЯРНО С ОРИГИНАЛА





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





Photos 3, 4 - Aspect of the prefabricated transformer substation and indicators in the test circuit after test

TECHNICAL SPECIFICATION

PREFABRICATED TRANSFORMER SUBSTATION MADE OF REINFORCED CONCRETE

TYPE: CCTS 20/0.4KV 1x800KVA
PRODUCER: "PAVEL & SONS ELECTRIC"LTD. , SHUMEN, BULGARIA
FACTORY NUMBER: 12119

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

1.1. MEASUREMENTS (ROOF INCLUDED) :
L= 3200MM;B=2300MM;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", CABLE "OUT" AND "TRANSFORMER PROTECTION".

2.2. INTERCONNECTIONS 20 KV FROM MV SWITCHBOARD TO TRANSFORMERS NA2X(F)2Y 3X1X50MM2.

2.3. TRANSFORMER:
TRANSFORMER 20/0.4KV 800 KVA
DIMENTIONS:
L=1690MM.
W=950MM.
H=1300MM.

2.4.CONNECTING CABLE FROM TRANSFORMERS TO LV SWITCHBOARD – NYY 3X(4X240MM2)+2X240MM2.

2.5.MAIN CIRCUIT –BREAKERS OF LV SWITCHBOARD – AUTOMATIC CIRCUIT–BREAKERS NS 1250A "SCHNEIDER ELECTRIC".

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

2.7. COPPER BARS' SYSTEM:
DISTRIBUTING RIMS – COPPER BARS 80X10MM.
CONNECTION BETWEEN MAIN CIRCUIT – BREAKER AND DISTRIBUTING RIMS – COPPER BARS 50X15MM.

3.EARTHING INSTALATION:
INTERNAL CONNECTIONS- CONDUCTOR H07V-K 1X50MM2.

ВЯРНО С ОРИГИНАЛА

"ПАВЕЛ И СИНОВЕ ЕЛЕКТРИК"ООД ШУМЕН Тел: 054 87 44 99

Main office address: 9700 Shumen, Bldv 12 Madara; tel: +359 54 87 44 99; fax: +359 54 87 45 00
Sofia office address: 1000 Sofia Bldv 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

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

На основание чл. 2
от ЗЗЛД

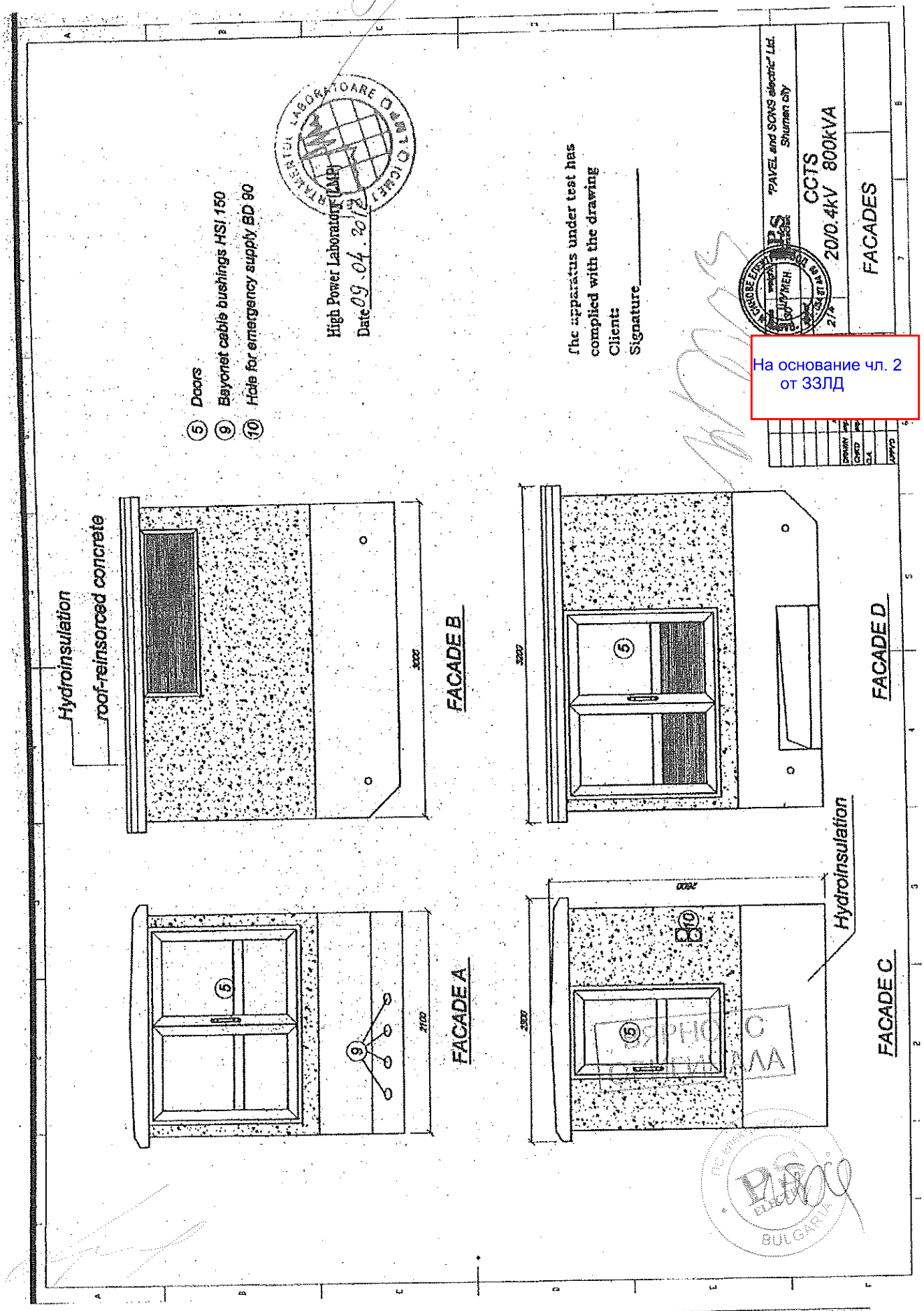
DATE: 07.03.2012
SHUMEN

PREPARED: ENG. D.
CHECKED: ENG. B.

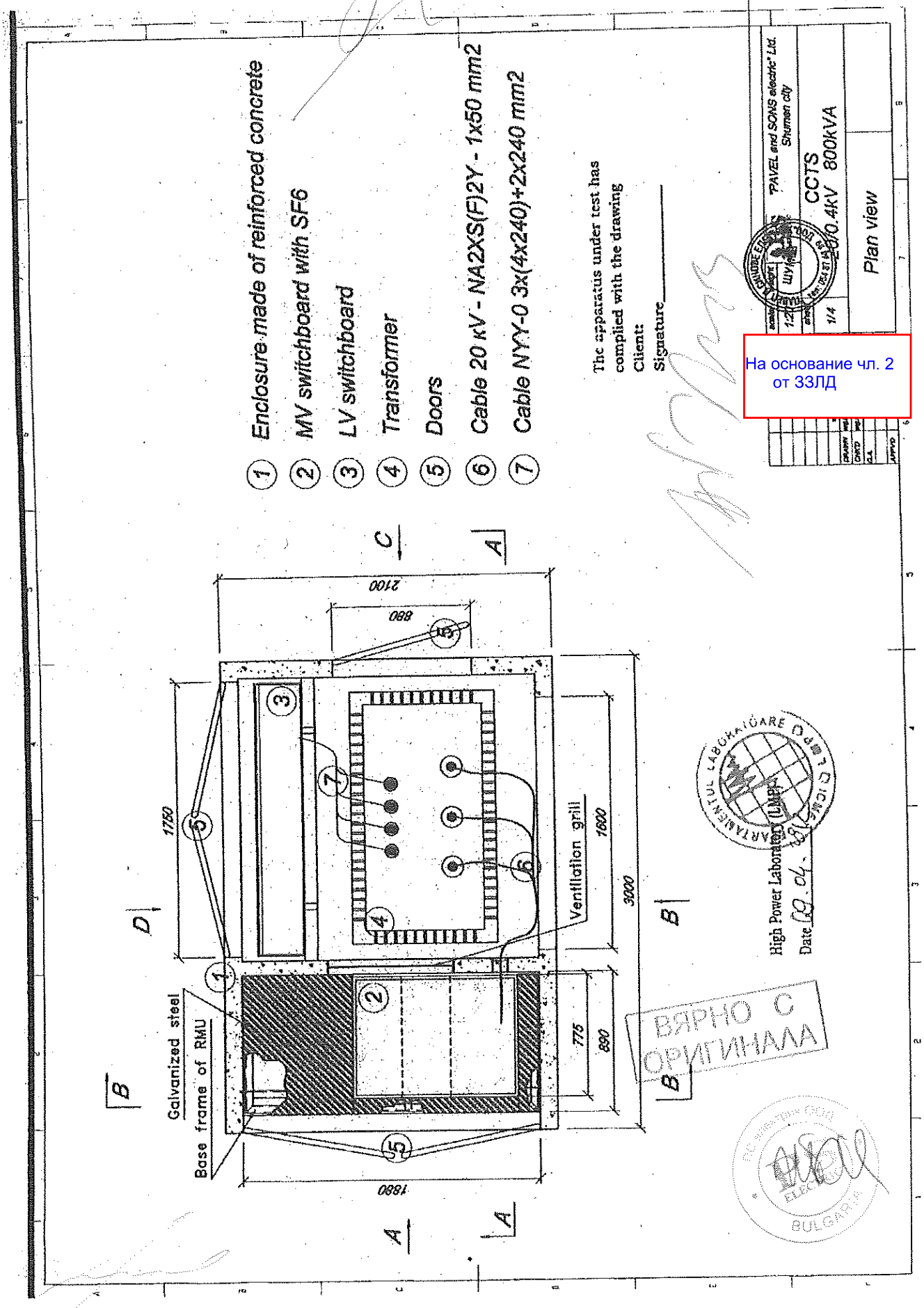
Produce of concrete complete transformer substation, distribution panels and equipment for the power engineering

ВЯРНО С
ОРИГИНАЛА

Main office address: 9700 Shumen, Bldv 12 Madara; tel: +359 54 87 44 99; fax: +359 54 87 45 00
Sofia office address: 1000 Sofia Bldv 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

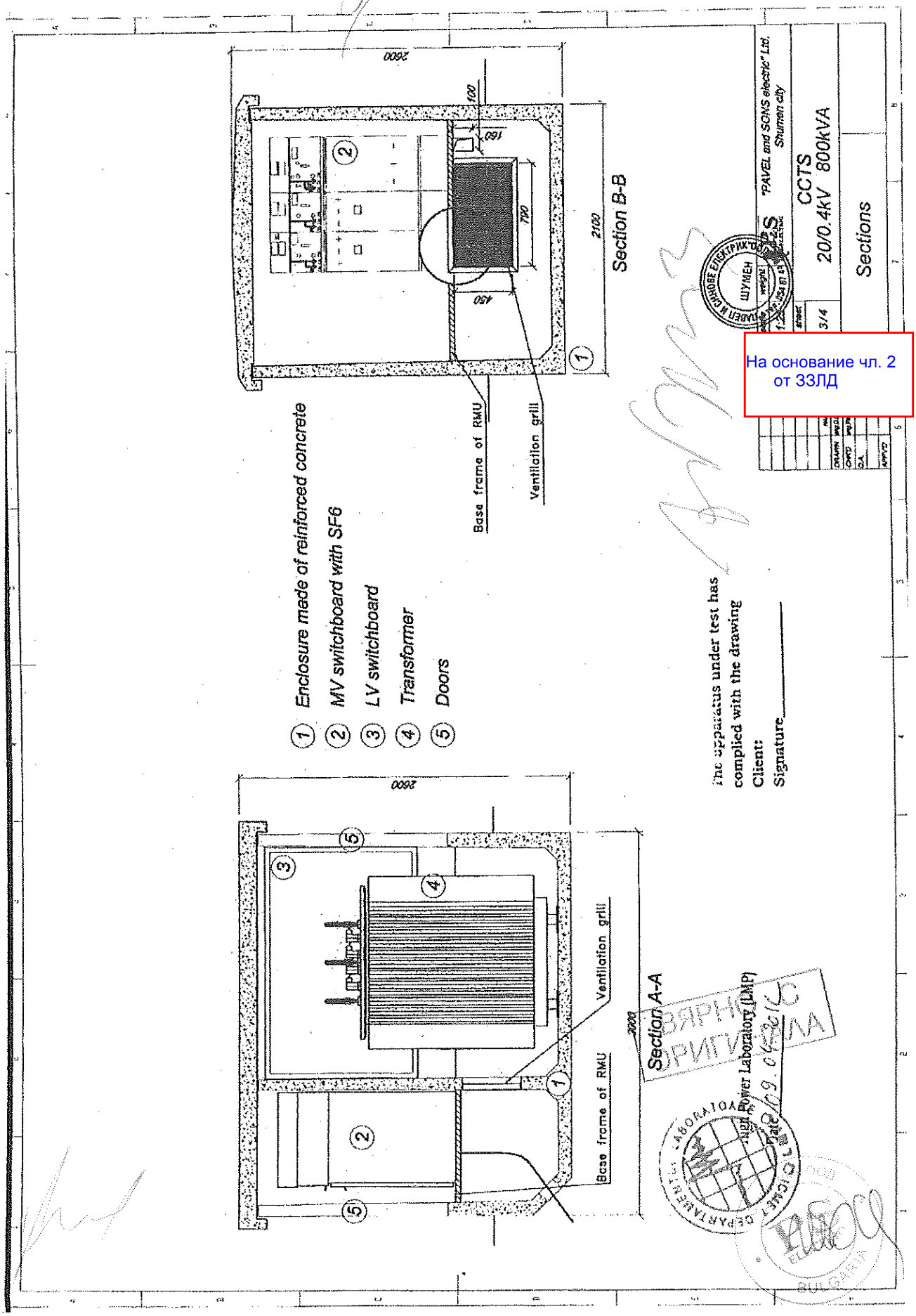


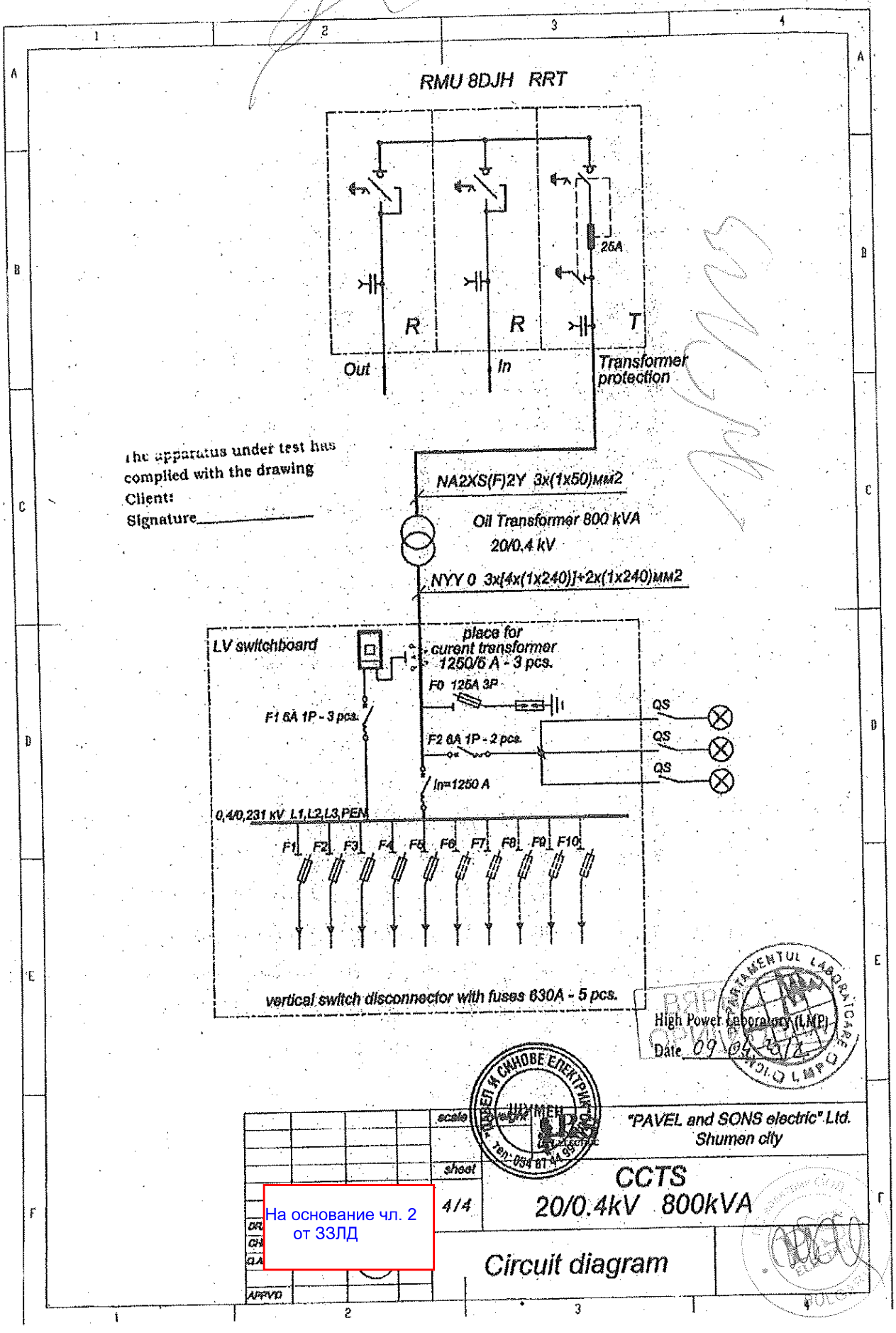
На основание чл. 2 от ЗЗЛД



На основание чл. 2 от ЗЗЛД

ВЯРНО С ОРИГИНАЛА





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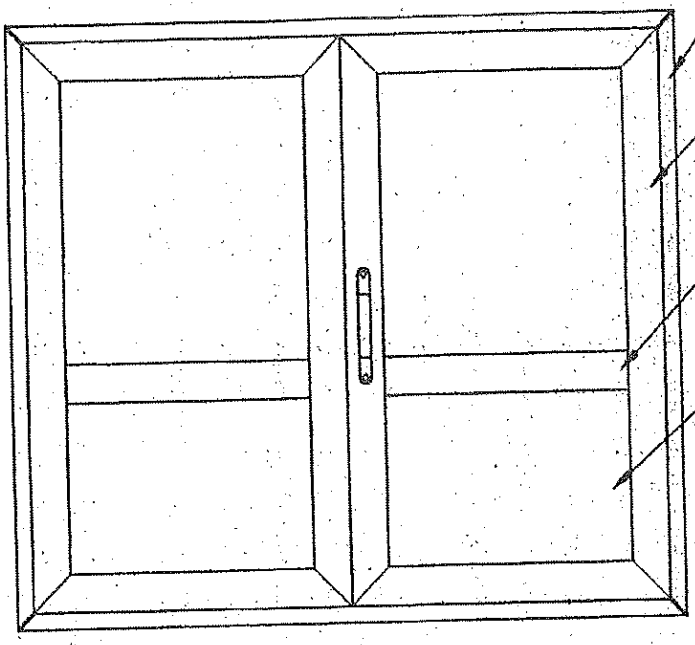


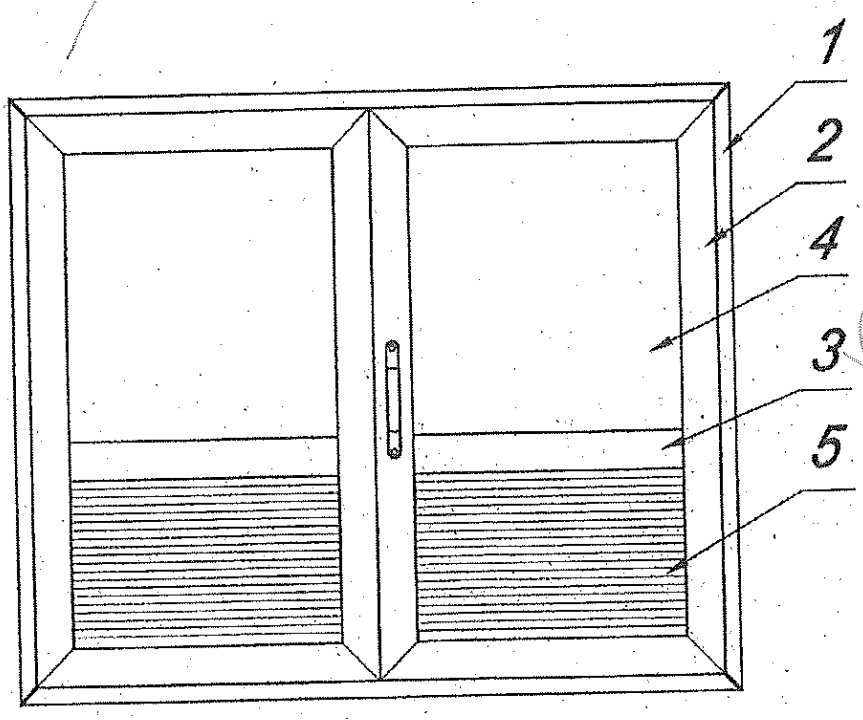
Laboratory (LMP)
date 09.04.2012

1. FRAME
2. OUTSITE OPENING DOORS/SASH
3. TRANSOM
4. SANDWICH PANEL / ALUM SHEETS+ STYROFOAM+ALUM SHEETS /

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

scale 1:16	"PAVEL and SONS electric" Ltd. Shumen city
sheet 1/4	CCTS 20/0.4kV 800kVA
DR CH Q.A. APPVD	Doors - MV switchboard

На основание чл. 2 от ЗЗЛД



High Power Laboratory (LMP)
Date 09.04.20

1 FRAME

2 OUTSITE OPENING DOORS/SASH

3 TRANSOM

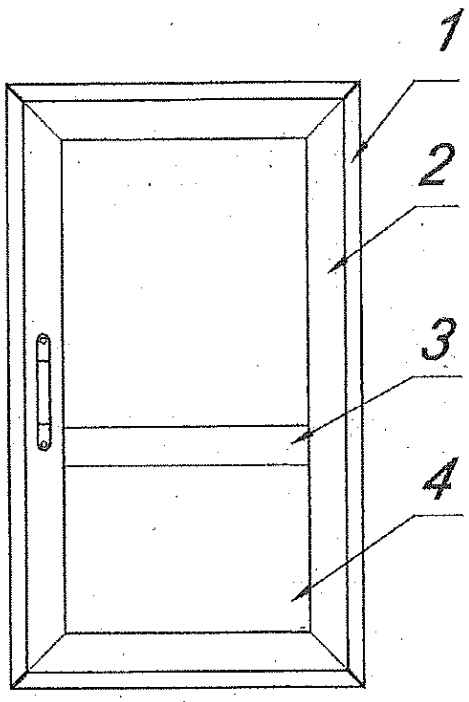
4 ALUMINIUM SHEETS

5 VENTILATION GRILL

The apparatus under test has complied with the drawing
Client:
Signature_____

					scale	weight	"PAVEL and SONS electric" Ltd. Shumen city
					1:16		
					sheet		CCTS
					2/4		20/0.4kV 800kVA
DR							Doors - LV switchboard
CH							
Q.A.							
APPVD							

На основание чл. 2 от ЗЗЛД



1. FRAME
2. OUTSITE OPENING DOORS/SASH
3. TRANSOM
4. ALUMINIUM SHEETS

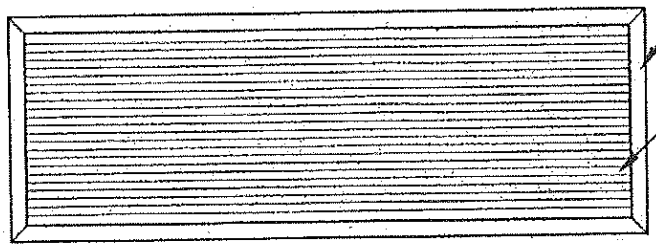
High Power Laboratory (LMP)
Date 28/04.2012

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

	scale 1:16	weight	"PAVEL and SONS electric" Ltd. Shumen city
	sheet 3/4		CCTS 20/0.4kV 800kVA
DR/ CH/ Q.A. APPVD			Doors - Transformer

На основание чл. 2 от ЗЗЛД

High Power Laboratory (LMP)
Date 04.04.2012



1 FRAME

2 VENTILATION GRILL

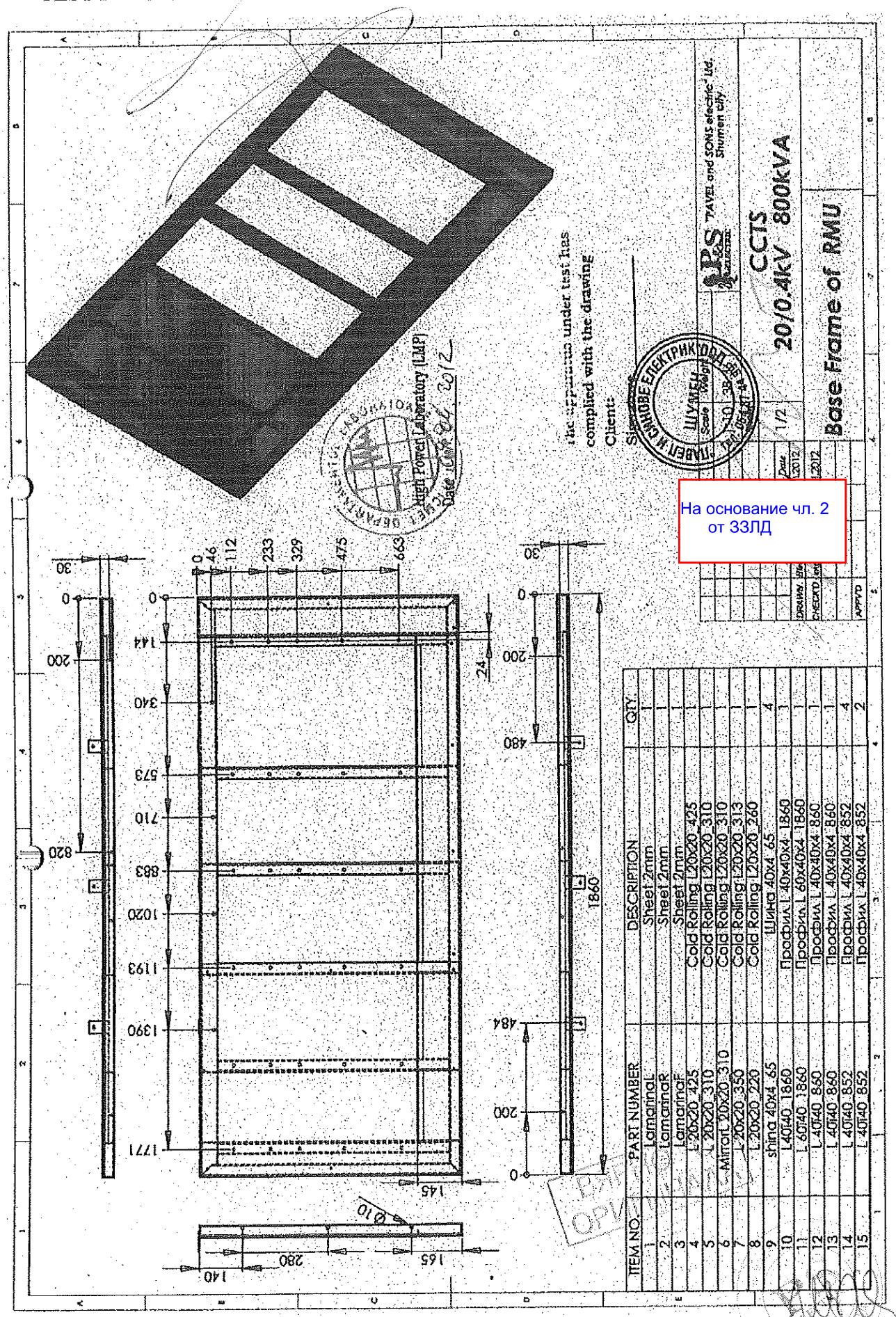
The apparatus under test has complied with the drawing
Client:
Signature_____

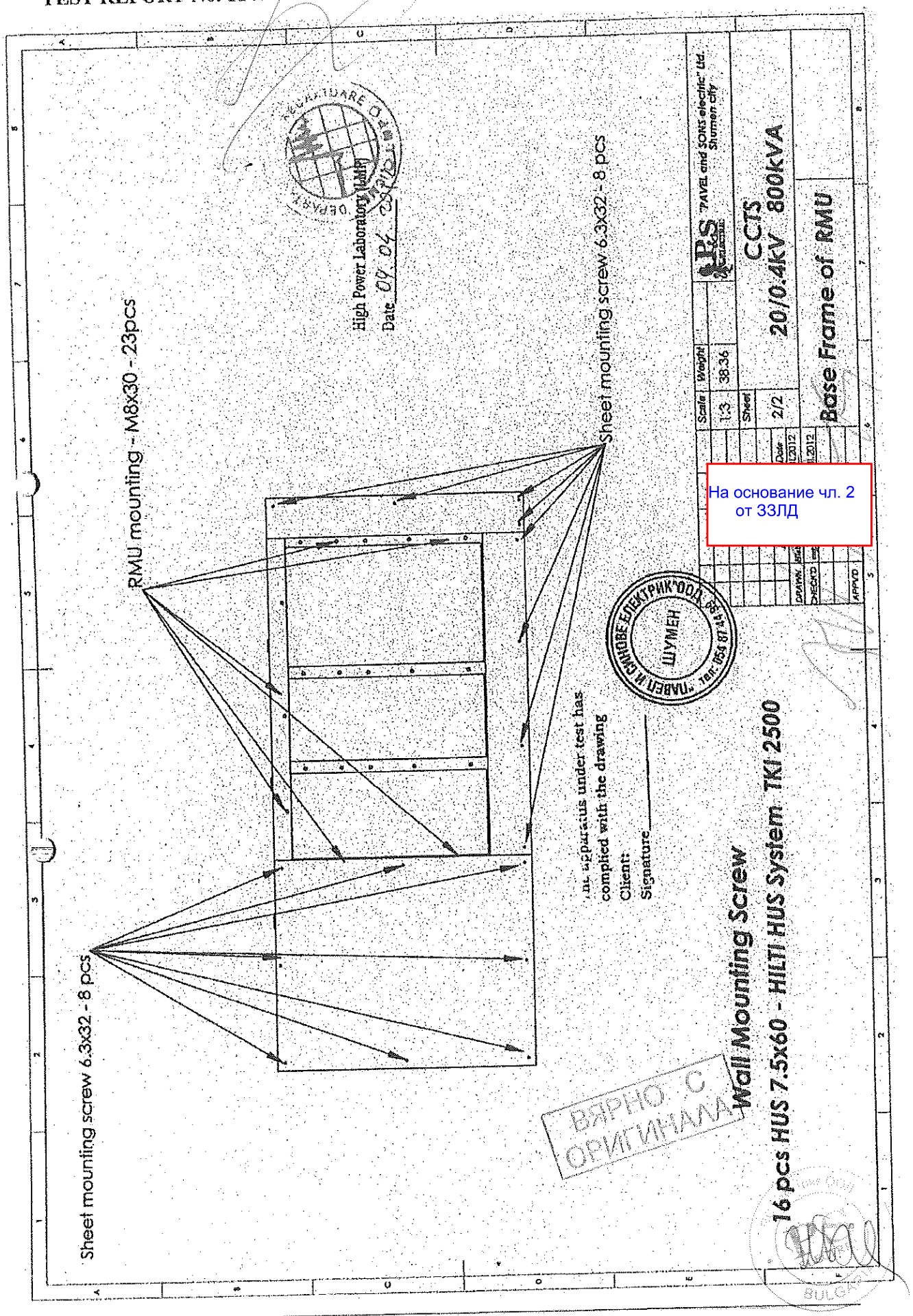
ВЯРНО С ОРИГИНАЛА

"ПЪВЕЛ И СИНОВЕ ЕЛЕКТРИК" ООД ШУМЕН

	scale	weight	"PAVEL and SONS electric" Ltd. Shumen city
	1:16		
	sheet		CCTS 20/0.4kV 800kVA
	4/4		
DR.			Ventilation grill
CH.			
Q.A.			
APPVD			

На основание чл. 2 от ЗЗЛД





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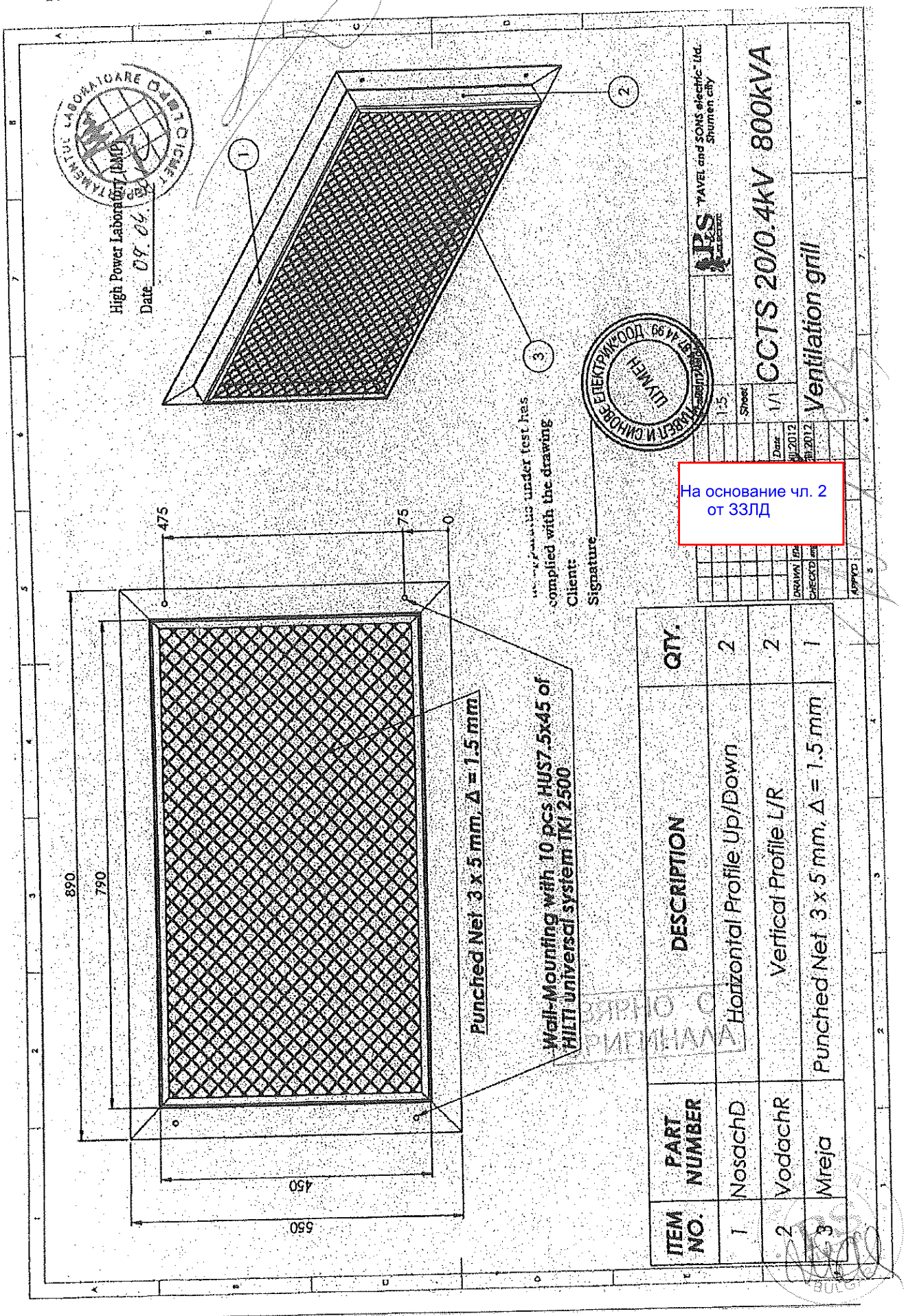
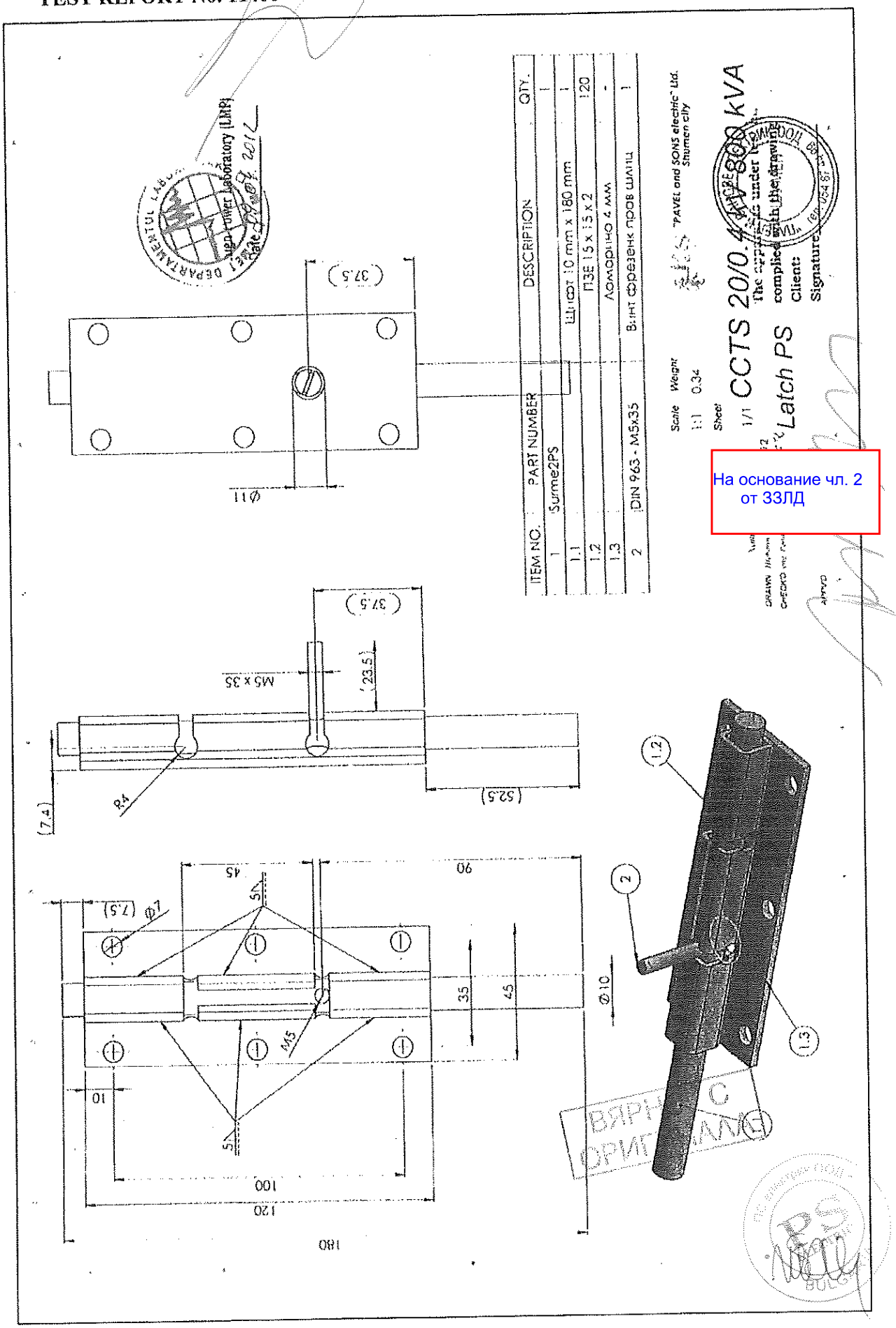
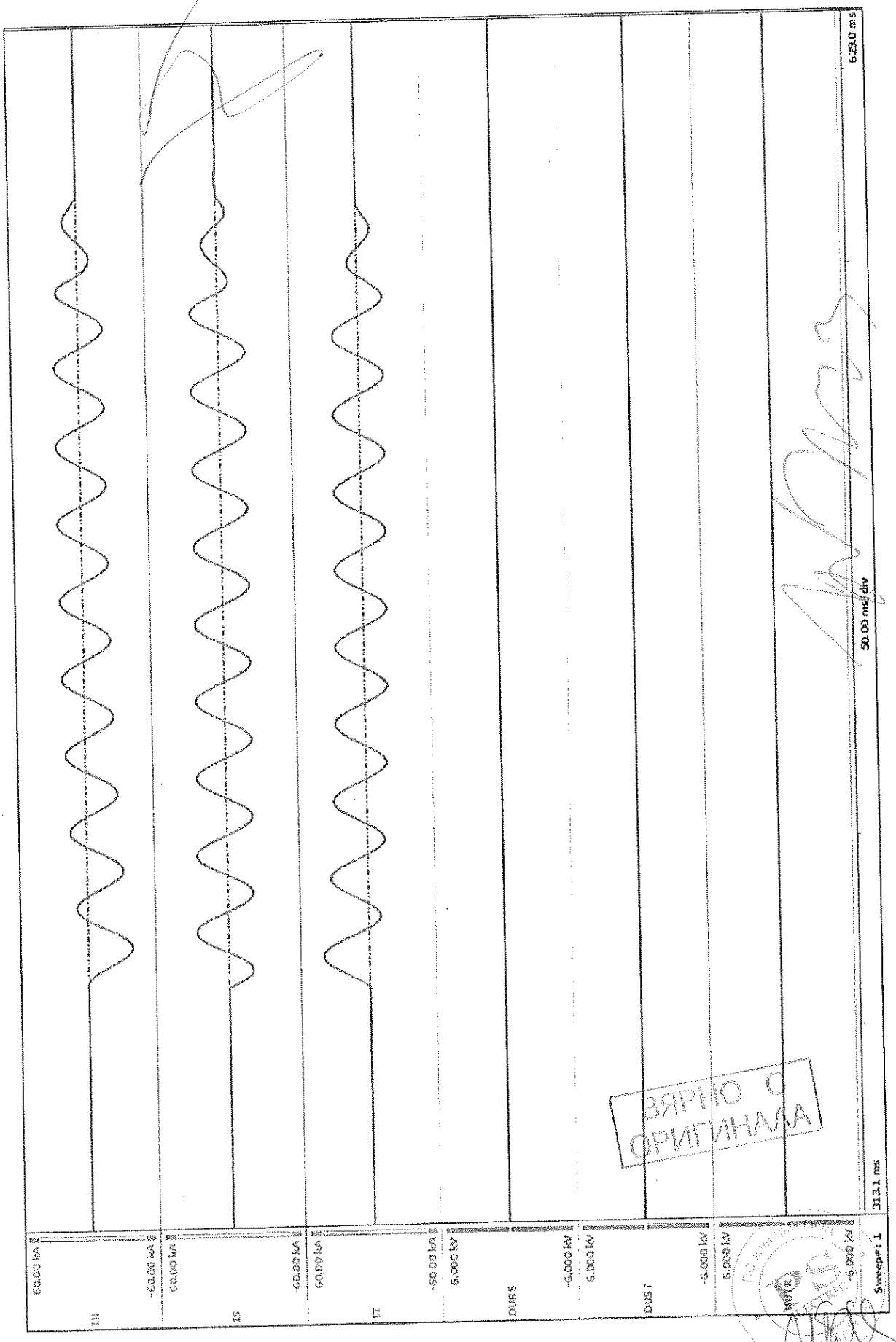
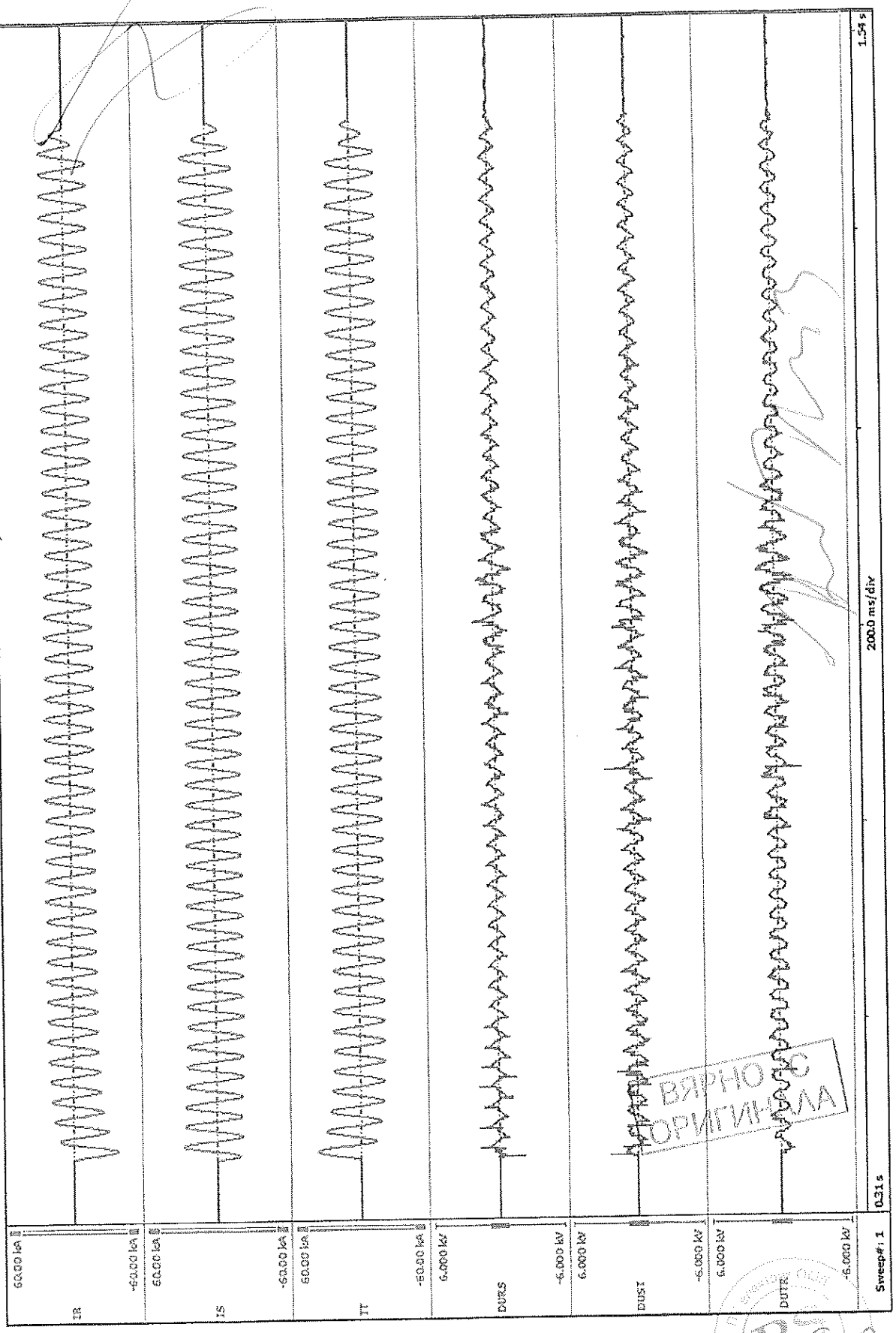






Oscillogram No. 82579 / 2012



Oscillogram No. 82580 / 2012

Copy 4 A.R.

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: lmp@icmet.ro

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

TEST REPORT
No. 11413

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 made of Reinforced Concrete

REFERENCE STANDARD: IEC 62271-202/2006 Annex A

TEST PERFORMED: Internal arc test

TEST DATE: 07.05.2012

TEST RESULT: Passed the test for IAC - A

Test Report has 23 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

R DIVISION:

ICMET
ORATORUL
ARE PUTERE *
U RARINCA"
RAIOVA
5.2012

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На основание чл. 2 от ЗЗЛД

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Content

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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 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 three phase arc initiation point inside of tank on terminals of Load Break Switch from cell 1.

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

Test parameters were: Ip = 40 kA, Ik = 16 kA, tk = 1 s and three-phase applied voltage of 6 kV on the input terminals of cell 2.

The Prefabricated Transformer Substation compartments doors were in the following condition:
- LV compartment – closed;
- Transformer compartment – closed;
- MV compartment – opened;
- MV switchgear (RMU Siemens) – closed.

The combined vertical and horizontal indicators were placed at the following distances:
- in front of MV switchgear at 300 mm,
- in front of the doors of Prefabricated transformer substation compartments at 100 mm;
- in front of the windows at 100 mm.

Tests are performed according to own procedure PT 03.07.

4. RESPONSIBLE FOR TESTS: Eng. Ilie Sbora

5. PRESENT AT THE TESTS: Mr. Dimitar Dimitrov from "PAVEL and SONS electric" Ltd., Bulgaria

6. TEST REPORT DOCUMENTATION Oscillograms 2 ; Tables 3 ; Photos 4 ; Drawings 12.

7. DATA OF TESTING AND MEASURING CIRCUIT

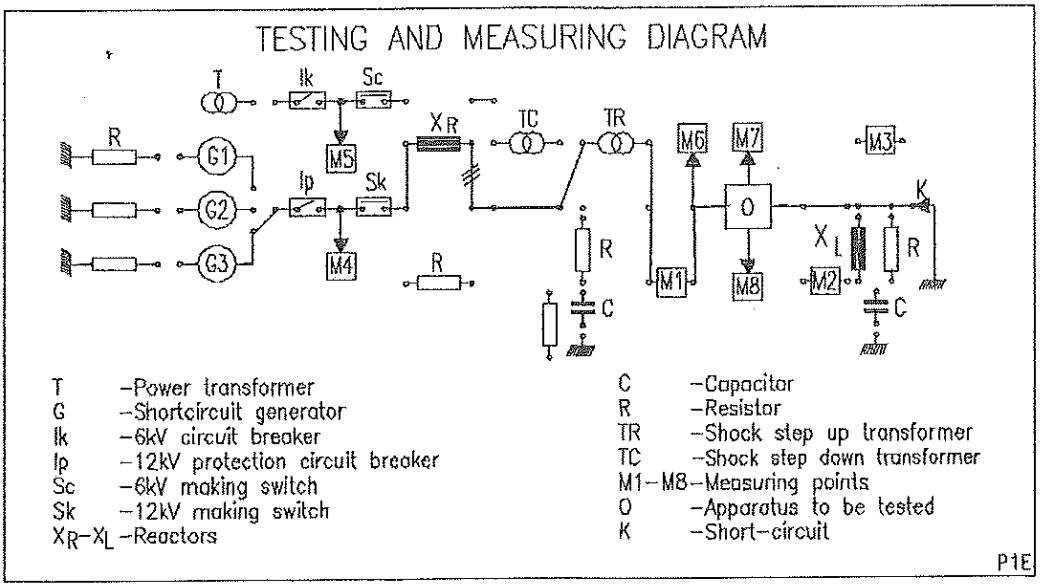


Table 1

Number of phases		3
Power supply / Connection		G3 /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.	U_{RS} U_{ST} U_{TR} [kV]	I_{pR} I_{pS} I_{pT} [kA]	I_{tR} I_{tR} I_{tT} [kA]	t_t [sec.]	I_t med [kA]	DU_{RS} DU_{ST} DU_{TR} [V]	Remarks
83012/2012	6.1 6.1 6.1	- - 41.8	16.7 16.8 16.4	0.2	-	- - -	Current calibration
83013/2012	6.4 6.4 6.4	- - 40	16.6 16.6 16.3	1	16.5	460 590 490	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

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

$I_{t\,med}$ = Effective current mean value

DU_{RS}, DU_{ST}, DU_{TR} = Voltage drop on arc

U_{RS}, U_{ST}, U_{TR} = 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 and 4.
3. During the test:
- the doors of MV Switchgear didn't open;
- the doors of Power Transformer compartment and LV compartment didn't open ;
- parts from the Substation didn't fly off;
- the indicators didn't ignite;
- the earthing connections are effective.

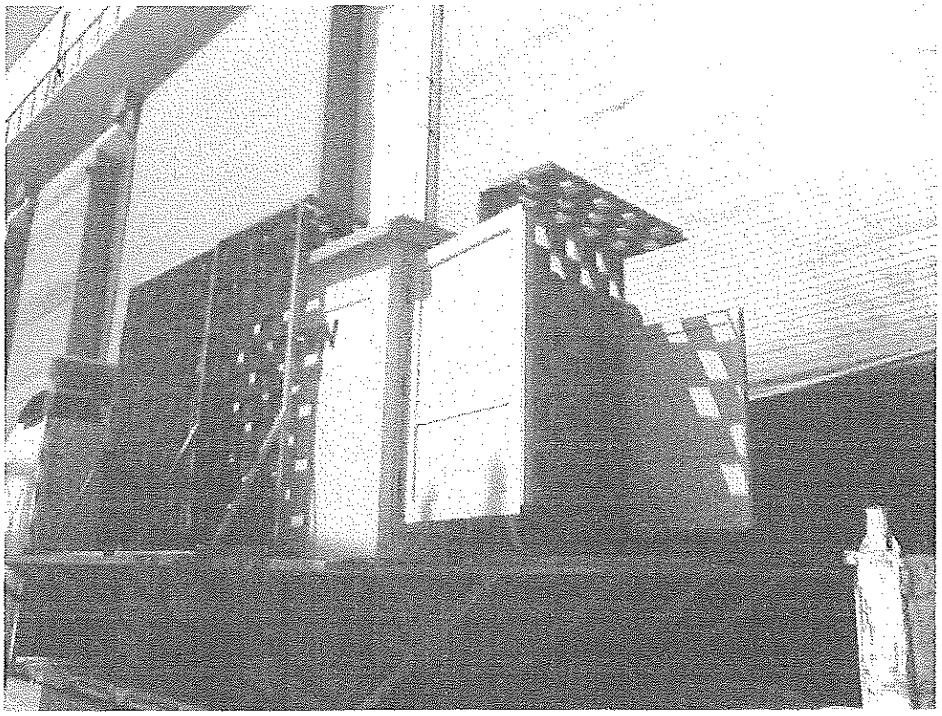
8.3 Assessment of the test result

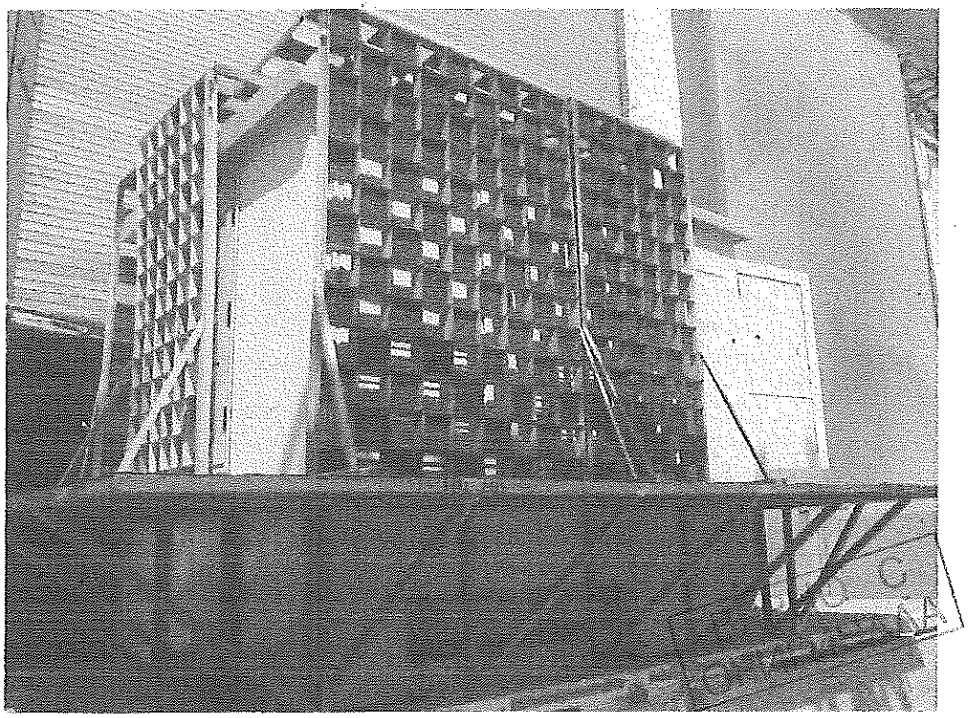
Table 3

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

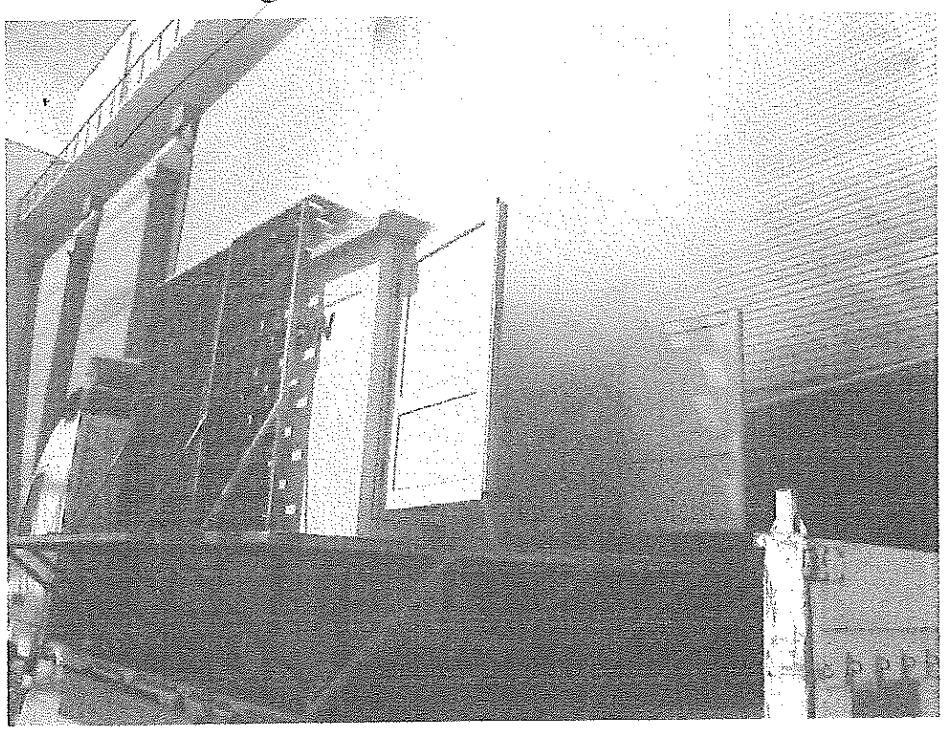
9. TEST RESULT: PASSED THE TEST

ВЯРНО С ОРИГИНАЛА





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



Photos 3, 4 - Aspect of the prefabricated transformer substation and indicators in the test circuit after test

TECHNICAL SPECIFICATION

PREFABRICATED TRANSFORMER SUBSTATION MADE OF REINFORCED CONCRETE

TYPE: CCTS 20/0.4KV 1X800KVA
PRODUCER: "PAVEL & SONS ELECTRIC"LTD. , SHUMEN, BULGARIA
FACTORY NUMBER: 12119

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

1.1. MEASUREMENTS (ROOF INCLUDED) :
L= 3200MM;B=2300MM;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", CABLE "OUT" AND "TRANSFORMER PROTECTION".

2.2. INTERCONNECTIONS 20 KV FROM MV SWITCHBOARD TO TRANSFORMERS NA2X(F)2Y 3X1X50MM2.

2.3. TRANSFORMER:
TRANSFORMER 20/0.4KV 800 KVA
DIMENTIONS:
L=1690MM.
W=950MM.
H=1300MM.

2.4.CONNECTING CABLE FROM TRANSFORMERS TO LV SWITCHBOARD – NYY 3X(4X240MM2)+2X240MM2.

2.5.MAIN CIRCUIT –BREAKERS OF LV SWITCHBOARD – AUTOMATIC CIRCUIT–BREAKERS NS 1250A "SCHNEIDER ELECTRIC".

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

2.7. COPPER BARS' SYSTEM:
DISTRIBUTING RIMS – COPPER BARS 80X10MM.
CONNECTION BETWEEN MAIN CIRCUIT – BREAKER AND DISTRIBUTING RIMS – COPPER BARS 50X15MM.

3.EARTHING INSTALATION:
INTERNAL CONNECTIONS- CONDUCTOR H07V-K 1X50MM2.

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

ВЯРНО С ОРИГИНАЛА

Main office address: 9700 Shumen, Bldv 12 Madara; tel: +359 54 87 44 99; fax: +359 54 87 45 00
Sofia office address: 1000 Sofia Bldv 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

CONNECTION BETWEEN NEUTRAL COPPER BAR AND POTENTIAL COPPER BAR – CONDUCTOR H07V-K 1x150мм2.
CONNECTION TO EXTERNAL EARTHING CONTOUR –H07V-K 1x50мм2.

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

На основание чл. 2
от ЗЗЛД

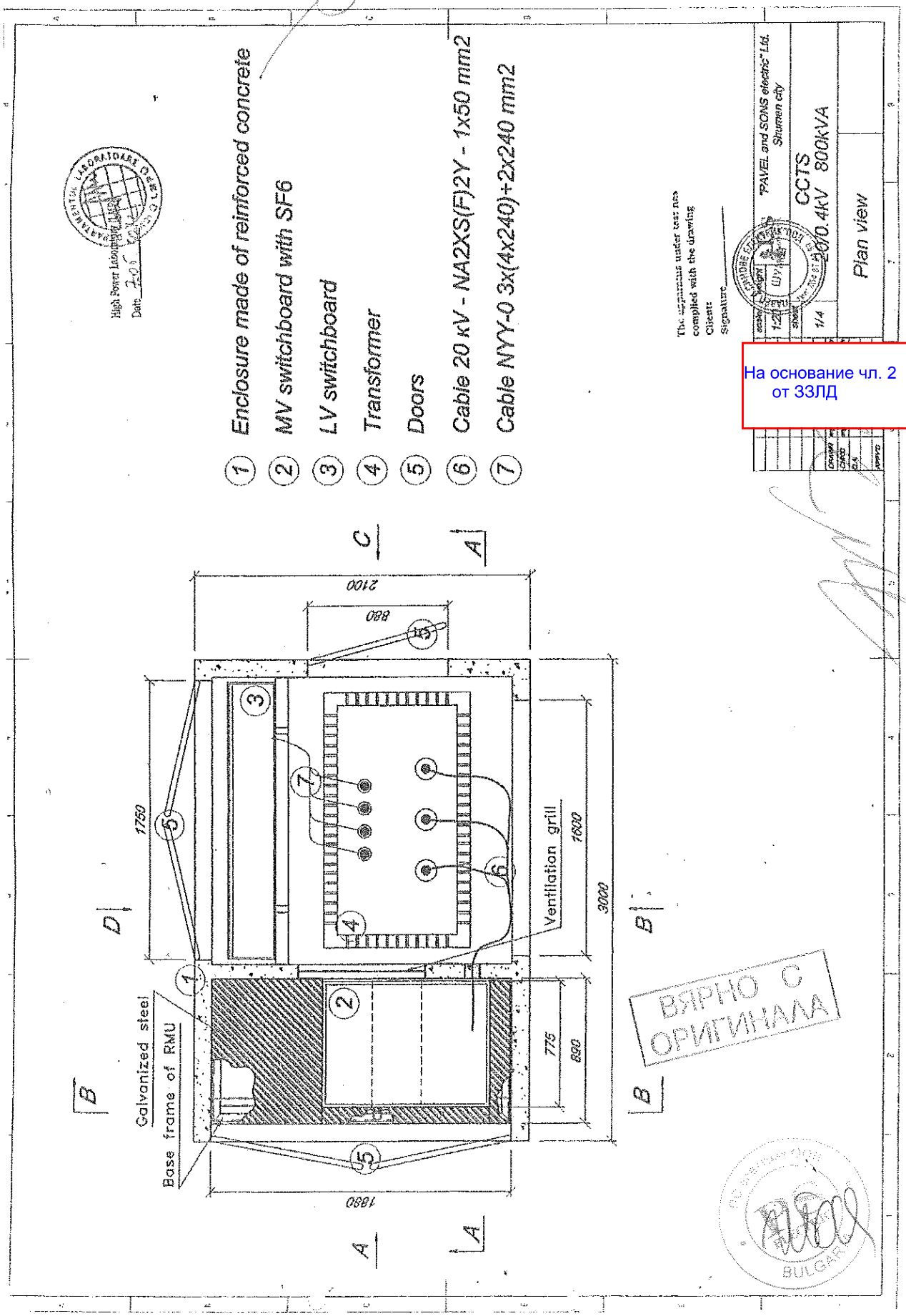
DATE: 07.03.2012
SHUMEN

PREPARED: ENG. D
CHECKED: ENG. B.

ВЯРНО С ОРИГИНАЛА

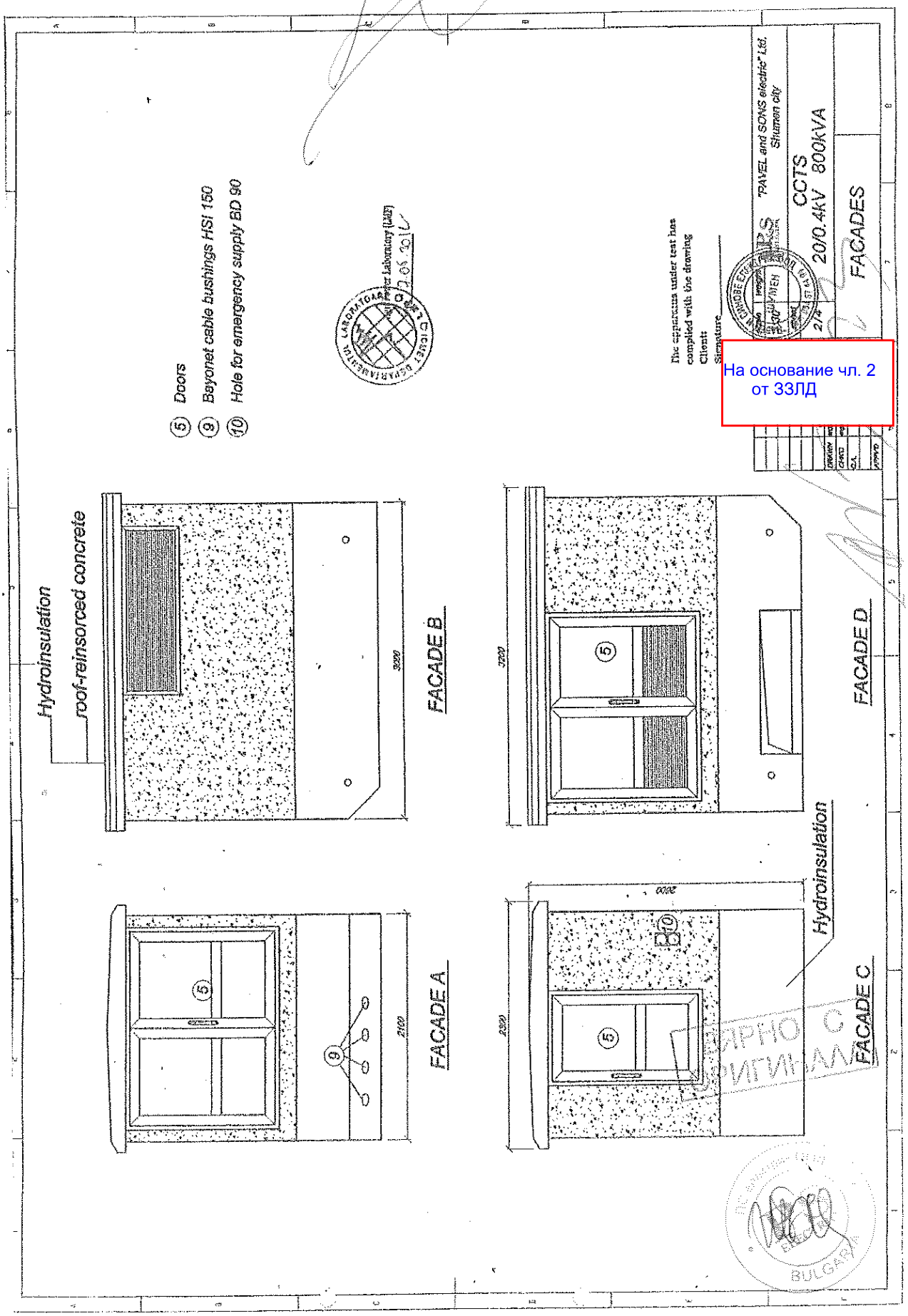
Produce of concrete complete transformer substation, distribution panels and equipment for the power engineering

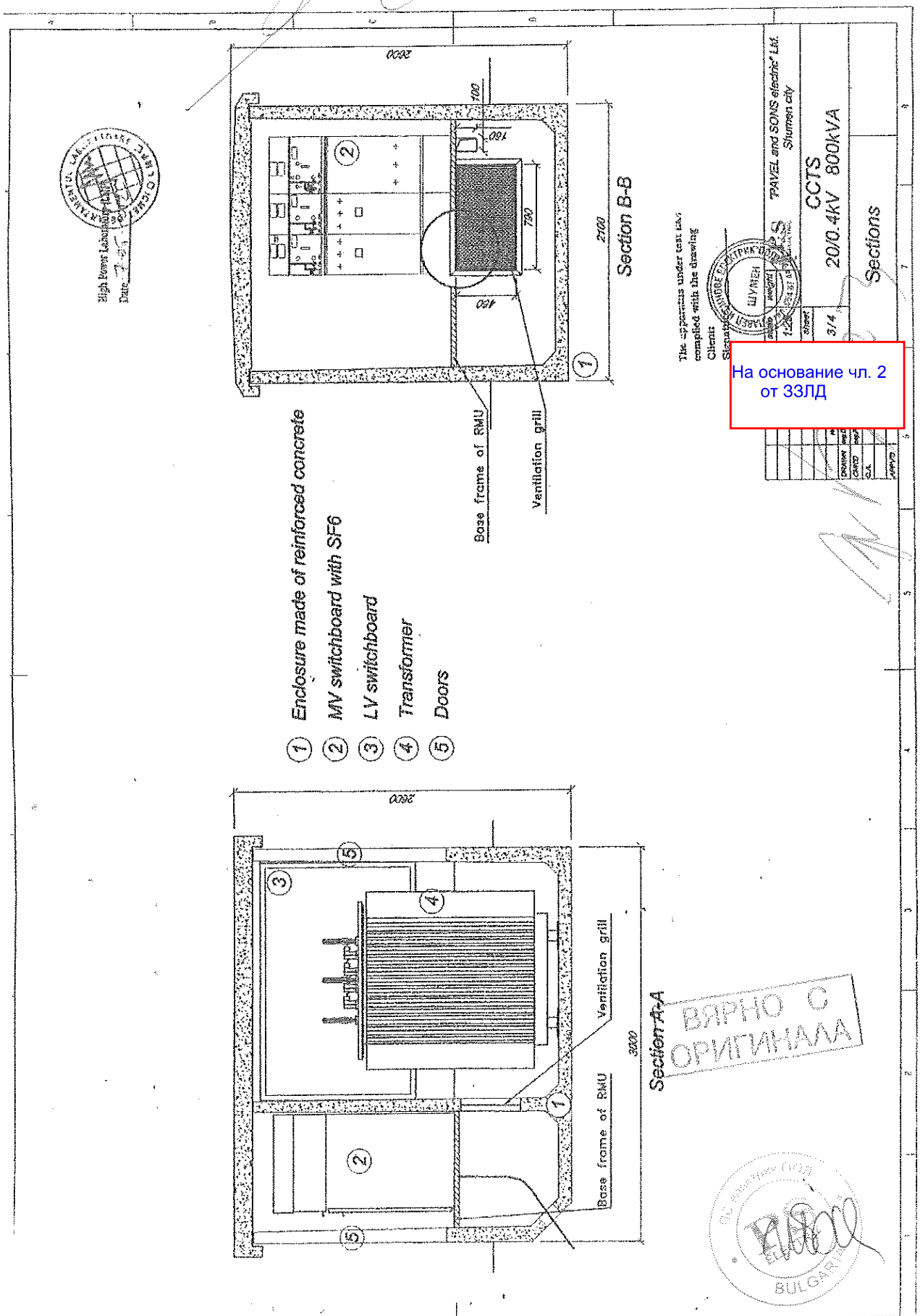
Main office address: 9700 Shumen, Bldv 12 Madara; tel: +359 54 87 44 99; fax: +359 54 87 45 00
Sofia office address: 1000 Sofia Bldv 129 Vitosha; tel: +359 2 952 24 05; fax: +359 2 952 67 20
e-mail: office@pavel-sons.com web: www.pavel-sons.com

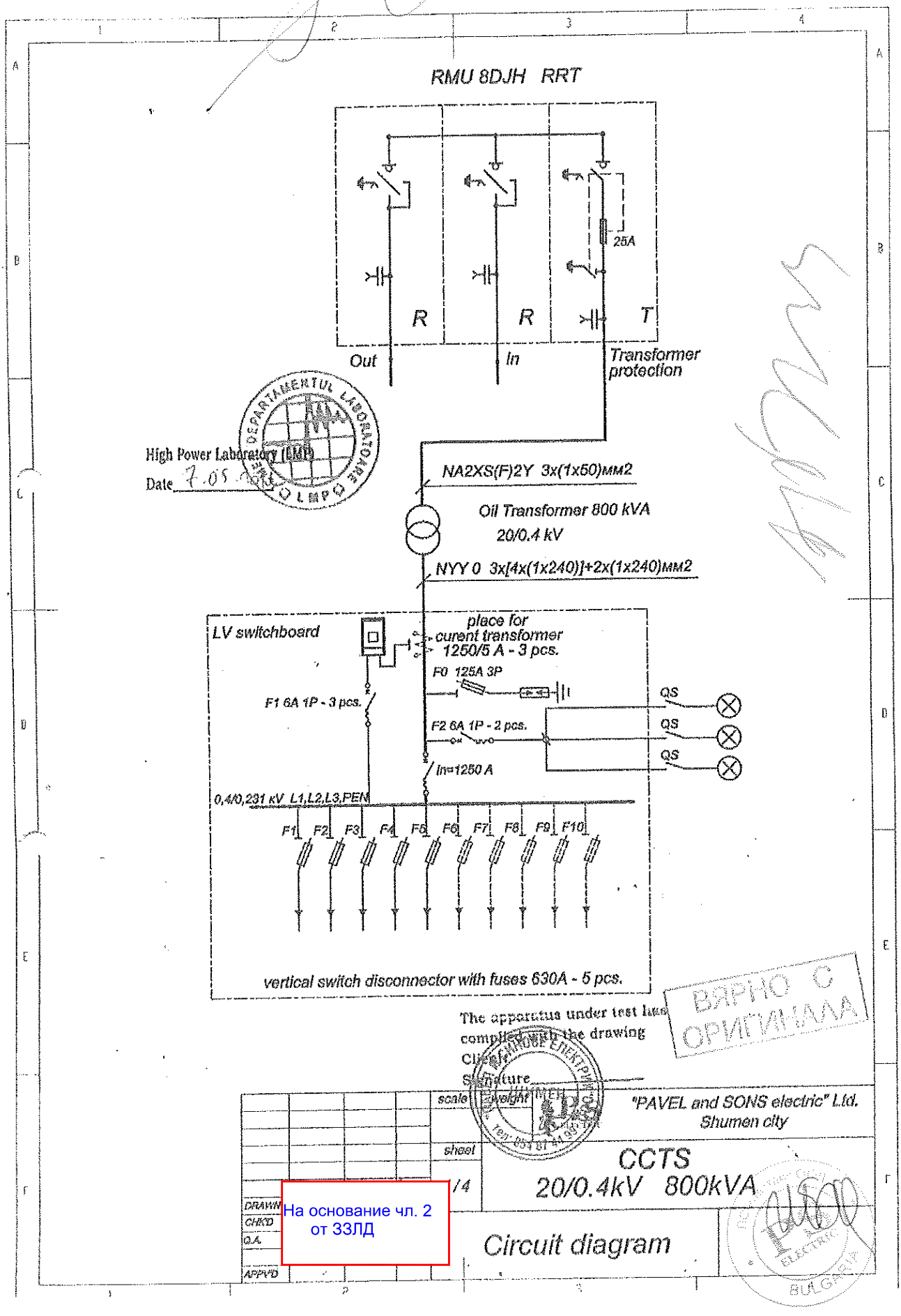


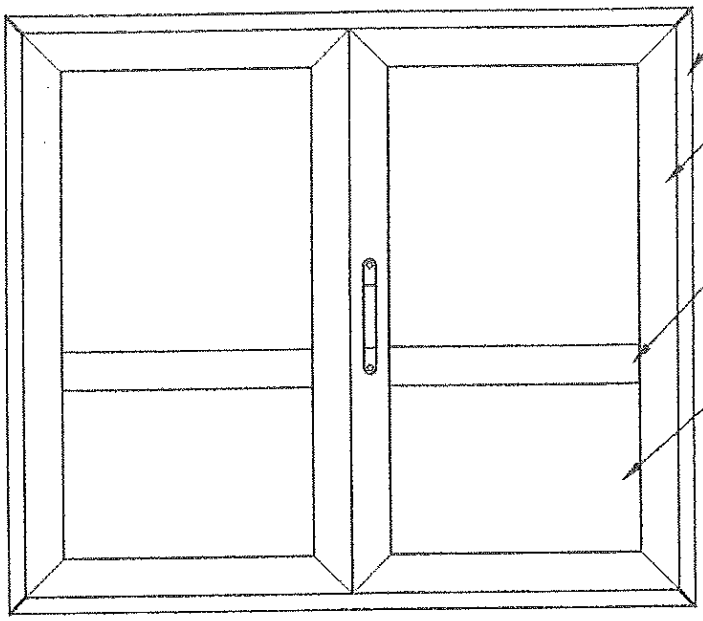
На основание чл. 2 от ЗЗЛД

ВЯРНО С ОРИГИНАЛА









High Power Laboratory
Date 7.05.20

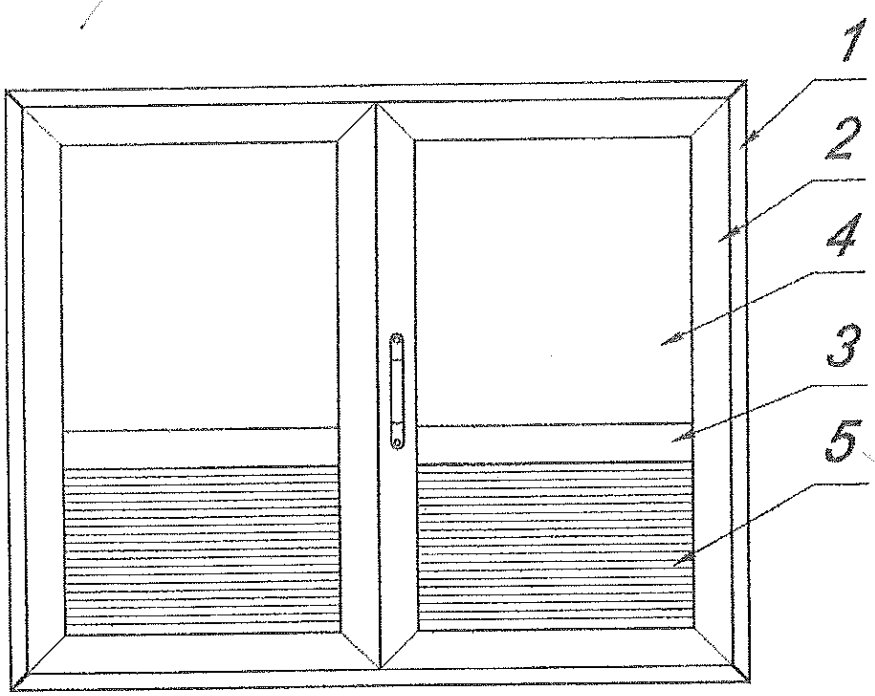
1. FRAME
2. OUTSITE OPENING DOORS/SASH
3. TRANSOM
4. SANDWICH PANEL / ALUM SHEETS+ STYROFOAM+ALUM SHEETS /

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

ВЯРНО С ОРИГИНАЛА

scale 1:16	"PAVEL and SONS electric" Ltd. Shumen city
sheet /4	CCTS 20/0.4kV 800kVA
DRAWN / CHKD / Q.A. / APPVD	Doors - MV switchboard

На основание чл. 2 от ЗЗЛД



High Power Laboratory - IMP
Date 7.05.2012

1 FRAME

2 OUTSITE OPENING DOORS/SASH

3 TRANSOM

4 ALUMINIUM SHEETS

5 VENTILATION GRILL

The apparatus under test has complied with the drawing

Signature

ВЯРНО С ОРИГИНАЛА

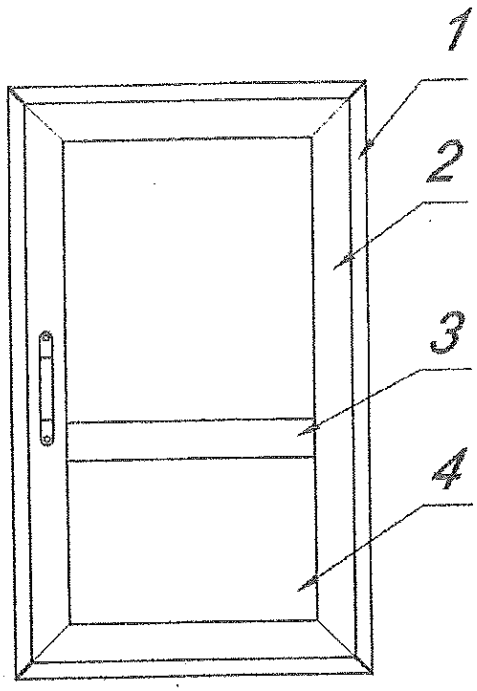
				scale 1:16	weight
				sheet /4	
DRAWN					
CHK'D					
Q.A.					
APPV'D					

"PAVEL and SONS electric" Ltd. Shumen city

CCTS
20/0.4kV 800kVA

Doors - LV switchboard

На основание чл. 2 от ЗЗЛД



High Power Laboratory (LMP)
Date 7.05

1 FRAME

2 OUTSITE OPENING DOORS/SASH

3 TRANSOM

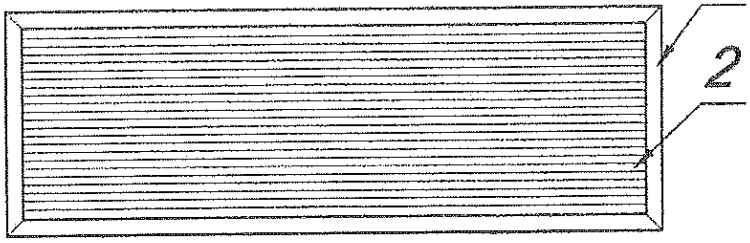
4 ALUMINIUM SHEETS

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

ВЯРНО С ОРИГИНАЛА

scale	weight	"PAVEL and SONS electric" Ltd. Shumen city
1:16		
sheet		CCTS 20/0.4kV 800kVA
3/4		Doors - Transformer

На основание чл. 2 от ЗЗЛД

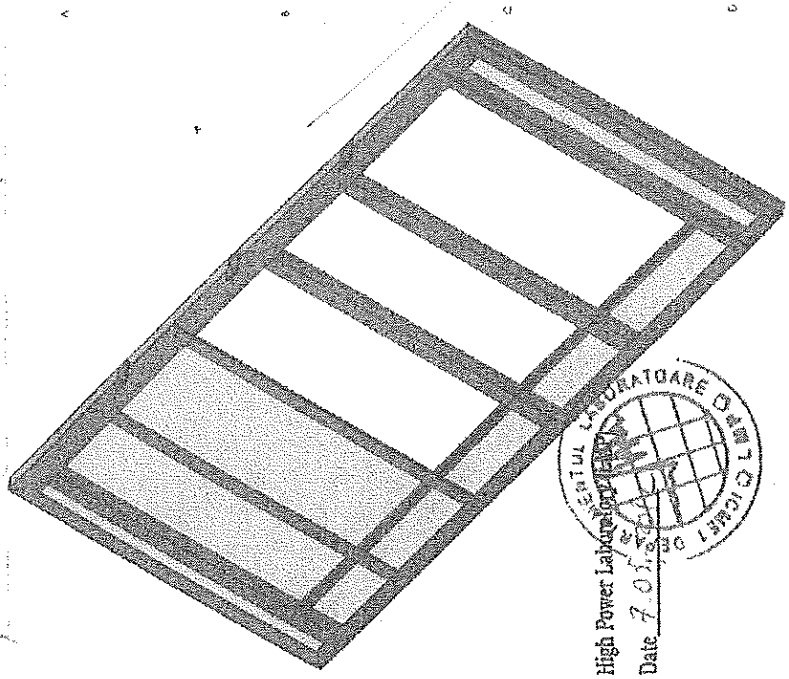


1 FRAME

2 VENTILATION GRILL

The appliance under test has complied with the drawing
Client:
Signature

	scale 1:16	weight
	sheet 4/4	"TRAVEL and SONS electric" Ltd. Shumen city
DR. CHK. Q.A. APPVD	Ventilation grill	CCTS 20/0.4kV 800kVA



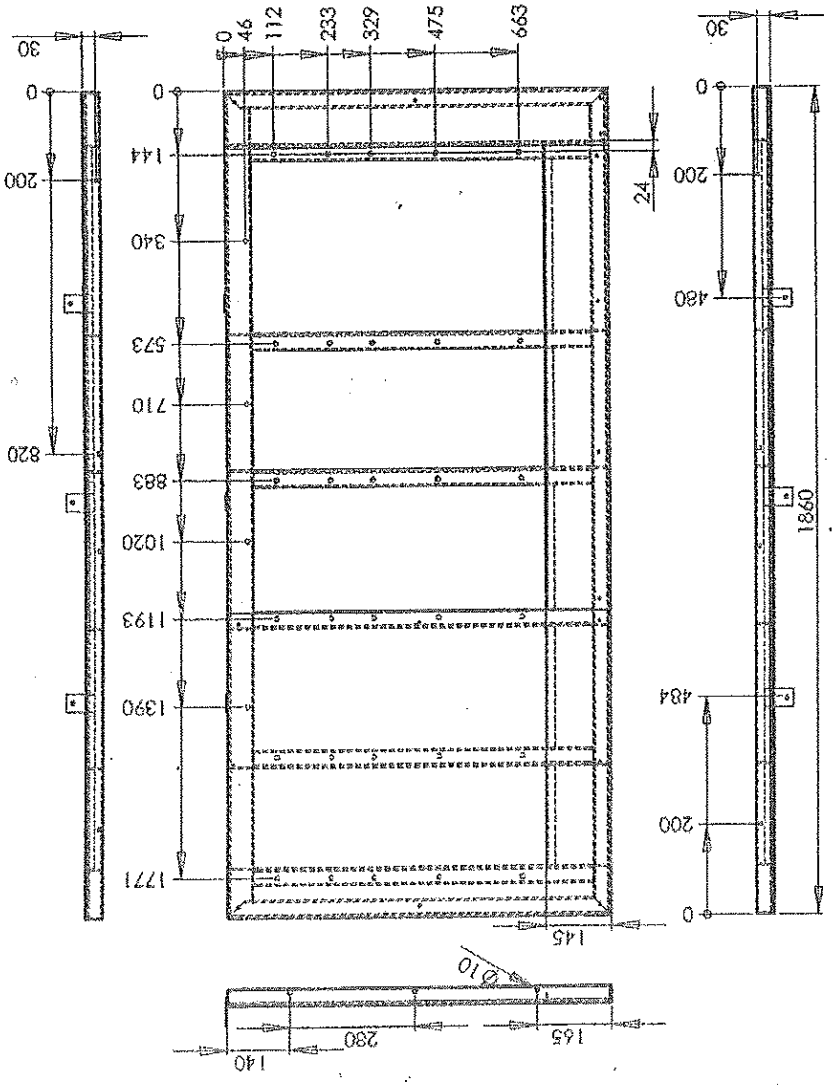
High Power Laboratory
Date 7.01.

The apparatus under test has complied with the drawing
Client
Signature

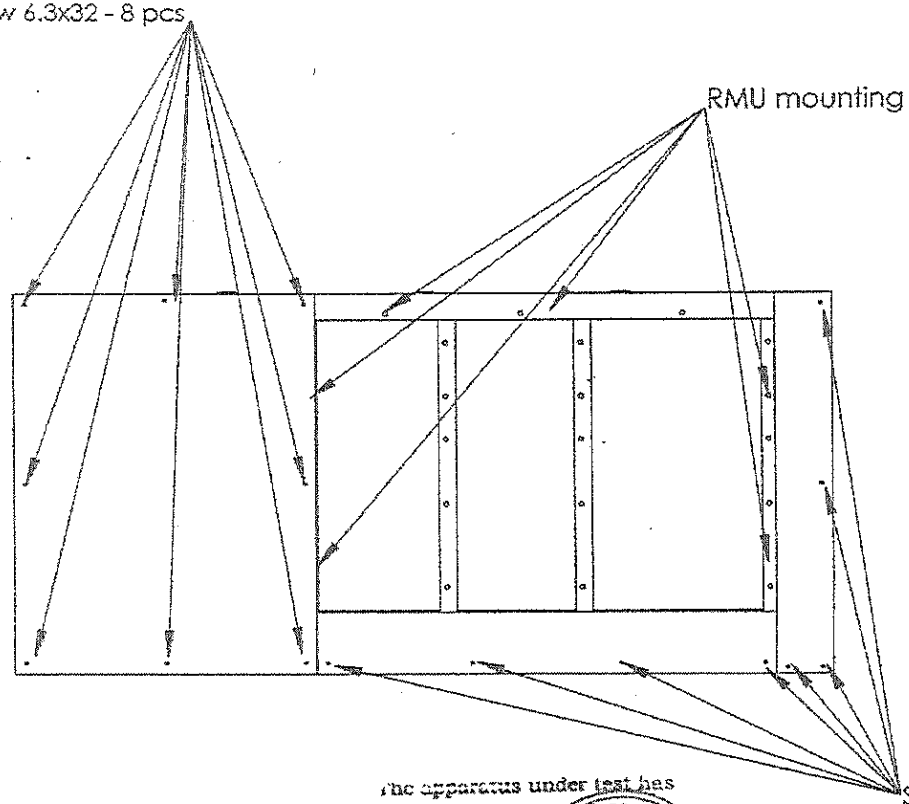
"PAVEL and SONS electric" Ltd.
Shumen city

CCTS
20/0.4kV 800kVA
1/2
Base Frame of RMU

На основание чл. 2
от ЗЗЛД



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	LamafinaL	Sheet 2mm	1
2	LamafinaR	Sheet 2mm	1
3	LamafinaF	Sheet 2mm	1
4	L 20x20_425	Cold Rolling L20x20_425	1
5	L 20x20_310	Cold Rolling L20x20_310	1
6	Mirror 20x20_310	Cold Rolling L20x20_310	1
7	L 20x20_350	Cold Rolling L20x20_313	1
8	L 20x20_220	Cold Rolling L20x20_260	1
9	shina 40x4_65	Шина 40x4_65	4
10	L 40*40_1860	Профил L 40x40x4_1860	1
11	L 60*40_1860	Профил L 60x40x4_1860	1
12	L 40*40_860	Профил L 40x40x4_860	1
13	L 40*40_852	Профил L 40x40x4_852	4
14	L 40*40_852	Профил L 40x40x4_852	2
15	L 40*40_852	Профил L 40x40x4_852	2



High Power Laboratory (LMP)
Date 7.05.2013

The apparatus under test has complied with the standard
Client:
Signature

Wall Mounting Screw

16 pcs HUS 7.5x60 - HILTI HUS System TKI 2500

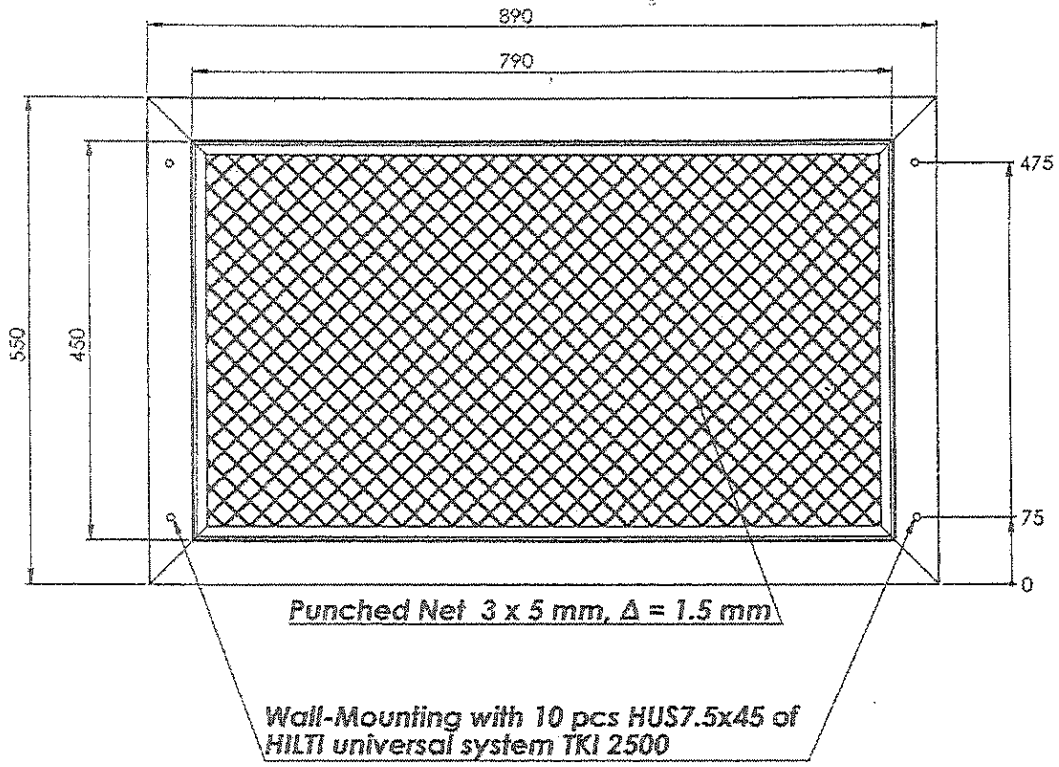
Scale	Weight
1:3	38.36
Sheet	
2/2	

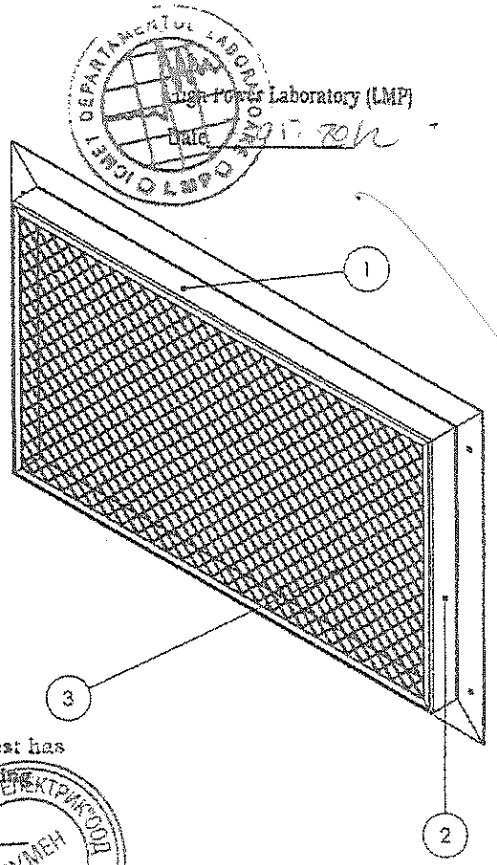
"PAVEL and SONS electric" Ltd.
Shumen city

CCTS
20/0.4kV 800kVA

Base Frame of RMU

На основание чл. 2 от ЗЗЛД





ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	NosachD	Horizontal Profile Up/Down	2
2	VodachR	Vertical Profile L/R	2
3	Mreja	Punched Net 3 x 5 mm, Δ = 1.5 mm	1

High Power Laboratory (LMP)
Date

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

"PAVEL and SONS electric" Ltd.
Shumen city

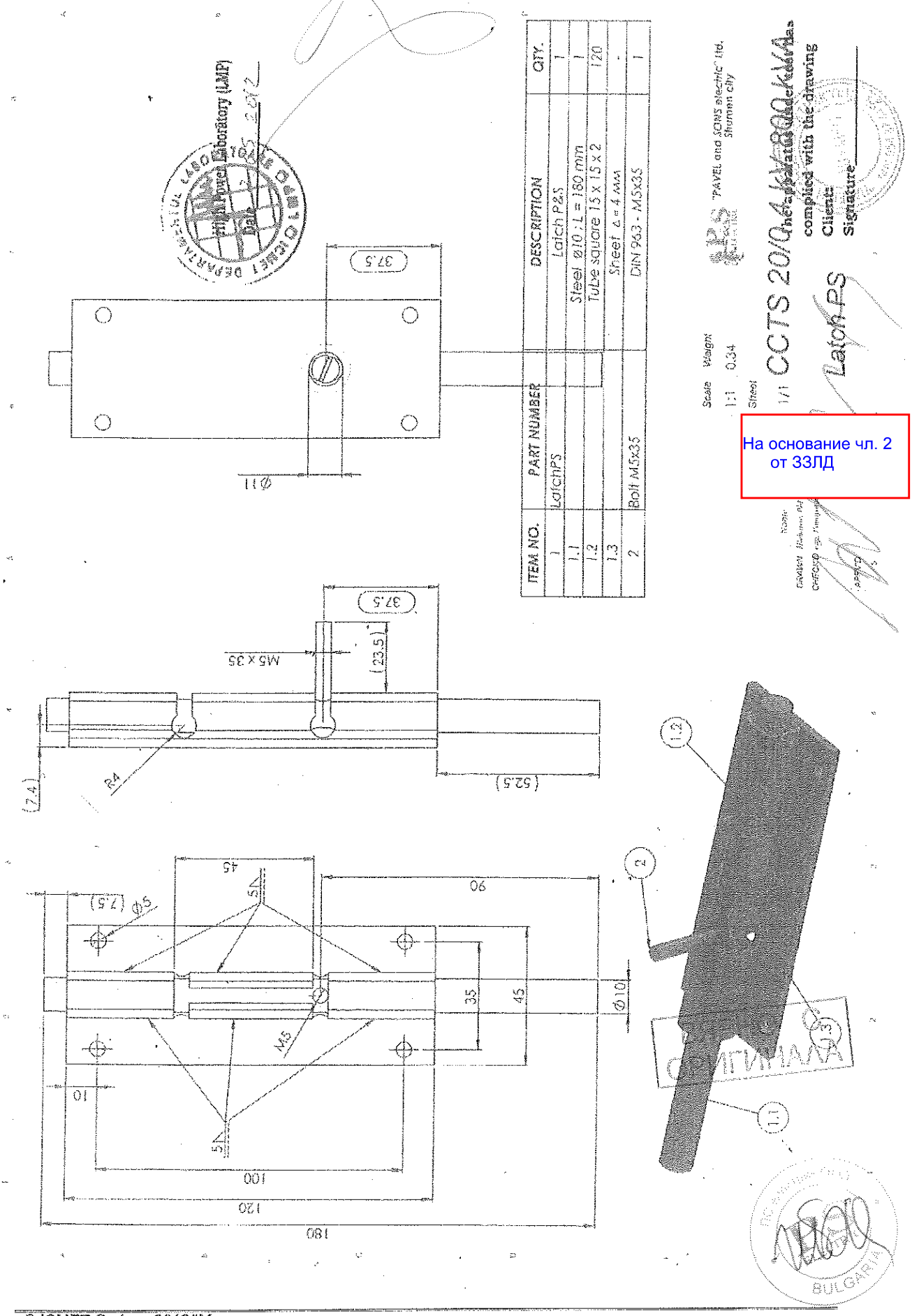
Scale: 1:5
Sheet 1/1

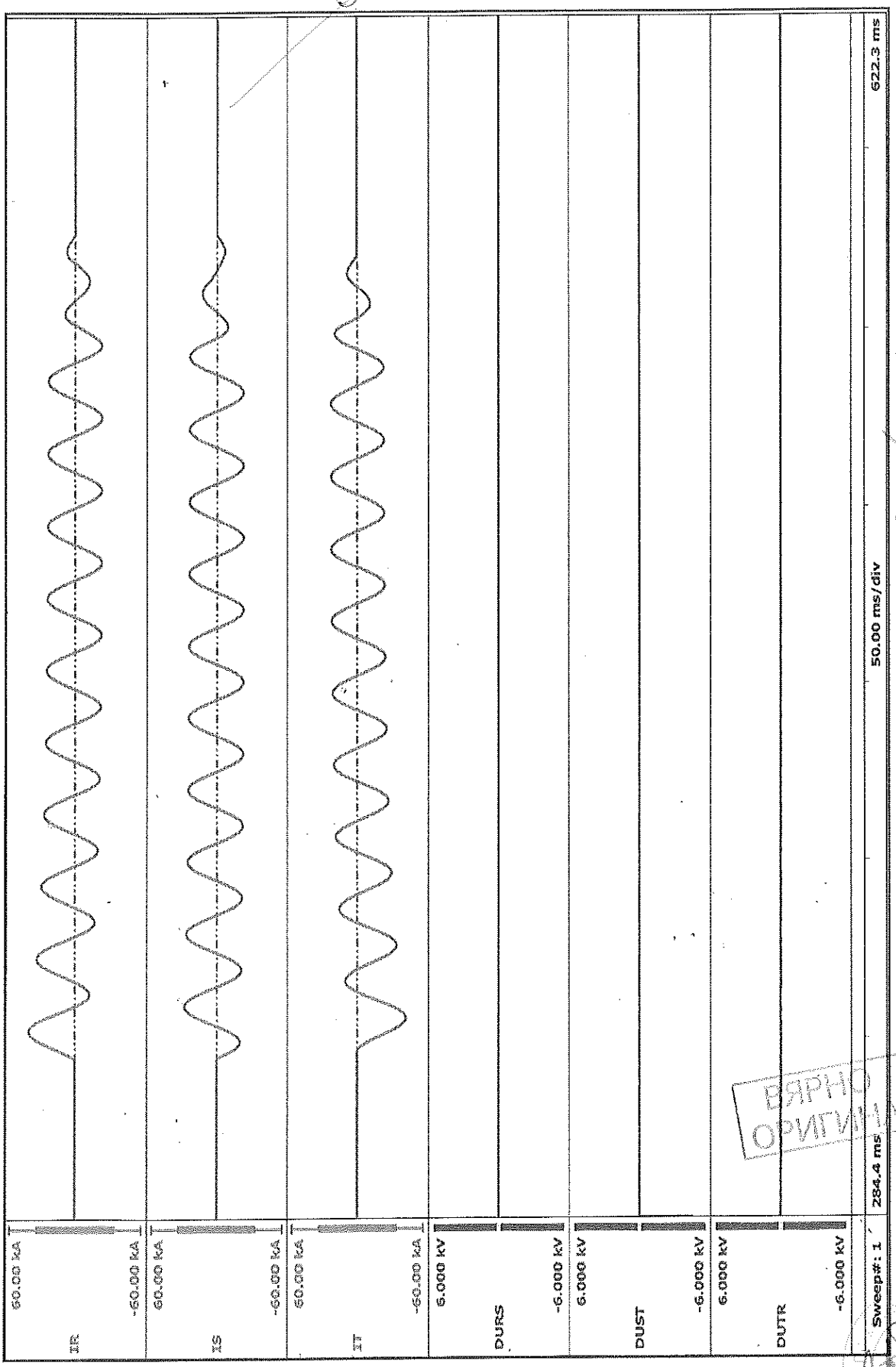
CCTS 20/0.4kV 800kVA

Ventilation grill

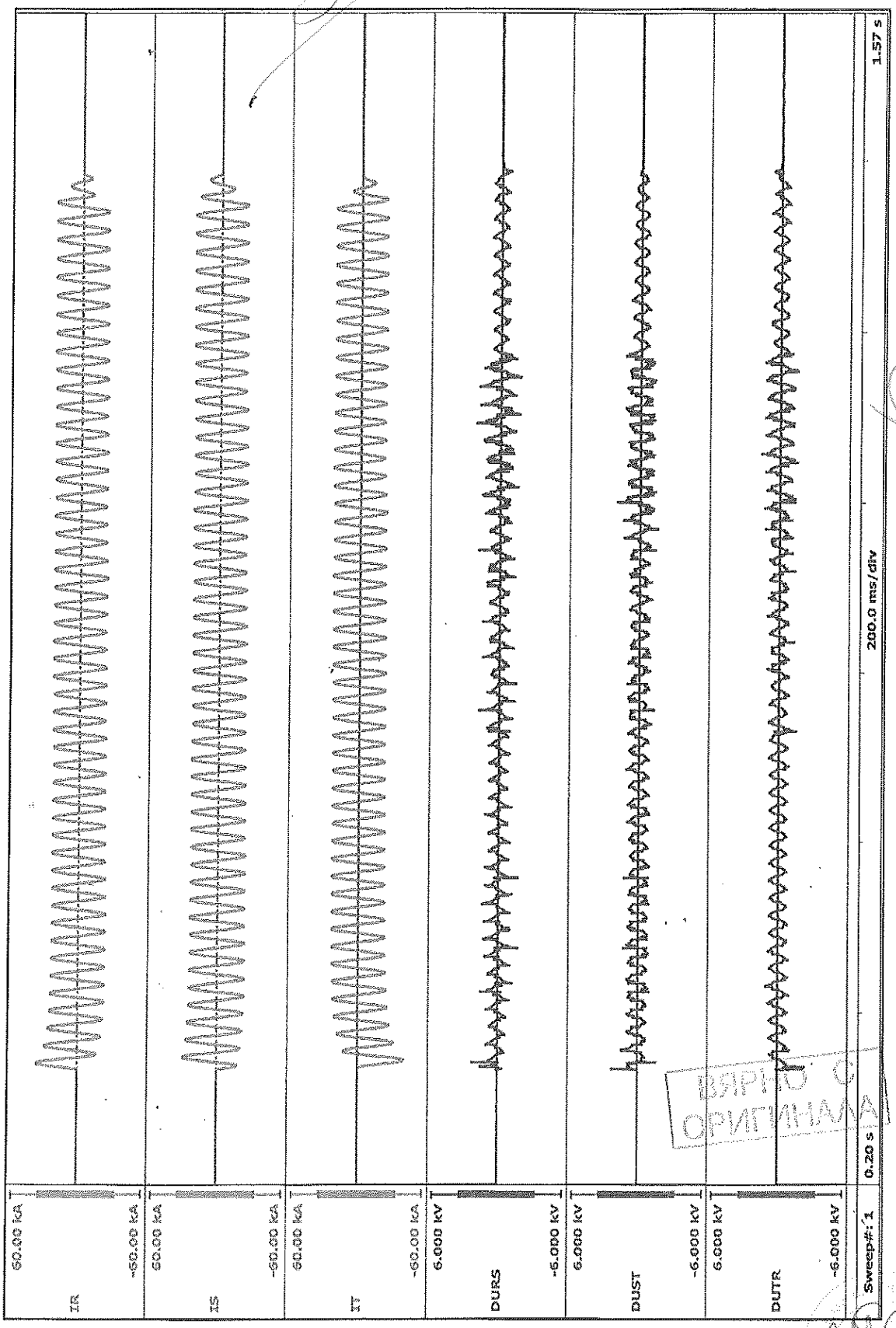
DRAWN
CHECK'D
APPV'D
Date .2012
.2012

На основание чл. 2 от ЗЗЛД





Oscillogram No. 83012 / 2012



Oscillogram No. 83013 / 2012

4.3. ex.4

RESEARCH-DEVELOPMENT AND TESTING NATIONAL
INSTITUTE FOR ELECTRICAL ENGINEERING

ICMET CRAIOVA
ROMANIA

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

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

TEST REPORT
No. 9865 / April 26, 2007

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

Test: Temperature-rise test and determination of thermal class

Test method: According to IEC 62271-202/2006, clause 6.3

Test date: April 26, 2007

Test result: Passed the test

На основание чл. 2
от ЗЗЛД

LABORATORUL DE MARE PUTERE "OVIDIU RARINCA" CRAIOVA

ICMET CRAIOVA AC LMP

На основание чл. 2
от ЗЗЛД

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

ВЯРНО С ОРИГИНАЛА

Report has 17 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.

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

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

IDENTIFICATION OF APPARATUS

	Substation	Transformer
Type	BM 01A31	TM800/20/0.4
Serial number/Year	07057/2007	110365/2006
Technical documentation	-	
Drawing	BM 01A31	
Order no.:	Contract No. 3266/ 28.02.2007	
Product receiving date:	April, 2007	
Product condition at receiving:	New	

PERFORMANCES ESTABLISHED BY PRODUCER

	Substation	Transformer
Rated power	800 kVA	800 kVA
Rated voltage	20/0.4 kV	20/0.4 kV
Rated current	-	32/1155 A
Rated frequency	50 Hz	50 Hz
Short-circuit voltage		4.06 %
Connection		DYn5

TEST PROGRAM

One test to check the temperature-rise test of the transformer and the low voltage apparatuses from the substation.
The temperature rise test is performed at total losses of 10412 W up to the oil temperature stabilisation, followed by the heating at rated current In = 1155 A for an hour.
Supply was made by copper flexible cables with S = 150 mm^2 in low voltage panel at the output terminals of the fuses F1 to F5 (see drawing from page 10).
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.

TEST REPORT DOCUMENTATION: Diagrams 2 ; Tables 6 ;
Photos 1 ; Drawings 8 ;

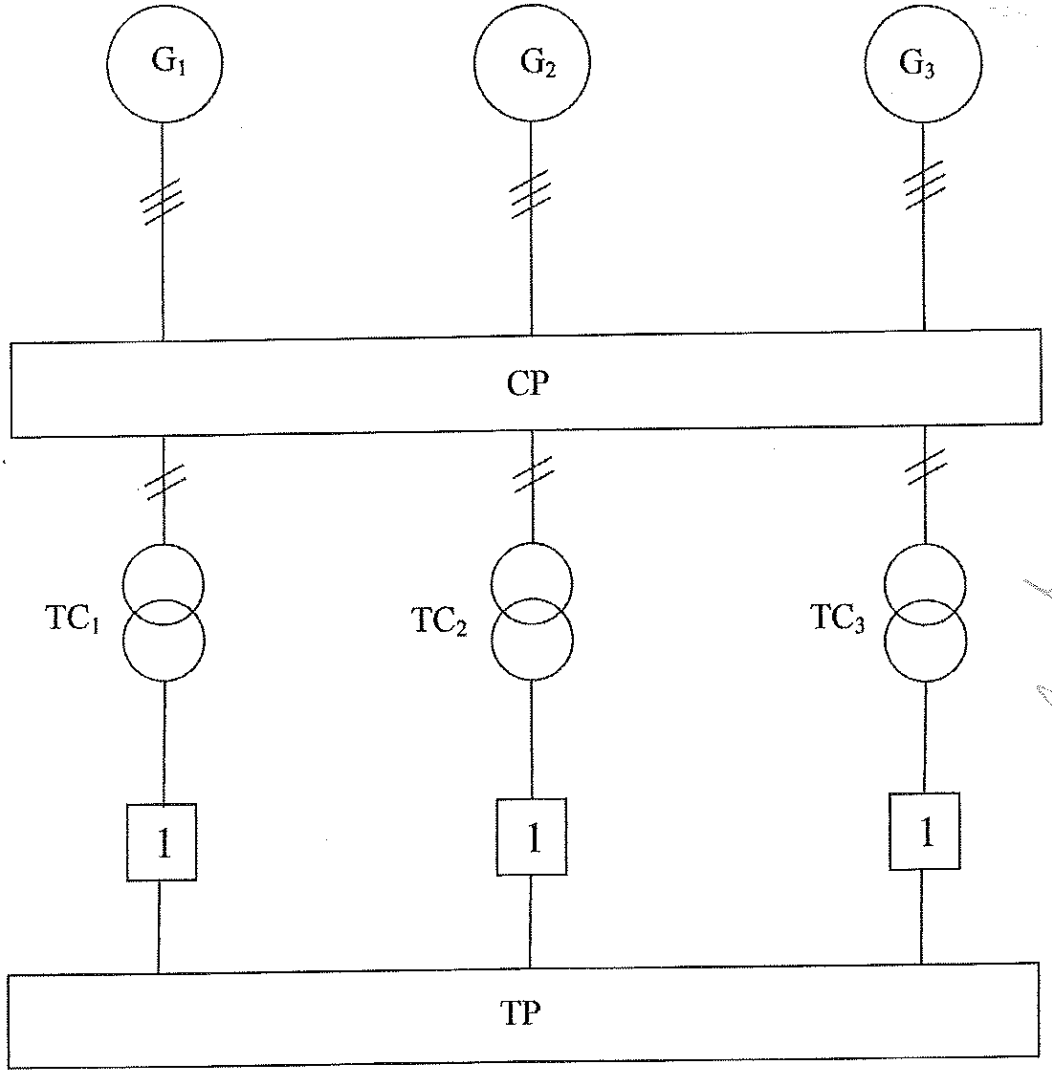


Fig. 1 – Three-phase supply circuit for temperature rise test

G_1, G_2, G_3	- Generators
CP	- Connections panel
TC_1, TC_2, TC_3	- Step down transformers
1	- Measurement point of current: 2000A/5 A current transformers
TP	- Test product

TEST CONDITIONS AND CALCULATION RELATIONS OF TMPERATURE-RISE

Table 1

Test stage	I	II
Load type	Loss (W)	Current / period (A / minute)
	10412	1155 / 60

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

$\theta = (R_2 / R_1)*(235 + \theta_1) - 235$ - for copper winding

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

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

where:

θ - windings average temperature
R_1 - windings resistance measured in cold condition
R_2 - windings resistance measured at shutdown
θ_1 - environment temperature in cold condition
θ_a - environment temperature at the end of temperature-rise test
$\Delta\theta$ - windings temperature-rise
θ_u - oil average temperature at the upper part
$\Delta\theta_u$ – oil temperature-rise

REZULTS OBTAINED AT TEST

1) Transformer's temperature-rise inside the substation

Table 2

Windings	Determined values						Specified values	
	R_1 (Ω)	θ_1 (^oC)	R_2 (Ω)	θ_a (^oC)	$\Delta\theta$ (^oC)	$\Delta\theta_u$ (^oC)	θ (^oC)	θ_u (^oC)
HV	5.726	17	7,26	22	62,51	62,78	75	70
LV	$2.01x10^{-3}$		$2.6x10^{-3}$		68,97		75	

Measurements were performed with 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

ВЯРНО С ОРИГИНАЛА

Remarks: Values of the measured resistances, calculated temperatures and temperature diagrams are presented in pages 4, 5, 6, 16, 17.

MEASURED VALUES OF CURRENTS, LOSSES AND TEMPERATURES

Table 3

Time		Hour	12:00	13:00	14:00	15:00	16:00	17:00	18:00	18:01	19:01
Current on phase	I_1	A	1284	1267	1245	1222	1191	1180	1171	1157	1158
	I_2	A	1279	1264	1241	1190	1190	1178	1172	1157	1156
	I_3	A	1271	1258	1234	1187	1187	1179	1170	1151	1151
Average current I_m		A	1278	1263	1240	1189	1189	1179	1171	1155	1155
Measured loss	P_1	W	3540	3540	3530	3522	3502	3495	3490	3090	3080
	P_2	W	3540	3530	3530	3524	3490	3480	3485	3080	3080
	P_3	W	3480	3470	3460	3430	3470	3440	3440	3042	3052
Total loss	P_m	W	10560	10540	10520	10476	10422	10415	10415	9212	9212
	θ_{a1}	°C	19.67	20.38	20.96	21.33	21.56	21.85	22.01	22.01	22.02
	θ_{a2}	°C	19.60	20.31	20.88	21.29	21.51	21.77	22.00	22.00	22.01
	θ_{a3}	°C	19.55	20.26	20.86	21.27	21.48	21.73	21.94	21.92	21.96
	θ_a	°C	19.61	20.32	20.90	21.30	21.52	21.79	21.98	21.98	22
	θ_u	°C	72.11	78.34	81.16	83.10	83.55	83.76	84.07	84.07	84.06
	$\Delta\theta_u$	°C	52.5	58.02	60.26	61.80	62.09	62.07	62.09	62.09	62.06

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

Symbols used in table 3:

θ_{a1} ; θ_{a2} ; θ_{a3} - environment temperature in 3 measuring points
θ_a - environment average temperature: $\theta_a = (\theta_{a1} + \theta_{a2} + \theta_{a3})/3$

Values of the high and low voltage windings resistance measured after shutdown

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 determiantion at the time of shutdown (t_0) was made by extrapolation from the resistances diagrams (see pages 16 and 17).

Table 4

Time	High voltage winding			Low voltage winding		
t [min]	U_{HV} [V]	I_{HV} [A]	R_{HV} [Ω]	U_{LV} [mV]	I_{LV} [A]	R_{LV} [mΩ]
1	6.95	0.96	7.24	26.26	10.12	2.595
2	6.92	0.958	7.22	26.16	10.10	2.59
3	6.88	0.956	7.2	26.01	10.08	2.58
4	6.86	0.955	7.18	25.85	10.04	2.575
5	6.84	0.954	7.17	25.75	10.02	2.57
6	6.82	0.952	7.16	25.6	10	2.56
7	6.79	0.951	7.14	25.5	9.98	2.555
8	6.76	0.949	7.12	25.42	9.97	2.55
9	6.73	0.948	7.1	25.35	9.96	2.545
10	6.72	0.948	7.09	25.27	9.95	2.54

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

Remark: Currents and loss values were measured using class 0.2 apparatuses.

2) Low voltage equipment temperature-rise

Table 5

No.	Elements and temperature measuring points denomiantion in fig. 1	Temperature-rise [°C]			
		Measured			Admitted
		R	S	T	
1	Circuit breaker's terminals				70
	Input	53.66	55.09	54.37	
	Output	55.74	57.21	56.29	
2	General bar, fuses derivation junction	46.67	44.62	46.60	70
3	Fuses terminals				70
	Sig. F1 input	31.25	34.86	36.18	
	Sig. F2 output	34.13	35.14	38.28	
	Sig. F4 input	27.17	31.56	28.04	
	Sig. F4 output	26.64	31.38	32.32	
	Sig. F5 input	26.71	27.91	25.07	
	Sig. F5 output	28.70	29.88	27.06	
	Manual operating lever	14.32			25
	Accessible metal door	10.41			30
	Low voltge compartment environment	43.45			-

Measurements were performed with uncertainty of: 3 % for temperatures and the confidence level P = 95%.

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,

Δt_1 - temperature-rise test 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

Δt_2 - temperature-rise test of the transformer windings inside the substation.

Table 6

	Δt_1 [^{0}C]	t_{t1} [^{0}C]	t_{a1} [^{0}C]	Δt_2 [^{0}C]	t_{t2} [^{0}C]	t_{a2} [^{0}C]	Δt [^{0}C]
HV winding	56.12	77.12	21	62,51	84,51	22	6.39
LV winding	60.94	81.94		68,97	90,97		8.03
Remarks:	These data are according to technical records made in the temperature-rise register on 25.04.2007			These data are according to table 2 of this Test Report			

Acceptance criterion: $5 < \Delta t \leq 10$ K $\Rightarrow$ Class 10

Remark: Aspect of the substation in the test circuit is presented in photo 1.

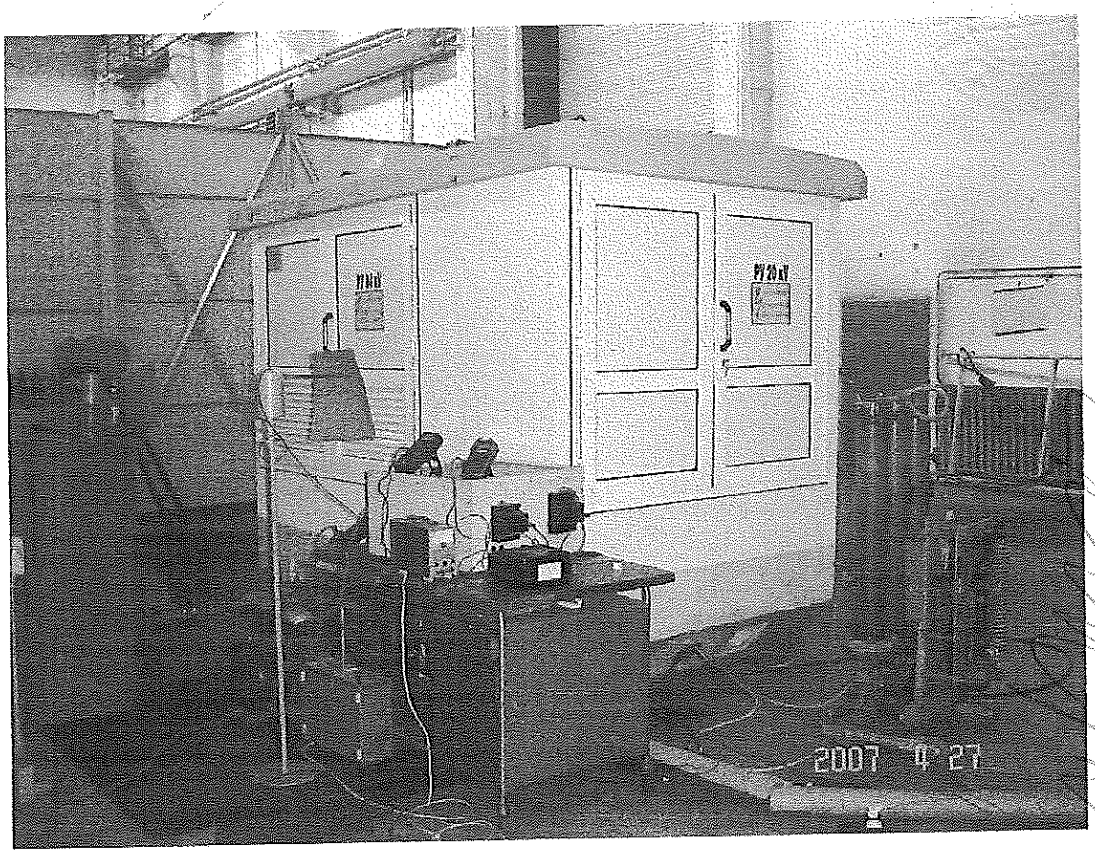
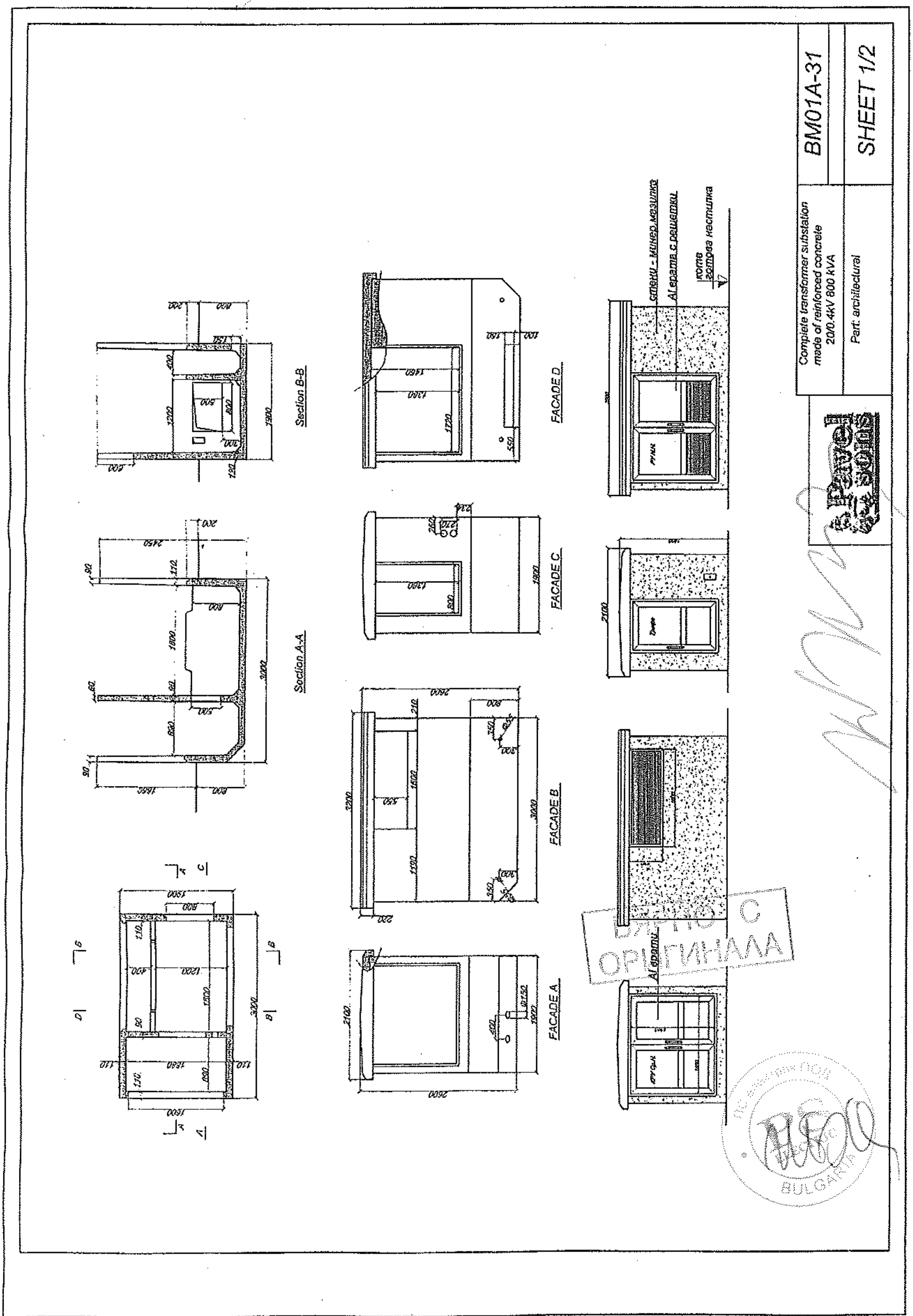
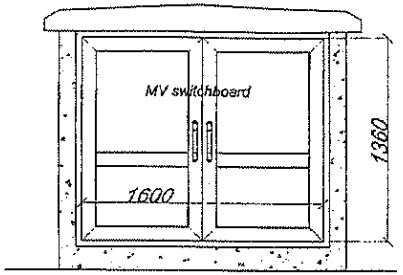
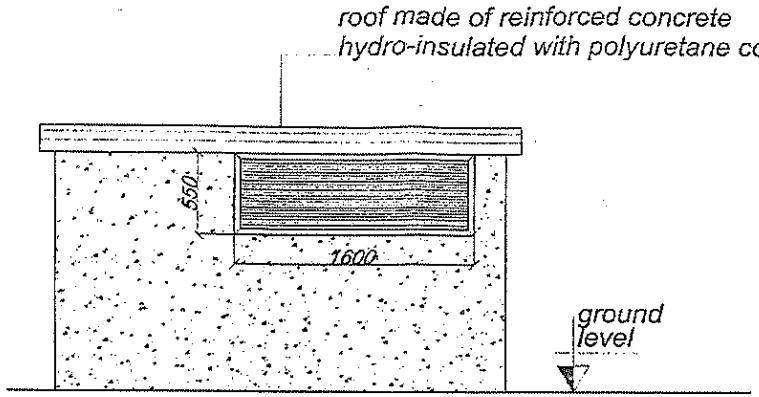


Photo 1 – Aspect of the complete transformer substation in the test circuit

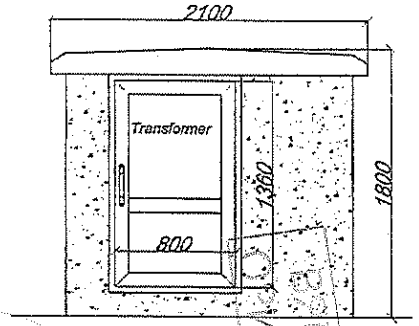

Section B-B
Section A-A
FACADE A
FACADE B
FACADE C
FACADE D
Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA
Part: architectural
BM01A-31
SHEET 1/2



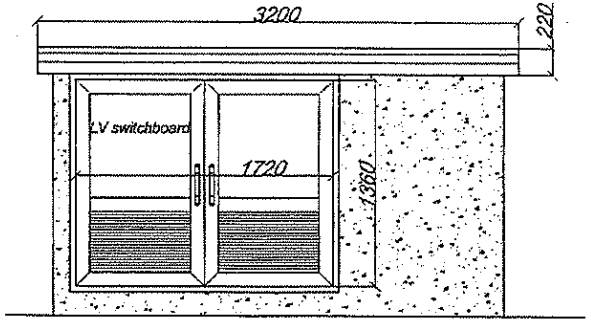
FACADE A



FACADE B

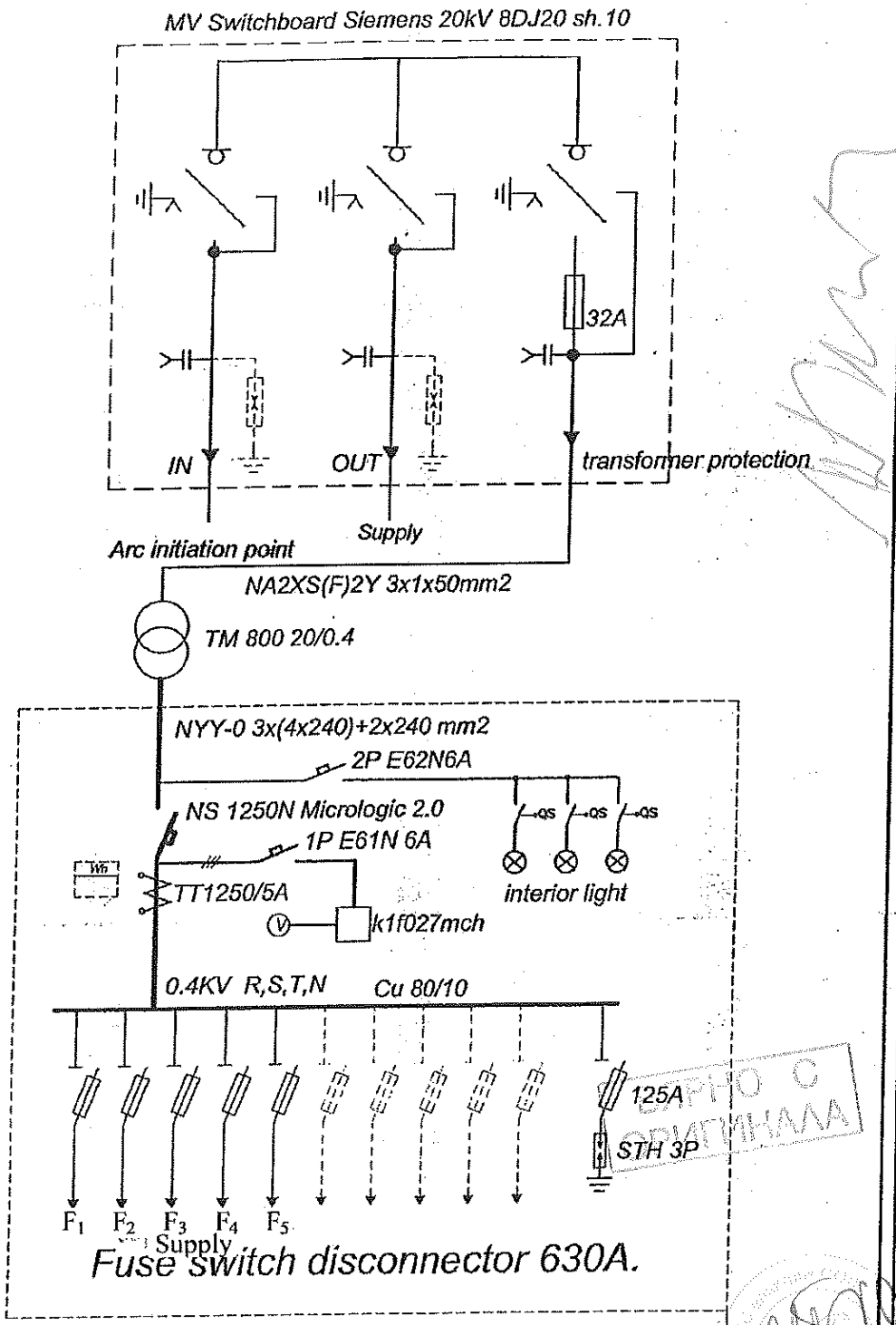


FACADE C

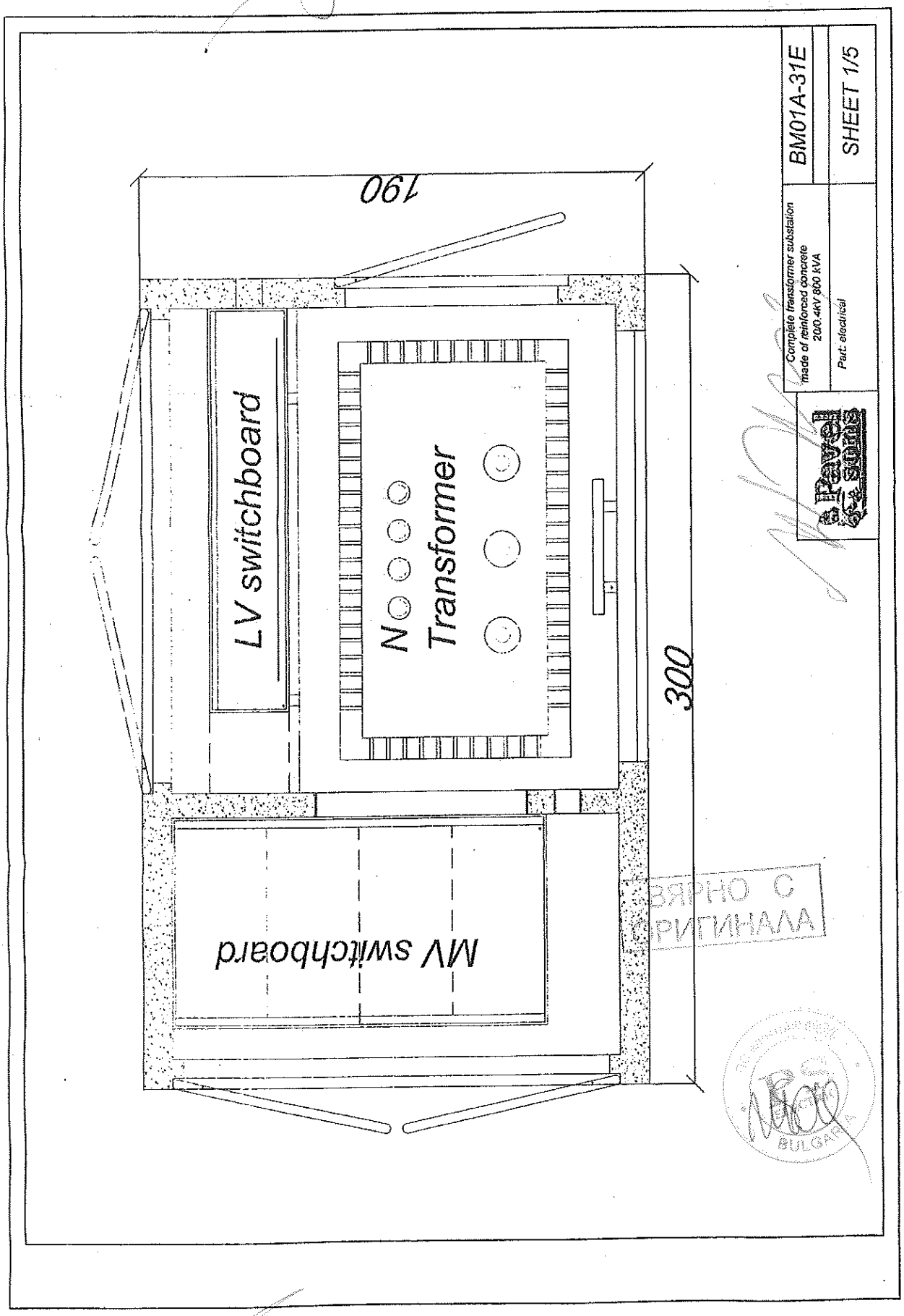


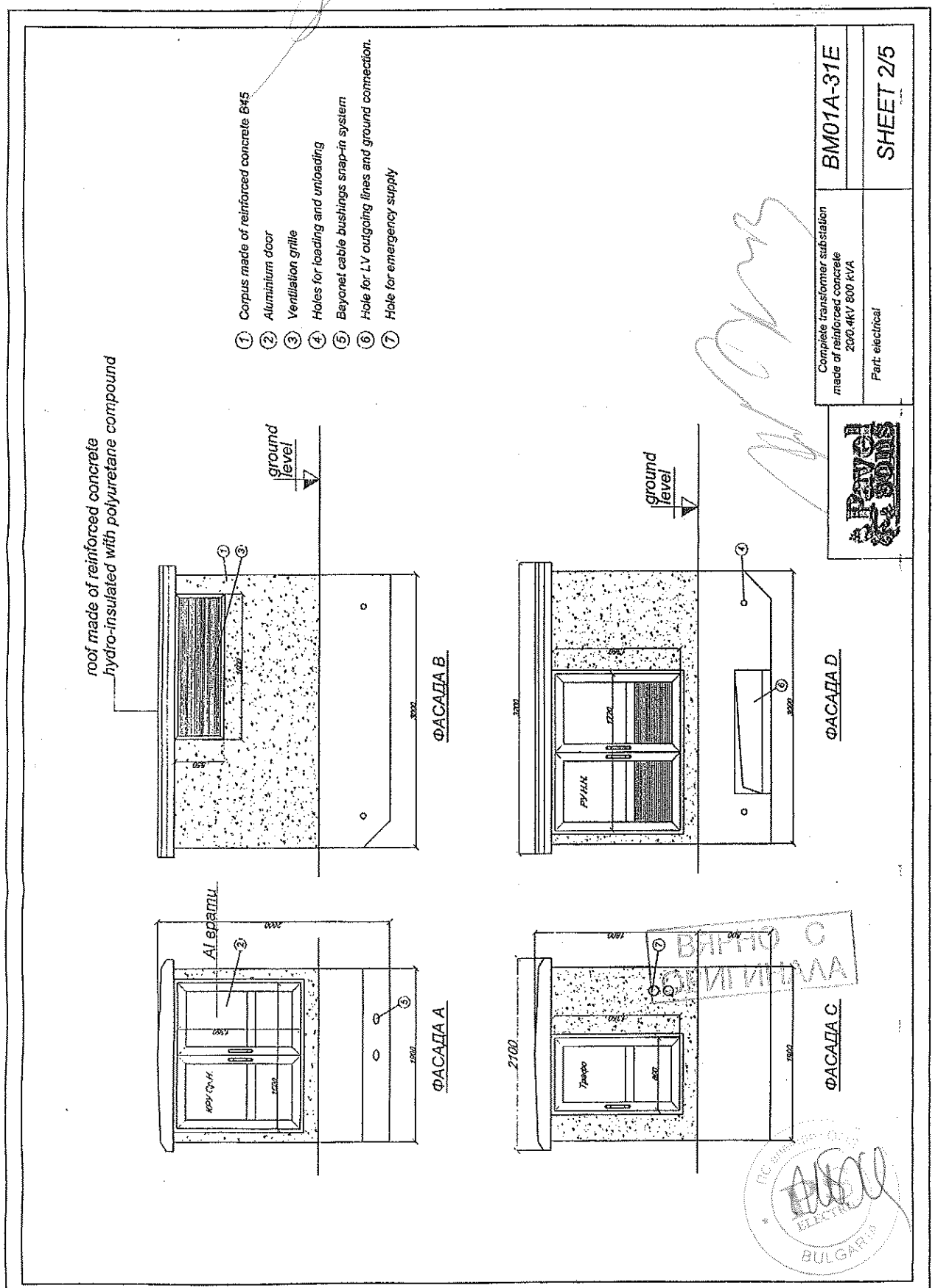
FACADE D

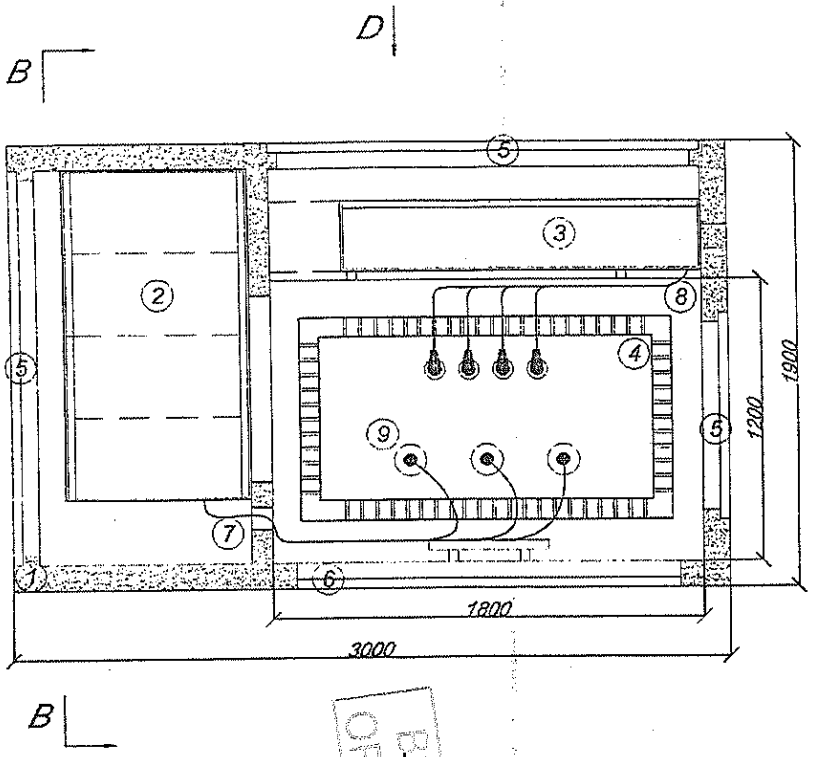
Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA	BM01A-31
Part: architectural	SHEET 2/2



Pavel sons	Complete transformer substation made of reinforced concrete 20/0 4kV 800 kVA	BM01A31 SHEET 1/1
	CIRQUIT DIAGRAM	"Павел и синове" ООД

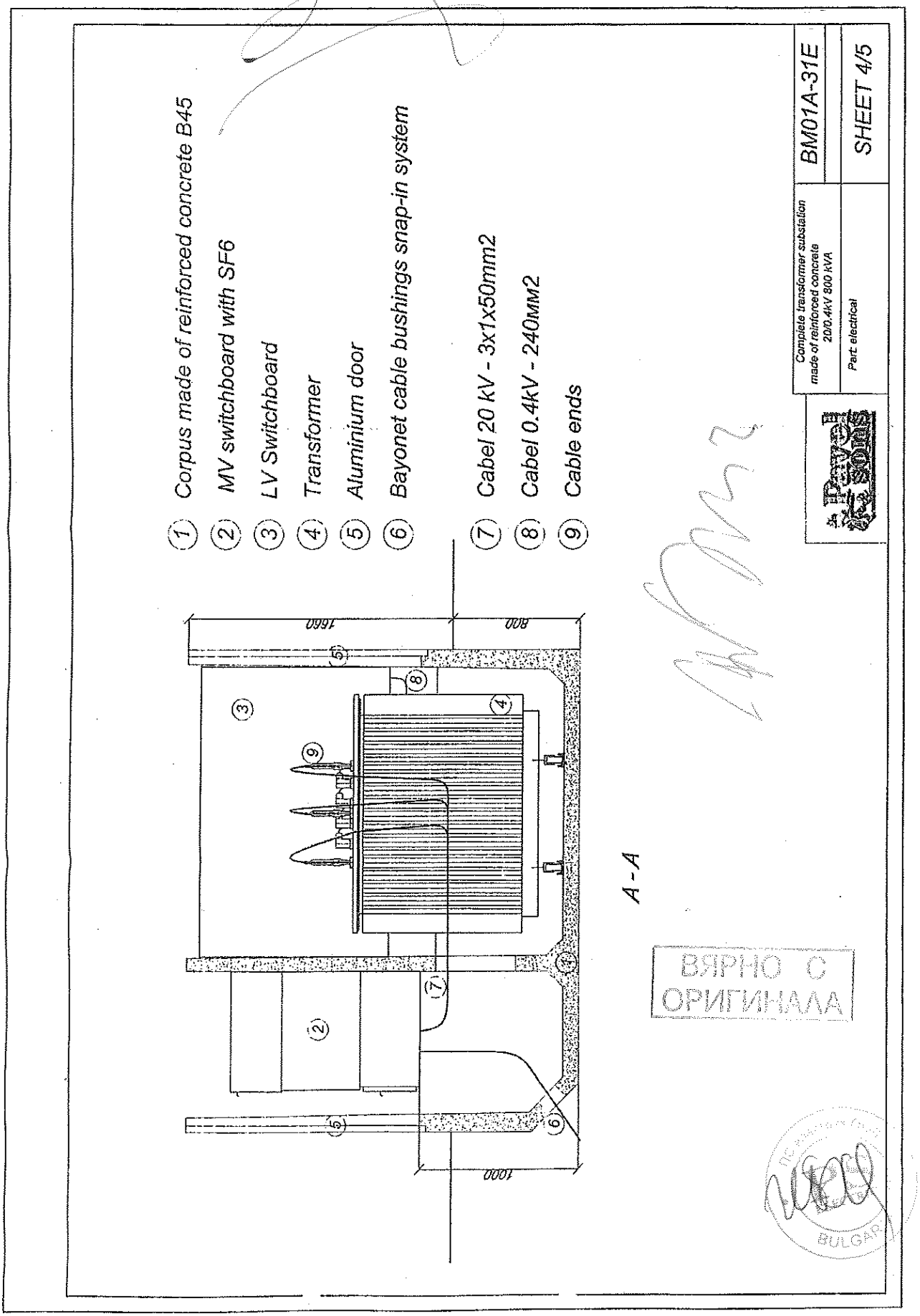

190
300
LV switchboard
N
Transformer
MV switchboard
BM01A-31E
SHEET 1/5
Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA
Part: electrical
ВЯРНО С ОРИГИНАЛА

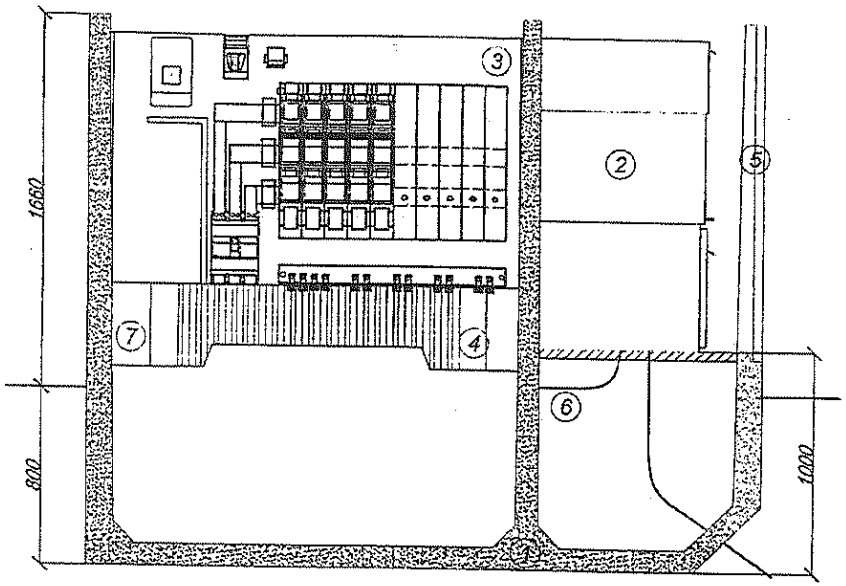

roof made of reinforced concrete
hydro-insulated with polyuretane compound
ground level
ФАСАДА B
ФАСАДА D
ФАСАДА A
ФАСАДА C
Al врати
РУНН
Трафо
2100
1. Corpus made of reinforced concrete B45
2. Aluminium door
3. Ventilation grille
4. Holes for loading and unloading
5. Bayonet cable bushings snap-in system
6. Hole for LV outgoing lines and ground connection.
7. Hole for emergency supply
Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA
Part: electrical
BM01A-31E
SHEET 2/5
ВЯРНО С ОРИГИНАЛА
BULGARIA



1. Corpus made of reinforced concrete B45
2. MV switchboard with SF6 Siemens 8DJ20 -
3. LV Switchboard
4. Transformer hermetic 20/0.4kV 800kVA
5. Aluminium door
6. Ventilation grille
7. Cabel 20 kV - 3x1x50mm2 NA2XS(F)2Y
8. Cabel 0.4kV - NYY 3x(4x240мм2)+2x240mn
9. Cable ends 20kV Raychem RSSS 5225

Pavel & Sons	Compiete transformer substation made of reinforced concrete 20/0.4kV 800 kVA	BM01A-31E
	Part: electrical	SHEET 3/5


1. Corpus made of reinforced concrete B45
2. MV switchboard with SF6
3. LV Switchboard
4. Transformer
5. Aluminium door
6. Bayonet cable bushings snap-in system
7. Cabel 20 kV - 3x1x50mm2
8. Cabel 0.4kV - 240мм2
9. Cable ends
1660
800
1000
A - A
Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA
Part: electrical
BM01A-31E
SHEET 4/5
ВЯРНО С ОРИГИНАЛА

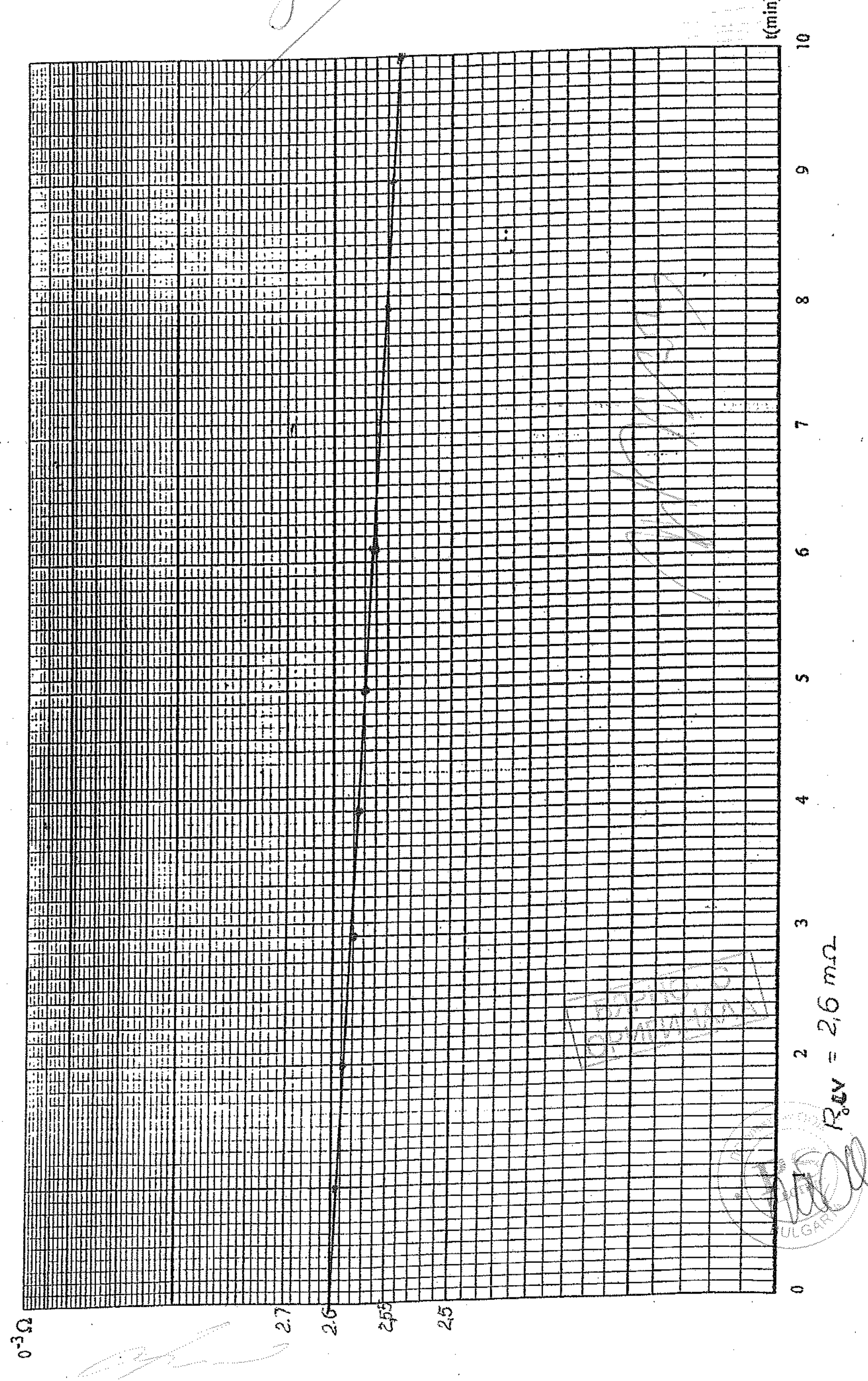


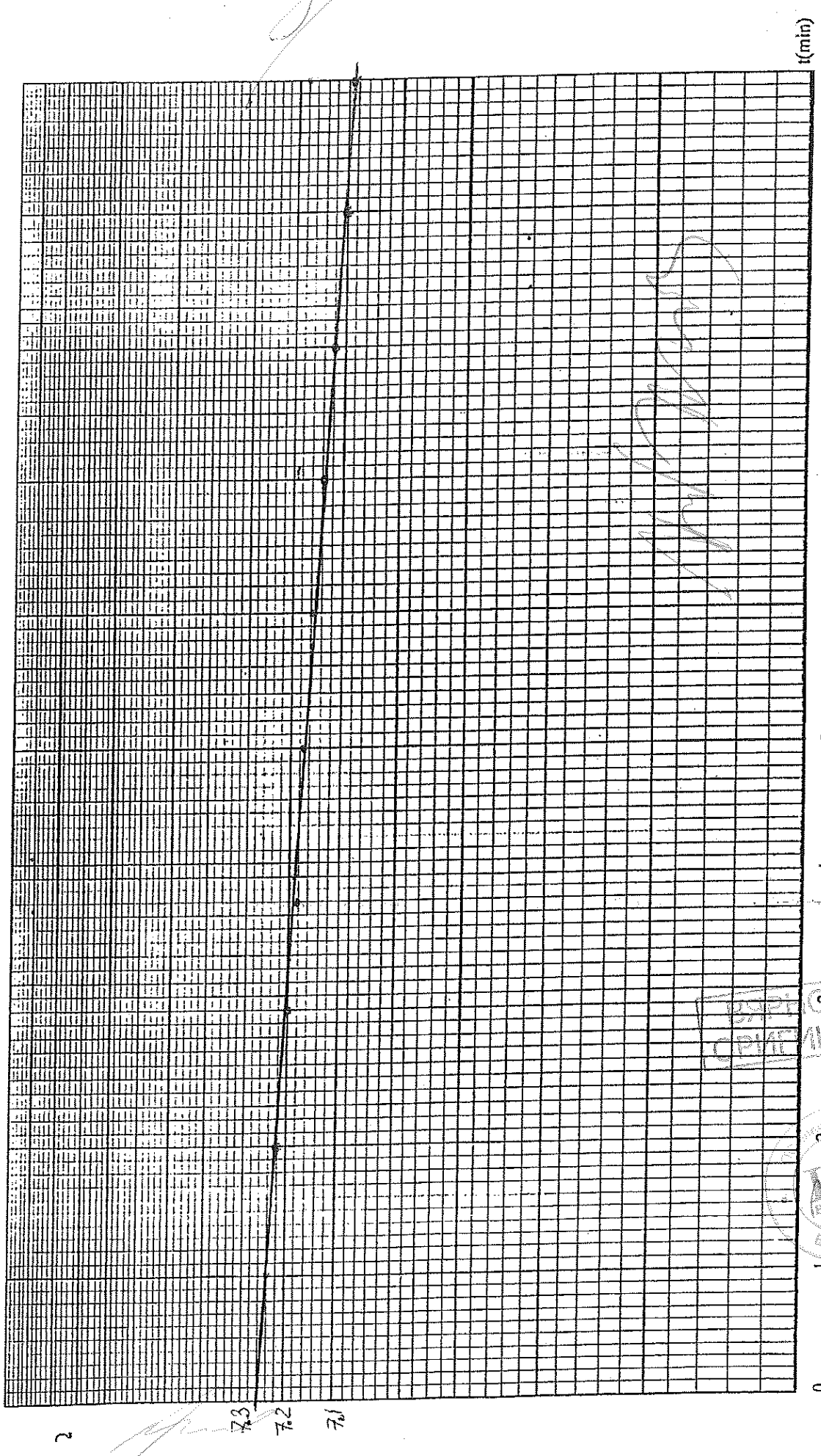
C - C

1. Corpus made of reinforced concrete B45
2. MV switchboard with SF6
3. LV Switchboard
4. Transformer
5. Aluminium door
6. Cabel 20 kV - 3x1x50mm2
7. Cabel 0.4kV - 240мм2
8. Fuse switch disconnector 630A.

ВЯРНО С ОРИГИНАЛА

Pavel & Sons	Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA	BM01A-31E
	Part: electrical	SHEET 5/5


t(min)
0
1
2
3
4
5
6
7
8
9
10
0-3Ω
2.7
2.6
2.55
2.5
= 2,6 mΩ


t(min)
0
1
2
3
4
5
6
7
8
9
10
7.3
7.2
7.1
2

4.4. ex3

RESEARCH , DEVELOPMENT AND
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HIGH VOLTAGE LABORATORY - LIT

200515 Craiova, Calea Bucuresti 144
Phone : 0351 - 404888, 0351 - 404889, 0351 - 402425, Fax: 0251 – 415482; 0351 – 404890

TEST REPORT
No.41063 / 03.05.2007

1. **Product:** **Prefabricated Substation 24 kV, 800 kVA type BM 01 A31**
Serial no. 07057
2. **Tests:** Dielectric tests according to IEC 62271 – 202 : 2006
   – Lightning impulse withstand voltage test
   – Power frequency voltage test
   – Tests to verify the degree of protection IP - 43
   – Measurement of partial discharge
3. **Test order:** 20499 / 23.04.2007 (Contract no.3266 / 28.02.2007)
4. **Producer:** Pavel & Sons
5. **Customer:** Pavel & Sons
6. **Customer's address:** Central office: 9700, Shumen - BULGARIA

На основание чл. 2 от ЗЗЛД

На основание чл. 2 от ЗЗЛД

ВЯРНО С ОРИГИНАЛА

7. **The test report contains 14 pages.**
8. **The test report was edited in 4 ex.; 1 ex to LIT and 3 ex to customer.**

CAUTION:
a. The test result makes reference only to tested product .
b. Integral reproduction of the test report is forbidden.
c. Any part of this test report may be reproduced only with the accord of LIT and RENAR.
d. Reports without original signatures are not valid.
e. Laboratory accreditation or any of its test reports elaborated in accreditation conditions not constitute or imply, themselves, an approval of product by RENAR, which has accredited the test laboratory, or by any other organization.

LIT

1. Table of contents

2. CONCLUSIONS:

Prefabricated Substation 24 kV; 800kVA type BM 01 A31 is considered satisfactory.

LIT

3. Ratings of the Prefabricated Substation

Apparatus	: **Prefabricated Substation 24 kV; 20 / 0.4 kV; 800kVA**
- type	: **BM 01 A31**
- manufacturing serial no.	: **07057**
Manufacturer	: Pavel & Sons Ltd., Shumen Bulgaria
Rated voltage	: 20 kV
Rated insulation level	
- power frequency	: 50 $kV_{r.m.s.}$, 50Hz, 1 min
- lightning impulse	: 125 kV_{peak}, 1.2 / 50 µs
Rated current	: 400 - 1250 A

4. Mounting arrangement

Prefabricated Substation 24 kV; 20 / 0.4 kV 800 kVA, sheet 1/1 – circuit diagram, sheet 4/5 - part: electrical, sheet 5/5 - part: electrical drawings.

5. Test standard:

IEC 62271 – 202 : 2006; IEC 60694 : 2002; Technical Specification BM01 A31 no.1107 / 21.04.2007.

6. Test procedures

6.1. Application of the test voltage

To entrance in S2 of MV switchboard they were connected three MV cables by customer (see pictures from pages 13 and 14), where it was applied the specified voltage level.
Disconnector S1 open, disconnector S2 and disconnector S3 closed.
Test to earth and between phases: When voltage was applied to on phase, the other phases were earthed.
During the test, the MV transformer (20 / 0.4 kV) were connected in the tested circuit and LV circuit breakers were in open position.

6.2. Test with lightning impulse voltage

Withstand voltage level
3 impulses, for polarity (-), with specified level were applied.

ВЯРНО С ОРИГИНАЛА

6.3. Power frequency voltage tests

Withstand voltage test
The specified voltage level was maintained for 60 s.

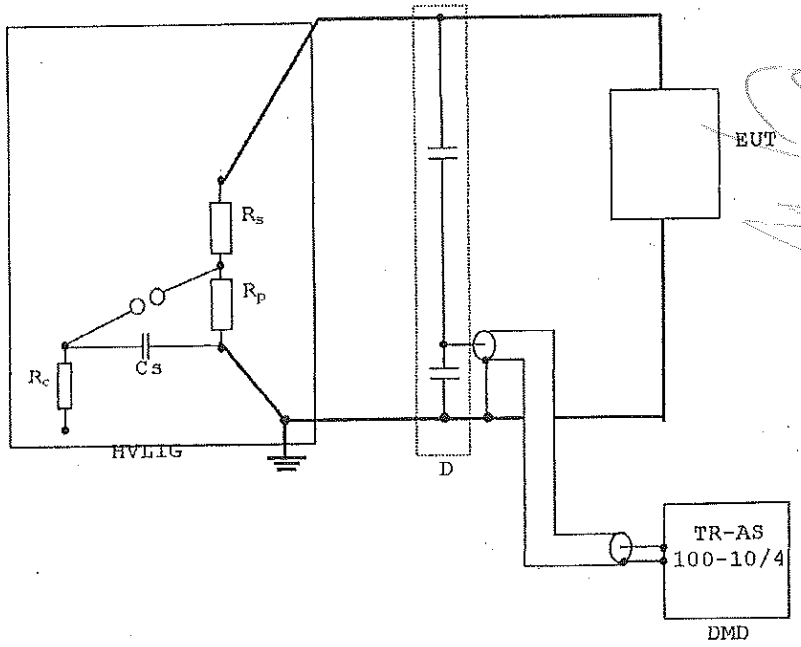
LIT

6. Lightning impulse voltage test

6.1. Reception date : 23.04.2007
6.2. Test date : 23.04.2007
6.3. Atmospheric conditions :

pressure	p = 1014 mbar
temperature	t = (14.7 ± 0.5) °C
absolute humidity	h = 34.4 %

6.4. Test voltage: 125 kV
6.5. Test standard: IEC 62271 – 202; IEC 60694 / 2002 subclause 6.2.6.2
6.6. Test circuit diagram and equipment used :



HVLIG - High Voltage Lightning Impulse Generator HV, no.5 - 1197, connection I (1x2)
Value of stage elements
C_s = 0.576 μF; R_s = 32.7 Ω; R_p = 115 Ω
D - Capacitor divider, dividing ratio k_{div} = 348
DMD - Digital Measuring Device type TR – AS 100 – 10 / 4 Dr. Strauss, no.241, channel 3;
Uncertainty of measuring chain: The expanded uncertainty of measurements for the coverage factor k = 2 (coverage probability appr. 95 %) equal with 1.2 % for peak value and 4.1 % for front and tail times (Calibration Certificate no.0049a / DKD – K – 18702 / 03.06).
EUT - Equipment Under Test.

Measuring uncertainty for the peak value of lightning impulse is: 1.7 %.
The uncertainty stated is expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2. The value of measurand lies within the assigned range of values with probability of 95 %.

LIT

6.7. Table with testing sequence and results

Test condition			Earthed connected to	Voltage applied to	Pol	Level of testing voltage [kV]	Test result
S1	S2	S3					
open	closed	closed	L2,L3	L1	Neg	125	Withstood 3 impulses
open	closed	closed	L1,L3	L2	Neg	125	Withstood 3 impulses
open	closed	closed	L1,L2	L3	Neg	125	Withstood 3 impulses

Legend: L1, L2, L3 – terminals.
Note: For terminal identification see drawing sheet 1/1 – circuit diagram from page 10.

6.8. Conclusion: The product passed the test.

6.9. Test responsible: En

На основание чл. 2 от ЗЗЛД

ВЯРНО С ОРИГИНАЛА

LIT

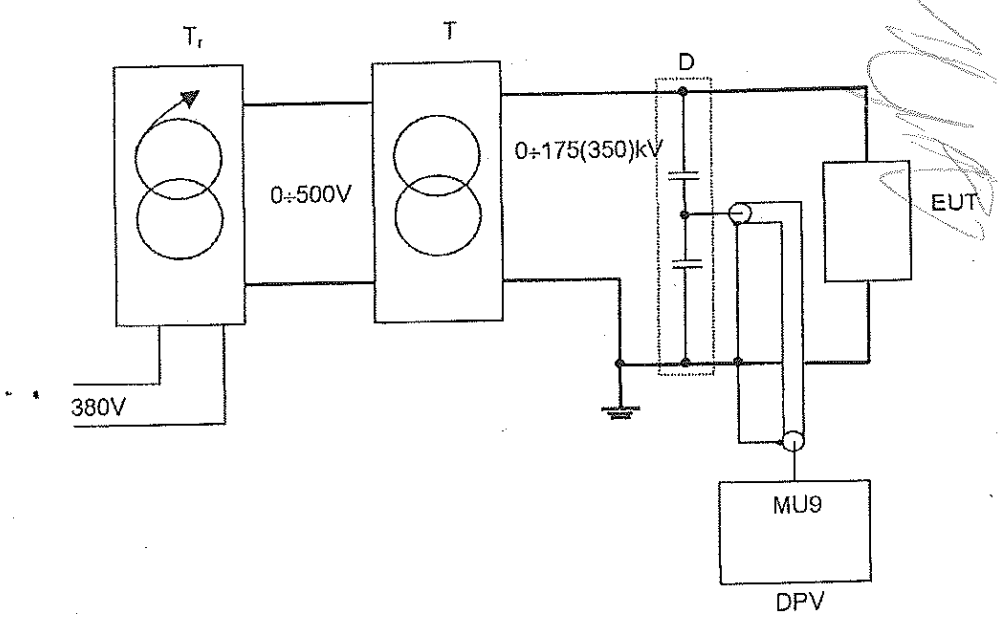
7. Power frequency voltage test

7.1. Reception date : 24.04.2007
7.2. Test date : 24.04.2007
7.3. Atmospheric conditions :

pressure	p = 1006 mbar
temperature	t = (14.5 ± 0.1) °C
absolute humidity	h = 43.7 %

7.4. Test standard: IEC 61330

7.5. Test circuit diagram and equipment used :



Tr - Regulating transformer 380 V / 0 ÷ 500 V
T - High voltage set up transformer 0.5 / 175 (350) kV 350 kVA
DPV - Digital Peak Voltmeter type MU9, no.892204
EUT - Equipment Under Test
D -Capacitor divider 350 kV consists of: high voltage compressed gas capacitor type MCF 75/350P, no.853889 and low voltage arm type H90, no.898939

Measuring uncertainty is ± 1.2 %.
The reported uncertainty is an expanded uncertainty, based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 %.

7.6. Table with testing sequence and results

Test condition			Earthed connected to	Voltage applied to	Level of testing voltage [kV]	Test result
S1	S2	S3				
open	closed	closed	L2,L3	L1	50	Withstood 60 sec
open	closed	closed	L1,L3	L2	50	Withstood 60 sec
open	closed	closed	L1,L2	L3	50	Withstood 60 sec

Legend: L1, L2, L3 – terminals.
Note: For terminal identification see drawing sheet 1/1 – circuit diagram from page 10.

7.7. Conclusion: The product passed the test.

7.8. Test responsible: Eng. На основание чл. 2 от ЗЗЛД

ВЯРНО С ОРИГИНАЛА

LIT

8. – VERIFICATION ON THE DEGREE PROTECTION IP – 43

8.1. Reception date of the product: 24.04.2007
8.2. Measurement date: 24.04.2007
8.3. Atmospheric conditions: p = 1006 mbar; t = (14.5 ± 0.1) °C; h = 43.7 %
8.4. Test standard: CEI 60529 / 1999

a. **Verification of the first characteristic numeral, "4"**

a.1. Protection against access to hazardous parts
a.2. Protection against the penetration of solid foreign objects

For a.1 were used the test access probe of 1 mm diameter and a length of 100 mm.
For a.2 were used the object probe of 1 mm diameter.
They did not penetrate the test object.

b. **Verification of the second characteristic numeral "3", against spraying water**

b.1. Against spraying water at angle up to 60° on either side of the vertical.
It was used the spay nozzle compliant with Fig.5 of IEC 60529.

The spaying time was of 7.5 min, because total area A_T = 7.5 m^2.
The debit was 10 l / min.
There was no ingress of water into the test object.

8.5. Conclusion: The product corresponding to the degree of protection IP – 43.

8.6. Test responsible: Eng.Gh.

На основание чл. 2 от ЗЗЛД

ВЯРНО С ОРИГИНАЛА

ICMET LIT

9. Measurement of partial discharge

9.1. Reception date : 24.04.2007
9.2. Test date : 25.04.2007
9.3. Atmospheric conditions :

pressure	p = 1005.5 mbar
temperature	t = (14.6 ± 0.1) °C
absolute humidity	h = 45 %

9.4. Test standard: IEC 62271, IEC 60270, Specification ERP-15/01 / 11.01.2007 subclause 6.7.2.1;
9.5. Equipment used :

- Panel E12, 525V/85A of the LV installation of the HV Laboratory
- Coupling capacitor no.02: 500 pF/300kV
- Charge for calibration: 25 pC
  Calibrator type PET 2 -1, no.893534, Calibration Certificate DKD no.0085 / 20.03.2006.
- Measuring system: measuring impedance type LDM – 5/U (no.735 35 131) + wide band instrument type LDS – 6 (no.21543181), Calibration Certificate DKD no.0087/03.07.2006

9.6. Results:

Voltage [kV]	PD level (pC)		
	L1	L2	L3
24	8	9	8

During the tests was determined also the PD inception and extinction voltages on each phase.

Phase	PD inception voltage [kV]	PD extinction voltage [kV]
L1	15.6	13
L2	15.2	13.4
L3	15.8	13.7

Note: The PD measuring system was moved on each phase.

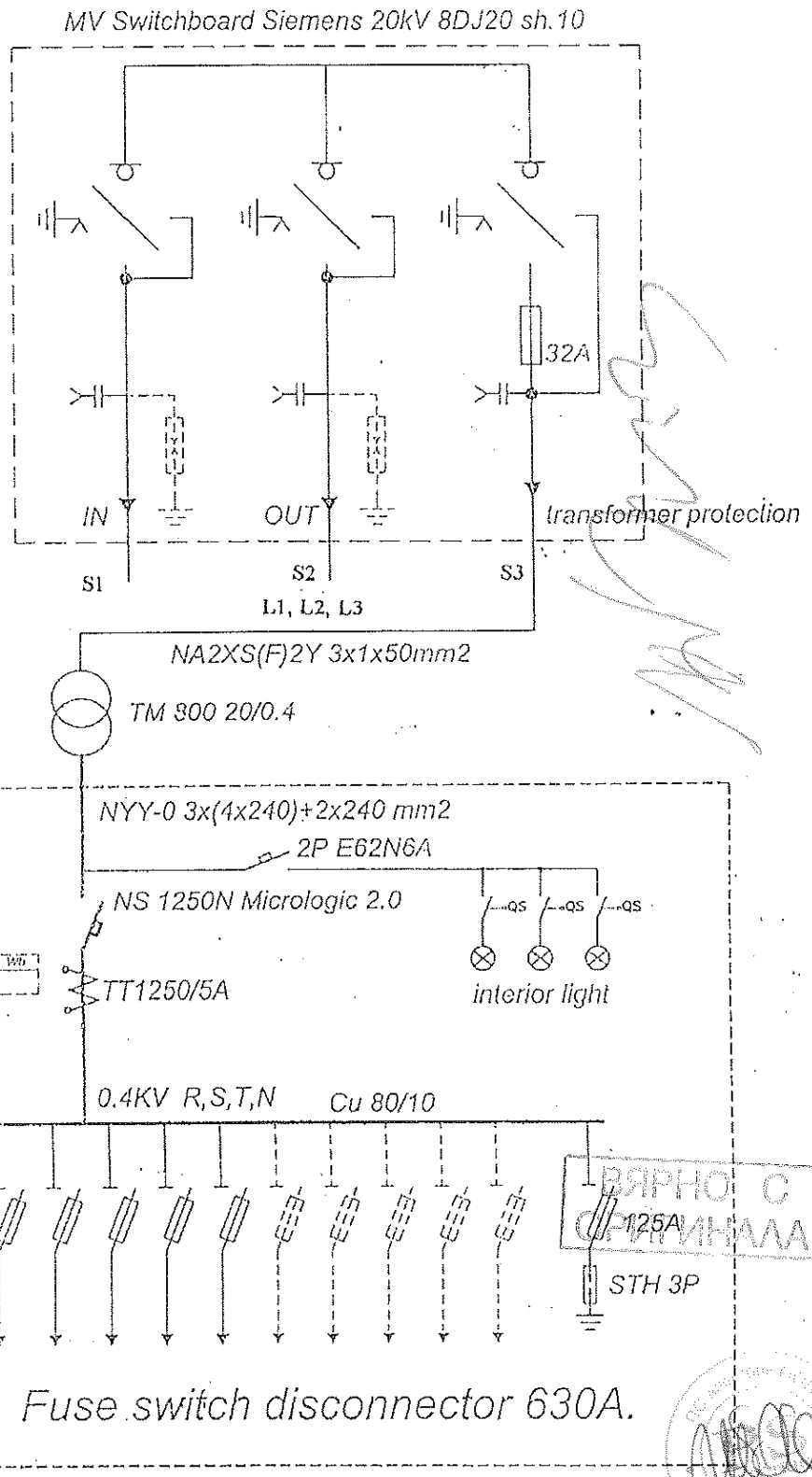
Верно с оригинала

Measuring uncertainty for the PD measurement is: 0.5 pC + 0.04q (pC)
The uncertainty stated is expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2 (coverage probability appr.95 %).

9.7. Conclusion: The product passed the test.

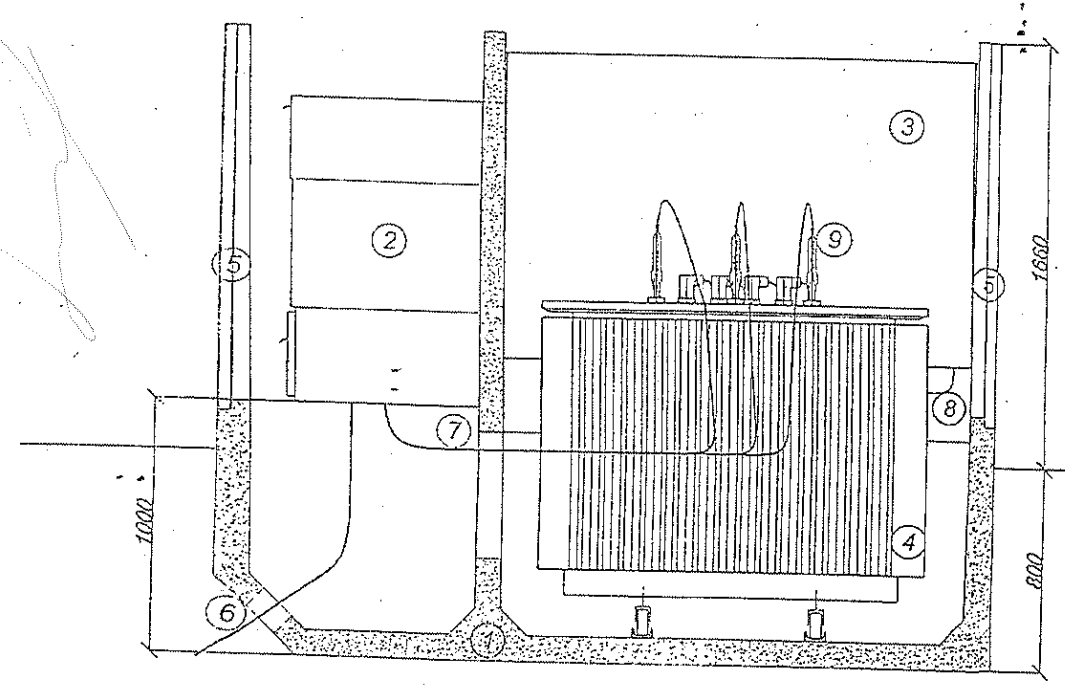
9.8. Test responsible: Eng. На основание чл. 2 от ЗЗЛД

LIT



ВЯРНО С ОРИГИНАЛА

Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA	BM01A31
CIRCUIT DIAGRAM	SHEET 1/1



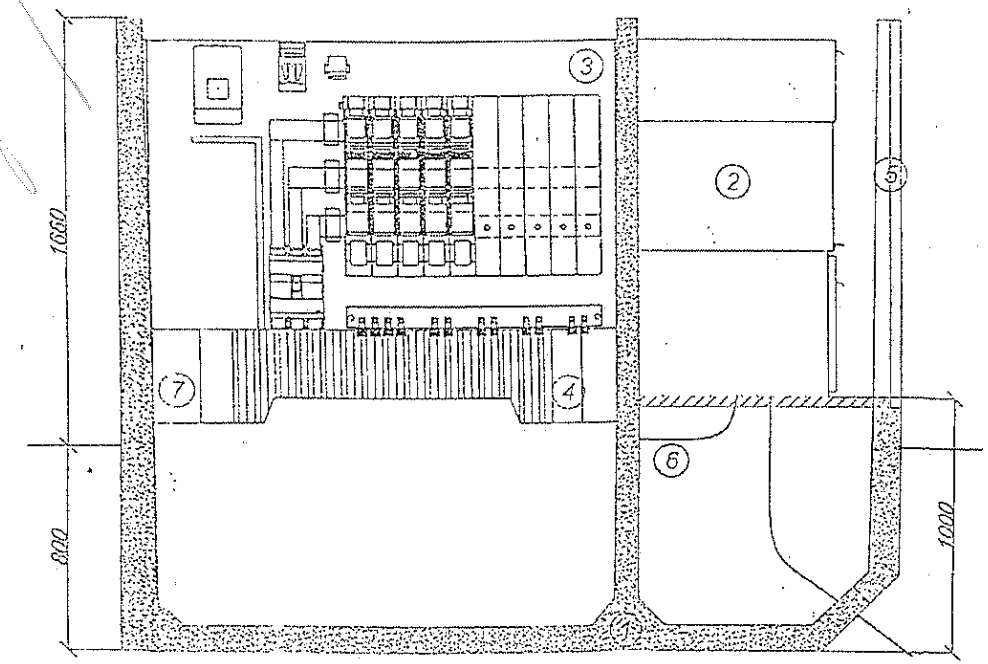
A - A

1. Corpus made of reinforced concrete B45
2. MV switchboard with SF6
3. LV Switchboard
4. Transformer
5. Aluminium door
6. Bayonet cable bushings snap-in system
7. Cabel 20 kV - 3x1x50mm2
8. Cabel 0.4kV - 240мм2
9. Cable ends

ВЯРНО С ОРИГИНАЛА

Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA	BMKA-31
Part: electrical	SHEET 4/5

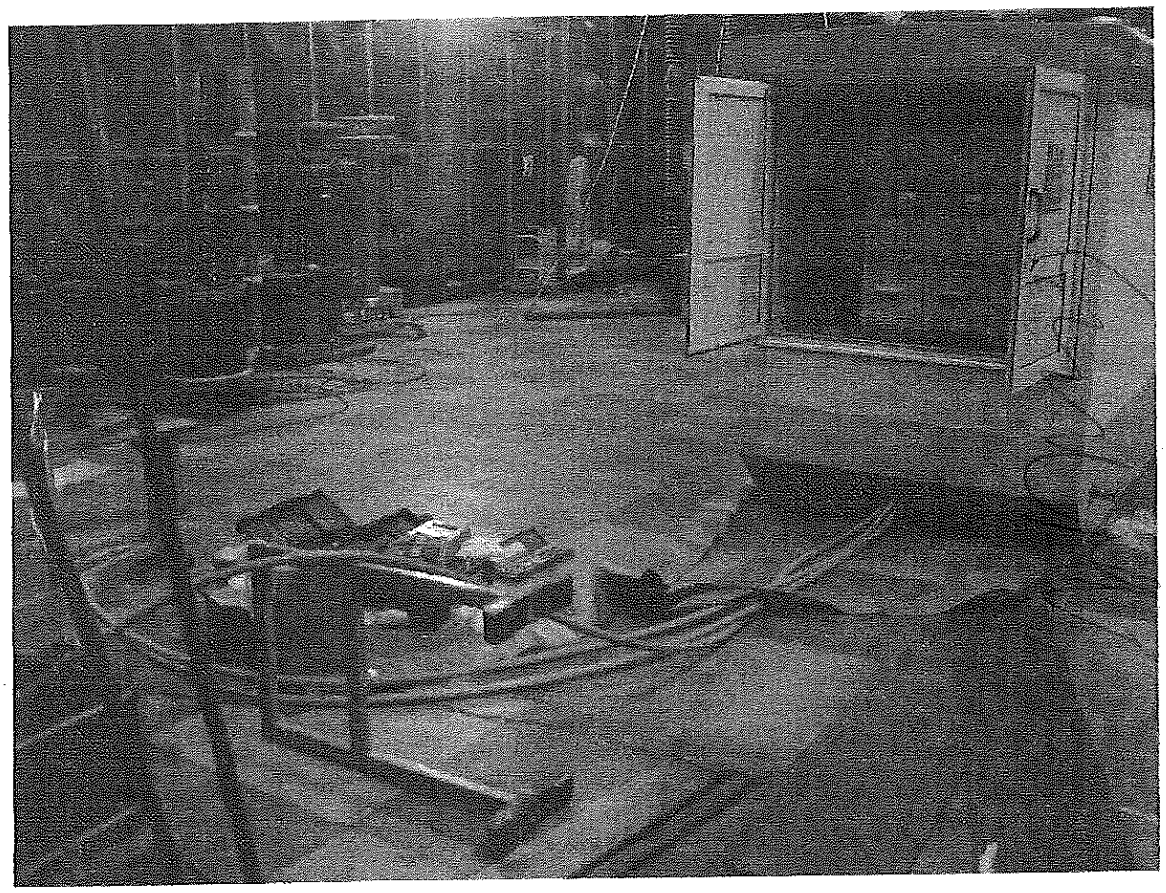
TEST REPORT No. 41063



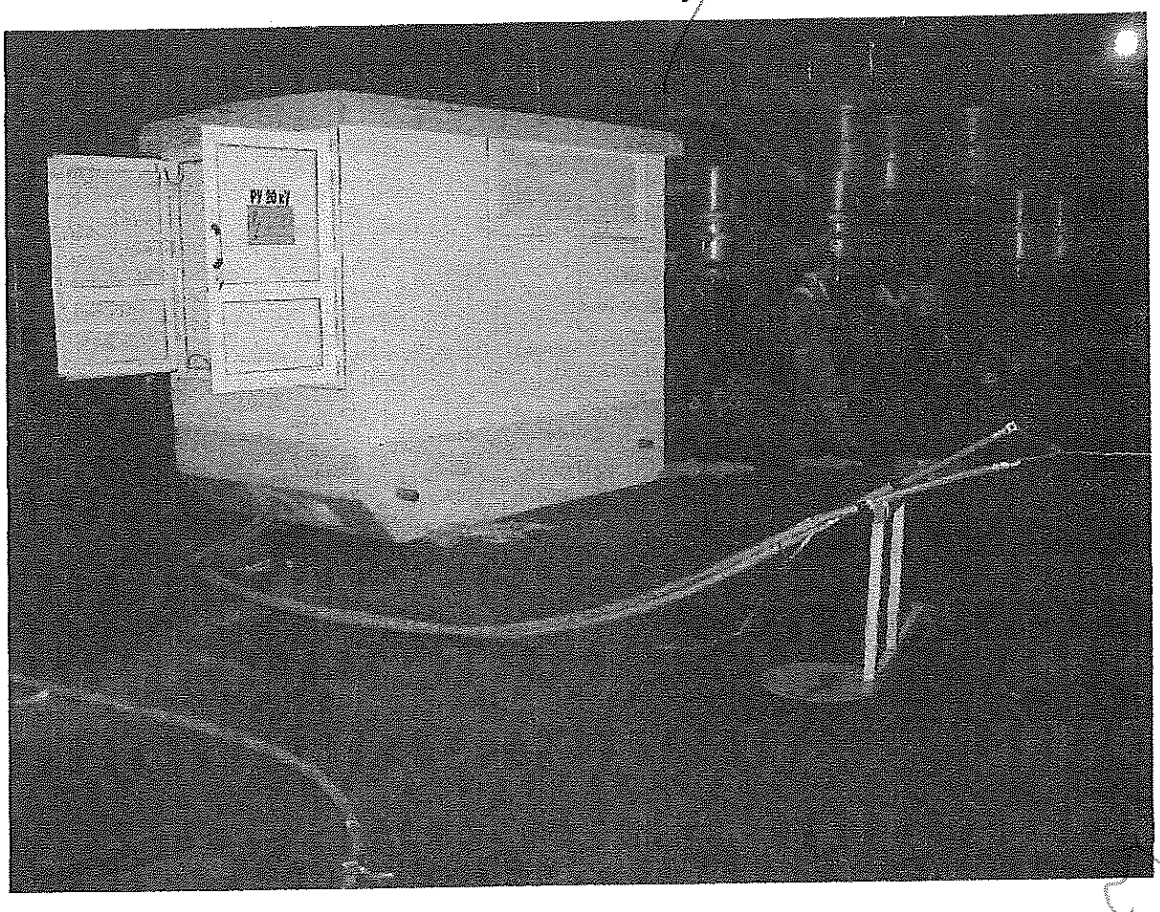
1. Corpus made of reinforced concrete B45
2. MV switchboard with SF6
3. LV Switchboard
4. Transformer
5. Aluminium door
6. Cabel 20 kV - 3x1x50mm2
7. Cabel 0.4kV - 240мм2
8. Fuse switch disconnector 630A.

	Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA	BM01A-STE
	Part: electrical	SHEET 5/5

LIT



LIT



Ex. 2

4.5.

RESEARCH, DEVELOPMENT AND TESTING
NATIONAL INSTITUTE FOR
ELECTRICAL ENGINEERING

I C M E T CRAIOVA

HIGH VOLTAGE DIVISION - HVD
Low Voltage Laboratory
Calea București No.144, 200515 Craiova, ROMANIA
Phone: + 40 0351 402425, 404888; Fax: + 40 0251 415482, 0351 404890
www.icmet.ro, e-mail: market@icmet.ro; ljt@icmet.ro

TEST REPORT
Nr. 41064 / 24.04.2007

1. **Test product:** **24kV, 800VA Prefabricated Substation**
   Type BM01A31, Serial no.07057
2. **Tests:** I. Dielectric tests on auxiliary and control circuit
   II. Withstand of the enclosure against mechanical stress
3. **Test order:** Contract No. 3266 / 28.02.2007
4. **Client:** PAVEL & SONS
5. **Client address:** Central office 9700, Shumen, BULGARIA
6. **Manufacturer:** PAVEL & SONS
7. **Test responsible:** Eng. На основание чл. 2 от ЗЗЛД
   Eng.

На основание чл. 2 от ЗЗЛД

8. **The report contains 3 pages.**
9. **The report is edited in 3 copies: 2 copies for the client and 1 copy for HVD**

ВЕРНО С ОРИГИНАЛА

WARNINGS:

a. *Test results refer to the equipment under test mentioned at point 1, only;*
b. *The integral reproduction of the present report is forbidden;*
c. *Partial reproduction of the present report is only allowed with prior written consent of HVD;*
d. *All signatures of the present report are originals.*

I – DIELECTRIC TESTS ON AUXILIARY AND CONTROL CIRCUIT

1. **Reception product date:** 24.04.2007
2. **Test date:** 24.04.2007
3. **Test standard:** IEC 61330:1995
4. **Atmospheric conditions:** t = 18 ^{0}C, RH = 53 %
5. **Equipment and apparatus used:**
   - Impulse generator type SIP 01, serial no. 620090, manufactured by RFT Germany, CE no. 0088/26.10.2006, expanded uncertainty U=2,2% for coverage factor k=2
   - Impulse generator type SIP 01, serial no. 620091, manufactured by RFT Germany, CE no. 0089/26.10.2006 expanded uncertainty U=2,3% for coverage factor k=2
   - Thermohigrometer type HD 100, serial no. 06102404, manufactured by KIMO, France, CE no.4.8-11-06-025/13.11.2006, expanded uncertainty U=0,3°C for temperature measurement and U=2% for relative humidity for coverage factor k=2.

6. **Procedure**

Dielectric tests on auxiliary and control circuits are performed according IEC 61330:1995, subclause 6.1.2 and consists in the following tests:

a) Impulse voltage withstand test

The impulse test voltage of 5kV, 1,2/50μs was applied three times for each polarity at intervals of 1s minimum.

The test voltage is applied as follows:
- between all poles connected together and the earth;
- between each pole and the others poles connected together and to the earth.

b) Power frequency withstand test

The power frequency test voltage of 2,5kV, 1 min was applied as follows:
- between all poles connected together and the earth;
- between each pole and the others poles connected together and to the earth.

ВЯРНО С ОРИГИНАЛА

7. **Results**

There were not disruptive discharges during the tests. The product withstood the test.

II – WITHSTAND OF THE ENCLOSURE AGAINST MECHANICAL STRESS

1. **Reception product date:** 24.04.2007
2. **Test date:** 24.04.2007
3. **Test standard:** IEC 61330:1995
4. **Atmospheric conditions:** $t = 18\ ^0C$, $u_r = 53\ \%$
5. **Equipment and apparatus used:** - Pendulum hammer, manufacturer ICMET according IEC 60068-2-75:1997, serial no.3, CE no.Dj 06-3061545/2006, expanded uncertainty U=0,75% for coverage factor k=2
   - Thermohigrometer type HD 100, series 06102404, manufactured by KIMO, France, CE no.4.8-11-06-025/13.11.2006, expanded uncertainty U=0,3°C for temperature measurement and U=2% for relative humidity for coverage factor k=2

6. **Procedure**

The mechanical impact tests were performed according IEC 61330:1995, subclause 6.6.

The product was visually examined before the tests.

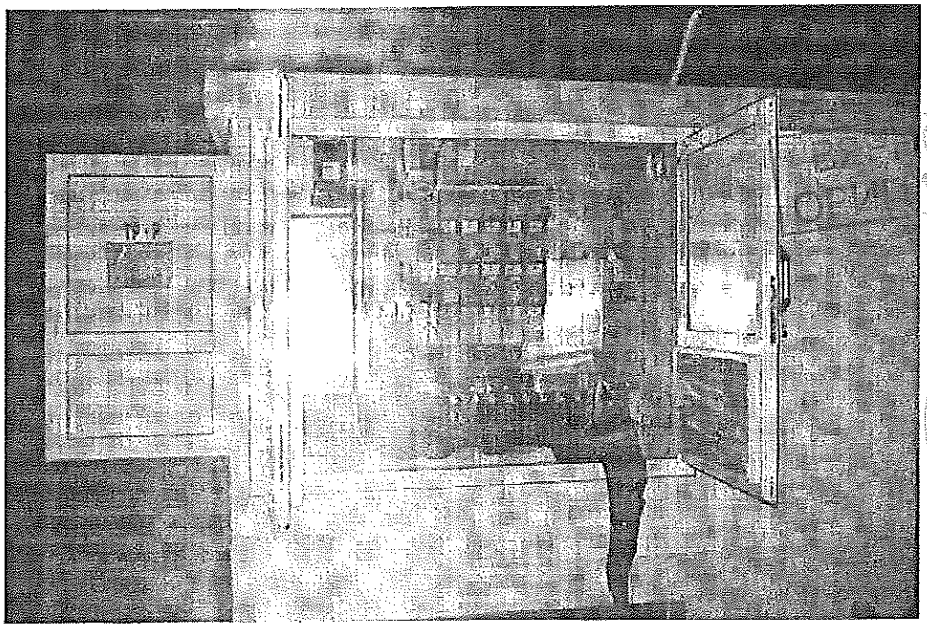
The impact energy was 20 J, produced by a pendulum hammer with an equivalent mass of 5kg±5% and the height of fall 400mm ± 1%.

Three blows were applied on each access door, ventilation openings and covers of the enclosure to points that are likely to be the weakest points.

After the tests, the enclosure did not present any breaks or deformations which could affect the normal function of the equipment.

7. **Result**

The product withstood the mechanical impact test.



RESEARCH-DEVELOPMENT AND TESTING NATIONAL
INSTITUTE FOR ELECTRICAL ENGINEERING

ICMET CRAIOVA
ROMANIA

"Ovidiu Rarinca" HIGH POWER LABORATORY- LMP
200515-CRAIOVA Calea Bucuresti Nr. 144 ROMANIA
Phone: +40 351 402427; Fax:+40 351 404 890; +40 251 415 482
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ÎNCERCARE
ROMANIA
RENAR
SR EN ISO/CEI 17025:2001
CERTIFICAT DE ACREDITARE
Nr. 004 - L

TEST REPORT
No. 9866 / April 28, 2007

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

Test: Short-time and peak withstand current test on earthing circuit
Functional tests

Test method: According to IEC 62271-202/2006, clause 6.4 and 6.5

Test date: April 28, 2007

Test result: Passed the test

На основание чл. 2 от ЗЗЛД

LABORATORUL DE MARE PUTERE "OVIDIU RARINCA" CRAIOVA

ICMET CRAIOVA LMP

Responsible for test:
Eng. I На основание чл. 2 от ЗЗЛД

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

Report has 14 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.

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

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

IDENTIFICATION OF APPARATUS

	Substation	Transformer
Type	BM 01A31	TM800/20/0.4
Serial number/Year	07057/2007	110365/2006
Technical documentation Drawing	-/BM 01A31	
Order no.:	Contract No. 3266/ 28.02.2007	
Product receiving date:	April, 2007	
Product condition at receiving:	New	

PERFORMANCES ESTABLISHED BY PRODUCER

	Substation		Transformer	
Rated power	800	kVA	800	kVA
Rated voltage	20/0.4	kV	20/0.4	kV
Rated current	-		32/1155	A
Rated frequency	50	Hz	50	Hz
Short-circuit voltage			4.06	%
Connection			DYn5	

TEST PROGRAM

I. One single phase short-time withstand current and peak withstand current test on earthing connections at parameters: Ip = 40 kA, Ik = 16 kA, tk = 1 s.

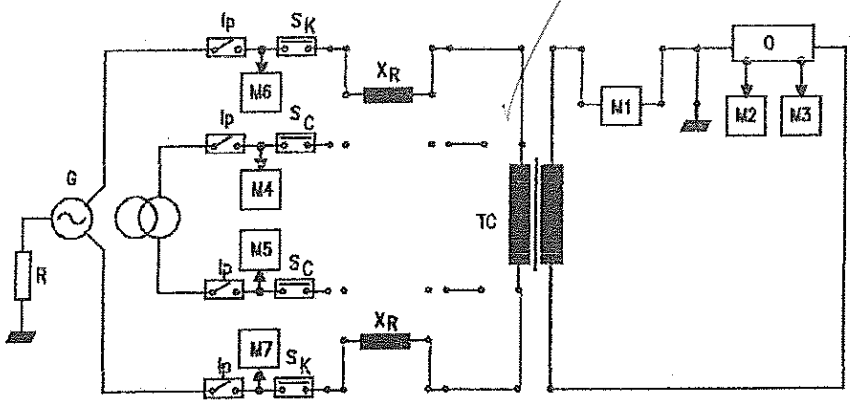
II. Functional tests.

1. Operation of the switchgear and controlgear;
2. Mechanical operation of substation doors;
3. Replacement of the fuses;
4. Operation of the transformer tap-changer;
5. Cleaning of ventilation grid.

ВЯРНО С ОРИГИНАЛА

TEST REPORT DOCUMENTATION: Oscillograms 1; Tables 2;
Photos 1; Drawings 8;

TESTING AND MEASURING DIAGRAM



T –Power transformer
G –shortcircuit generator
Ik –6kV circuit breaker
Ip –12kV protection circuit breaker
Sc –6kV making switch

Sk –12kV making switch
XR –Reactor
TC –Shock step down transformer
M1–M7 –Measuring points
0 –Apparatus to be tested

P2E

DATA OF TESTING AND MEASURING CIRCUIT

Table 1

Test		Short-time withstand current and peak withstand current test
Phases number		2
Source / connection		G3/Y
Transformer /Rate		TC 8 / 20
Earthing	Source	–
	Apparatus	Net earthing connection
Reactor [Ω]		2
Power factor		< 0.15
M6 - Source voltage - Voltage transformer 15000/ 100V		
M1 - Apparatus current - Shunt 70 kA / 1.75 V		

1. TEST ON EARTHING CONNECTIONS

Table 2

Oscillogram No.	Ip [kA]	It [kA]	tt [sec]	It equiv.*tk [kA]	Remarks
68773/2007	41.1	17.1	0.95	16.66	Test on earthing circuit

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

SYMBOLS USED IN TABLES AND OSCILLOGRAMS

I = Short-circuit current
Ip = Peak value of short - circuit withstand current
It = R.m.s. value of short - circuit withstand current
tt = The duration of short - circuit
U0 = Apparatus voltage
Us = Source voltage
It equiv.*tk = Equivalent value of short-time withstand current on tk = 1 s, calculated as follows:

$$It\ equiv.*tk = It * \sqrt{\frac{t_t}{t_k}}$$

Remark:
The earthing circuit did not interrupt.

2. FUNCTIONAL TESTS

The following activities were performed:

1. A manual close open operation of the switchgears was performed. No manifestation.
2. Substation doors have been closed and opend. No manifestation.
3. The fuses were removed and put back. No manifestation.
4. Transformer tap-changer worked correctly. No manifestation.
5. The ventilation grid was clean.

ВЯРНО С ОРИГИНАЛА

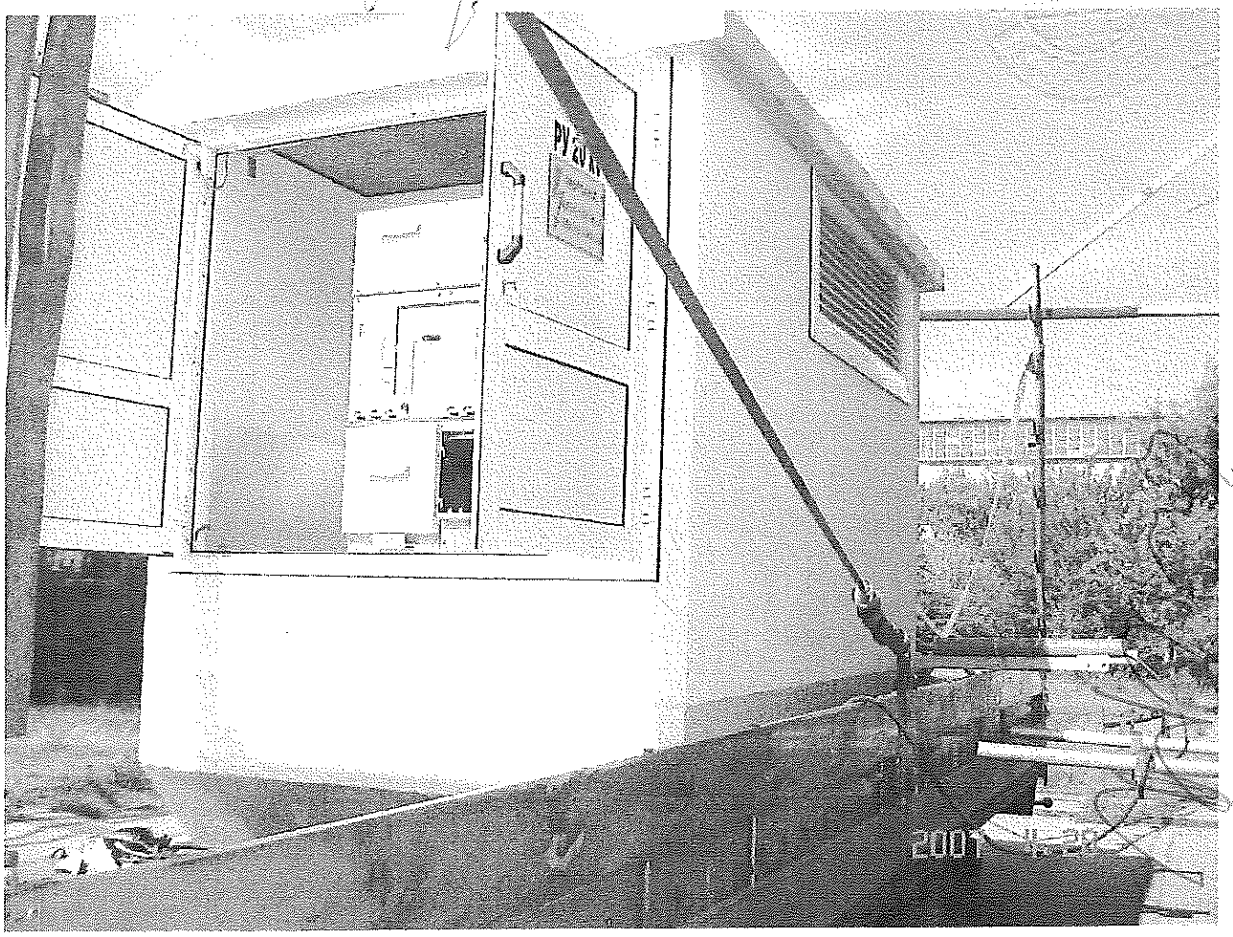
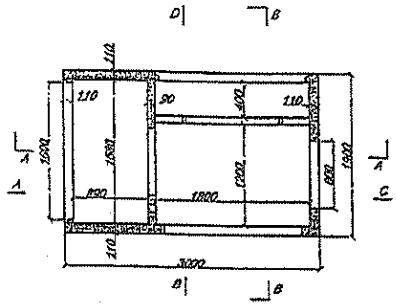
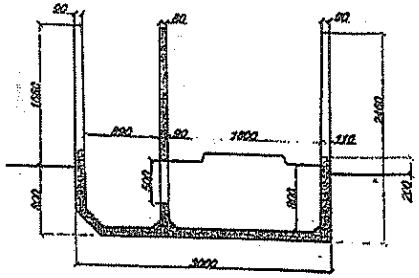
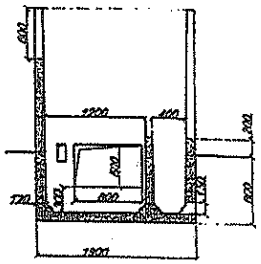


Photo 1 – Aspect of the complete transformer substation in the test circuit

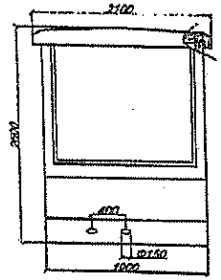




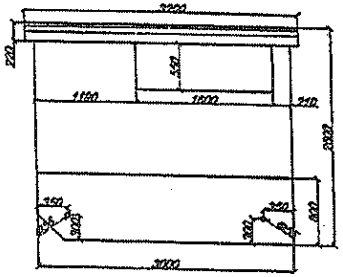
Section A-A



Section B-B



FACADE A



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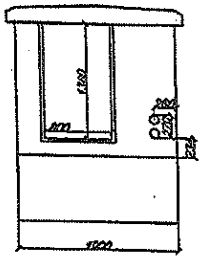
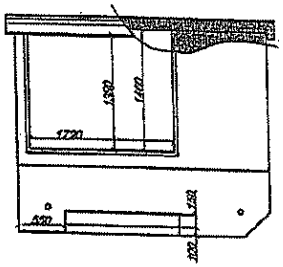


FACADE C



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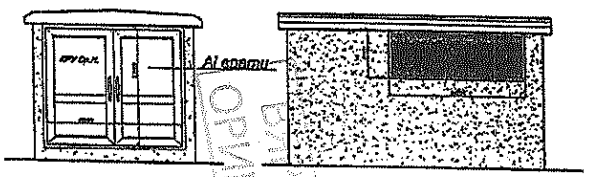
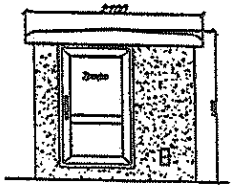
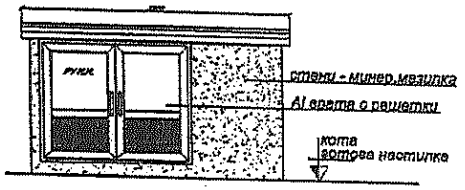
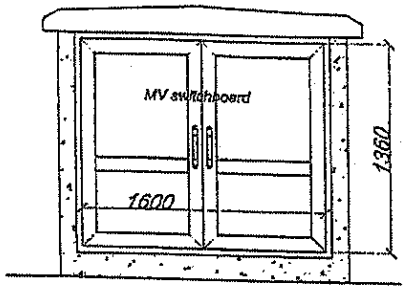


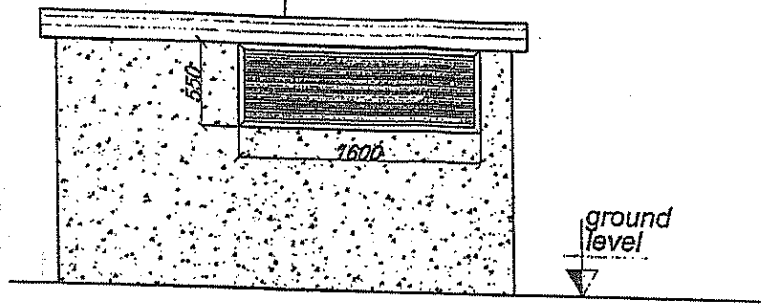




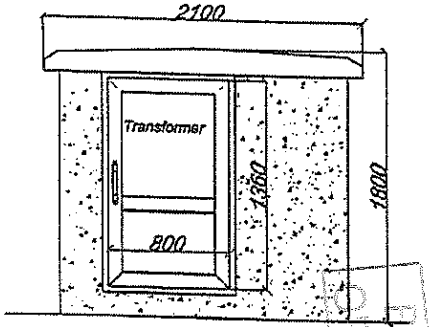
Pavel Ilinov	Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA	BM01A-31
	Part: architectural	SHEET 1/2



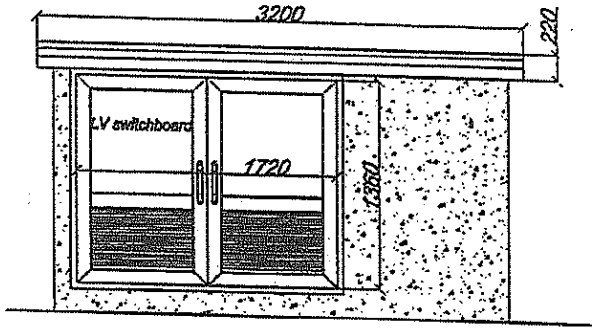
FACADE A



FACADE B

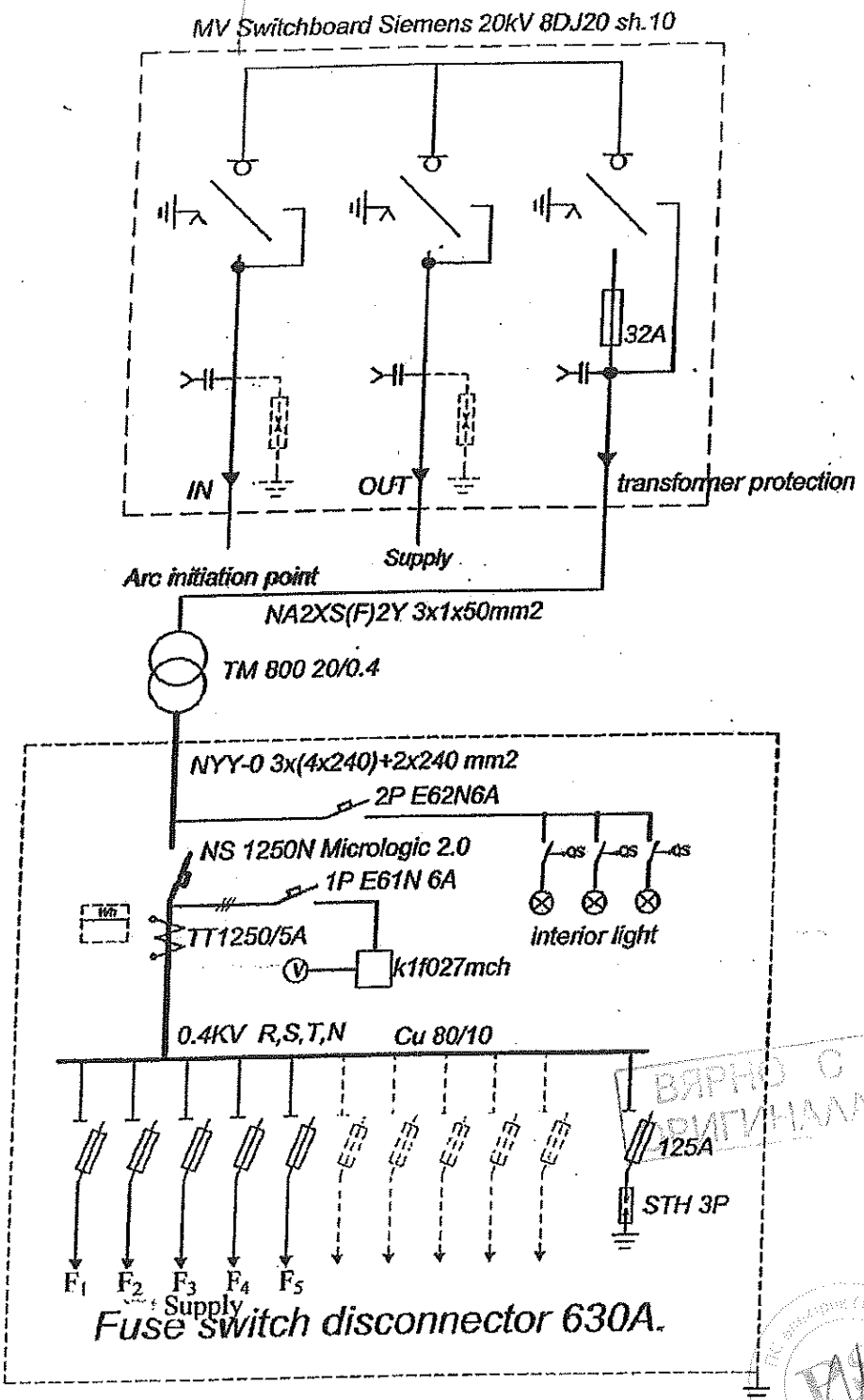


FACADE C

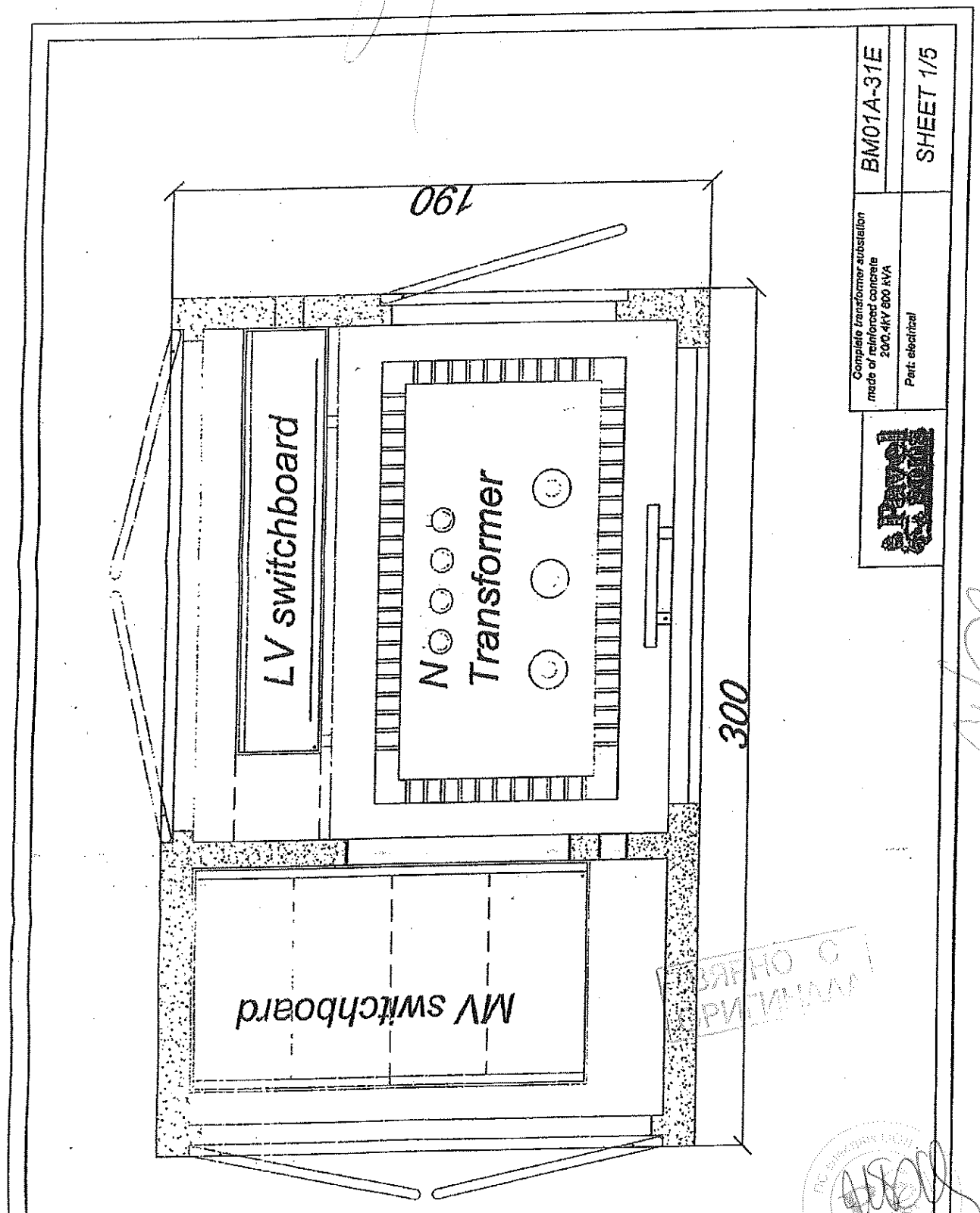


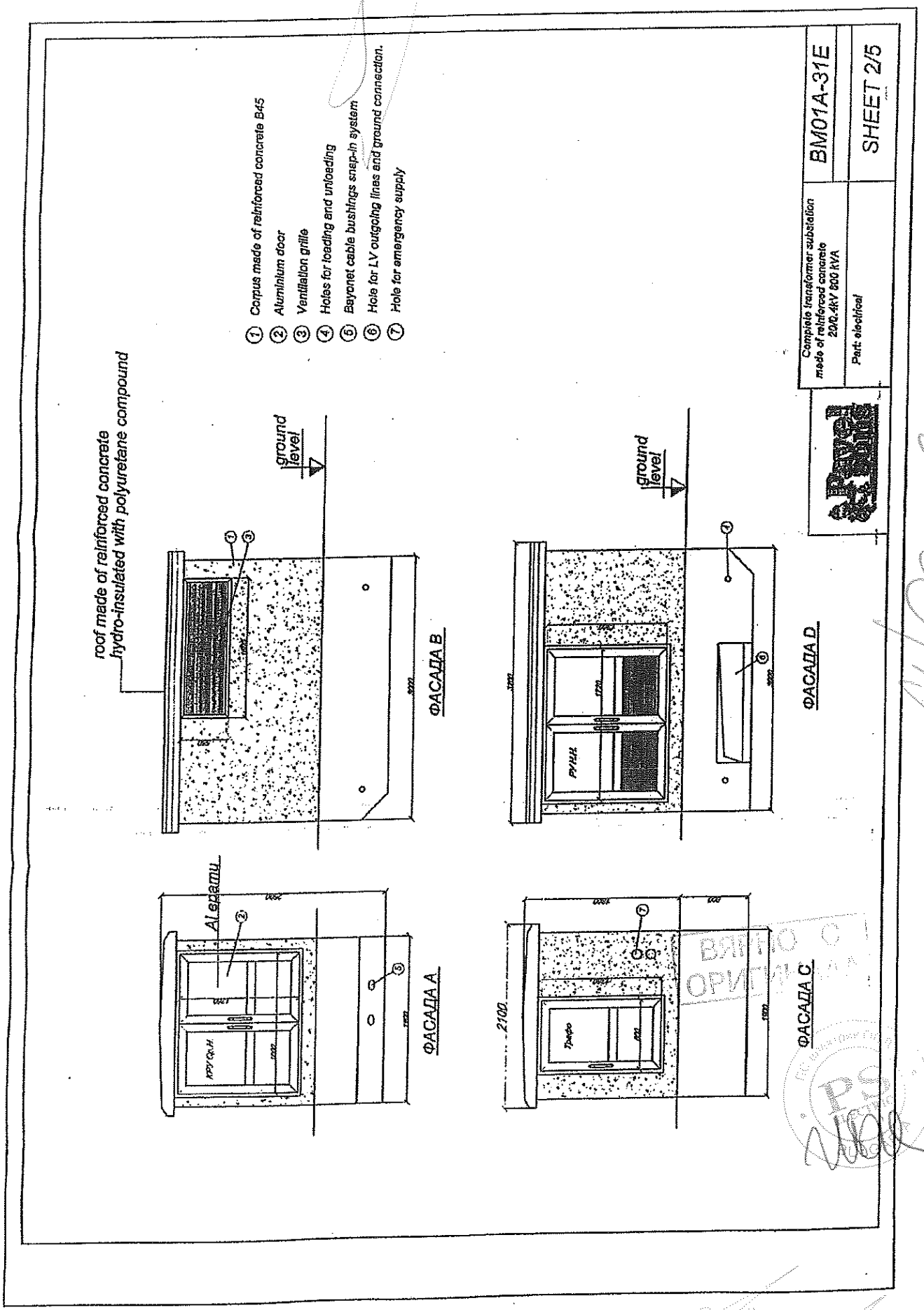
FACADE D

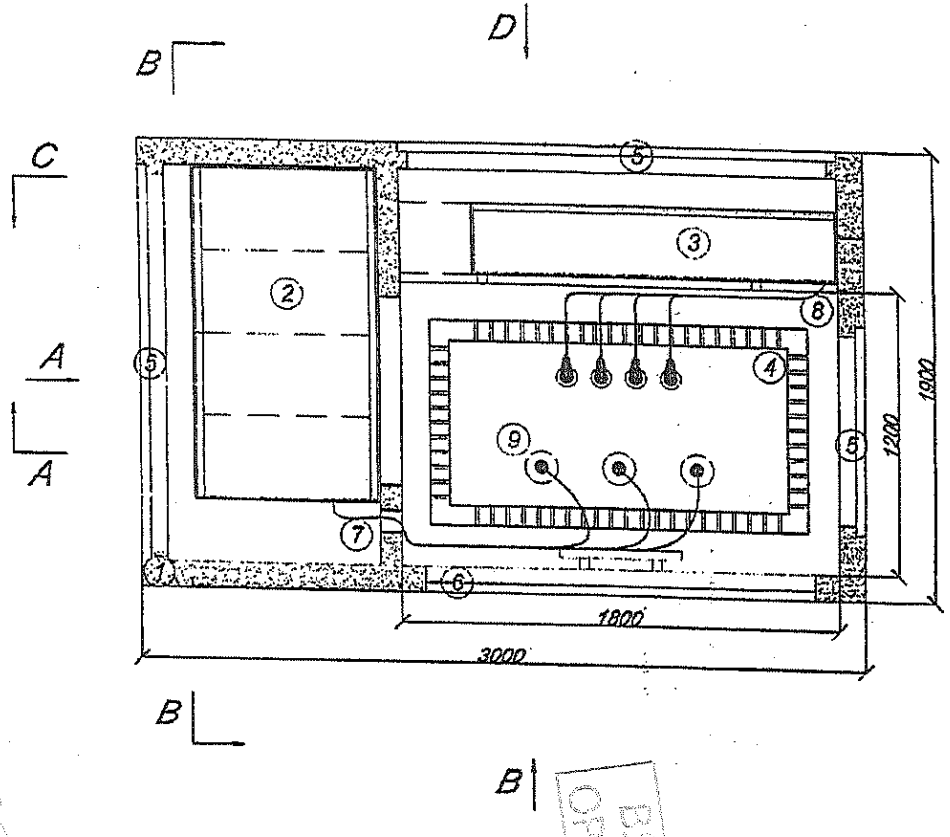
Pavel Enjuts	Complete transformer substation made of reinforced concrete 20/0.4kV 600 kVA	BM01A-31
	Part: architectural	SHEET 2/2



Pavel Sorts	Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA	BM01A31
		SHEET 1/1
	CIRQUIT DIAGRAM	"Павел и синове" ООД

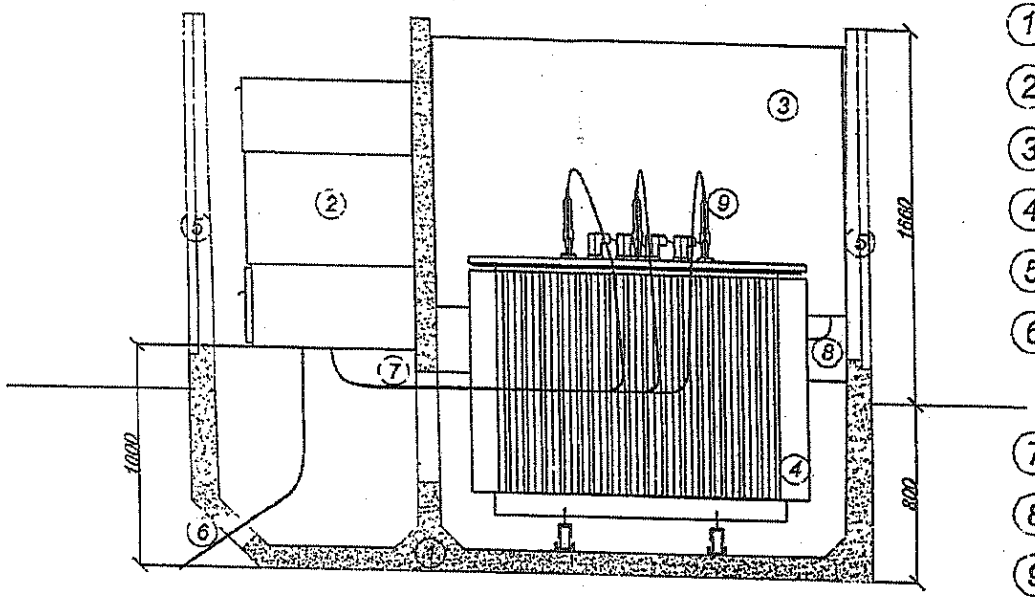

190
300
LV switchboard
Transformer
MV switchboard
BM01A-31E
SHEET 1/5
Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA
Part: electrical


1 Corpus made of reinforced concrete B45
2 Aluminium door
3 Ventilation grille
4 Holes for loading and unloading
5 Bayonet cable bushings snap-in system
6 Hole for LV outgoing lines and ground connection.
7 Hole for emergency supply
roof made of reinforced concrete hydro-insulated with polyuretane compound
ground level
ФАСАДА В
ФАСАДА А
ФАСАДА D
ФАСАДА С
Compiete transformer substation made of reinforced concrete 20/0.4kV 600 kVA
BM01A-31E
Part: electrical
SHEET 2/5



1. Corpus made of reinforced concrete B45
2. MV switchboard with SF6 Siemens 8DJ20 -
3. LV Switchboard
4. Transformer hermetic 20/0.4kV 800kVA
5. Aluminium door
6. Ventilation grille
7. Cabel 20 kV - 3x1x50mm2 NA2XS(F)2Y
8. Cabel 0.4kV - NYY 3x(4x240мм2)+2x240mn
9. Cable ends 20kV Raychem RSSS 5225

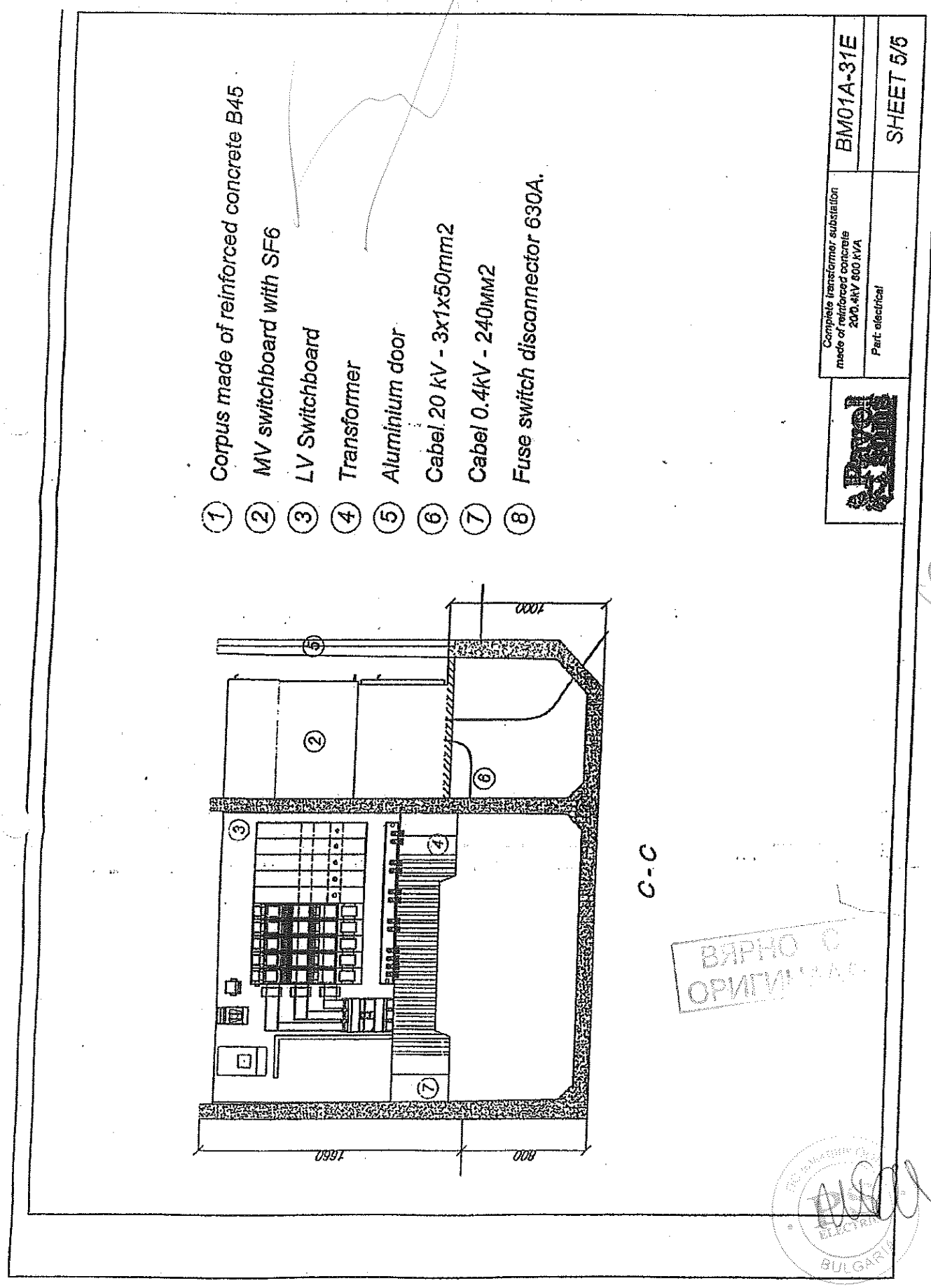
Pavel & Ing.	Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA	BM01A-31E
	Part: electrical	SHEET 3/5

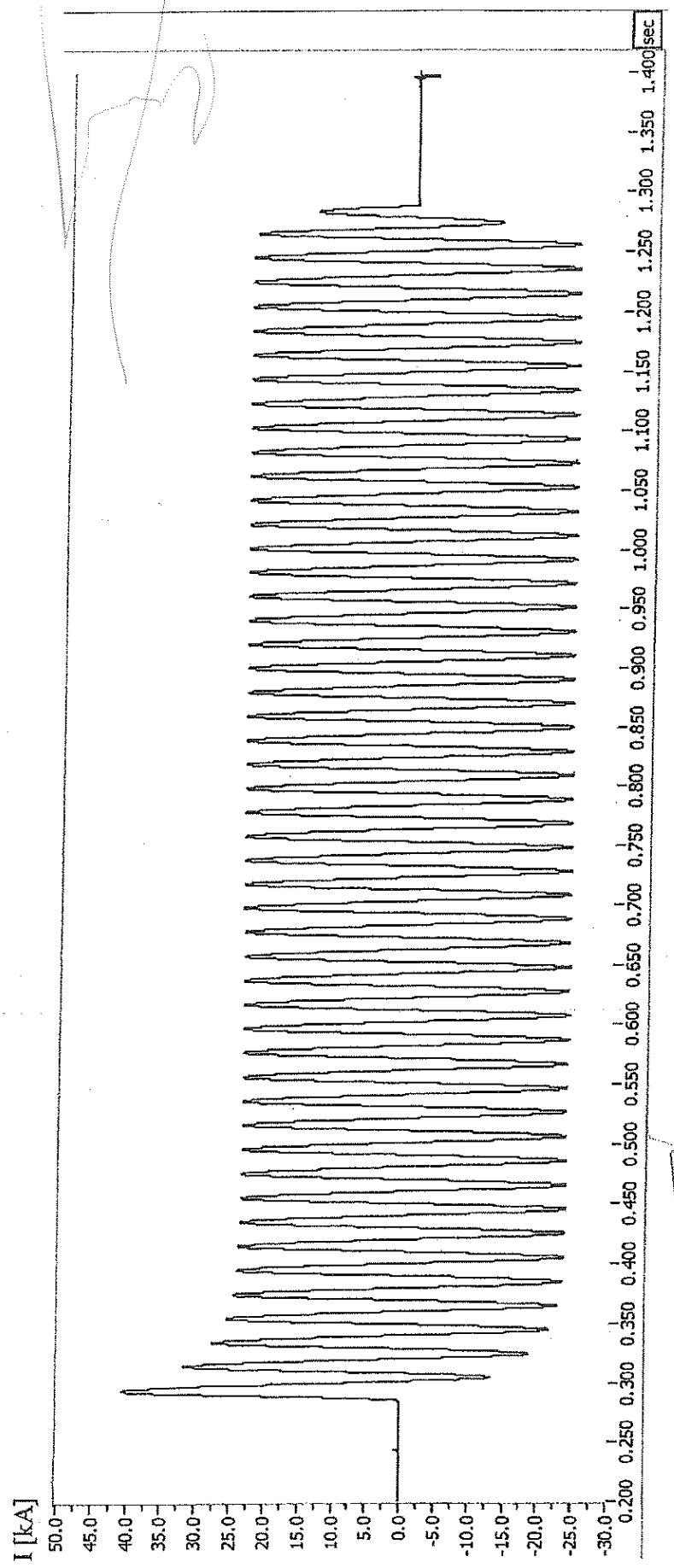


A - A

1. Corpus made of reinforced concrete B45
2. MV switchboard with SF6
3. LV Switchboard
4. Transformer
5. Aluminium door
6. Bayonet cable bushings snap-in system
7. Cabel 20 kV - 3x1x50mm2
8. Cabel 0.4kV - 240мм2
9. Cable ends

Complete transformer substation made of reinforced concrete 20/0.4kV 800 kVA		BM01A-31E
Part: electrical		SHEET 4/5


1. Corpus made of reinforced concrete B45
2. MV switchboard with SF6
3. LV Switchboard
4. Transformer
5. Aluminium door
6. Cabel 20 kV - 3x1x50mm2
7. Cabel 0.4kV - 240мм2
8. Fuse switch disconnector 630A.
1000
1660
800
C-C
Complete transformer substation made of reinforced concrete 200,4kV 800 kVA
Part: electrical
BM01A-31E
SHEET 5/5



Oscillogram No. 68773 / 2007

ВЯРНО С ОРИГИНАЛА

BULGARIA

RESEARCH, DEVELOPMENT AND TESTING NATIONAL INSTITUTE FOR ELECTRICAL ENGINEERING

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HIGH VOLTAGE DIVISION – HVD

ELECTROMAGNETIC COMPATIBILITY LABORATORY – EMC Laboratory

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TEST REPORT

No. 41037 / 29.04.2007

1.	**Customer:**	Pavel & Sons
2.	**Customer's address:**	Central office: 9700, Shumen - BULGARIA
3.	**Manufacturer:**	Pavel & Sons
4.	**Manufacturer's address:**	Central office: 9700, Shumen - BULGARIA
5.	**EUT:**	**Prefabricated Substation 24kV, 800kVA type BM 01 A31, Serial no. 07057**
6.	**Tests:**	- Measurement of electric field strength - Measurement of magnetic field strength
7.	**Test date:**	25.04.2007, 27.04.2007
8.	**Test result:**	RESULTS MADE KNOWN

9. **The Test Report contains 6 pages and was edited in 4 copies of which 3 copies for Customer.**

Head of Laboratory,
E На основание чл. 2 от ЗЗЛД

Test witnessed by
Eng. F На основание чл. 2 от ЗЗЛД

ead of High Voltage Division,
E На основание чл. 2 от ЗЗЛД

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Contents

1. General information about EUT

1.1 Description of the EUT:

Type of EUT: Prefabricated Substation 24 kV; 800kVA
Model: BM 01 A31
Serial number: 07057

1.2 Technical data:

Rated voltage: 24 kV
Rated current: 400 - 1250 A
Dimensions: 3000 x 1900 x 2600 mm

1.3 Operating modes used for the test:

1.3.1 During the measurement the EUT was supplied at rated voltage.

1.3.2 The measurement was performed during the temperature rise test.

2. Measuring results

2.1 Results of the electric field strength measurement

General information about the test:

Tested by:	Eng. Cătălin Vărgatu
Test date:	25.04.2007

Instruments:

Description	Manufacturer	Type	Serial
EM Field analyzer	Narda Safety Test Solution GmbH, Germany	EFA-300	P/N 2245/30 S/N S-0007
E-Field Unit (EFA-300)	Narda Safety Test Solution GmbH, Germany	BN 2245/90.31	P-0003

Environmental conditions:

Parameter	*Rated value*	Measured value
Ambient temperature:	15 °C ÷ 35 °C	(14.6 ± 0.1) °C
Atmospheric pressure:	860 ÷ 1060 mbar	1006.1 mbar
Relative Humidity:	30 % ÷ 60 %	45 %

Test plan:

Test set-up:	The equipment was placed in the HV Hall with all doors closed, see figure 2 of this test report, page 5.
Operating modes:	According 1.3.1
Distance between EUT and EMR 20:	1 m

Test procedure:

It was measured the electric field strength using the EFA 300 EM field analyzer and E-Field unit.
The measurement was performed on each side of the EUT.
The maximum value obtained was 15.1 V/m.

Result: The maximum value of electric field strength measured was 15.1 V/m

The measurement uncertainty is ± 1.5 V/m. The reported uncertainty is an expanded uncertainty, based on a standard uncertainty multiplied by a coverage factor k = 2, providing a confidence level of approximately 95 %.

2.2 Results of the magnetic field strength measurement

General information about the test:

Tested by:	Eng. Cătălin Vărgatu
Test date:	27.04.2007

Instruments:

Description	Manufacturer	Type	Serial
EM Field analyzer	Narda Safety Test Solution GmbH, Germany	EFA-300	P/N 2245/30 S/N S-0007

Environmental conditions:

Parameter	Rated value	Measured value
Ambient temperature:	15 °C ÷ 35 °C	20 °C
Atmospheric pressure:	860 ÷ 1060 mbar	1009 mbar
Relative Humidity:	30 % ÷ 60 %	43 %

Test plan:

Test set-up:	Temperature rise test, see figure 3 of this test report, page 6.
Operating modes:	According 1.3.2
Points of measurement:	See the following scheme.
Heights of points:	1,2,3,5,6,8: 1500 mm 4,7: 1800 mm

Test procedure:

It was measured the magnetic field strength using the EFA-1 meter.

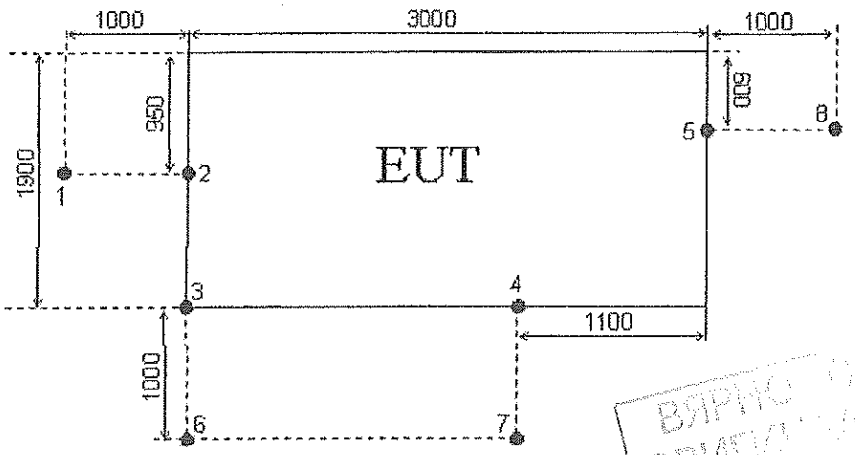

Fig. 1 Points of measurement

The results of the measurement are shown in the following table:

Point	Level [μT]	Point	Level [μT]	Point	Level [μT]	Point	Level [μT]
1	13,92	3	21,45	5	91,23	7	13,67
2	25,87	4	76,54	6	11,25	8	22,63

Result: The maximum value of magnetic field strength measured was 91.23 μT and it was obtained in the point number 5 shown on the above scheme.

The measurement uncertainty is ± 0.01 μT. The reported uncertainty is an expanded uncertainty, based on a standard uncertainty multiplied by a coverage factor k = 2, providing a confidence level of approximately 95 %.

3. Appendix

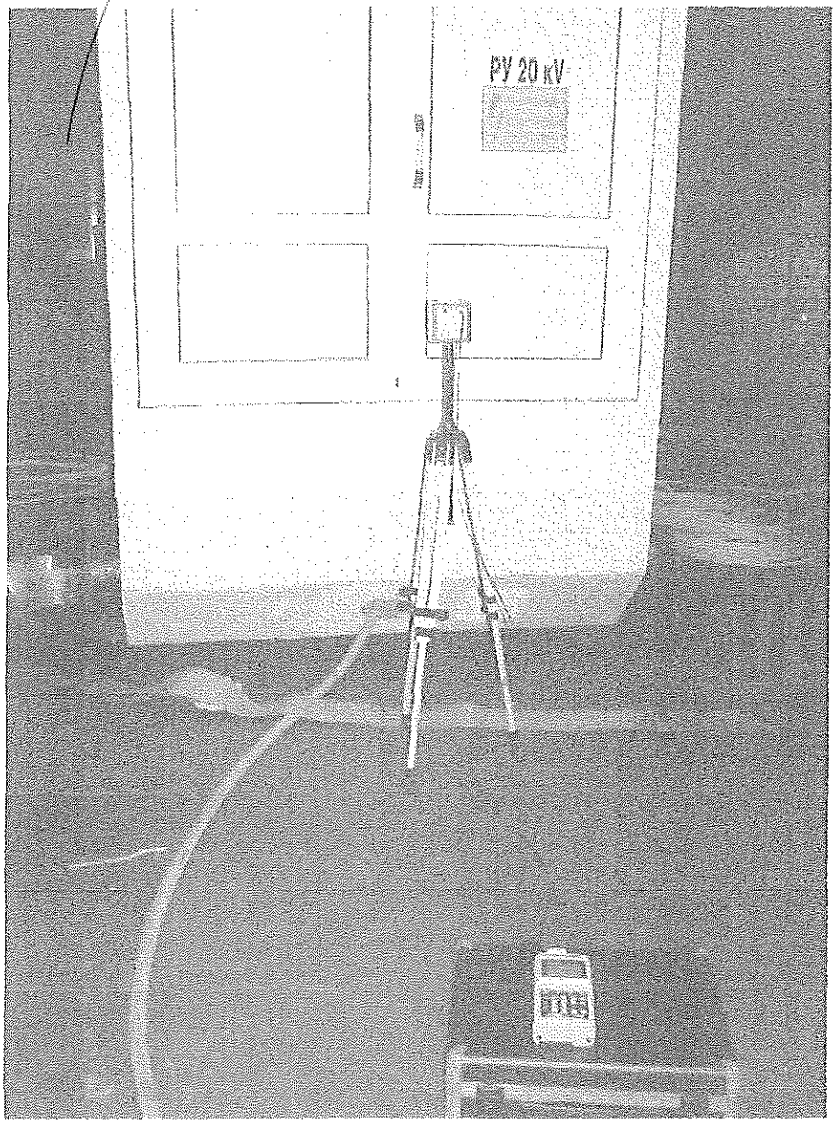

Fig. 2 Test set-up for electric field strength measurement

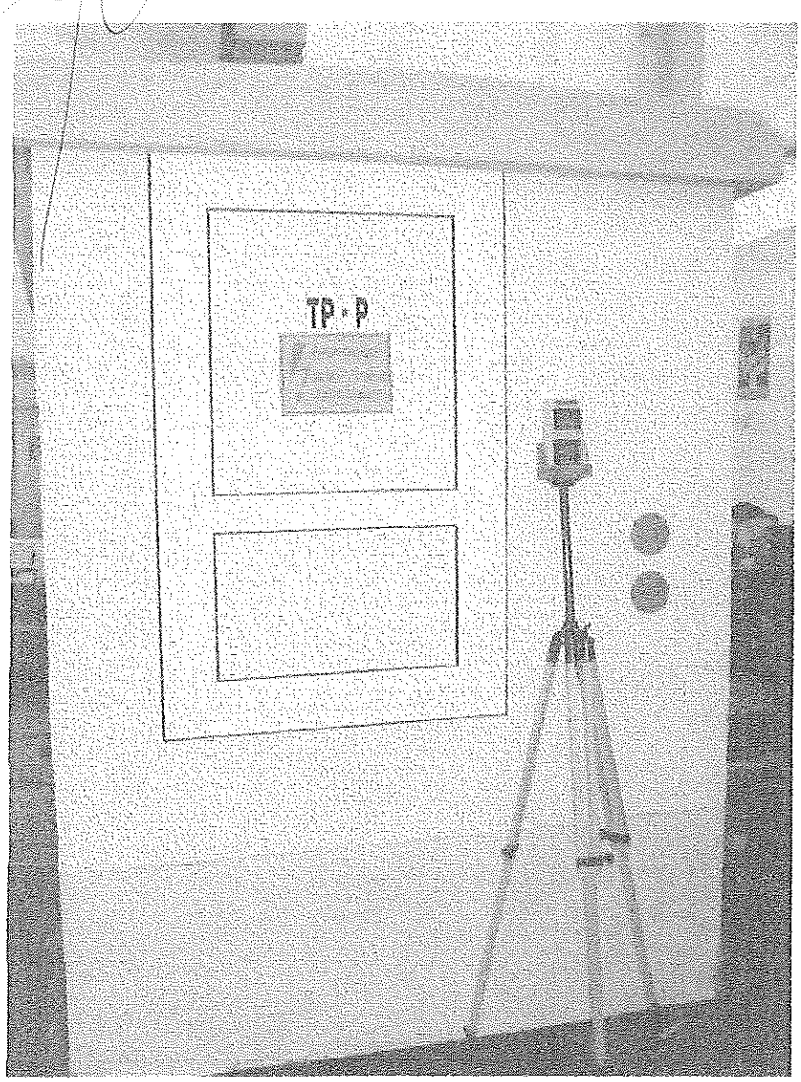

Fig. 3 Test set-up for measurement magnetic field strength

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nr. LI 004/2010

TEST REPORT
No. 11202

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, 1250 kVA Prefabricated Transformer Substation

REFERENCE STANDARD: IEC 62271-202/2003, Annex A

TEST PERFORMED: Internal arc test

TEST DATE: 29.07.2011

TEST RESULT: Passed the test

Test Report has 17 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:
Dr. Eng. (

На основание чл. 2 от ЗЗЛД

HEAD OF LABORATORY:
Eng. (

На основание чл. 2 от ЗЗЛД

DATE OF ISSUE: 05.08.2011

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Content

1. IDENTIFICATION OF THE TESTED PRODUCT

	Substation	MV Switchgear (RMU Siemens)
Type	CCTS 20/0.4 kV/1x1250 kVA	8DJH RRT
Serial number/year	11319/2011	CV 815242-000040/002/2011 for IAC-A CV 815242-000040/001/2011 for IAC-B
Technical specification	See pages 9 and 10	
Drawing	See pages 11 to 14	
Contract No.	705.2/8520/03.05.2011	
Product receiving date	29.07.2011	
Product condition at receiving	New	

2. TECHNICAL CHARACTERISTICS ESTABLISHED BY PRODUCER

	Substation	MV Switchgear
Rated power	1250 kVA	-
Rated voltage	20/0.4 kV	24 kV
Rated current	36.08/1804.2 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_k)	1 s	1 s
IAC Classification	AB	AFL
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 Switchgears Assembly (RMU Siemens) containing:
- cell 1 – Incoming/Outgoing switchgear serial no. CV 815242-000040/002/2011 for IAC-A
  – Incoming/Outgoing switchgear serial no. CV 815242-000040/001/2011 for IAC-B
- cell 2 – Incoming/Outgoing switchgear
- cell 3 – Transformer protection

3.1 Current calibration test

3.2 Internal arc test for IAC – A with arc initiation point made by customer inside of tank of cell no. 1, on LBS terminals, and three phase applied voltage on the input terminals of cell no. 2 with 3x1x185 mm^2 copper cables.

3.3 Current calibration test

3.4 Internal arc test for IAC – B with arc initiation point made by customer inside of tank of cell no. 1 and three phase applied voltage on the input terminals of cell no. 2 with 3x1x185 mm^2 copper cables.

Test parameters were I_P= 40 kA, I_k = 16 kA, t_k =1 s.

The combined vertical and horizontal indicators (simulators) were placed:
- for IAC-A in the front of MV Switchgear at 300 mm distance with door of substation in open position and in front of chimney cover (transformer side and cubicle side) at 100 mm distance;
- for IAC-B in front of door of substation in close position, in front of chimney cover (transformer side and cubicles side) at 100 mm distance.

Test were performed according to own procedure PT 03.07.

ВЯРНО С ОРИГИНАЛА

4. RESPONSIBLE FOR TESTS: Eng. Ilie Sbora

5. PRESENT AT THE TESTS: Eng. Dimitar Dimitrov from "PAVEL and SONS electric" Ltd, Bulgaria

6. TEST REPORT DOCUMENTATION Oscillograms 3; Tables 3; Photos 7; Drawings 4.

7. DATA OF TESTING AND MEASURING CIRCUIT

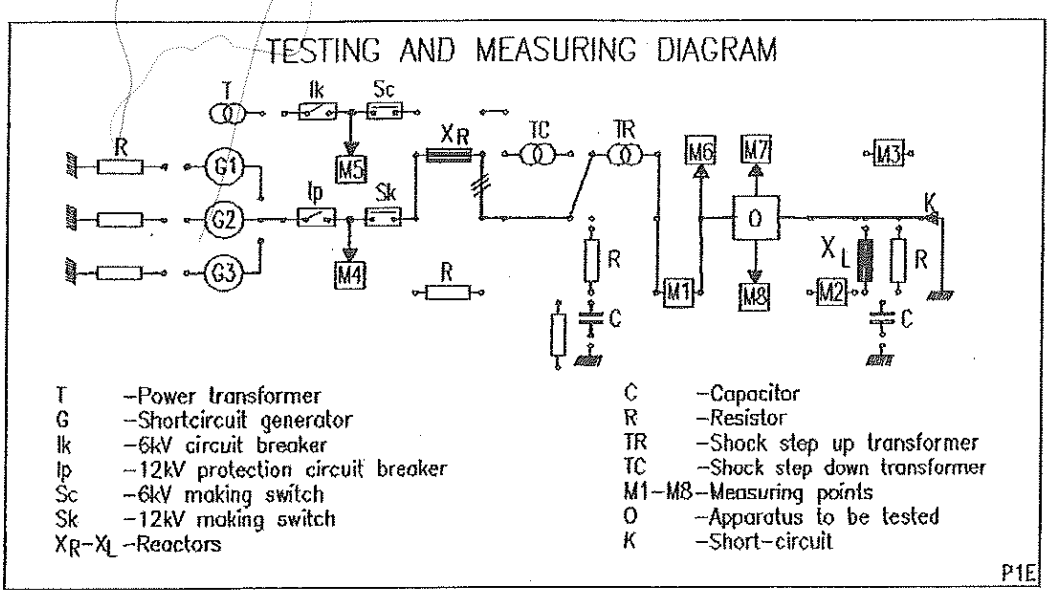


Table 1

Number of phases		3
Power supply / Connection		G2 /Δ
Transformer / Ratio		TR 4, 5, 6 / 1.07
Earthing	Power supply	-
	Apparatus	Net earthing connection
Reactor [Ω]		0.6
Power factor		<0.133
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/ 60V		
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.	U_{RS} U_{ST} U_{TR} [kV]	I_{pR} I_{pS} I_{pT} [kA]	I_{tR} I_{tR} I_{tT} [kA]	t_t [sec.]	$I_{t\,med}$ [kA]	DURS DUST DUTR [V]	Remarks
80950/2011	6.2 6.2 6.2	40.5 - -	16.1 16.3 16.2	0.2	16.2	- - -	Current calibration
80951/2011	6.6 6.6 6.6	40 - -	16.2 16.2 16.3	1	16.23	538 554 497	Test for IAC-A
80952/2011	6.6 6.6 6.6	41 - -	16.4 16.6 16.4	1	16.43	408 566 517	Test for IAC-B

The measurements were performed with expanded uncertainty of: 1% for voltages; 1.5% for currents; 0.1% 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

$I_{t\,med}$ = Effective current mean value

DU_{RS}, DU_{ST}, DU_{TR} = Voltage drop on arc

U_{RS}, U_{ST}, U_{TR} = No-load applied voltage

8.2 Opinions and interpretations

1. Aspect of the MV Switchgears and simulators in the test circuit before test for IAC-A is presented in photo 1.
2. Aspect of the substation and simulators in the test circuit before test for IAC-A is presented in photo 2.
3. Aspect of the substation and simulators after test for IAC-A is presented in photo 3.
4. Aspect of the MV Switchgears and simulators after test for IAC-A is presented in photo 4.
5. Aspect of the substation and simulators in the test circuit for IAC-B before test for IAC-B is presented in photos 5 and 6.
6. Aspect of the substation and simulators after test for IAC-B is presented in photos 7 and 8.
7. Aspect of the MV Switchgears after tests is presented in photo 9.
8. At the test for IAC-A:
   - the doors of MV Switchgears did not open;
   - the indicators did not ignite;
   - parts from the substation and MV Switchgears did not fly oft;
   - the earthing connection are effective.
9. At the test for IAC-B:
   - the doors of the substation did not open;
   - the indicators did not ignite;
   - parts from the substation did not fly oft;
   - the earthing connection 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. 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 do not ignite	Fulfilled
5. All earthing connections are still effective	Fulfilled

9. TEST RESULT: PASSED THE TEST

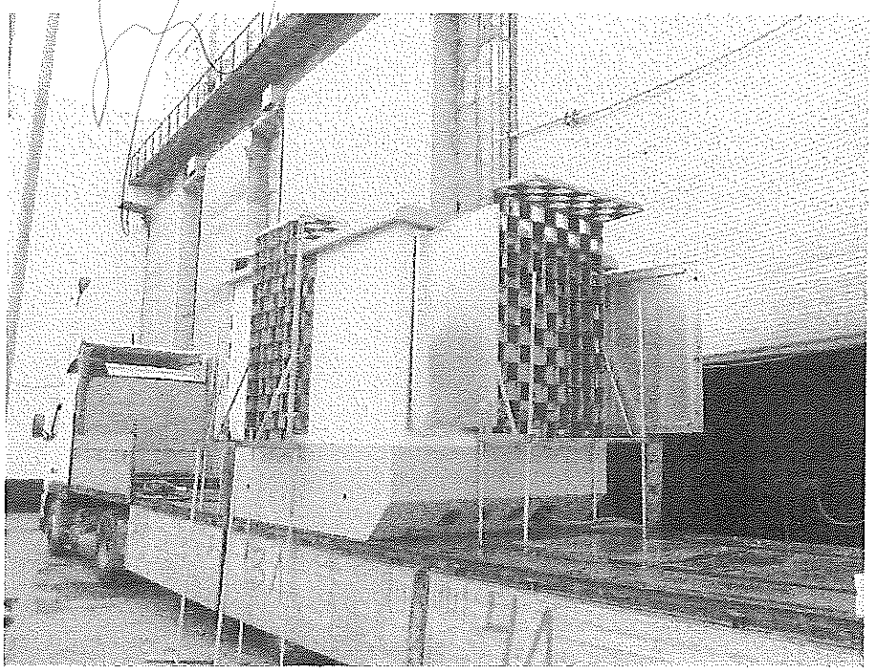


Photo 1 - Aspect of the MV Switchgears and simulators in the test circuit before test for IAC-A

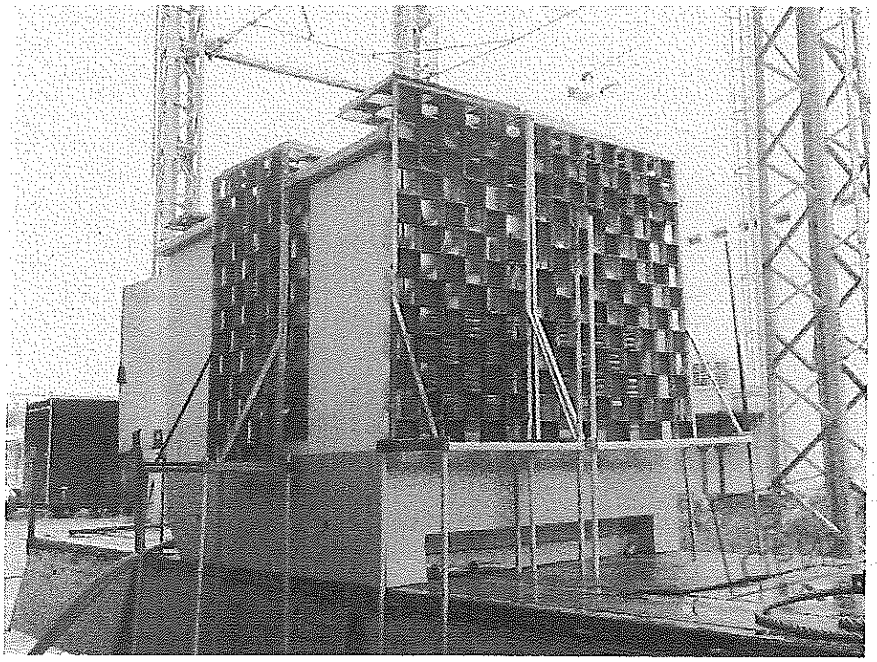


Photo 2 - Aspect of the substation and simulators in the test circuit before test for IAC-A

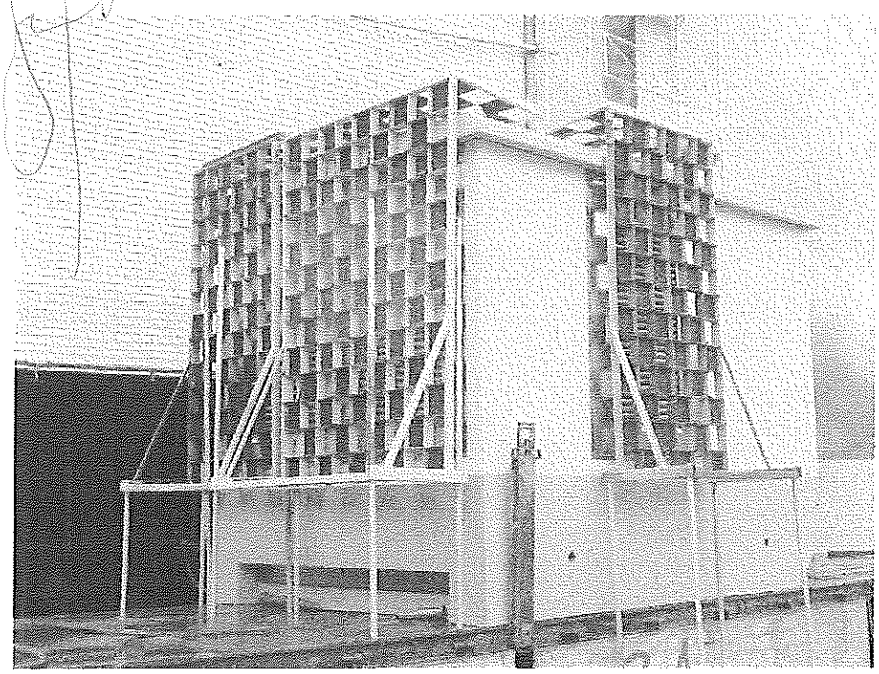


Photo 3 - Aspect of the substation and simulators after test for IAC-A

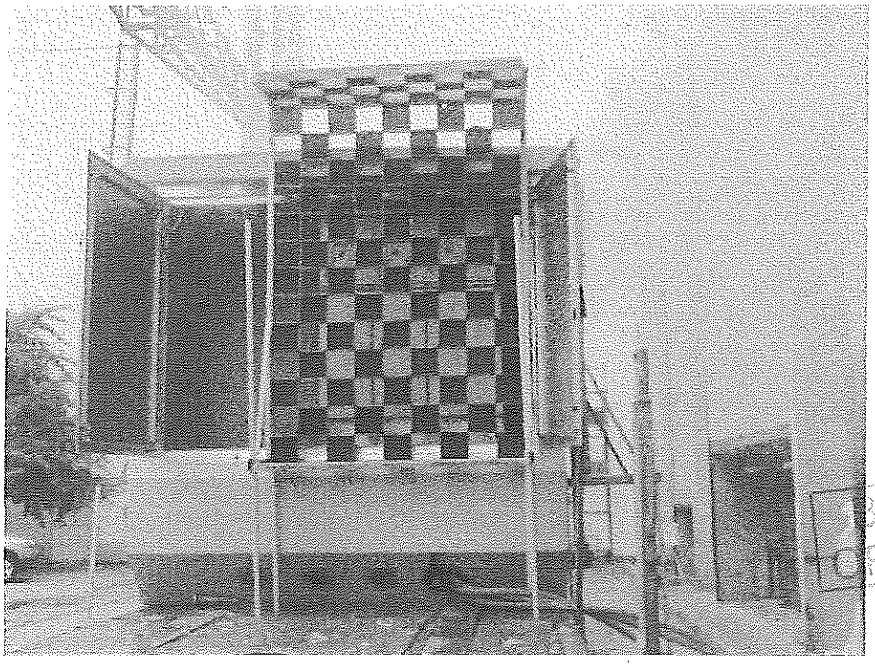
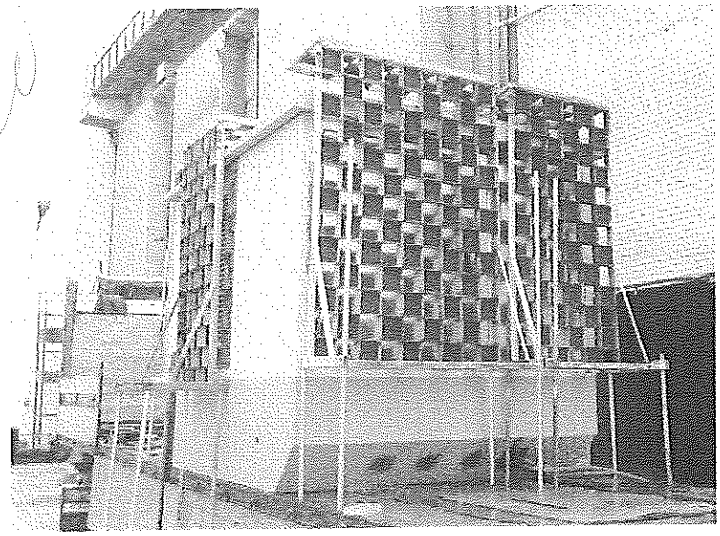
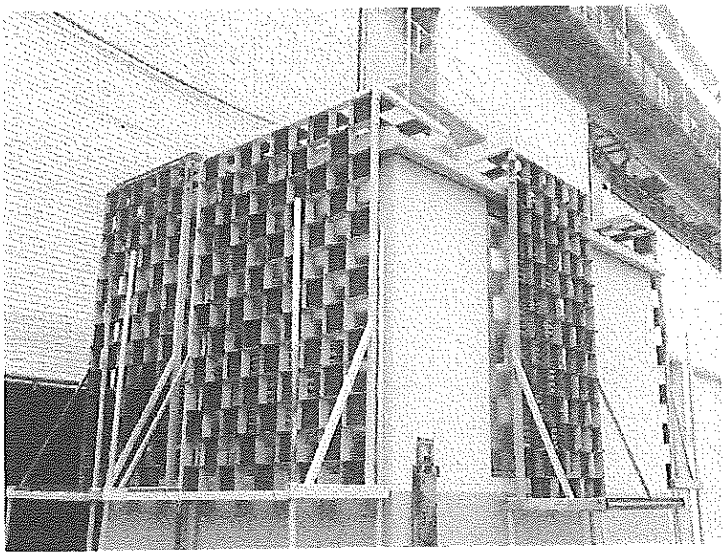


Photo 4 - Aspect of the MV Switchgears and simulators after test for IAC-A





Photos 5, 6 - Aspect of the MV Switchgears and simulators in the test circuit before test for IAC-B

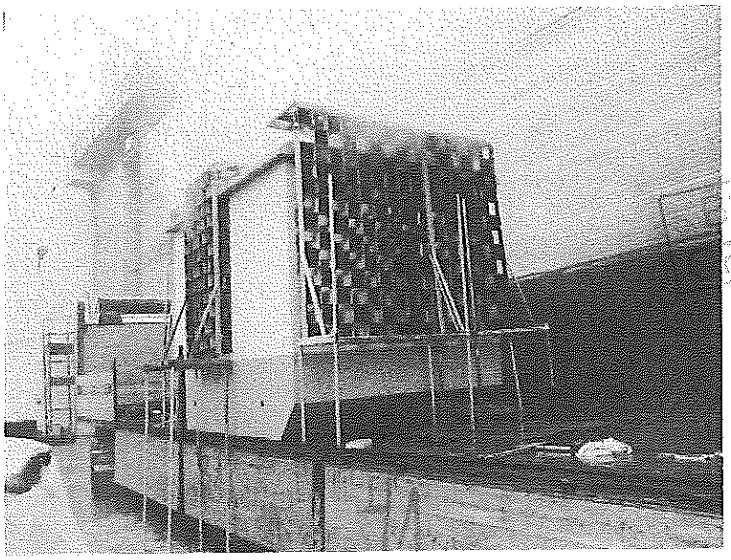


Photo 7 - Aspect of the substation and simulators in the test circuit after test for IAC-B

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 - 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 3X1X50MM2.

2.3. TRANSFORMER:
TRANSFORMER 20/0.4KV 1250 KVA
DIMENTIONS:
L=1600MM.
W=920MM.
H=1520MM.

2.4.CONNECTING CABLE FROM TRANSFORMERS TO LV SWITCHBOARD – NYY 3X(6X240MM2)+3X240MM2.

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

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

2.7. COPPER BARS' SYSTEM:
DISTRIBUTING RIMS – COPPER BARS 2X80X10MM.
CONNECTION BETWEEN MAIN CIRCUIT – BREAKER AND DISTRIBUTING RIMS – COPPER BARS 2X80X10MM.
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

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Sofia office address: 1000 Sofia Bldv 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

На основание чл. 2
от ЗЗЛД

DATE:19.07.2011
SHUMEN

PREPARED: ENG.
CHECKED: ENG.

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

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