TIPSKI ISPITNI LIST
TYPE TEST REPORT

Br/No. 013048

Sadržaj / Contents: 42 stranica / pages

Predmet ispitivanja / Test object: **KOMBINIRANI TRANSFORMATOR VAU-123 / COMBINED TRANSFORMER VAU-123**

Proizvođač / Manufacturer: KONČAR - MJERNI TRANSFORMATORI d.d.

Ispitivanje je provedeno / The tests were performed at: KONČAR - LABORATORIES

Ispitivanja su provedena u skladu s / The tests were performed in accordance with: Publications IEC 61869-4 and IEC 61869-1

Ispitivanja obuhvaćaju - Tests performed:

Usklađenost sa mjernom skicom - Dimensional check	013017
Zagrijavanje - Temperature rise test	013029
Udarni napon - Impulse and chopped impulse voltage test	009713
Ispitivanje na kiši - Power-frequency withstand wet test	010113
Ispitivanje otpornosti na kratki spoj - Short-circuit Withstand Capability Test	010513
Ispitivanje kratkotrajnim strujama - Short-time current tests	35/6422
Mjerenje radio smetnji - Radio interference voltage measurement	013045
Određivanje međuutjecaja - Determination of mutual influence	013047
Mehaničko ispitivanje - Mechanical test	013046
Određivanje pogrešaka - Determination of errors	*(Included in test report 010513)*

Rezultat ispitivanja : Kombinirani transformator tipa **VAU-123** izdržao je sva ispitivanja u skladu sa Publikacijama IEC 61869-4 i IEC 61869-1.

Test result: Combined transformer type **VAU-123** withstood the tests carried out in accordance with Publications IEC 61869-4 and IEC 61869-1.

Zagreb, 08. 03. 2013.

KONČAR
INSTRUMENT TRANSFORMERS Inc.

KONČAR Končar - Instrument transformers, Inc.	USKLAĐENOST SA MJERNOM SKICOM DIMENSIONAL CHECK	Broj / No.: 013017 Strana / Page: 1/1

Kombinirani transformator tip: Combined transformer type:	Tvornički broj: Serial number:	Nazivni teret i razred točnosti: Rated burden and accuracy class:
VAU- 123	**31100116** **M112492** *Porcelain Insulator*	**1S1-1S2: 5VA, 0,2 FS 5** **2S1-2S2: 10VA, 0,5 FS 5** **3S1-3S2: 20VA, 5 P 20** **4S1-4S2: 20VA, 5 P 20**
Nazivna primarna struja: Rated primary current: **400 A**	Nazivna sekundarna struja: Rated secondary current: **1-1-1-1 A**	
Nazivni primarni napon: Rated primary voltage: **110000/√3 V**	Nazivni sekundarni napon: Rated secondary voltage: **100/√3-100/3 V**	Nazivni teret i razred točnosti: Rated burden and accuracy class: **a-n: 60 VA, 0,2** **da-dn: 100 VA, 3P**

1. Usklađenost sa mjernom skicom – Dimensional check (Crteži-Drawings: M113458 & M82688)

Izmjerene vrijednosti – Measured values:

a)	**Ukupna visina transformatora – Total height of the transformer**	**2590 mm**
b)	**Visina do primarnog priključka – Height to the primary terminal**	**2090 mm**
c)	**Dimenzije primarnog priključka – Dimension of the primary terminal**	**105x100x20 mm**
d)	**Rupe za učvršćenje – Holes for fixing**	**Φ 20 / □ 520 mm**
e)	**Klizna staza – Creepage distance**	**4300 mm**

Zagreb, 23.01.2013.

"KONČAR - Mjerni transformatori"
2 d.d.
ZAGREB, Josipa Mokrovića 10

Measured by: D. Ložnjak, eng.

Заличено по чл.2 от ЗЗЛД

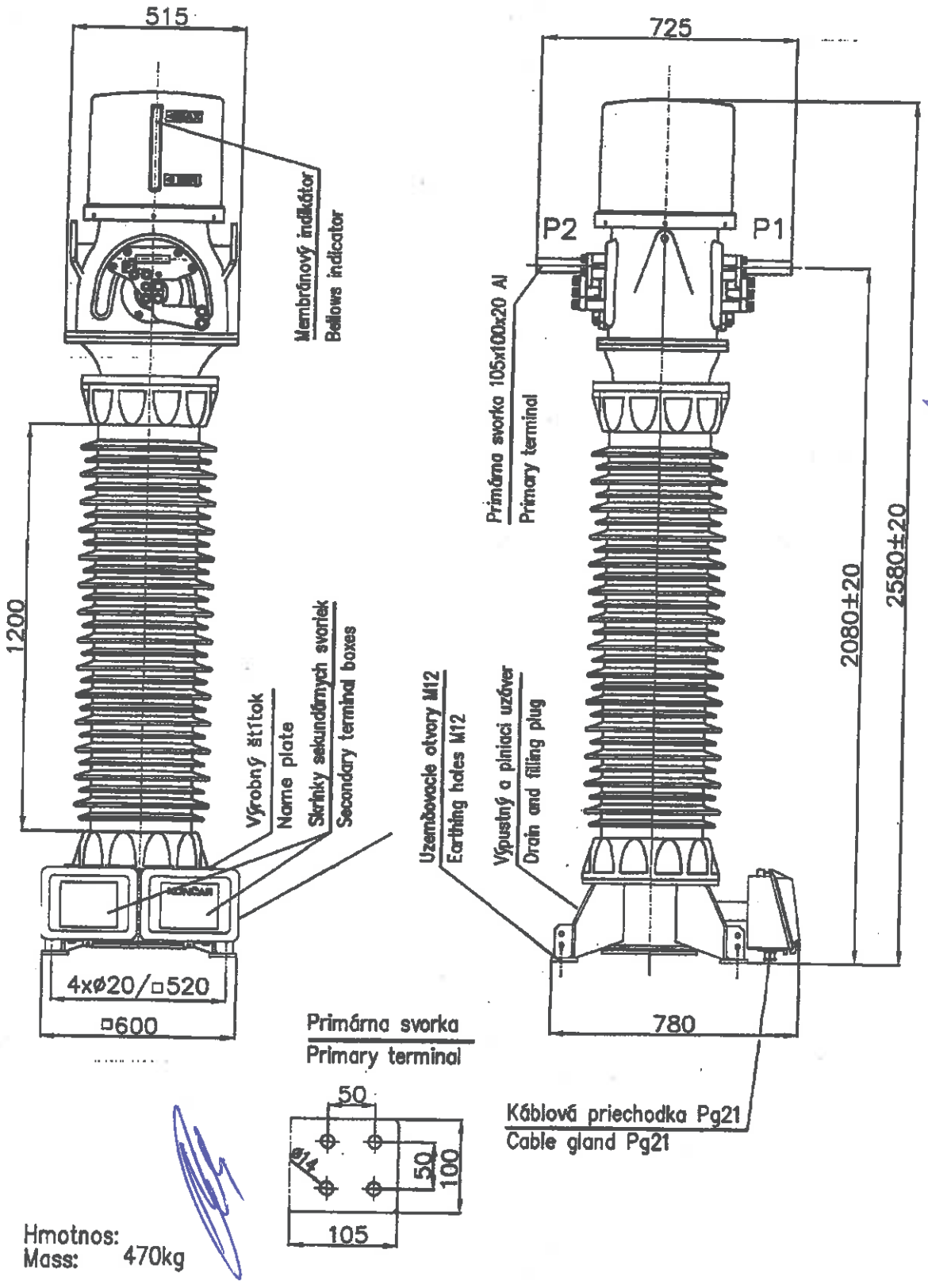
Zaključak: Transformator je proizveden u skladu sa crtežima M113458 i M82688
Conclusion: Transformer is produced according to the drawings M113458 i M82688

KONČAR – Instrument transformers Inc.

KONČAR
Končar - Instrument transformers, Inc.

KOMBINOVANÝ PRÍSTROJOVÝ TRANSFORMÁTOR
COMBINED INSTRUMENT TRANSFORMER VAU–123

M113458

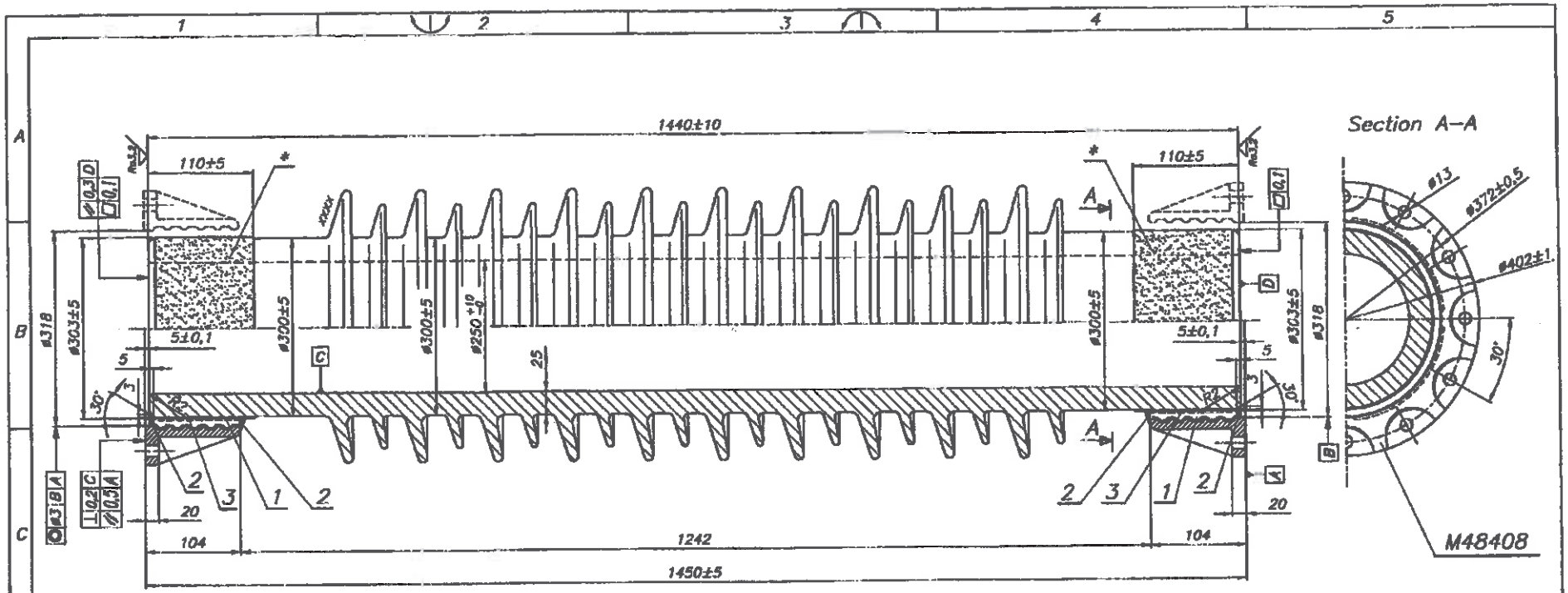


Hmotnos:
Mass: 470kg

Datum:	Konstruirao:	Odobrio:
07.2012.		

Заличено по чл.2 от ЗЗЛД

INSTRUMENT TRANSFORMERS Inc.



Note : – Material insulator : – Ceramical insulated material C 130 IEC 60672–3
– * Sanded (gritted) surface
– Material flanges : AlSi10Mg44
– 1. Cementing : Portland cement
– 2. Filled with silicone mastic 5 mm thicknes . Surface of the mastic must not jut above the face surface of the insulated .
– 3. Coat of bitumen .
– xxxx Producer's sign , year of production and identity code number of insulator .
– Dimensional tolerances to IEC–62155 .
– Tests acc. to IEC–62155 .

Creepage distance	Total	Protected 90°	Glaze colour
Nominal creepage distance	≥3815	≥1580	Brown
Measured IEC 60815 kp=1,1	≥4197	≥1738	

(Project) –
(Tolerance) DIN 7168 m
(Machining)
(Scale)
(Mass) 120,0
(Material-No.) –
nsulator with flanges
ø250
SI–123
KONČAR
– M82688
Sheet No. 1 of sheets 1
Replacement for: –
Replaced with: –

Заличено по чл.2 от ЗЗЛД

08–223/1E

KONČAR Končar - Instrument transformers, Inc.	**Ispitivanje zagrijavanja** **Temperature rise test**	No. **013029** Stranica - Page **1/3**

Kombinirani transformator Combined transformer Tip - Type **VAU – 123**	Tv. br. Serial No. **31100116 (M112492)** *Porcelain insulator*	Nazivni teret i klasa točnosti : Rated burden and accuracy class : **a-n 60 VA, cl. 0,2** **da-dn 100 VA, cl. 3P**
Nazivni primarni napon Rated primary voltage **110000 / √3 V** Nazivna primarna struja Rated primary current **400 A**	Nazivni sekundarni napon Rated secondary voltage **100 / √3, 100 / 3 V** Nazivna sekundarna struja Rated secondary current **1 / 1 / 1 / 1 A**	**1S1-1S2, 5 VA, cl. 0,2 FS 5** **2S1-2S2, 10 VA, cl. 0,5 FS 5** **3S1-3S2, 20 VA, cl. 5 P 20** **4S1-4S2, 20 VA, cl. 5 P 20**

Prisutni / The test was carried out in presence of:

1. Ispitivanje je provedeno s: **120% nazivnog napona i 120% nazivne struje**
The test was carried out with: **120% of rated voltage and 120% of rated current**

Mjerni i zaštitni namoti bili su opterećeni s teretom:
The measuring and the protecting windings were loaded by:

Omski otpor izmjeren je U-I metodom, u skladu s propisima: IEC 61869-4, IEC 61869-1
Winding resistance was measured by U-I method, in accordance with: IEC 61869-2 & IEC 61869-3

Prijenosni odnos strujnog transformatora kod ispitivanja: **400/1 A**
Actual transformation ratio of the current part: **400/1 A**

1.1 Početno stanje (Hladno) - Initial state (Cold)

Srednja temperatura okoline - Average ambient temperature	**22,0 °C**
Temperatura ulja u glavi - Oil temperature in the head	**21,0 °C**
Temperatura vanjske površine glave - Temperature at head surface	**21,0 °C**
Temperatura kućišta - The tank temperature	**21,5 °C**
Otpori namota kod T_1 (°C), tj. kod - Winding resistances at T1 (°C), i.e. at :	**22,0 °C**

A.	Naponski dio - Voltage part		
1.	V.N. - H.V.	A - N	**10250 Ω**
2.	N.N. - L.V.	a-n	**33,75 mΩ**
3.	N.N. - L.V.	da-dn	**27,85 mΩ**
B.	Strujni dio - Current part		
1.	V.N. - H.V.	P1 – P2	**(*)**
2.	N.N. - L.V.	1S1-1S2	**2,95 Ω**
3.	N.N. - L.V.	2S1-2S2	**2,35 Ω**
4.	N.N. - L.V.	4S1-4S2	**2,32 Ω**

(*) Temperature rise of primary winding (current part) was measured by means of thermocouple
Porast temperature primarnog namota strujnog dijela, mjeren je termoparom.

1.2 Stanje nakon stagnacije - Steady state temperature

Srednja temperatura okoline - Average ambient temperature	22,0 °C
Temperatura ulja u glavi - Oil temperature in the head	49,5 °C
Temperatura vanjske površine glave - Temparature at head surface	45,0 °C
Temperatura kućišta - The tank temperature	33,5 °C

Omski otpori namota R_2, ekstrapolirani, u momentu prestanka zagrijavanja, bili su:
Winding resistances R_2, extrapolated, on the moment of the loading end, were:

A.	Naponski dio - Voltage part		
1.	V.N. - H.V.	A - N	11546,2 Ω
2.	N.N. - L.V.	a-n	37,49 mΩ
3.	N.N. - L.V.	da-dn	30,99 mΩ
B.	Strujni dio - Current part		
1.	V.N. - H.V.	P1 – P2	(*)
2.	N.N. - L.V.	1S1-1S2	3,375 Ω
3.	N.N. - L.V.	2S1-2S2	2,684 Ω
4.	N.N. - L.V.	4S1-4S2	2,645 Ω

1.3 Zagrijavanja - Temperature rises of:

Namota – Windings

A.	Naponski dio - Voltage part		
1.	V.N. - H.V.	A - N	32,5 K
2.	N.N. - L.V.	a-n	28,5 K
3.	N.N. - L.V.	da-dn	29,0 K
B.	Strujni dio - Current part		
1.	V.N. - H.V.	P1 – P2	43,5 K
2.	N.N. - L.V.	1S1-1S2	37,0 K
3.	N.N. - L.V.	2S1-2S2	36,5 K
4.	N.N. - L.V.	4S1-4S2	36,0 K

Ulja u glavi - Oil in the head	27,5 K
Glave - The head	23,0 K
Kućište – The tank	11,5 K

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2. Ispitivanje kod: 1.5 Un / 30 sek.
Testing at : 1.5 Un / 30 sec.

Nakon stagnacije temperature kod 120% nazivnog napona, narinut je napon od 150% nazivnog napona u trajanju od 30 sek.
After attaining steady temperature at 120% rated voltage, a value of 150% of rated voltage was applied during 30 sec.

U tim uvjetima 1.5xUn / 30 sec. transformator je bio opterećen: nazivnim teretom
At this condition 1.5xUn / 30 sec. transformer was loaded: rated burden

2.1 Zagrijavanja - Temperature rises of:

Namota – Windings

A.	Naponski dio - Voltage part		
1.	V.N. - H.V.	A - N	**33,0 K**
2.	N.N. - L.V.	a-n	**29,0 K**
3.	N.N. - L.V.	da-dn	**29,5 K**
B.	Strujni dio - Current part		
1.	V.N. - H.V.	P1 – P2	**43,7 K**
2.	N.N. - L.V.	1S1-1S2	**37,0 K**
3.	N.N. – L.V.	2S1-2S2	**37,0 K**
4.	N.N. – L.V.	4S1-4S2	**36,5 K**

Ulja u glavi - Oil in the head	**27,5 K**
Glave - The head	**23,0 K**
Kućište – The tank	**11,5 K**

Zaključak : Rezultati ispitivanja zagrijavanja ispitanog transformatora su u ugovorenim granicama.
Conclusion: The results of temperature rise test show that the tested transformer is into contracted limits.

Zagreb , 05. 02. 2013.

Ispitao/Tested by: Marko Čukman, B.Sc.(Eng)

Pregledao/Checked by : Mladen Kranjčec, B.Sc.(Eng)

"KONČAR - Mjerni transformatori" d.d.
Z A G R E B, Josipa Mokrovića 10

Заличено по чл.2 от ЗЗЛД

TEST REPORT

17025 · HAA
1035/08

High Voltage Laboratory is competent according to HRN EN ISO/IEC 17025:2007 to carry out high voltage testing of electroenergetical equipment and calibration of electrical field strength meters of frequency 50 Hz – Accreditation certificate No.1035/08 – HAA, CROATIA

Tests performed:..... **Lightning impulse voltage withstand test**
Chopped impulse test

Test object: ..... **Combined transformer**

Type:..... **VAU – 123**

Part number: **M112492**

Serial No.: **31100116**

Manufacturer:..... **KONČAR – Instrument transformers**
J. Mokrovića 10, Zagreb
CROATIA

Client:..... **KONČAR – Instrument transformers**
J. Mokrovića 10, Zagreb
CROATIA

Place of the test: ..... **KONČAR – Electrical Engineering Institute**
High Voltage Laboratory
Fallerovo šetalište 22, Zagreb
CROATIA

Normative documents: ..... **HRN EN 61869-1:2010 (IEC 61869-1:2007)**
HRN EN 60044-3:2006 (IEC 60044-3:2002)

Date of test: ..... **2013 – 02 – 12**

Results:..... **PASSED**

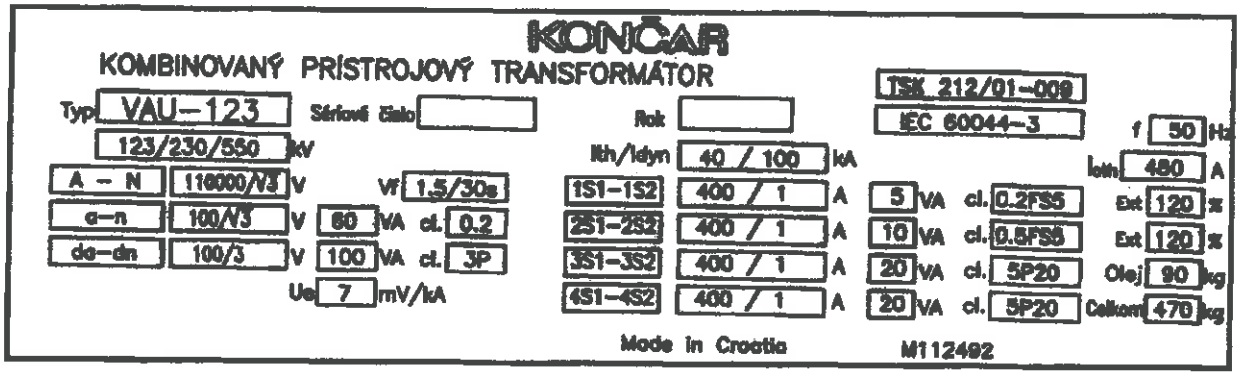
Заличено по чл.2 от ЗЗЛД

Danijel Brezak, B.Sc.E.E. Dalibor Filipović-Grčić, Ph.D.

KONČAR - Institut za elektrotehniku d. d.
ZAGREB 7

Zagreb, 2013 – 03 – 01

1. Transformer markings



2. Lightning impulse voltage withstand test

Full wave		Chopped wave	
kV (peak)	Wave shape	kV (peak)	Time to chopping
550	T_1 = 1,2 µs (± 30 %) T_2 = 50 µs (± 20 %)	632,5	T_c=2 µs to 5 µs

2.1. Measuring equipment

Voltage divider, Končar, SN: WO 553124.
Digital system for impulse voltage measurement and registration HIAS 742, Haefely, SN: 083 833-01.
The measuring equipment was checked in accordance with IEC 60060-2:2010.

2.2. Identification of specimen

Identification of the test object according to drawing M113458 submitted by manufacturer.

2.3. Tested in presence of:

-

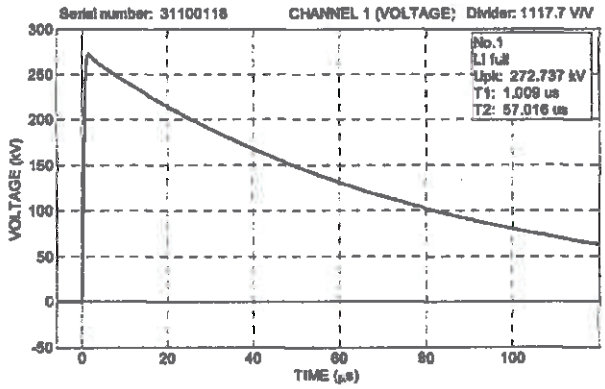
2.4. Connection of terminals

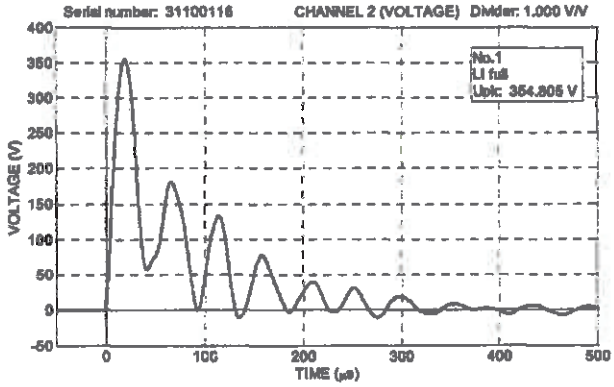
A .....applied voltage
a .....earthed through shunt S1
da .....insulated
all remaining terminals.....earthed

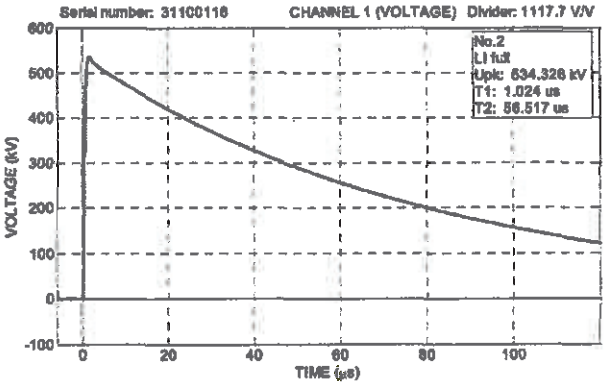
2.5. Test results

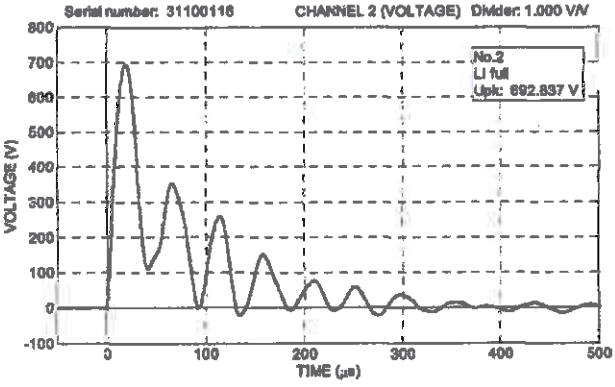
Voltage kV (peak)	Item	Oscillogr. No.	Remark
+272,7	applied voltage voltage S1	01 - Ch1 01 - Ch2	R.W.
+534,3	applied voltage voltage S1	02 - Ch1 02 - Ch2	F.W.
+545,5	applied voltage voltage S1	03 - Ch1 03 - Ch2	F.W.
+545,6	applied voltage voltage S1	04 - Ch1 04 - Ch2	F.W.
+549,0	applied voltage voltage S1	05 - Ch1 05 - Ch2	F.W.
+548,8	applied voltage voltage S1	06 - Ch1 06 - Ch2	F.W.
+548,2	applied voltage voltage S1	07 - Ch1 07 - Ch2	F.W.
+548,1	applied voltage voltage S1	08 - Ch1 08 - Ch2	F.W.
+547,9	applied voltage voltage S1	09 - Ch1 09 - Ch2	F.W.
+548,1	applied voltage voltage S1	10 - Ch1 10 - Ch2	F.W.
+548,1	applied voltage voltage S1	11 - Ch1 11 - Ch2	F.W.
+549,1	applied voltage voltage S1	12 - Ch1 12 - Ch2	F.W.
+548,4	applied voltage voltage S1	13 - Ch1 13 - Ch2	F.W.
+547,9	applied voltage voltage S1	14 - Ch1 14 - Ch2	F.W.
+547,2	applied voltage voltage S1	15 - Ch1 15 - Ch2	F.W.
+547,8	applied voltage voltage S1	16 - Ch1 16 - Ch2	F.W.

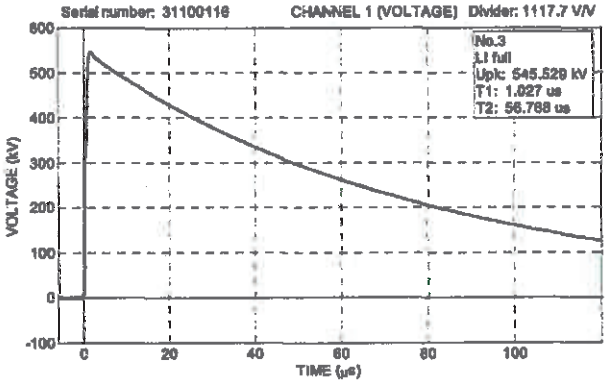
Voltage kV (peak)	Item	Oscillogr. No.	Remark
-272,4	applied voltage voltage S1	17 - Ch1 17 - Ch2	R.W.
-540,7	applied voltage voltage S1	18 - Ch1 18 - Ch2	F.W.
-628,1	applied voltage voltage S1	19 - Ch1 19 - Ch2	C.W.
-626,5	applied voltage voltage S1	20 - Ch1 20 - Ch2	C.W.
-539,8	applied voltage voltage S1	21 - Ch1 21 - Ch2	F.W.
-543,0	applied voltage voltage S1	22 - Ch1 22 - Ch2	F.W.
-545,4	applied voltage voltage S1	23 - Ch1 23 - Ch2	F.W.
-545,1	applied voltage voltage S1	24 - Ch1 24 - Ch2	F.W.
-545,5	applied voltage voltage S1	25 - Ch1 25 - Ch2	F.W.
-545,4	applied voltage voltage S1	26 - Ch1 26 - Ch2	F.W.
-544,9	applied voltage voltage S1	27 - Ch1 27 - Ch2	F.W.
-543,8	applied voltage voltage S1	28 - Ch1 28 - Ch2	F.W.
-544,7	applied voltage voltage S1	29 - Ch1 29 - Ch2	F.W.
-544,8	applied voltage voltage S1	30 - Ch1 30 - Ch2	F.W.
-545,5	applied voltage voltage S1	31 - Ch1 31 - Ch2	F.W.
-545,1	applied voltage voltage S1	32 - Ch1 32 - Ch2	F.W.
-544,0	applied voltage voltage S1	33 - Ch1 33 - Ch2	F.W.
-544,5	applied voltage voltage S1	34 - Ch1 34 - Ch2	F.W.

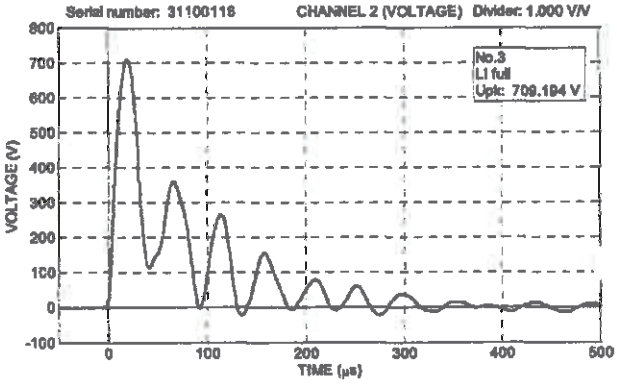

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
No.1
LI full
Upk: 272.737 kV
T1: 1.009 us
T2: 57.016 us
VOLTAGE (kV)
TIME (µs)

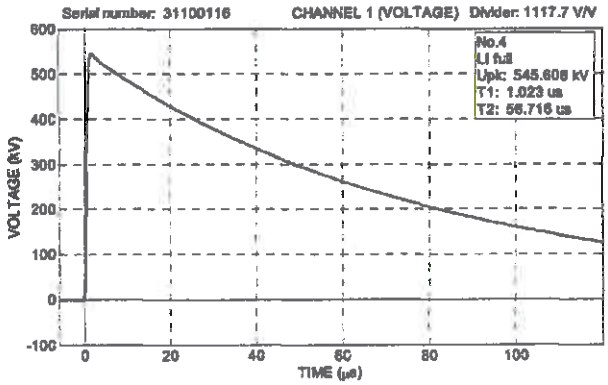

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
No.1
LI full
Upk: 354.805 V
VOLTAGE (V)
TIME (µs)

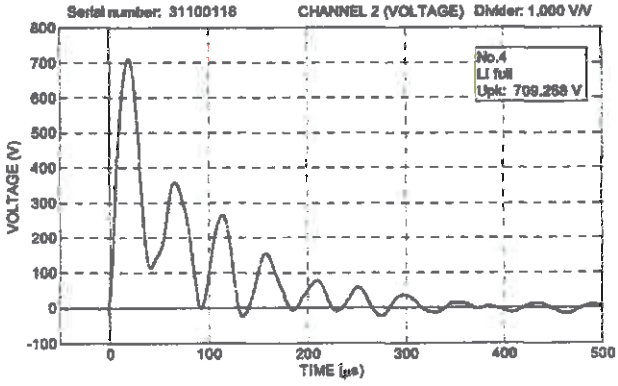

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
No.2
LI full
Upk: 634.326 kV
T1: 1.024 us
T2: 56.517 us
VOLTAGE (kV)
TIME (µs)

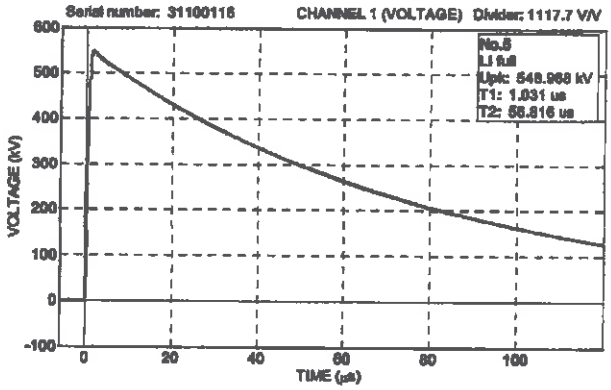

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
No.2
LI full
Upk: 692.837 V
VOLTAGE (V)
TIME (µs)

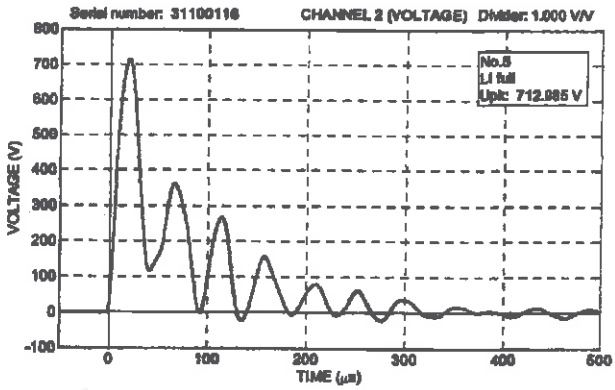

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
No.3
LI full
Upk: 645.529 kV
T1: 1.027 us
T2: 56.768 us
VOLTAGE (kV)
TIME (µs)

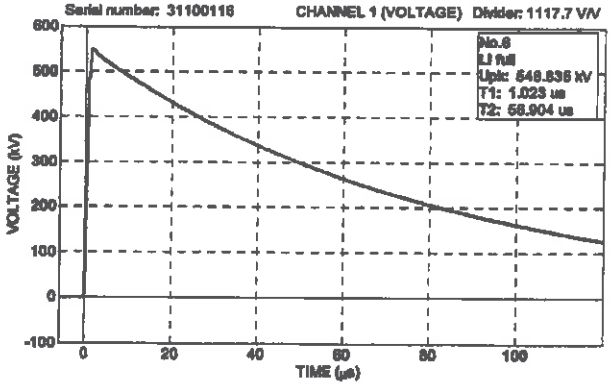

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
No.3
LI full
Upk: 709.194 V
VOLTAGE (V)
TIME (µs)

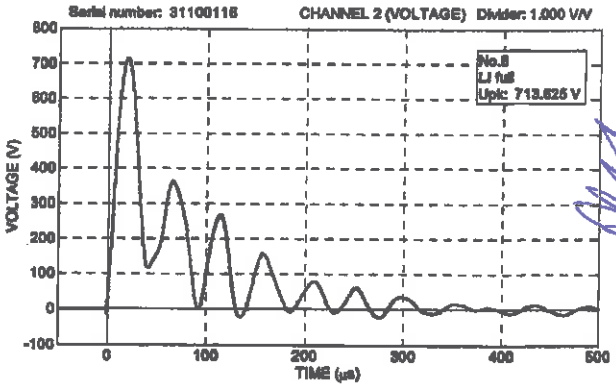

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
No.4
LI full
Upk: 645.606 kV
T1: 1.023 us
T2: 56.716 us
VOLTAGE (kV)
TIME (µs)

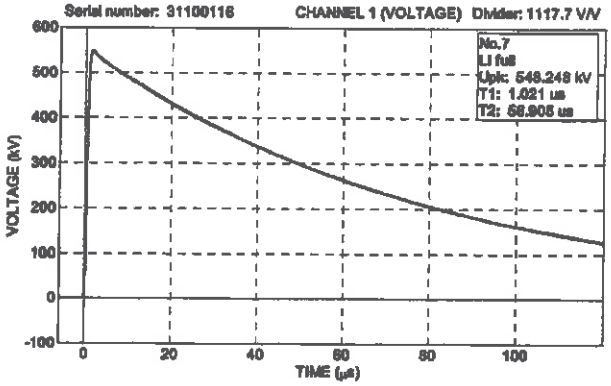

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
No.4
LI full
Upk: 709.268 V
VOLTAGE (V)
TIME (µs)

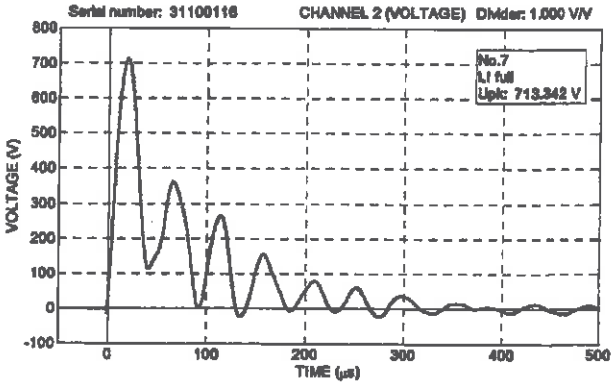

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
No.5
LI full
Upk: 548.968 kV
T1: 1.031 us
T2: 56.816 us
VOLTAGE (kV)
TIME (µs)

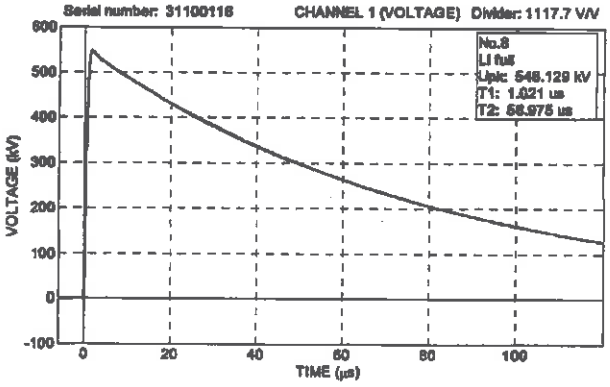

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
No.5
LI full
Upk: 712.985 V
VOLTAGE (V)
TIME (µs)

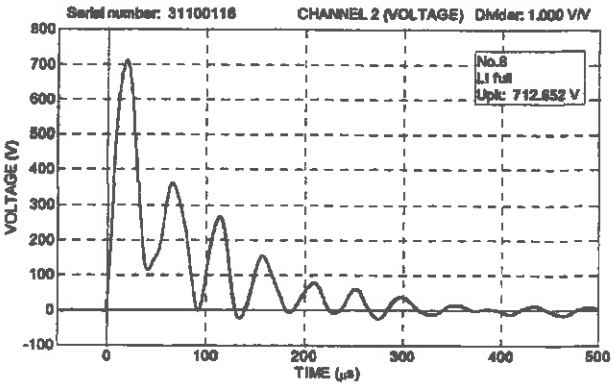

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
No.6
LI full
Upk: 548.836 kV
T1: 1.023 us
T2: 56.904 us
VOLTAGE (kV)
TIME (µs)

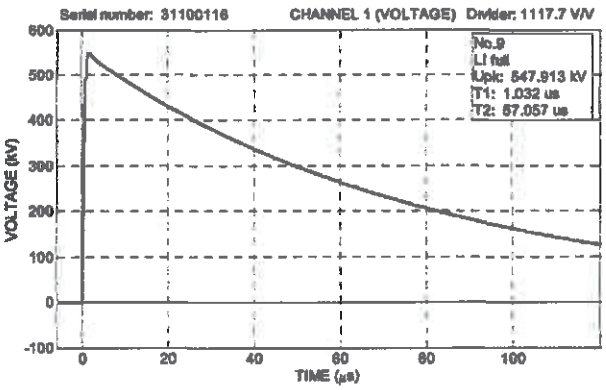

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
No.6
LI full
Upk: 713.625 V
VOLTAGE (V)
TIME (µs)

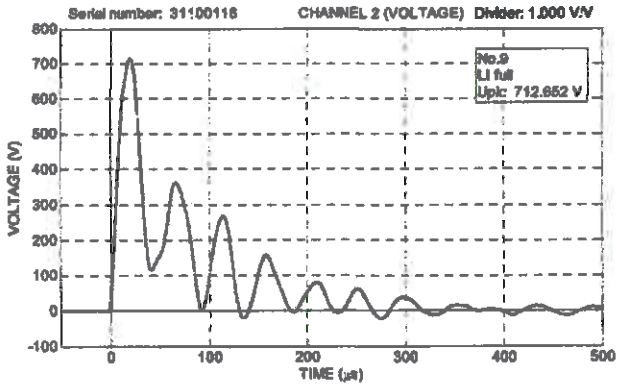

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
No.7
LI full
Upk: 548.248 kV
T1: 1.021 us
T2: 56.905 us
VOLTAGE (kV)
TIME (µs)

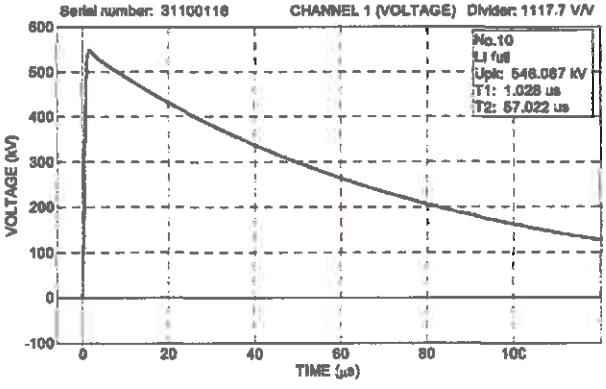

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
No.7
LI full
Upk: 713.342 V
VOLTAGE (V)
TIME (µs)

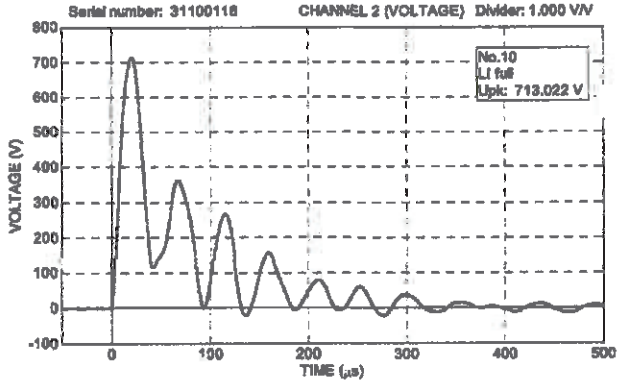

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
No.8
LI full
Upk: 548.129 kV
T1: 1.021 us
T2: 56.975 us
VOLTAGE (kV)
TIME (µs)

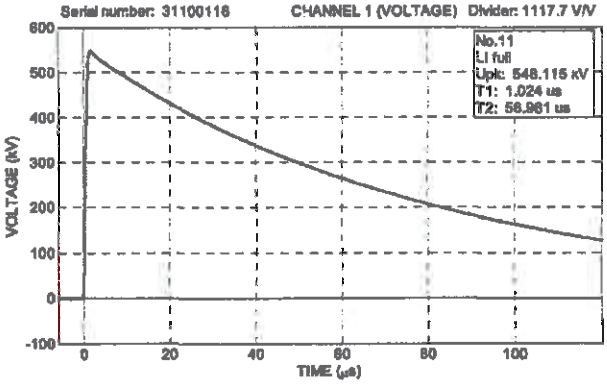

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
No.8
LI full
Upk: 712.652 V
VOLTAGE (V)
TIME (µs)

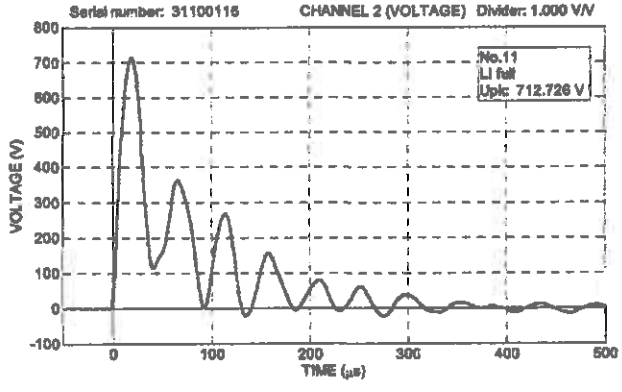

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
No.9
LI full
Upk: 547.913 kV
T1: 1.032 us
T2: 57.057 us
VOLTAGE (kV)
TIME (µs)

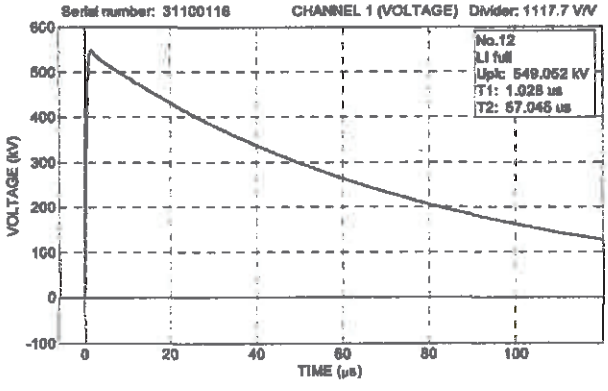

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
No.9
LI full
Upk: 712.652 V
VOLTAGE (V)
TIME (µs)

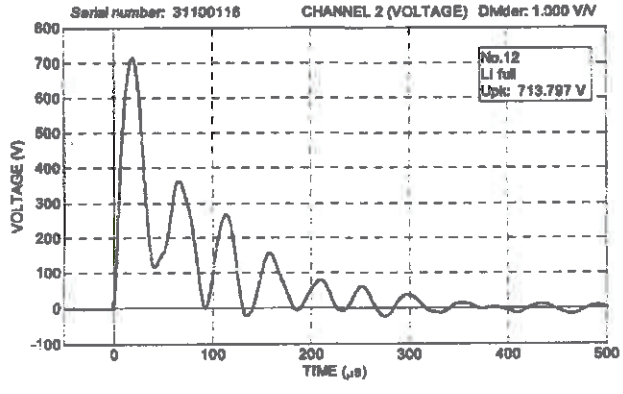

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
No.10
LI full
Upk: 546.087 kV
T1: 1.028 us
T2: 57.022 us
VOLTAGE (kV)
TIME (µs)

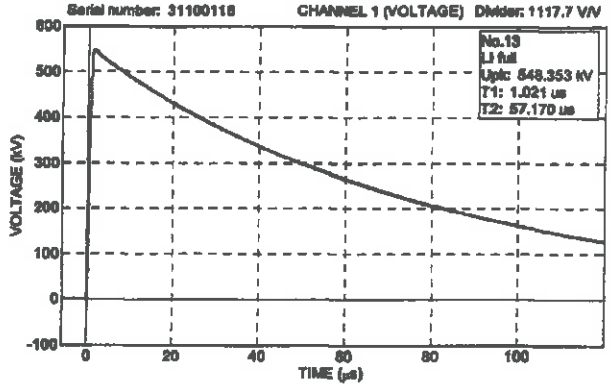

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
No.10
LI full
Upk: 713.022 V
VOLTAGE (V)
TIME (µs)

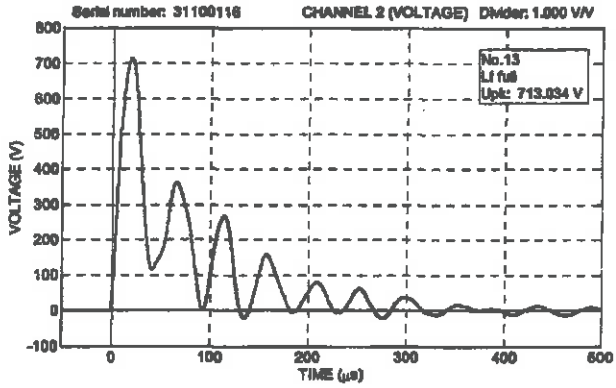

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
No.11
LI full
Upk: 548.115 kV
T1: 1.024 us
T2: 56.961 us
VOLTAGE (kV)
TIME (µs)

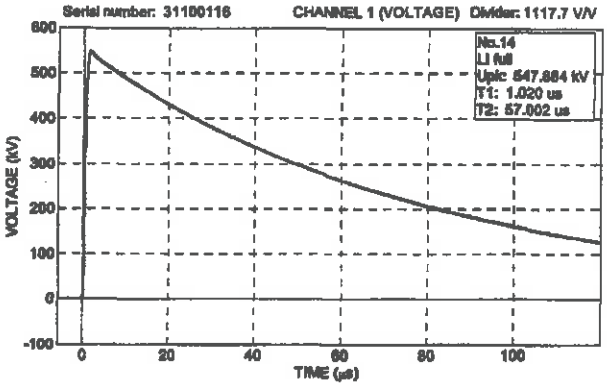

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
No.11
LI full
Upk: 712.726 V
VOLTAGE (V)
TIME (µs)

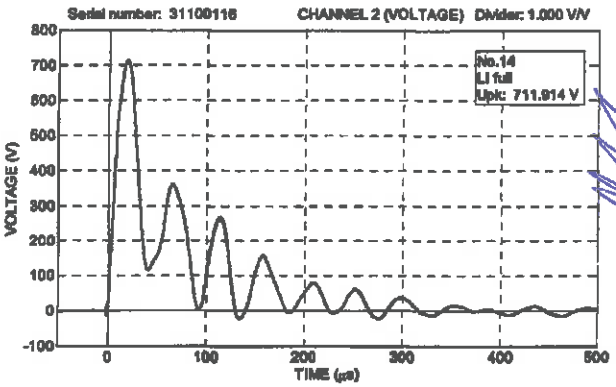

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
No.12
LI full
Upk: 549.052 kV
T1: 1.028 us
T2: 57.046 us
VOLTAGE (kV)
TIME (µs)

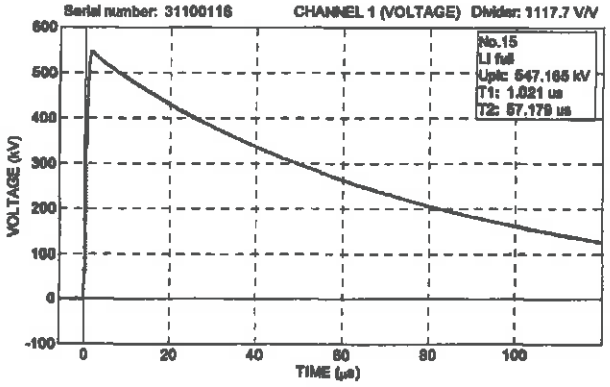

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
No.12
LI full
Upk: 713.797 V
VOLTAGE (V)
TIME (µs)

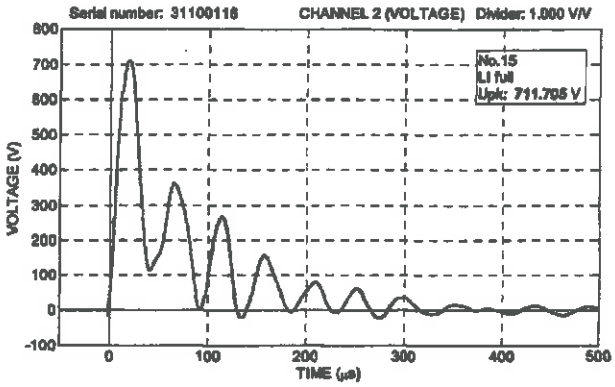

Serial number: 31100116
CHANNEL 1 (VOLTAGE)
Divider: 1117.7 V/V
No.13
LI full
Upk: 548.353 kV
T1: 1.021 us
T2: 57.170 us
VOLTAGE (kV)
TIME (µs)

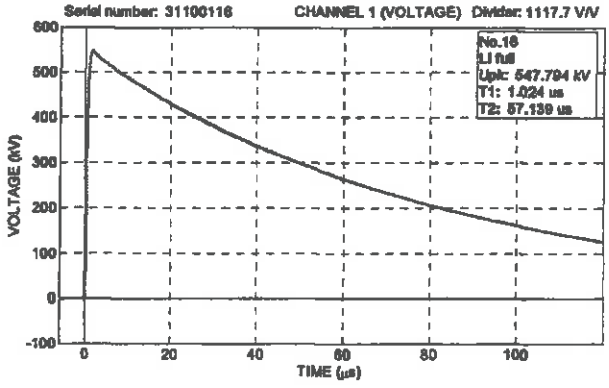

Serial number: 31100116
CHANNEL 2 (VOLTAGE)
Divider: 1.000 V/V
No.13
LI full
Upk: 713.034 V
VOLTAGE (V)
TIME (µs)

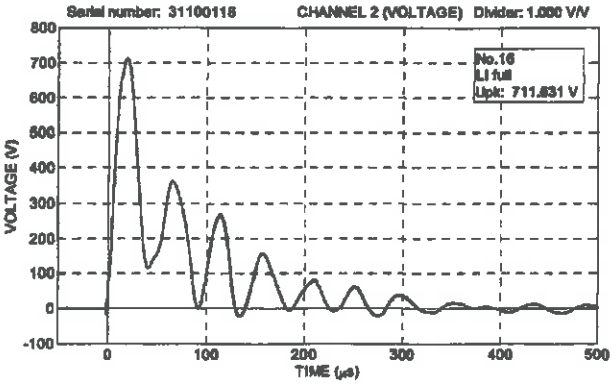

Serial number: 31100116
CHANNEL 1 (VOLTAGE)
Divider: 1117.7 V/V
No.14
LI full
Upk: 547.884 kV
T1: 1.020 us
T2: 57.002 us
VOLTAGE (kV)
TIME (µs)

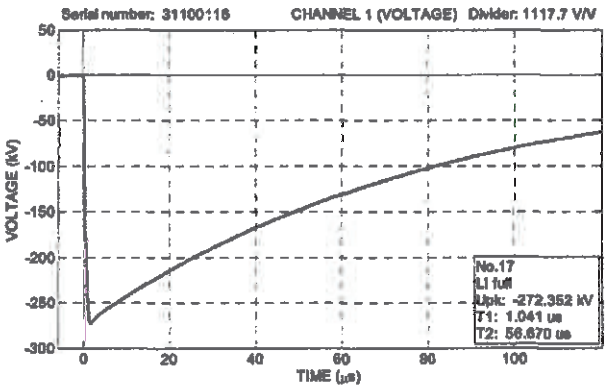

Serial number: 31100116
CHANNEL 2 (VOLTAGE)
Divider: 1.000 V/V
No.14
LI full
Upk: 711.914 V
VOLTAGE (V)
TIME (µs)

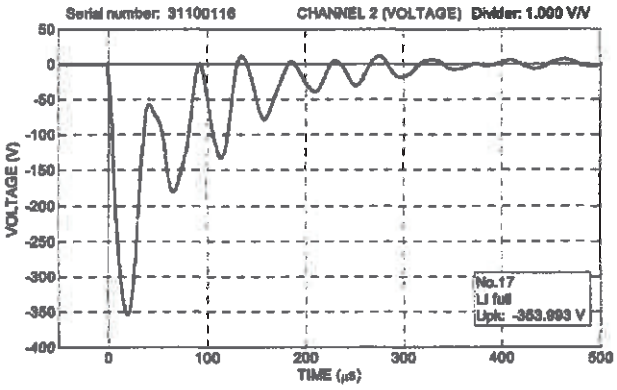

Serial number: 31100116
CHANNEL 1 (VOLTAGE)
Divider: 1117.7 V/V
No.15
LI full
Upk: 547.165 kV
T1: 1.021 us
T2: 57.179 us
VOLTAGE (kV)
TIME (µs)

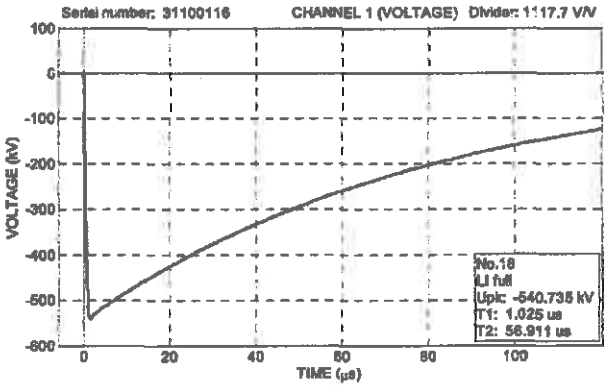

Serial number: 31100116
CHANNEL 2 (VOLTAGE)
Divider: 1.000 V/V
No.15
LI full
Upk: 711.705 V
VOLTAGE (V)
TIME (µs)

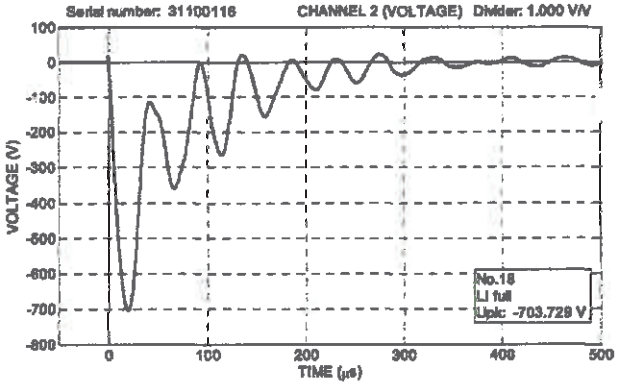

Serial number: 31100116
CHANNEL 1 (VOLTAGE)
Divider: 1117.7 V/V
No.16
LI full
Upk: 547.794 kV
T1: 1.024 us
T2: 57.139 us
VOLTAGE (kV)
TIME (µs)

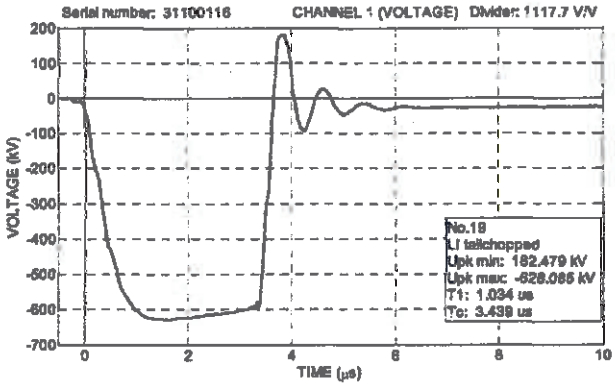

Serial number: 31100116
CHANNEL 2 (VOLTAGE)
Divider: 1.000 V/V
No.16
LI full
Upk: 711.831 V
VOLTAGE (V)
TIME (µs)

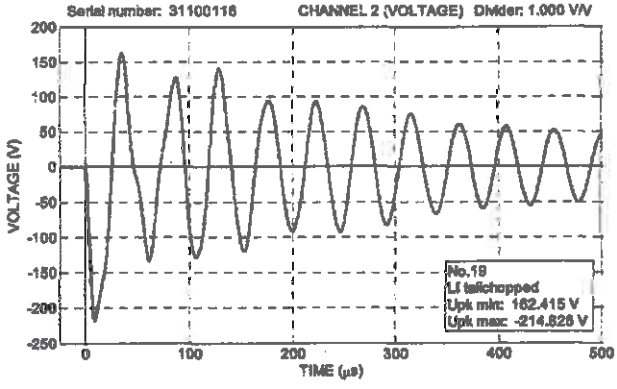

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.17
LI full
Upk: -272.352 kV
T1: 1.041 us
T2: 56.670 us

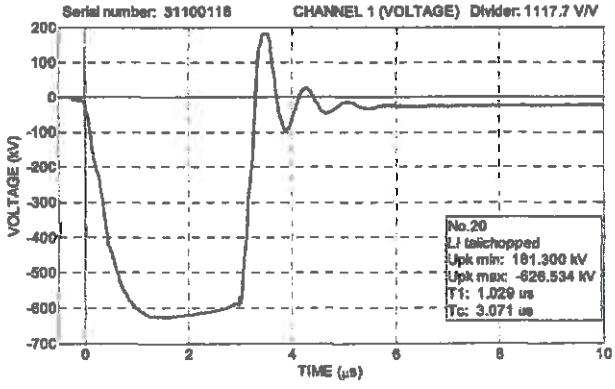

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.17
LI full
Upk: -363.993 V

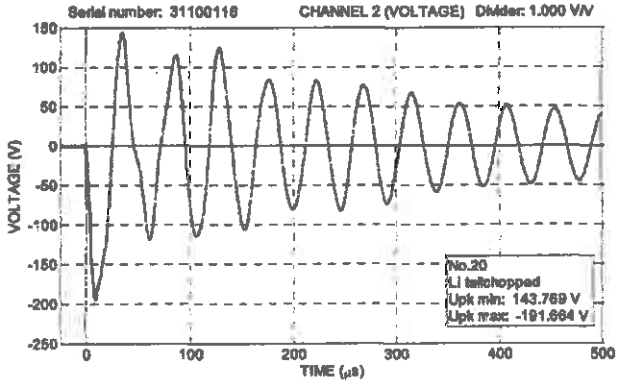

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.18
LI full
Upk: -540.735 kV
T1: 1.025 us
T2: 56.911 us

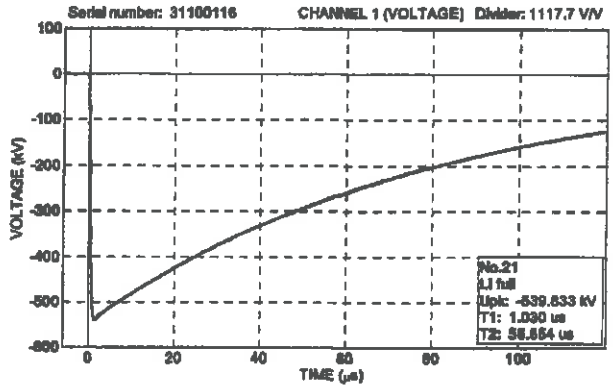

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.18
LI full
Upk: -703.729 V

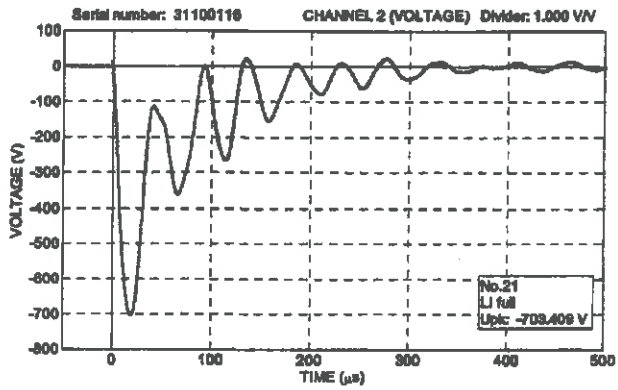

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.19
LI tailchopped
Upk min: 182.479 kV
Upk max: -628.085 kV
T1: 1.034 us
Tc: 3.439 us

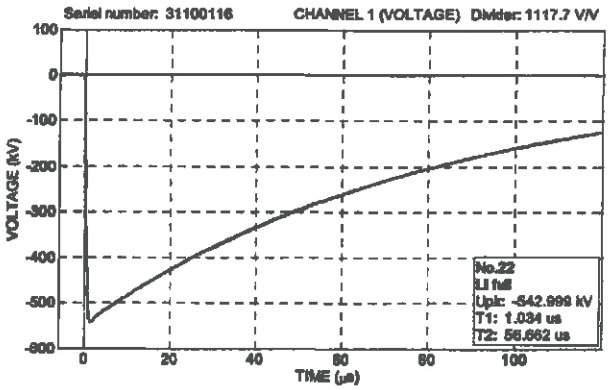

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.19
LI tailchopped
Upk min: 162.415 V
Upk max: -214.626 V

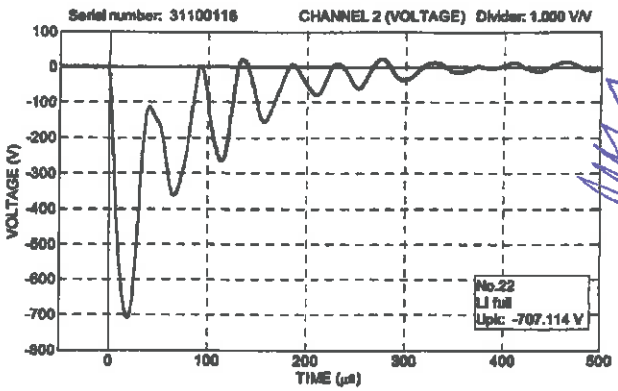

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.20
LI tailchopped
Upk min: 181.300 kV
Upk max: -626.534 kV
T1: 1.029 us
Tc: 3.071 us

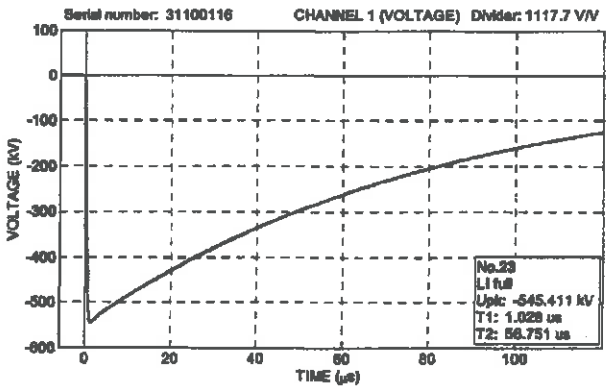

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.20
LI tailchopped
Upk min: 143.769 V
Upk max: -191.664 V

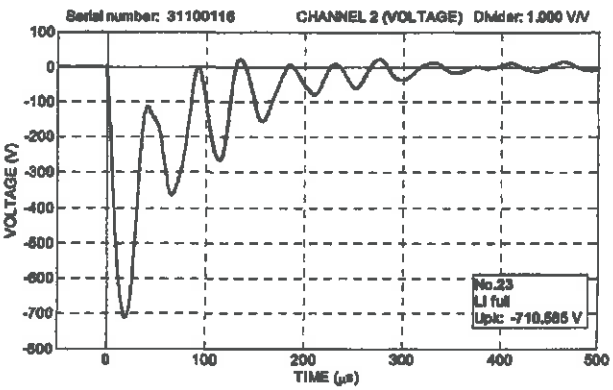

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.21
LI full
Upk: -539.633 kV
T1: 1.030 us
T2: 56.564 us

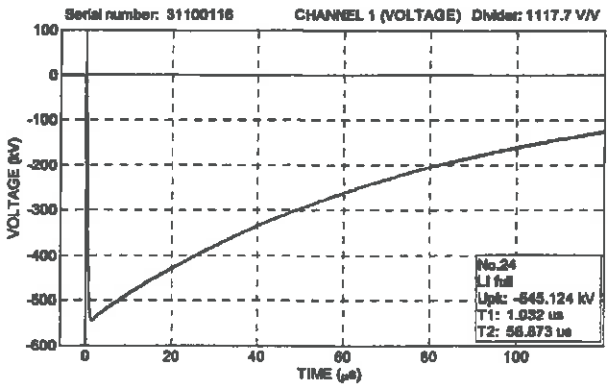

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.21
LI full
Upk: -709.409 V

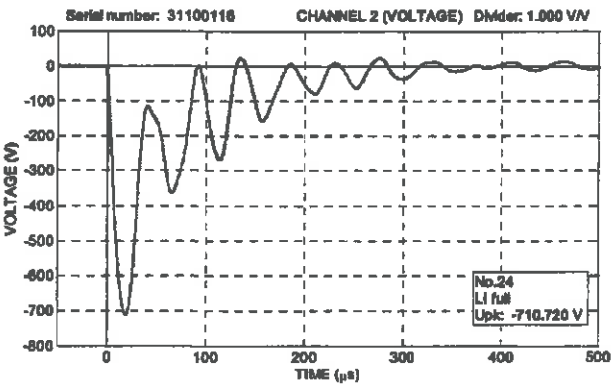

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.22
LI full
Upk: -542.999 kV
T1: 1.034 us
T2: 56.662 us

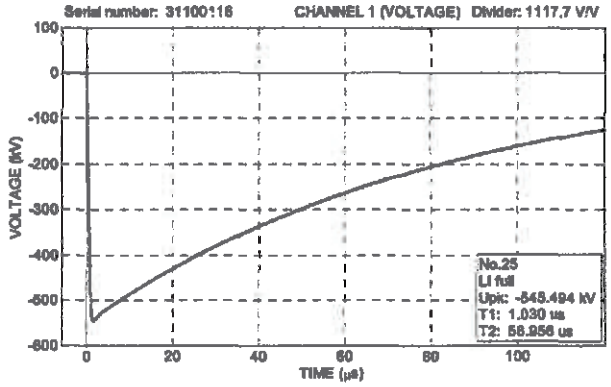

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.22
LI full
Upk: -707.114 V

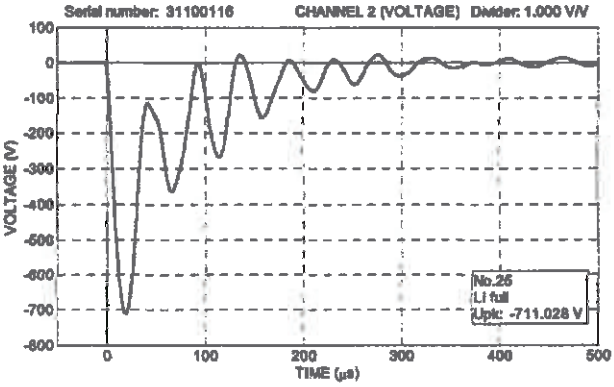

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.23
LI full
Upk: -545.411 kV
T1: 1.028 us
T2: 56.751 us

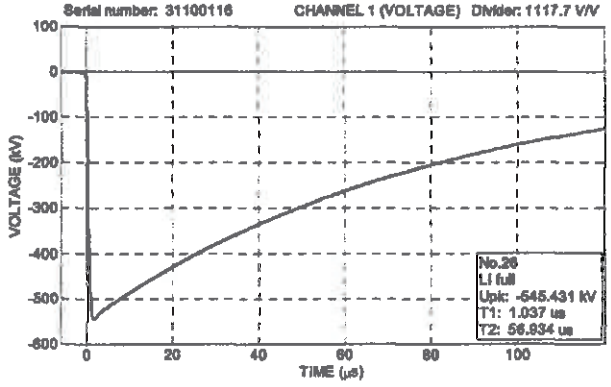

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.23
LI full
Upk: -710.585 V

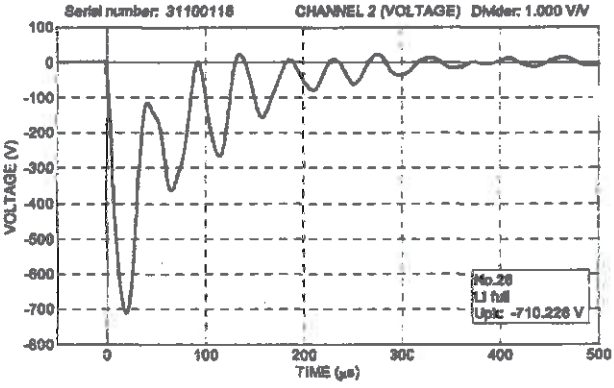

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.24
LI full
Upk: -545.124 kV
T1: 1.032 us
T2: 56.873 us

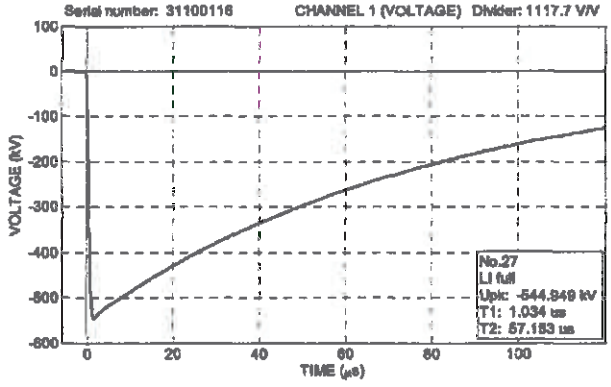

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.24
LI full
Upk: -710.720 V

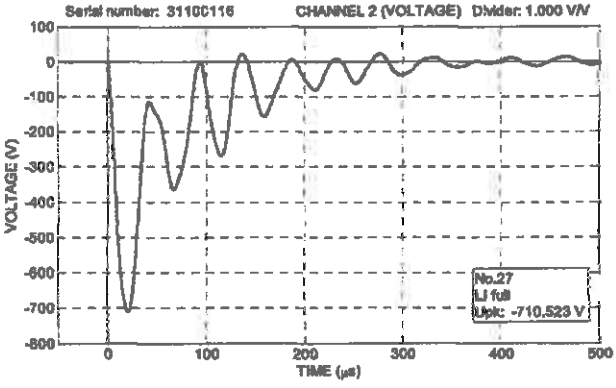

Serial number: 31100116 CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.25
LI full
Upk: -545.494 kV
T1: 1.030 us
T2: 56.956 us

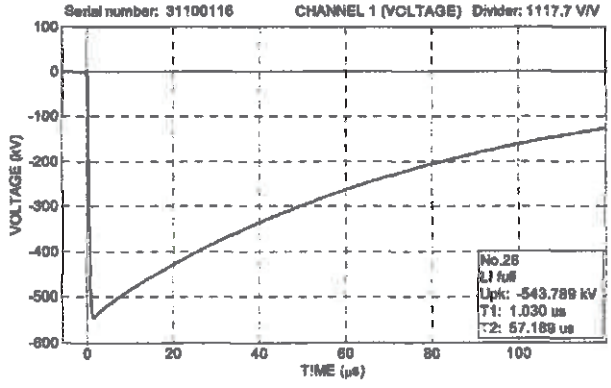

Serial number: 31100116 CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.25
LI full
Upk: -711.028 V

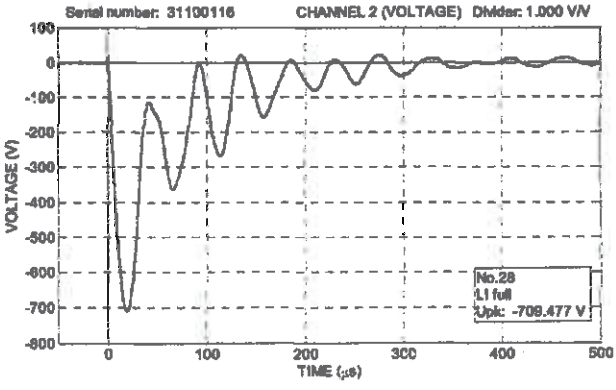

Serial number: 31100116 CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.26
LI full
Upk: -545.431 kV
T1: 1.037 us
T2: 56.934 us

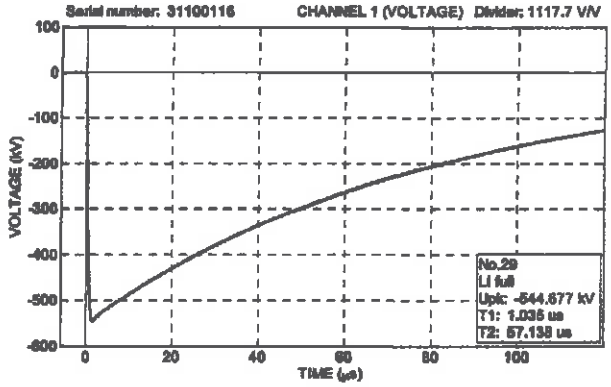

Serial number: 31100116 CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.26
LI full
Upk: -710.226 V

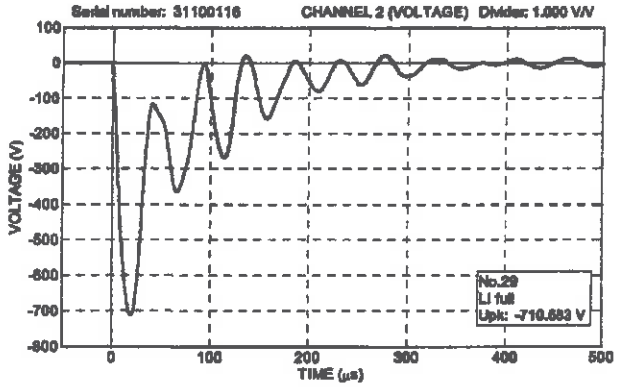

Serial number: 31100116 CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.27
LI full
Upk: -544.849 kV
T1: 1.034 us
T2: 57.153 us

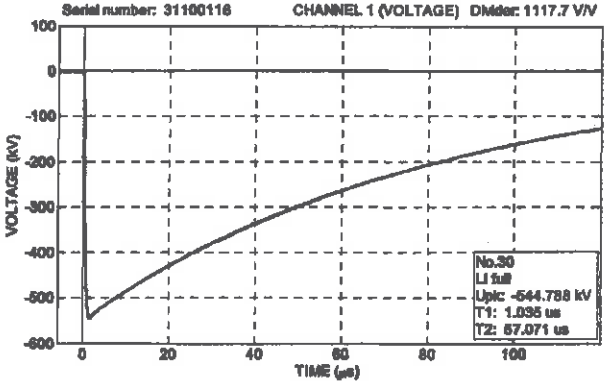

Serial number: 31100116 CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.27
LI full
Upk: -710.523 V

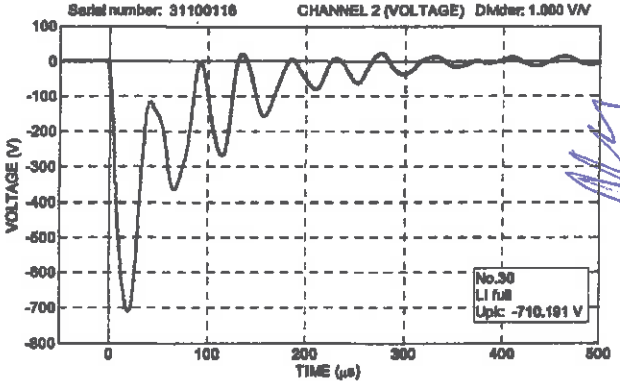

Serial number: 31100116 CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.28
LI full
Upk: -543.789 kV
T1: 1.030 us
T2: 57.169 us

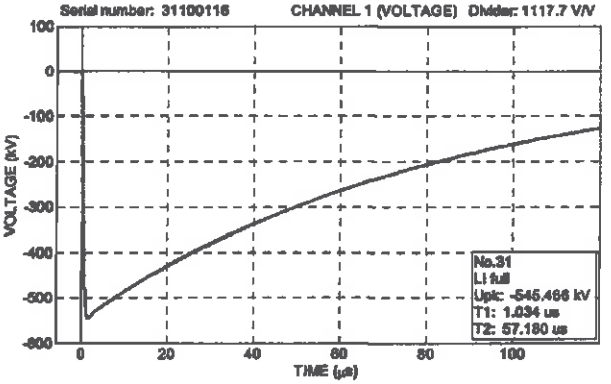

Serial number: 31100116 CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.28
LI full
Upk: -709.477 V

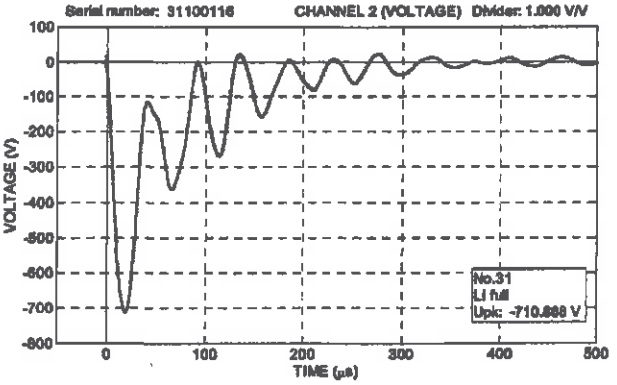

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.29
LI full
Upk: -544.677 kV
T1: 1.035 us
T2: 57.138 us

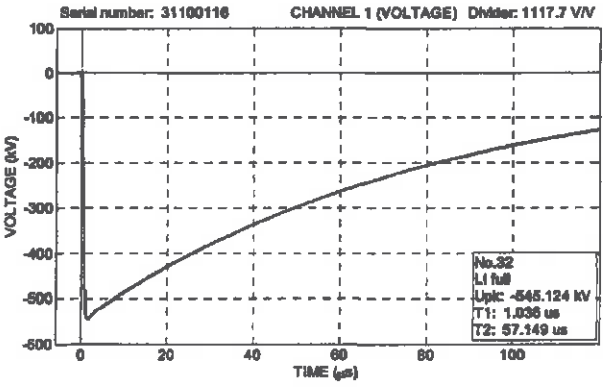

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.29
LI full
Upk: -710.683 V

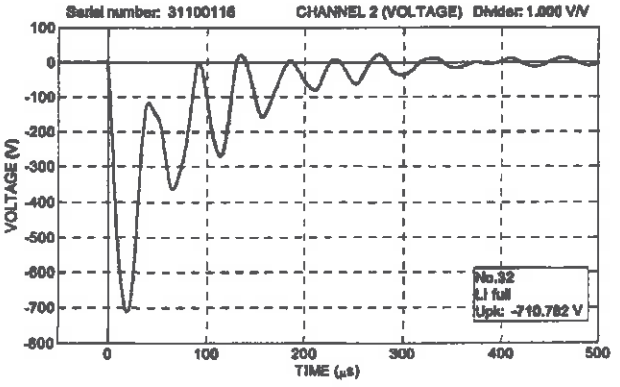

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.30
LI full
Upk: -544.788 kV
T1: 1.035 us
T2: 57.071 us

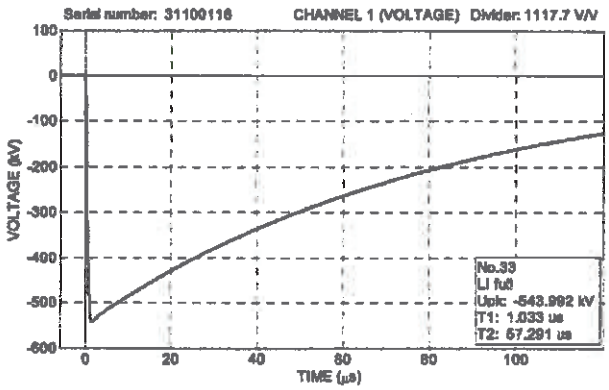

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.30
LI full
Upk: -710.181 V

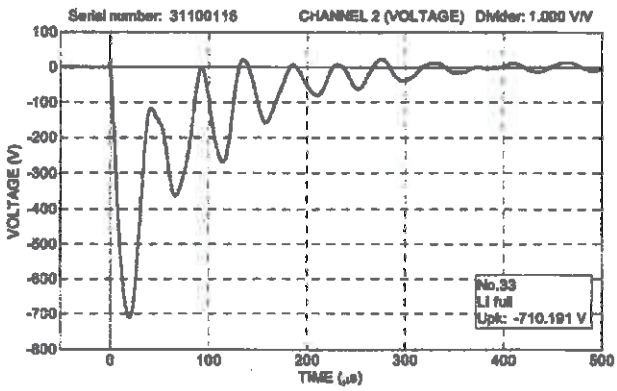

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.31
LI full
Upk: -545.466 kV
T1: 1.034 us
T2: 57.180 us

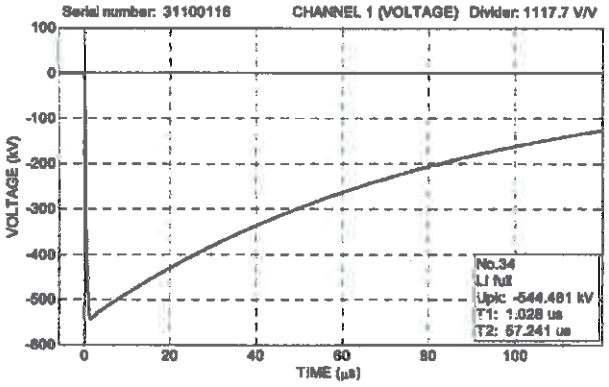

Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.31
LI full
Upk: -710.888 V

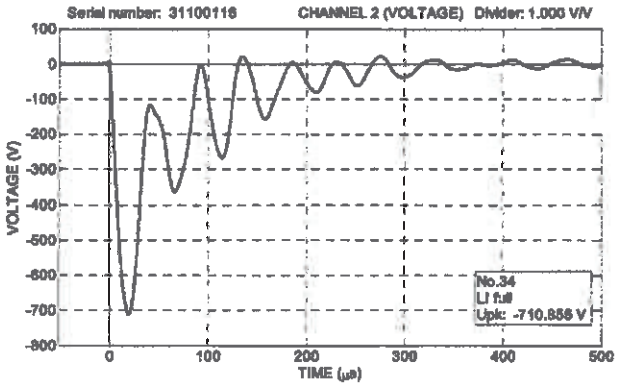

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.32
LI full
Upk: -545.124 kV
T1: 1.035 us
T2: 57.149 us


Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.32
LI full
Upk: -710.782 V

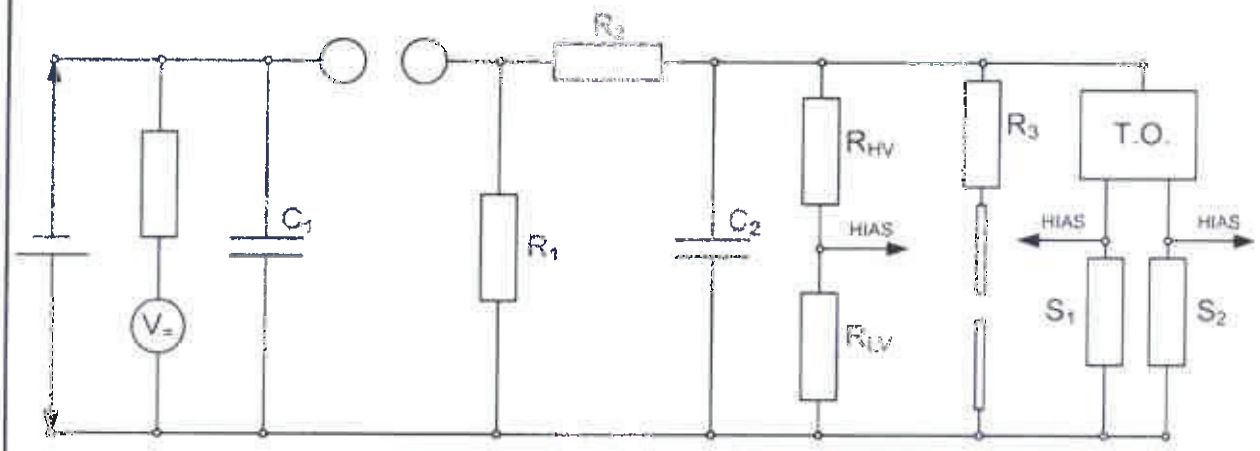

Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.33
LI full
Upk: -543.992 kV
T1: 1.033 us
T2: 57.291 us


Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.33
LI full
Upk: -710.191 V


Serial number: 31100116
CHANNEL 1 (VOLTAGE) Divider: 1117.7 V/V
VOLTAGE (kV)
TIME (µs)
No.34
LI full
Upk: -544.481 kV
T1: 1.028 us
T2: 57.241 us


Serial number: 31100116
CHANNEL 2 (VOLTAGE) Divider: 1.000 V/V
VOLTAGE (V)
TIME (µs)
No.34
LI full
Upk: -710.858 V

2.6. Equivalent diagram of test circuit



2.7. Constants of impulse circuit

C_1 [pF] 83333
C_2 [pF] ..... -
R_1 [Ω] 960
R_2 [Ω] 385
R_3 [Ω] 17,5
R_{HV} [Ω] 19226
R_{HV}/R_{LV} 1117,7
S_1 [µF] 0,54
S_2 [µF] ..... -

2.8. Test arrangement

TEST REPORT

17025·HAA
1035/08

High Voltage Laboratory is competent according to HRN EN ISO/IEC 17025:2007 to carry out high voltage testing of electroenergetical equipment and calibration of electrical field strength meters of frequency 50 Hz – Accreditation certificate No.1035/08 – HAA, CROATIA

Test performed: ..... **Wet power-frequency voltage withstand test**

Test object: ..... **Combined transformer**

Type: ..... **VAU – 123**

Part number: **M112492**

Serial No.: **31100116**

Manufacturer: ..... **KONČAR – Instrument transformers**
J. Mokrovića 10, Zagreb
CROATIA

Client: ..... **KONČAR – Instrument transformers**
J. Mokrovića 10, Zagreb
CROATIA

Place of the test: ..... **KONČAR – Electrical Engineering Institute**
High Voltage Laboratory
Fallerovo šetalište 22, Zagreb
CROATIA

Normative documents: ..... **HRN EN 61869-1:2010 (IEC 61869-1:2007)**
HRN EN 60044-3:2006 (IEC 60044-3:2002)

Date of test: ..... **2013 – 02 – 15**

Results: ..... **PASSED**

Tested by: Approved by:

Danijel Brezak, B.Sc.E.E. KONČAR - Institut za elektrotehniku d. d. ZAGREB Dalibor Filipović-Grčić, Ph.D.

Zagreb, 2013 – 03 – 01

1. The purpose of test

The test to verify dielectric strength of the test object with rated power-frequency withstand voltage in wet, according to the requirements of the HRN EN 61869-1:2010, clause 7.2.4. and HRN EN 60044-3:2006, clause 6.2.

2. Transformer markings and identification of specimen

KONČAR

KOMBINOVANÝ PRÍSTROJOVÝ TRANSFORMÁTOR

TSK 212/01-009

Typ VAU-123 Sériové číslo Rok IEC 60044-3

123/230/550 kV Ith/Idyn 40 / 100 kA f 50 Hz

A – N 110000/√3 V Vf 1,5/30s Ith 480 A

a–n 100/√3 V 60 VA cl. 0.2 1S1–1S2 400 / 1 A 5 VA cl. 0.2FS5 Ext 120 %

da–dn 100/3 V 100 VA cl. 3P 2S1–2S2 400 / 1 A 10 VA cl. 0.5FS5 Ext 120 %

Ue 7 mV/kA 3S1–3S2 400 / 1 A 20 VA cl. 5P20 Olej 90 kg

4S1–4S2 400 / 1 A 20 VA cl. 5P20 Celkom 470 kg

Made in Croatia M112492

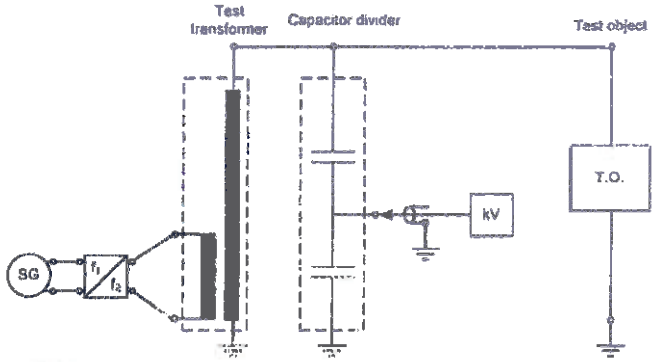
Identification of the test object according to drawing M113458 submitted by manufacturer.

3. Wet power-frequency voltage withstand test

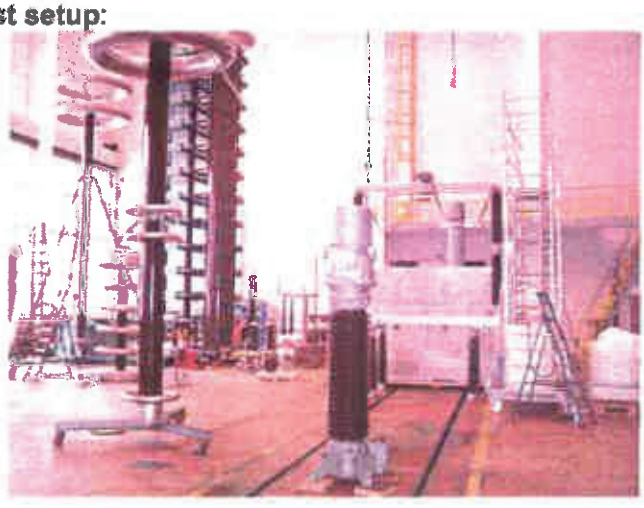
Measuring equipment:

Capacitor divider, Haefely, 750 kV, SN: 570187
Peak voltmeter, Trüb.Tauber, SN: 3442997
Barometer, Casella, type: ANEROID, SN: B03148
Thermohygromether, AMR THERM, type 2246-2 + C845,SN: 47836
Conductometer, Iskra, type MA 5960, SN: 221

Test circuit:



Photorgaphy of the test setup:



Test conditions:

Atmospheric conditions during the test:	
Temperature:	14,7 °C
Pressure:	995,9 hPa
Correction factor, air density:	1,0013
Test voltage:	230 kV
Test voltage value after the correction factor was applied:	231 kV

Characteristics of artificial rain:	
Vertical component:	1,2 mm/min
Horizontal component:	1,7 mm/min
Water resistivity:	108 Ωm
Water temperature:	15,1 °C
Pre-wetting time:	15 min

Test results:

The test object withstood power-frequency withstand voltage 231 kV, 105 Hz, 58 s in wet. During the test no disruptive discharges occurred.

TEST REPORT

Tests performed: ..... Short-Circuit Withstand Capability Test

Test object: ..... Combined transformer

Type: ..... VAU – 123

Part number: M112492

Serial No.: 31100116

Manufacturer: ..... KONČAR – Instrument transformers
J. Mokrovića 10, Zagreb
CROATIA

Client: ..... KONČAR – Instrument transformers
J. Mokrovića 10, Zagreb
CROATIA

Place of the test: ..... KONČAR – Electrical Engineering Institute
High Voltage Laboratory
Fallerovo šetalište 22, Zagreb
CROATIA

Normative documents: ..... HRN EN 61869-3:2012 (IEC 61869-3:2011)

Date of test: ..... 2013 – 02 – 15

Results: ..... PASSED

Заличено по чл.2 от ЗЗЛД

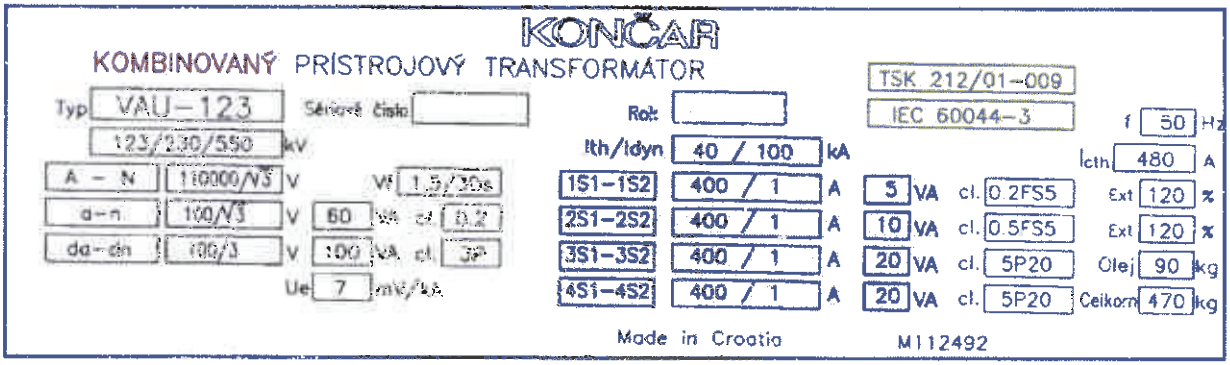
Danijel Brezak, B.Sc.E.E. Dalibor Filipović-Grčić, Ph.D.

Zagreb, 2013 – 03 – 01

1. **The purpose of test**

The short-circuit withstand capability test was carried out according to the requirements of the HRN EN 61869-3:2012, clause 7.2.301.

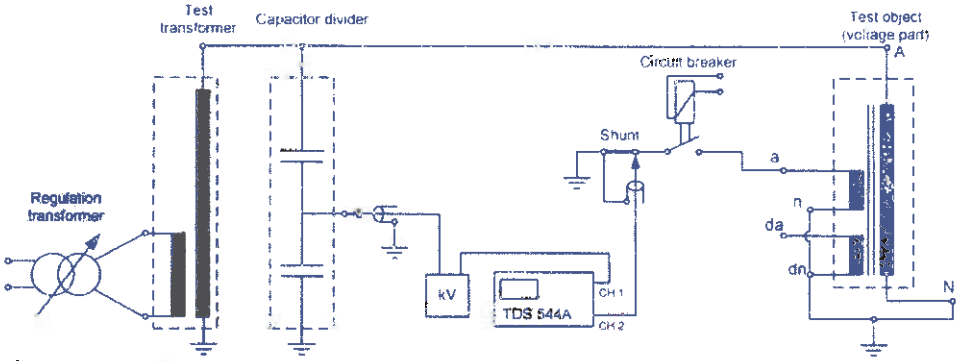
2. **Transformer markings and identification of specimen**



Identification of the test object according to drawing M113458 submitted by manufacturer.

3. **Short-circuit withstand capability test**

Measuring equipment:
Capacitor divider, Haefely, SN: 570187
Peak voltmeter, Trüb.Tauber, SN: 3442997
Digital oscilloscope, Tektronix, type TDS 544A, SN: B010509
Current Shunt, Končar, 100 A / 94 mV, SN: 001
Barometer, Casella, type: ANEROID, SN: B03148
Thermohygromether, AMR THERM, type 2246-2 + C845, SN: 47836
Test **circuit:**

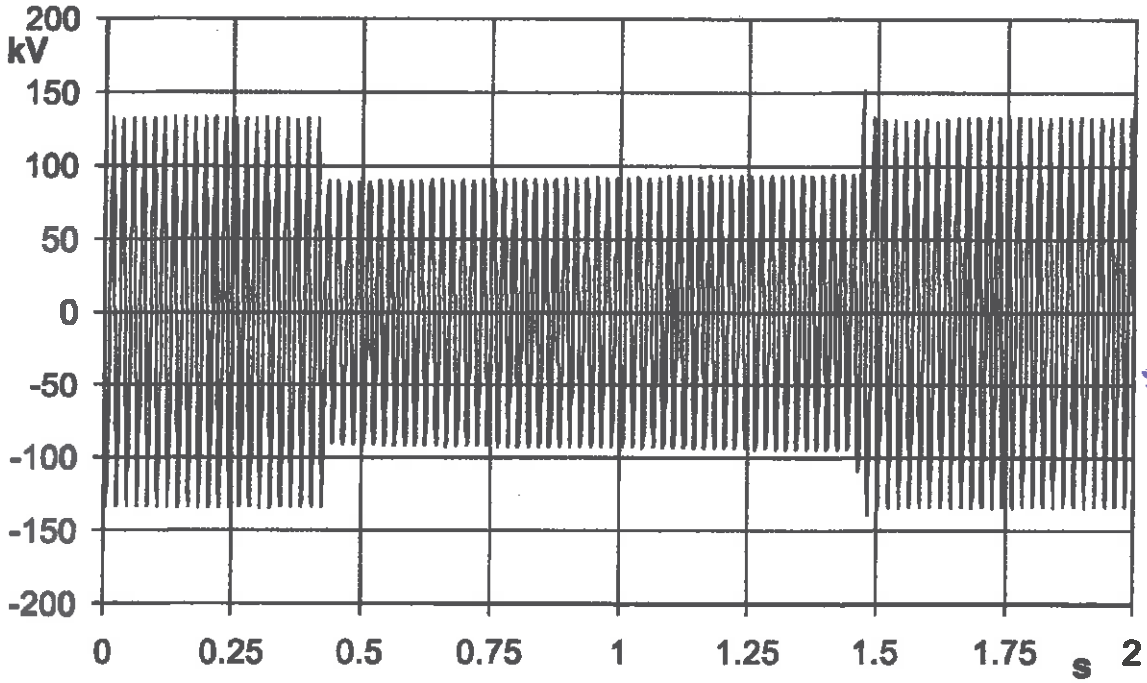


Photography of the test setup:

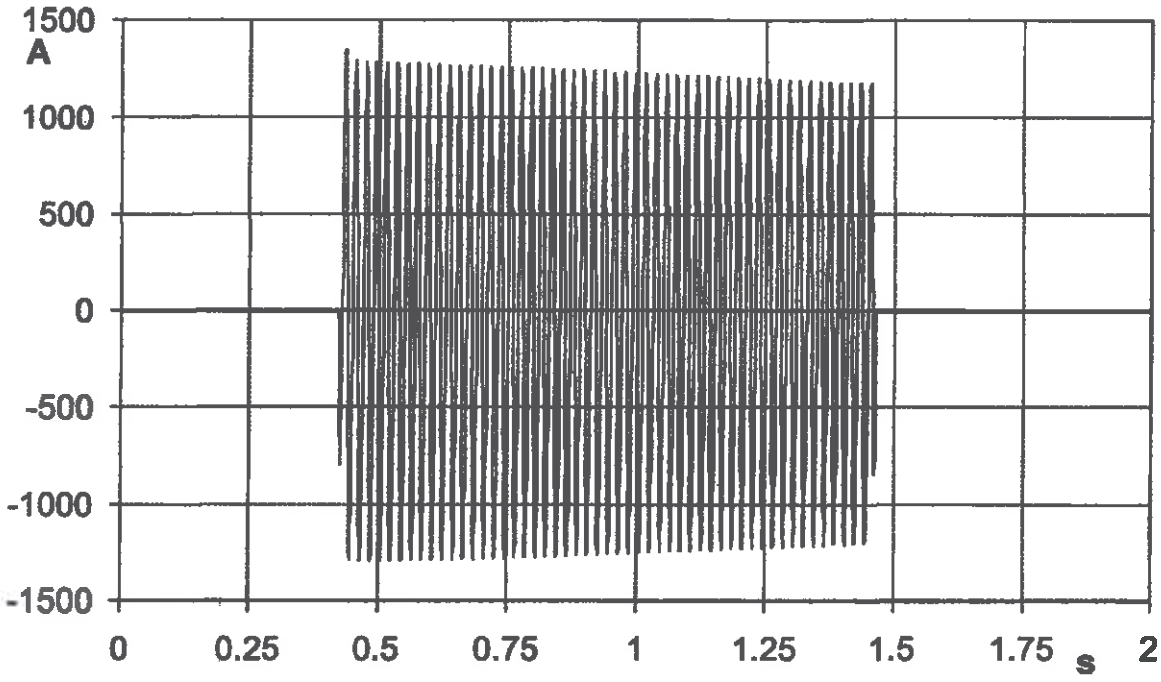
Atmospheric conditions during the test:
14,7 °C / 1001,3 hPa / 38,0 %

Test results:

The voltage transformer was energized from the primary side. The r.m.s. value of the applied voltage during short circuit was not less than the rated voltage. Short-circuit was applied on the secondary terminals a – n for the duration of 1 second. After the test transformer has not been visibly damaged. During the short - circuit test, the current through secondary winding has reached the value of 873 A_{rms}, what can be seen on the oscillogram 2.



Osc. 1 – Applied voltage



Osc. 2 – Short-circuit current

Results of measurements of errors before and after the short - circuit test are given on the pages 4/5 and 5/5.

KONČAR
Končar - Instrument transformers, Inc.

ISPITNI LIST KOMBINIRANOG TRANSFORMATORA
COMBINED TRANSFORMER TEST REPORT

Strana / Page: 4/5
Broj / No.: 010513

Naručilac / Purchaser:	EFACEC Austria for JAVYS Slovakia	Br. ugovora / Contract No:	C.11.003/2012-0006 356 - 33218	Ispitano prema / Tested against:	IEC 60044-3

KOMBINIRANI TRANSFORMATOR / COMBINED TRANSFORMER — Tip / Type: VAU-123 — TSK 212/01-009 — Br. / No.: 31100116

123 / 230 / 550 kV — Kl. izolacije / Cl. of ins.: A — Frekv. / Freq.: 50 Hz — Godina proizvodnje / Year of manuf.: 2012.

NAPONSKI TRANSFORMATOR / VOLTAGE TRANSFORMER — A - N — 110000/√3 V — Vf: 1.5/30s

a - n	100 / √3 V	60 VA	r.t. cl.	0,2	
da - dn	100 / 3 V	100 VA	r.t. cl.	3P	
	V	VA	r.t. cl.		

STRUJNI TRANSFORMATOR / CURRENT TRANSFORMER — I_{th}/I_{dyn}: 40 / 100 kA — I_{cth}: 480 A

1S1 - 1S2	400 / 1 A	5 VA	r.t. cl.	0,2 FS 5	ext	120	%
2S1 - 2S2	400 / 1 A	10 VA	r.t. cl.	0,5 FS 5	ext	120	%
3S1 - 3S2	400 / 1 A	20 VA	r.t. cl.	5 P 20	Masa ulja / Oil mass	90	kg
4S1 - 4S2	400 / 1 A	20 VA	r.t. cl.	5 P 20	Ukupna masa / Total mass	470	kg

1 ISPITIVANJE IZOLACIJE NAPONOM MREŽNE FREKVENCIJE / POWER-FREQUENCY WITHSTAND TESTS

VN namot strujnog transformatora prema NN namotima i uzemljenim dijelovima / H.V. winding of the current transformer against L.V. windings and earthed parts	230 kV	Trajanje / Duration	50 sec	Frekv. / Freq.	120 Hz
VN namot naponskog transformatora prema NN namotima i uzemljenim dijelovima / H.V. winding of the voltage transformer against L.V. windings and earthed parts	3 kV	Trajanje / Duration	60 sec	Frekv. / Freq.	50 Hz
NN namot prema NN namotima i uzemljenim dijelovima / L.V. winding against L.V. windings and earthed parts	3 kV	Trajanje / Duration	60 sec	Frekv. / Freq.	50 Hz

2 MJERENJE FAKTORA DIELEKTRIČKIH GUBITAKA / MEASUREMENT OF DIELECTRIC DISSIPATION FACTOR

U (kV)	2		
tg δ (%)	0,370		
Cx (pF)	2943		

3 MJERENJE PARCIJALNIH IZBIJANJA / PARTIAL DISCHARGE MEASUREMENT

U (kV)	85	123	
PD (pC)	< 5	< 10	

4 ISPITIVANJE IZOLACIJE INDUCIRANIM NAPONOM / INTERTURN OVERVOLTAGE TEST

Naponski transformator / Voltage transformer	230 kV	Trajanje / Duration	50 sec	Frekv. / Freq.	120 Hz
Strujni transformator - sekundarni namot / Current transformer - secondary winding		Trajanje / Duration	60 sec	Frekv. / Freq.	50 Hz

1S1-1S2: 32,5 V — 2S1-2S2: 60,5 V — 3S1-3S2: 539 V — 4S1-4S2: 542 V — V

5 ODREĐIVANJE POGREŠAKA NAPONSKOG TRANSFORMATORA / DETERMINATION OF ERRORS OF THE VOLTAGE TRANSFORMER

U / Un	a - n						da - dn					
	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)
0.05								+0,48	-25,7		-0,01	-28,5
0.8		+0,07	+0,8		-0,02	+0,5						
1.0	15	+0,07	+0,7	60	-0,03	+0,5	25+0	+0,46	-26,5	100+60	-0,02	-29,5
1.2		+0,06	+0,6		-0,04	+0,4						
1.5								+0,44	-27,3		-0,04	-30,0

KONČAR
Končar - Instrument transformers, Inc.

ISPITNI LIST KOMBINIRANOG TRANSFORMATORA
COMBINED TRANSFORMER TEST REPORT

Br. dijela: / No.: M112492

6 *ODREĐIVANJE POGREŠAKA STRUJNOG TRANSFORMATORA*
DETERMINATION OF ERRORS OF THE CURRENT TRANSFORMER *No. 31100116*

I/In	1S1-1S2						I/In	2S1-2S2					
	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)		S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)
1.2	1,25	+0,06	+0,6	5	+0,03	+0,1	1.2	2,5	+0,34	+8,2	10	-0,08	+2,5
1.0		+0,06	+1,0		+0,02	+0,8	1.0		+0,34	+9,5		-0,10	+3,5
0.2		+0,05	+4,5		-0,06	+2,2	0.2		+0,30	+12,0		-0,30	+9,0
0.05		+0,06	+6,3		-0,10	+6,3	0.05		+0,21	+16,5		-0,54	+15,0

6

I/In							I/In						
	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)		S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)
1.2							1.2						
1.0							1.0						
0.2							0.2						
0.05							0.05						

I/In	3S1-3S2					I/In	4S1-4S2				
	S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$		S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$
1.0	20	-0,15	+3,0	< 1,0	2,80	1.0	20	-0,13	+3,0	< 1,0	2,82

I/In						I/In					
	S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$		S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$
1.0						1.0					

EQUIPMENT: 1. Bridge MWB TAB, 903504, 20555 PTB 10. 2. Etalon Končar, NVPU-420-1, Br. 1, 01/0270(10)-PTB/DZM
3.Etalon Končar, NNST-1200, 170967/2008 , 20528 PTB 10., 4.Burden N.Tesla, NO-3, 01/06, 01/0294 (10)-DZM,
5.Burden Tesla, NO-3, 02/06, 01/0293(10)-DZM, 6. Burden N.Tesla, SO-2, 0020/88, 01/0279 (10)-DZM. ; *Differential measuring method*

7 *Provjeravanje označavanja priključaka* / *Verification of terminal marking* — *ISPITANO I NAĐENO U REDU* / *TESTED AND FOUND O.K.*

Napomena:
Remarks: OIL *SHELL DIALA S3 ZX - IG*

Tests were carried out before Short-Circuit Withstand Capability Test

ZAKLJUČAK : ***Transformator je uspješno prošao ispitivanja u skladu sa Publikacijama IEC 60044-3***
CONCLUSION : ***Transformer satisfactory passed the tests in accordance with Publications IEC 60044-3***

Zagreb,

Заличено по чл.2 от ЗЗЛД

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KONČAR
Končar - instrument transformers, inc.

ISPITNI LIST KOMBINIRANOG TRANSFORMATORA
COMBINED TRANSFORMER TEST REPORT

Strana / Page: 5/5
Broj / No.: 010513

Naručilac: Purchaser:	EFACEC Austria for JAVYS Slovakia	Br. ugovora: Contract No:	C.11.003/2012-0006 356 - 33218	Ispitano prema: Tested against:	IEC 60044-3

KOMBINIRANI TRANSFORMATOR / COMBINED TRANSFORMER — Tip / Type: VAU-123 — TSK 212/01-009 — Br. / No.: 31100116

123 / 230 / 550 kV — Kl. izolacije / Cl. of ins.: A — Frekv. / Freq.: 50 Hz — Godina proizvodnje / Year of manuf.: 2012.

NAPONSKI TRANSFORMATOR / VOLTAGE TRANSFORMER — A - N — 110000/√3 V — Vf: 1.5/30s

a - n	100 / √3 V	60	VA	r.t. cl.	0,2	
da - dn	100 / 3 V	100	VA	r.t. cl.	3P	
	V		VA	r.t. cl.		

STRUJNI TRANSFORMATOR / CURRENT TRANSFORMER — I_{th}/I_{dyn}: 40 / 100 kA — I_{cth}: 480 A

1S1 - 1S2	400 / 1 A	5	VA	r.t. cl.	0,2 FS 5	ext	120 %
2S1 - 2S2	400 / 1 A	10	VA	r.t. cl.	0,5 FS 5	ext	120 %
3S1 - 3S2	400 / 1 A	20	VA	r.t. cl.	5 P 20	Masa ulja / Oil mass	90 kg
4S1 - 4S2	400 / 1 A	20	VA	r.t. cl.	5 P 20	Ukupna masa / Total mass	470 kg

1 ISPITIVANJE IZOLACIJE NAPONOM MREŽNE FREKVENCIJE / POWER-FREQUENCY WITHSTAND TESTS

			Trajanje / Duration		Frekv. / Freq.	
VN namot strujnog transformatora prema NN namotima i uzemljenim dijelovima / H.V. winding of the current transformer against L.V. windings and earthed parts	207	kV	50	sec	120	Hz
VN namot naponskog transformatora prema NN namotima i uzemljenim dijelovima / H.V. winding of the voltage transformer against L.V. windings and earthed parts	3	kV	60	sec	50	Hz
NN namot prema NN namotima i uzemljenim dijelovima / L.V. winding against L.V. windings and earthed parts	3	kV	60	sec	50	Hz

2 MJERENJE FAKTORA DIELEKTRIČKIH GUBITAKA / MEASUREMENT OF DIELECTRIC DISSIPATION FACTOR

U (kV)	2			
tg δ (%)	0,375			
Cx (pF)	2945			

3 MJERENJE PARCIJALNIH IZBIJANJA / PARTIAL DISCHARGE MEASUREMENT

U (kV)	85	123	
PD (pC)	< 5	< 10	

4 ISPITIVANJE IZOLACIJE INDUCIRANIM NAPONOM / INTERTURN OVERVOLTAGE TEST

			Trajanje / Duration		Frekv. / Freq.	
Naponski transformator / Voltage transformer	0,9x230	kV	50	sec	120	Hz
Strujni transformator - sekundarni namot / Current transformer - secondary winding			60	sec	50	Hz

1S1-1S2: 32,6 V — 2S1-2S2: 60,5 V — 3S1-3S2: 540 V — 4S1-4S2: 542 V — V

5 ODREĐIVANJE POGREŠAKA NAPONSKOG TRANSFORMATORA / DETERMINATION OF ERRORS OF THE VOLTAGE TRANSFORMER

U / Un	a - n						da - dn					
	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)
0.05								+0,47	-25,5		-0,01	-28,6
0.8		+0,07	+1,0		-0,02	+0,9						
1.0	15	+0,07	+0,9	60	-0,03	+0,9	25+0	+0,46	-26,5	100+60	-0,02	-29,5
1.2		+0,06	+0,8		-0,04	+0,8						
1.5								+0,45	-27,0		-0,04	-29,9

OB-229/1

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KONČAR Končar - Instrument transformers, Inc.	**ISPITNI LIST KOMBINIRANOG TRANSFORMATORA** **COMBINED TRANSFORMER TEST REPORT**	*Strana:* *Page:* 2/2 *Br. dijela:* *No.:* M112492

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ODREĐIVANJE POGREŠAKA STRUJNOG TRANSFORMATORA
DETERMINATION OF ERRORS OF THE CURRENT TRANSFORMER *No. 31100116*

I/In	1S1-1S2						I/In	2S1-2S2					
	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)		S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)
1.2	1,25	+0,06	+0,5	5	+0,03	+0,1	1.2	2,5	+0,35	+8,5	10	-0,08	+2,5
1.0		+0,06	+1,2		+0,02	+0,8	1.0		+0,34	+9,5		-0,10	+3,8
0.2		+0,05	+4,5		-0,06	+2,2	0.2		+0,30	+12,0		-0,31	+9,0
0.05		+0,06	+6,0		-0,11	+6,5	0.05		+0,21	+16,5		-0,55	+15,5

6

I/In							I/In						
	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)		S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)
1.2							1.2						
1.0							1.0						
0.2							0.2						
0.05							0.05						

I/In	3S1-3S2					I/In	4S1-4S2				
	S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$		S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$
1.0	20	-0,17	+3,0	< 1,0	2,82	1.0	20	-0,15	+3,0	< 1,0	2,83

I/In						I/In					
	S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$		S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$
1.0						1.0					

EQUIPMENT: 1. Bridge MWB TAB, 903504, 20555 PTB 10. 2. Etalon Končar, NVPU-420-1, Br. 1, 01/0270(10)-PTB/DZM
3.Etalon Končar, NNST-1200, 170967/2008 , 20528 PTB 10., 4.Burden N.Tesla, NO-3, 01/06, 01/0294 (10)-DZM,
5.Burden Tesla, NO-3, 02/06, 01/0293(10)-DZM, 6. Burden N.Tesla, SO-2, 0020/88, 01/0279 (10)-DZM. ; *Differential measuring method*

7 *Provjeravanje označavanja priključaka*
Verification of terminal marking

ISPITANO I NAĐENO U REDU
TESTED AND FOUND O.K.

Napomena:
Remarks: OIL *SHELL DIALA S3 ZX - IG*

Tests were carried out after Short-Circuit Withstand Capability Test

ZAKLJUČAK : ***Transformator je uspješno prošao ispitivanja u skladu sa Publikacijama IEC 60044-3***
CONCLUSION : ***Transformer satisfactory passed the tests in accordance with Publications IEC 60044-3***

Zagreb, *20. 02. 2013.*

High Power Laboratory is accredited by HAA acc. to HRN EN ISO/EC 17025:2007 – Accreditation Certificate Number: 1139/08

Test item:	**COMBINED TRANSFORMER**
Type:	**VAU – 123**
Rated voltage:	**110/√3 kV**
Part No. / Serial No.	**M112492 / 31100116**
Ith/Idyn:	**40 kA-1s / 100 kA**
Rated transformation ratio:	**Voltage transformer:** A - N = 110000/√3 V a - n = 100/√3 V da - dn = 100/3 V **Current transformer:** 1S1 – 1S2 = 400/1 A 2S1 – 2S2 = 400/1 A 3S1 – 3S2 = 400/1 A 4S1 – 4S2 = 400/1 A

Manufacturer:	KONČAR – Instrument transformers Inc., Zagreb, Croatia
Test ordered by:	KONČAR – Instrument transformers Inc., Zagreb, Croatia
Test specification:	Short time and peak withstand current test of transformer with: I_{th} = 40 kA/1 s and I_{dyn} = 100 kA
Number of order:	21530-U00051/12
Test method:	IEC 60044-3:2002
Location of test:	High Power Laboratory
Date of test:	18.02.2013.
Date of issue:	05.03.2013.
Additions:	I – Control measurements before the short-circuit test II – Control measurements after the short-circuit test

Conclusion:	On the basis of the recorded oscillogram, control measurements and visual inspection confirmed that the tested transformer has withstood the dynamic and thermic stresses under short-circuit conditions given in this report in accordance with testing specification.

Test Engineers: Ž. Nehadović, ing. **Laboratory Manager:** I. Šimec, dipl.ing.

The test results apply only to the apparatus tested. ZAGREB

File: 102-8/4

Address: KONČAR – Electrical Engineering Institute, Inc. Phone: 385 (0)1 3667-315 Fax: 385 (0)1 3667-309
pp 202, HR-10002 ZAGREB, Fallerovo šetalište 22 385 (0)1 3666-351
http://www.koncar-institut.hr e-mail: info-iet@koncar-institut.hr
High Power Laboratory Phone: 385 (0)1 3656293 Fax: 385 (0)1 3667-334

LIST OF EQUIPMENT USED IN TESTS AND ENVIROMENTAL CONDITIONS

- Shunts primary 85 kA, No. LVS 57 and secondary 60 A, No. 1 and 2, manufacturer Rade Končar.
- Tranzient recorderTR12K, manufacturer HermoLab
- Humidity and temperature meter, type HM34C, No. C3710019, manufacturer Vaisala.

- Temperature during test: 5 °C
- Humidity during test: 62 %

DESCRIPTION AND METHOD OF THE TEST

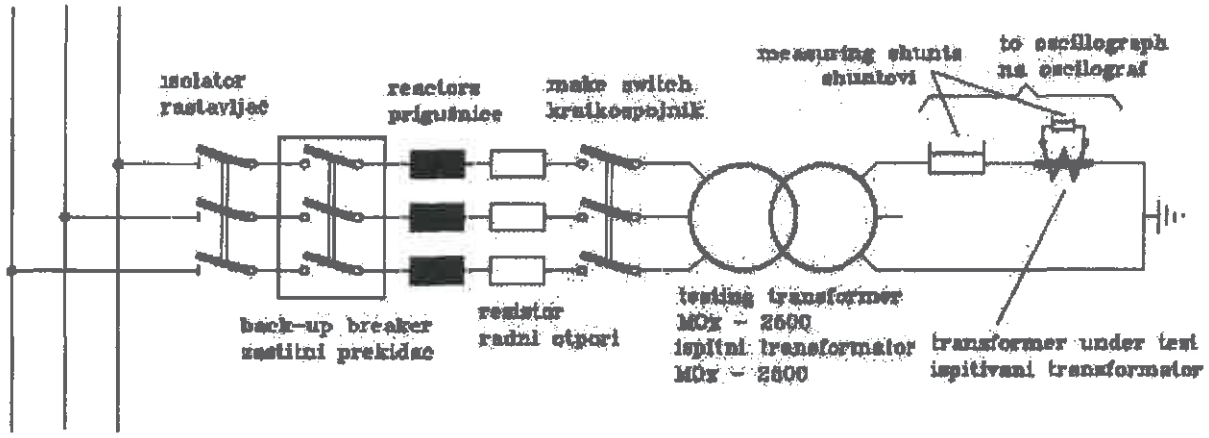
A current part of combined instrument transformer with type designation VAU-123, having rated transformation ratio 400 / 1/1/1/1 A, and part / serial number M112492 / 31100116 was subjected to short-time current tests. Rating plate of the tested current transformer is shown on page 4 picture 3 and drawing on page 5 picture 4.

Test was performed in connection for transformation ratio 400/1/1/1/1 A.

The primary (P1-P2) and the secondary (1S1-1S2 and 4S1-4S2) test currents were measured by means of shunts and recorded by transient recorder TR12K.

The scheme of the test circuit is shown on page 2 picture 1 and the test arrangement is shown on the photos 1a and 1b, page 4.

Picture 1. Wiring diagram of the testing circuit:



One test was performed under thermal and dynamic conditions (oscillogram No. 6297).

Oscillogram No. 6297 (picture 2, page 3) is included in this Report and results taken from test oscillograms are listed in table 1.

In table 2 are shown channel arrangements for each channel.

Visual check of the tested transformer after the short-time current tests has not discovered any damage due to the test.

Before and after the short-time current test the tested transformer was subjected to dielectric tests and measurements of current and phase errors according to clause 7.1 from IEC 60044-3:2002.
Results of these tests are given in App. I and App. II.

Table 1: Characteristic values taken from oscillographic record

Test No.	Oscillogram No.	CURRENT				Time [s]
		Peak value [kA_{max}]	r. m. s. [kA]			
		Primary	Primary	Secondary		
		P1 – P2	P1 – P2	1S1 – 1S2	4S1 – 4S2	
1	6297	**105.8**	**41.78**	0.027	0.107	**1.01**

Remark: Secondary current was measured for information purposes only.

Table 2: channel arrangement for each channel (oscillogram No. 6297)

Ch. number	Offset	Ch. Name	Scale
#1	3	Primary Current (I_{P1-P2})	110 kA/Div
#2	2	Secondary Current ($I_{1S1-1S2}$)	100 A/Div
#3	1	Secondary Current ($I_{4S1-4S2}$)	400 A/Div

Picture 2 - Oscillogram No. 6297:

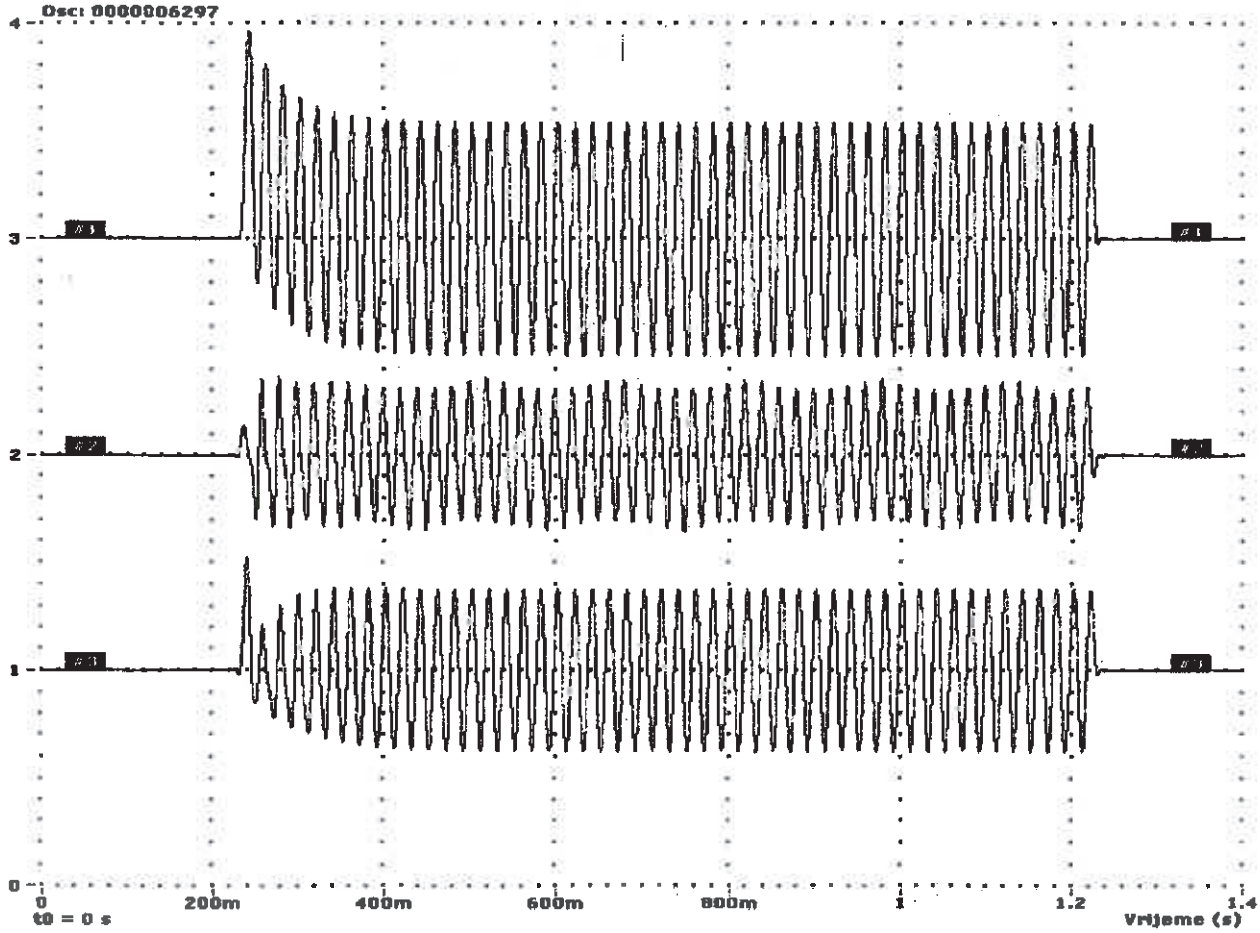


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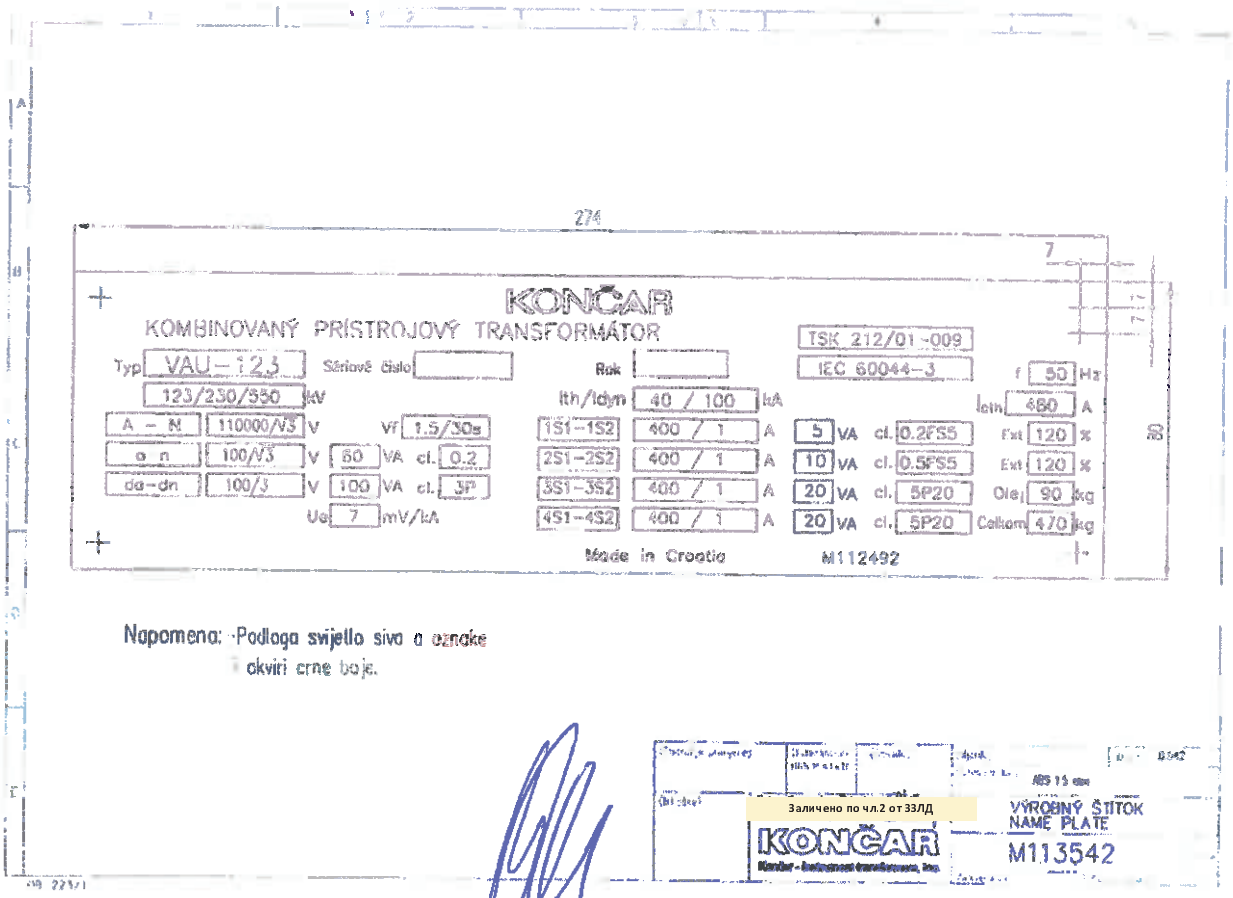
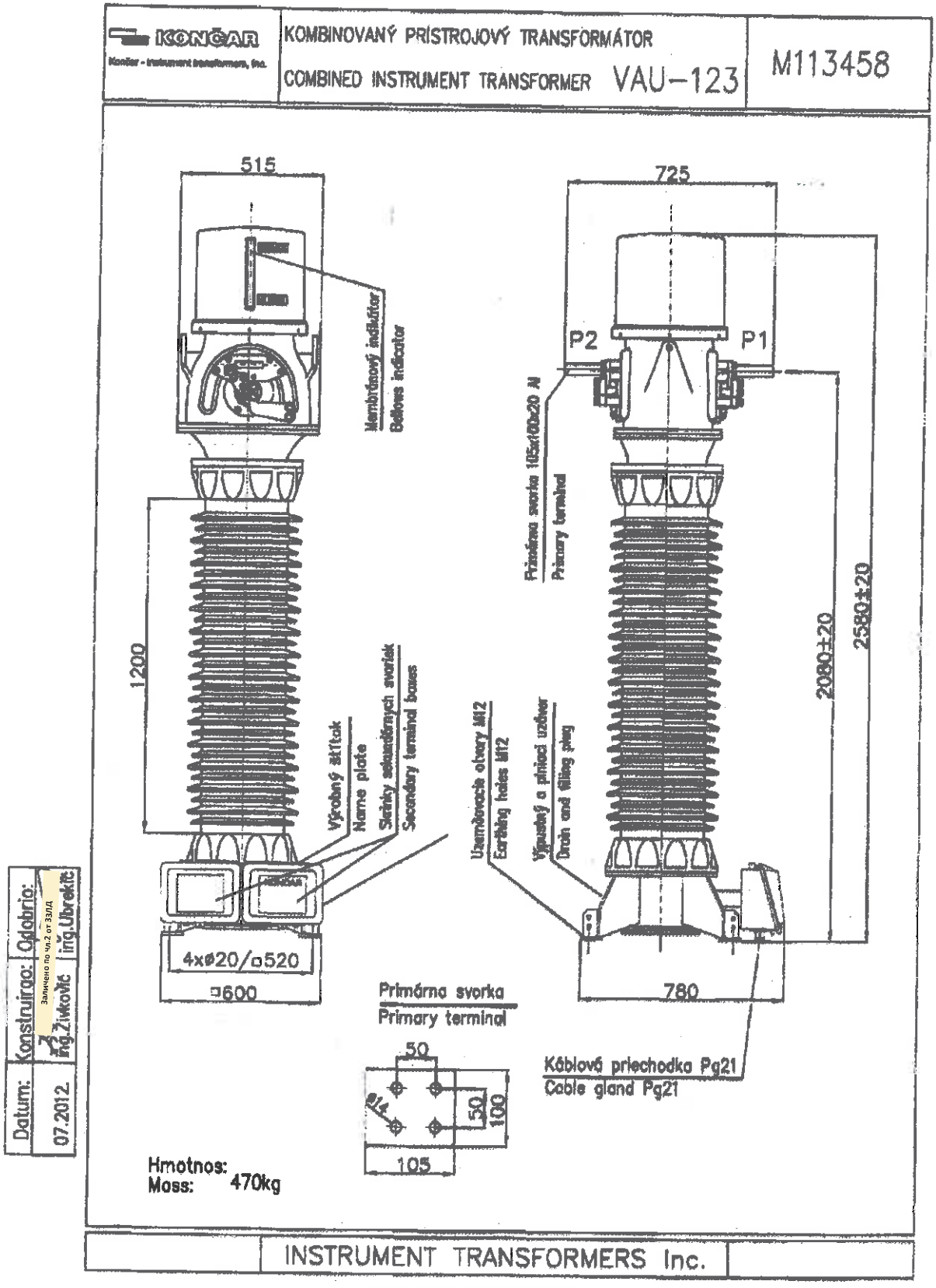
Photo 1a – Test disposition primary connections

Photo 1b – Test disposition secondary connections

Picture 3: Rating plate drawing No.: M113542



Picture 4: combined transformer drawing No. M113458



——End of the Test Report——

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KONČAR
Končar - Instrument transformers, Inc.

ISPITNI LIST KOMBINIRANOG TRANSFORMATORA
COMBINED TRANSFORMER TEST REPORT

Strana: / Page: 1/2

Br. dijela: / No.: M112492

Naručilac: / Purchaser:	EFACEC Austria for JAVYS Slovakia	Br. ugovora: / Contract No:	C.11.003/2012-0006 356 - 33218	Ispitano prema: / Tested against:	IEC 60044-3

KOMBINIRANI TRANSFORMATOR / COMBINED TRANSFORMER — Tip / Type: VAU-123 — TSK 212/01-009 — Br. / No.: 31100116

123 / 230 / 550 kV — Kl. izolacije / Cl. of. ins.: A — Frekv. / Freq.: 50 Hz — Godina proizvodnje / Year of manuf.: 2012.

NAPONSKI TRANSFORMATOR / VOLTAGE TRANSFORMER — A - N — 110000/√3 V — Vf: 1.5/30s

a - n	100 / √3 V	60 VA	r.t. cl.	0,2	
da - dn	100 / 3 V	100 VA	r.t. cl.	3P	
	V	VA	r.t. cl.		

STRUJNI TRANSFORMATOR / CURRENT TRANSFORMER — I_{th}/I_{dyn}: 40 / 100 kA — I_{cth}: 480 A

1S1 - 1S2	400 / 1 A	5 VA	r.t. cl.	0,2 FS 5	ext	120	%
2S1 - 2S2	400 / 1 A	10 VA	r.t. cl.	0,5 FS 5	ext	120	%
3S1 - 3S2	400 / 1 A	20 VA	r.t. cl.	5 P 20	Masa ulja / Oil mass	90	kg
4S1 - 4S2	400 / 1 A	20 VA	r.t. cl.	5 P 20	Ukupna masa / Total mass	470	kg

1 — ISPITIVANJE IZOLACIJE NAPONOM MREŽNE FREKVENCIJE / POWER-FREQUENCY WITHSTAND TESTS

VN namot strujnog transformatora prema NN namotima i uzemljenim dijelovima / H.V. winding of the current transformer against L.V. windings and earthed parts	230 kV	Trajanje / Duration	50 sec	Frekv. / Freq.	120 Hz
VN namot naponskog transformatora prema NN namotima i uzemljenim dijelovima / H.V. winding of the voltage transformer against L.V. windings and earthed parts	3 kV	Trajanje / Duration	60 sec	Frekv. / Freq.	50 Hz
NN namot prema NN namotima i uzemljenim dijelovima / L.V. winding against L.V. windings and earthed parts	3 kV	Trajanje / Duration	60 sec	Frekv. / Freq.	50 Hz

2 — MJERENJE FAKTORA DIELEKTRIČKIH GUBITAKA / MEASUREMENT OF DIELECTRIC DISSIPATION FACTOR

U (kV)	2		
tg δ (%)	0,380		
Cx (pF)	2943		

3 — MJERENJE PARCIJALNIH IZBIJANJA / PARTIAL DISCHARGE MEASUREMENT

U (kV)	85	123	
PD (pC)	< 5	< 10	

4 — ISPITIVANJE IZOLACIJE INDUCIRANIM NAPONOM / INTERTURN OVERVOLTAGE TEST

Naponski transformator / Voltage transformer	230 kV	Trajanje / Duration	50 sec	Frekv. / Freq.	120 Hz
Strujni transformator - sekundarni namot / Current transformer - secondary winding		Trajanje / Duration	60 sec	Frekv. / Freq.	50 Hz

1S1-1S2: 32,5 V — 2S1-2S2: 60,5 V — 3S1-3S2: 539 V — 4S1-4S2: 542 V — V

5 — ODREĐIVANJE POGREŠAKA NAPONSKOG TRANSFORMATORA / DETERMINATION OF ERRORS OF THE VOLTAGE TRANSFORMER

U / Un	a - n						da - dn					
	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)
0.05	15			60			25+0	+0,45	-25,5	100+60	-0,03	-28,6
0.8		+0,07	+1,1		-0,01	+1,0						
1.0		+0,07	+1,0		-0,02	+0,9		+0,46	-26,3		-0,02	-29,4
1.2		+0,06	+0,9		-0,03	+0,8						
1.5								+0,46	-26,8		-0,02	-29,7

KONČAR Končar - Instrument transformers, Inc.	ISPITNI LIST KOMBINIRANOG TRANSFORMATORA COMBINED TRANSFORMER TEST REPORT	Strana: / Page: 2/2 Br. dijela: / No.: M112492

ODREĐIVANJE POGREŠAKA STRUJNOG TRANSFORMATORA
DETERMINATION OF ERRORS OF THE CURRENT TRANSFORMER — *No. 31100116*

6

I/In	1S1-1S2						I/In	2S1-2S2					
	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)		S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)
1.2	1,25	+0,06	+0,5	5	+0,03	+0,1	1.2	2,5	+0,35	+8,2	10	-0,08	+2,5
1.0		+0,06	+1,2		+0,02	+0,8	1.0		+0,34	+9,5		-0,10	+3,8
0.2		+0,05	+4,5		-0,06	+2,2	0.2		+0,30	+12,0		-0,30	+9,2
0.05		+0,07	+6,1		-0,12	+6,5	0.05		+0,22	+16,5		-0,58	+15,8

6

I/In							I/In						
	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)		S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)
1.2							1.2						
1.0							1.0						
0.2							0.2						
0.05							0.05						

I/In	3S1-3S2					I/In	4S1-4S2				
	S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$		S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$
1.0	20	-0,18	+2,8	< 1,0	2,82	1.0	20	-0,16	+3,2	< 1,0	2,83

I/In						I/In					
	S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$		S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$
1.0						1.0					

EQUIPMENT: 1. Bridge MWB TAB, 903504, 20555 PTB 10. 2. Etalon Končar, NVPU-420-1, Br. 1, 01/0270(10)-PTB/DZM
3.Etalon Končar, NNST-1200, 170967/2008 , 20528 PTB 10., 4.Burden N.Tesla, NO-3, 01/06, 01/0294 (10)-DZM,
5.Burden Tesla, NO-3, 02/06, 01/0293(10)-DZM, 6. Burden N.Tesla, SO-2, 0020/88, 01/0279 (10)-DZM. ; *Differential measuring method*

7 *Provjeravanje označavanja priključaka* / *Verification of terminal marking* — *ISPITANO I NAĐENO U REDU* / *TESTED AND FOUND O.K.*

Napomena:
Remarks: **OIL *SHELL DIALA S3 ZX – IG***

Tests were carried out before Short-time current tests.

ZAKLJUČAK : ***Transformator je uspješno prošao ispitivanja u skladu sa Publikacijama IEC 60044-3***
CONCLUSION : ***Transformer satisfactory passed the tests in accordance with Publications IEC 60044-3***

Zagreb, 31. 10. 2012.

KONČAR
Končar - Instrument transformers, Inc.

ISPITNI LIST KOMBINIRANOG TRANSFORMATORA
COMBINED TRANSFORMER TEST REPORT

Strana / Page: 1/2
Br. dijela / No.: M112492

Naručilac / Purchaser:	EFACEC Austria for JAVYS Slovakia	Br. ugovora / Contract No:	C.11.003/2012-0006 356 - 33218	Ispitano prema / Tested against:	IEC 60044-3

KOMBINIRANI TRANSFORMATOR / COMBINED TRANSFORMER — Tip / Type: VAU-123 — TSK 212/01-009 — Br. / No.: 31100116

123 / 230 / 550 kV — Kl. izolacije / Cl. of ins.: A — Frekv. / Freq.: 50 Hz — Godina proizvodnje / Year of manuf.: 2012.

NAPONSKI TRANSFORMATOR / VOLTAGE TRANSFORMER — A - N — 110000/√3 V — Vf: 1.5/30s

a - n	100 / √3 V	60 VA	r.t. cl.	0,2	
da - dn	100 / 3 V	100 VA	r.t. cl.	3P	
	V	VA	r.t. cl.		

STRUJNI TRANSFORMATOR / CURRENT TRANSFORMER — I_{th}/I_{dyn}: 40 / 100 kA — I_{cth}: 480 A

1S1 - 1S2	400 / 1 A	5 VA	r.t. cl.	0,2 FS 5	ext	120	%
2S1 - 2S2	400 / 1 A	10 VA	r.t. cl.	0,5 FS 5	ext	120	%
3S1 - 3S2	400 / 1 A	20 VA	r.t. cl.	5 P 20	Masa ulja / Oil mass	90	kg
4S1 - 4S2	400 / 1 A	20 VA	r.t. cl.	5 P 20	Ukupna masa / Total mass	470	kg

1 ISPITIVANJE IZOLACIJE NAPONOM MREŽNE FREKVENCIJE / POWER-FREQUENCY WITHSTAND TESTS

VN namot strujnog transformatora prema NN namotima i uzemljenim dijelovima / H.V. winding of the current transformer against L.V. windings and earthed parts	207 kV	Trajanje / Duration	50 sec	Frekv. / Freq.	120 Hz
VN namot naponskog transformatora prema NN namotima i uzemljenim dijelovima / H.V. winding of the voltage transformer against L.V. windings and earthed parts	3 kV	Trajanje / Duration	60 sec	Frekv. / Freq.	50 Hz
NN namot prema NN namotima i uzemljenim dijelovima / L.V. winding against L.V. windings and earthed parts	3 kV	Trajanje / Duration	60 sec	Frekv. / Freq.	50 Hz

2 MJERENJE FAKTORA DIELEKTRIČKIH GUBITAKA / MEASUREMENT OF DIELECTRIC DISSIPATION FACTOR

U (kV)	2			
tg δ (%)	0,375			
Cx (pF)	2945			

3 MJERENJE PARCIJALNIH IZBIJANJA / PARTIAL DISCHARGE MEASUREMENT

U (kV)	85	123	
PD (pC)	< 5	< 10	

4 ISPITIVANJE IZOLACIJE INDUCIRANIM NAPONOM / INTERTURN OVERVOLTAGE TEST

Naponski transformator / Voltage transformer	0,9 x	230 kV	Trajanje / Duration	50 sec	Frekv. / Freq.	120 Hz
Strujni transformator - sekundarni namot / Current transformer - secondary winding			Trajanje / Duration	60 sec	Frekv. / Freq.	50 Hz

1S1-1S2: 32,5 V — 2S1-2S2: 60,5 V — 3S1-3S2: 539 V — 4S1-4S2: 542 V — V

5 ODREĐIVANJE POGREŠAKA NAPONSKOG TRANSFORMATORA / DETERMINATION OF ERRORS OF THE VOLTAGE TRANSFORMER

U / Un	a - n						da - dn					
	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)
0.05	15			60			25+0	+0,47	-25,5	100+60	-0,01	-28,6
0.8		+0,07	+1,0		-0,02	+0,9						
1.0		+0,07	+0,9		-0,03	+0,9		+0,46	-26,5		-0,02	-29,5
1.2		+0,06	+0,8		-0,04	+0,8						
1.5								+0,45	-27,0		-0,03	-29,9

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KONČAR Končar - Instrument transformers, Inc.	ISPITNI LIST KOMBINIRANOG TRANSFORMATORA COMBINED TRANSFORMER TEST REPORT	Strana: / Page: 2/2 Br. dijela: / No.: M112492

ODREĐIVANJE POGREŠAKA STRUJNOG TRANSFORMATORA
DETERMINATION OF ERRORS OF THE CURRENT TRANSFORMER — *No. 31100116*

6

I/In	1S1-1S2						I/In	2S1-2S2					
	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)		S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)
1.2	1,25	+0,06	+0,5	5	+0,03	+0,1	1.2	2,5	+0,35	+8,5	10	-0,08	+2,5
1.0		+0,06	+1,2		+0,02	+0,8	1.0		+0,34	+9,5		-0,10	+3,8
0.2		+0,05	+4,5		-0,06	+2,2	0.2		+0,30	+12,0		-0,31	+9,0
0.05		+0,06	+6,0		-0,11	+6,5	0.05		+0,21	+16,5		-0,55	+15,5

6

I/In							I/In						
	S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)		S(VA)	p(%)	δ(min)	S(VA)	p(%)	δ(min)
1.2							1.2						
1.0							1.0						
0.2							0.2						
0.05							0.05						

I/In	3S1-3S2					I/In	4S1-4S2				
	S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$		S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$
1.0	20	-0,17	+3,0	< 1,0	2,82	1.0	20	-0,15	+3,0	< 1,0	2,83

I/In						I/In					
	S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$		S(VA)	p(%)	δ(min)	ε_c (%)	$R_{75°C}(\Omega)$
1.0						1.0					

EQUIPMENT: 1. Bridge MWB TAB, 903504, 20555 PTB 10. 2. Etalon Končar, NVPU-420-1, Br. 1, 01/0270(10)-PTB/DZM
3.Etalon Končar, NNST-1200, 170967/2008 , 20528 PTB 10., 4.Burden N.Tesla, NO-3, 01/06, 01/0294 (10)-DZM,
5.Burden Tesla, NO-3, 02/06, 01/0293(10)-DZM, 6. Burden N.Tesla, SO-2, 0020/88, 01/0279 (10)-DZM. ; *Differential measuring method*

7 *Provjeravanje označavanja priključaka* / *Verification of terminal marking* — *ISPITANO I NAĐENO U REDU* / *TESTED AND FOUND O.K.*

Napomena:
Remarks: *OIL SHELL DIALA S3 ZX – IG*

Tests were carried out after Short-time current tests.

ZAKLJUČAK : ***Transformator je uspješno prošao ispitivanja u skladu sa Publikacijama IEC 60044-3***
CONCLUSION : ***Transformer satisfactory passed the tests in accordance with Publications IEC 60044-3***

Zagreb, *20. 02. 2013.*

KONČAR
Končar - Instrument transformers, Inc.

TEST REPORT

No : 013045
Page : 1/2

Test performed:.....**Radio interference voltage test**

Test object:.....**Combined transformer**

Tip / Type:.....**VAU – 123 (M112492)**

Serial No.:.....**31100116**

Manufacturer:..... KONČAR - Instrument transformers Inc.

Place of the test:.....KONČAR - Instrument transformers Inc.

Normative document:.....Publication IEC 61869-1

Date of the test:.....22.02.2013.

Results:..... **Positive**

Ispitao / Tested by:

Potvrdio / Approved by:

Заличено по чл.2 от ЗЗЛД

Zagreb, 25. 02. 2013.

Radio interference voltage measuraement

1. Purpose of the test

The test was carried out to demonstrate that the behaviour of the combined transformer type VAU-123 is in accordance with IEC Publication 61869-1, Clause 6.11.2.

The test was carried out in accordance with procedure described in IEC 61869-1 Clause 7.2.5.1.
Surrounding conditions were as follows :

- temperature 22° C
- humidity 55 %
- pressure 1010 hPa

Measurung circuit was in accordance with CISPR 18-2 measuring frequency 0,5 MHz. Measurement was performed with "Siemens" device with measuring impedance 300 Ω.

Calibration of measuring circuit was done in accordance with CISPR 18-2.

2. Test result

Transformer was subjected to pre-stress voltage of 1.5 x Um/√3 (106,5 kV) and maintained for 30 sec. After that, the test voltage was decreased to 1.1 x Um/√3 (78,1 kV) in about 10 sec. The voltage was maintained at this value for 30 sec. before measuring the radio interference voltage.

Serial No.	RIV (μV)
31100116	30

Combined transformer type VAU-123 serial no. 31100116 satisfactory passed the test carried out in accordance with IEC 61869-1, because radio interference voltage does not reach prescribed value of 2500 μV.

ISPITIVANJE MEĐUSOBNOG UTJECAJA
DETERMINATION OF MUTUAL INFLUENCE

Objekt ispitivanja : Kombinirani transformator VAU-123, Serijski broj 31100116
Object of the test : Combined transformer type VAU-123, Serial No. 31100116

Ispitivanje je provedeno u skladu sa zahtjevima :
Test was carried out according to the requirements of: IEC 61869-4

Svrha ispitivanja .
The purpose of the test :

Svrha ispitivanja je da se odredi najveće odstupanje naponske/strujne pogreške uzrokovano utjecajem strujnog odnosno naponskog transformatora.
The purpose of the test is to determine the greatest possible variation of the voltage/current error caused by the influence of current/voltage transformer.

1. Međuutjecaj strujnog transformatora na naponski transformator
The influence of the current transformer on the voltage transformer

Apsolutni iznos odstupanja naponske pogreške ± Δεv i fazne pogreške ± Δδv kod trajne termičke struje (480 A).

The absolute value of the variations of voltage error ± Δεv and of the phase displacement ± Δδv at the rated continuous thermal current (480 A).

U/Un	a - n		da - dn	
	± Δεv (%)	± Δδv (min)	± Δεv (%)	± Δδv (min)
0.02	-	-	0,20	688
0.05	-	-	0,08	2,75
0.8	0,006	0,21		
1.0	0,005	0,17	0,004	0,14
1.2	0,004	0,14		
1.5	-	-	0,0027	0,093

Zaključak / Conclusion

Apsolutnu vrijednost odstupanja naponske (± Δεv) i fazne (± Δδv) pogreške potrebno je dodati na mjerne rezultate transformatora (Ispitni list kombiniranog transformatora)-Dobiveni rezultati ne prelaze granice pogrešaka date u IEC 61869-3.

Absolute value of the variations of the voltage error (± Δεv) nad phase displacement (± Δδv) have to be added to the test results of the transformer (Test report for combined transformer)-The results does not exceed the limits given in IEC 61869-3.

2. Međuutjecaj naponskog transformatora na strujni transformator
The influence of the voltage transformer on the current transformer

Apsolutni iznos odstupanja strujne pogreške ± Δεi i fazne pogreške ± Δδi kod 120% nazivnog napona
The absolute value of the variations of current error ± Δεi and of the phase displacement ± Δδi at 120% of rated voltage.

I/In	1S1-1S2		2S1-2S2		4S1-4S2	
	± Δεi (%)	± Δδi (min)	± Δεi (%)	± Δδi (min)	± Δεi (%)	± Δδi (min)
0.05	0,095	3,3	0,095	3,3	-	-
0.2	0,0235	0,82	0,0235	0,82	-	-
1.0	0,0047	0,16	0,0047	0,16	0,013	0,45
1.2	0,0039	0,135	0,0039	0,135	-	-

Zaključak / Conclusion

Apsolutnu vrijednost odstupanja strujne (± Δεi) i fazne (± Δδi) pogreške potrebno je dodati na mjerne rezultate transformatora (Ispitni list kombiniranog transformatora)-Dobiveni rezultati ne prelaze granice pogrešaka date u IEC 61869-2.
Absolute value of the variations of the current error (± Δεi) nad phase displacement (± Δδi) have to be added to the test results of the transformer (Test report for combined transformer)-The results does not exceed the limits given in IEC 61869-2.

Zagreb, 26. 02. 2013.

Ispitao/Tested by: Marko Čukman, B.Sc.(Eng)

KONČAR - Mjerni transformatori d.d. ZAGREB, Josipa Mokrovića 10

Kontrolirao/Checked by: Mladen Kranjčec, B.Sc.(Eng)

Заличено по чл.2 от ЗЗЛД

KONČAR
Končar - Instrument transformers, Inc.

TEST REPORT

No : 013046
Page : 1/2

Test performed:.....**Mechanical test**

Test object:.....**Combined transformer**

Tip / Type:.....**VAU – 123 (M112492)**

Serial No.:.....**31100116**

Manufacturer:.....KONČAR - Instrument transformers Inc.

Place of the test:.....KONČAR - Instrument transformers Inc.

Normative document:.....Publication IEC 61869-1

Date of the test:.....25.02.2013.

Results:..... **Positive**

Ispitao / Tested by:

M. Cukman, B.Sc. (Eng)

Potvrdio / Approved by:

M. Kranjčec, B.Sc. (Eng)

Заличено по чл.2 от ЗЗЛД

Zagreb, 27.02.2013.

Mechanical test

1. Purpose of the test

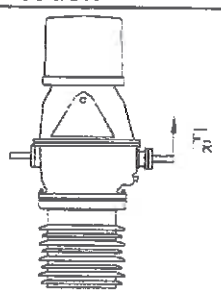
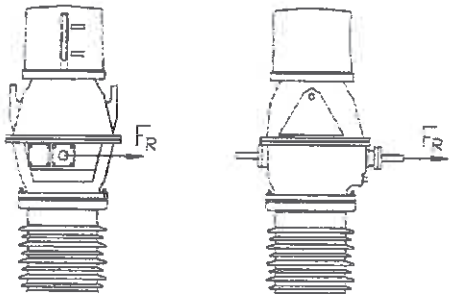
The tests were carried out to demonstrate that the transformer is capable of complying with the requirements specified in standard IEC 61869-1 Clause 7.4.5 and special customer's requirements.

During the test the transformer was installed in a vertical position with the frame rigidly fixed.

Specified test loads of 4000 N were applied for 60 seconds for each of the conditions given in Table below.

2. Result of the test

Combined transformer type **VAU-123** serial No. 31100116 successfully passed the test, because there was no evidence of damage during and after the test (there was no deformation, rupture or leakage).

Modality of application	
Vertical	
Horizontal	

Test item:
Secondary terminal box of CT and VT instrument transformers

Manufacturer:
Končar –Mjerni transformatori d.d.
Josipa Mokrovića 10, 10090 Zagreb.

Test ordered by:
Končar –Mjerni transformatori d.d.
Josipa Mokrovića 10, 10090 Zagreb

Number of contract:
Order No. 356-41220.

Test specification:
Testing and Verification of the degree of protection provided by enclosures (IP Code)
Protection degree IP65

Test method:
EN 60529 :1991+A1 :2000 (IEC 60529 :1989 +A1:1999) – IP65

Location of test:
IP laboratory in EMC & Safety Laboratory
Končar Institut za elektrotehniku d.d. Fallerovo šetalište 22. 10000 Zagreb

Date of test:
28.02.2011. – 03.03.2011.

Date of issue:
17.03.2011.

Additions:
IP 65 – model; Par.Nr.M95666; M95664

Conclusion:

The sample of product complies with the requirements for performed tests.
See Clause 3.

Test realized by:

Dar

Head of Laboratory:

Заличено по чл.2 от ЗЗЛД

elektrotehniku d. d.
ZAGREB 6

Address: KONČAR – Electrical Engineering Institute, Inc.
pp 202, HR-10002 ZAGREB, Fallerovo Šetalište 22
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TABLE OF CONTENTS

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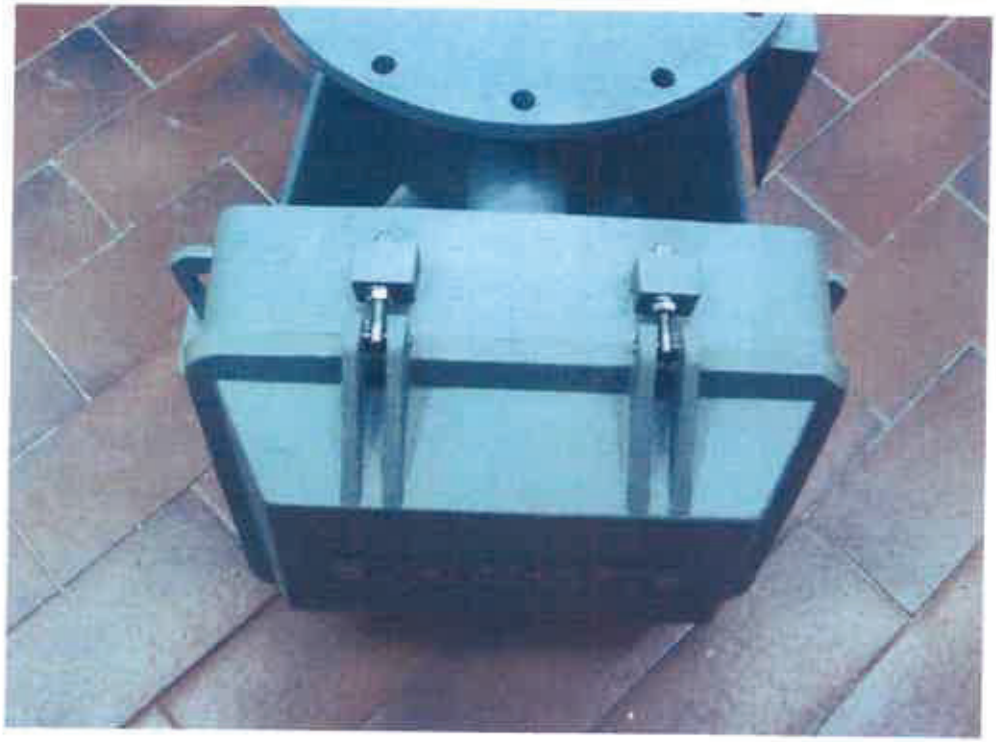
1. DEVICE UNDER TEST / PRODUCT DESCRIPTION

Product:	Secondary terminal box of CT and VT instrument transformers
Model:	-
Serial No:	Prototype
Manufacturer:	Končar –Mjerni transformatori d.d. Josipa Mokrovića 10, 10090 Zagreb
Rating:	-

Results are valid only for tested device.

2. TEST RESULTS

According to request of applicant, the EUT was tested to IP 65. The test results for the first digit are schown on the pictures 3, 4 and 5. The test results for the second digit are schown on the pictures 6, 7, 8, 9, 10, 11 and 12.



Picture 1: Photo of equipment under test – EUT

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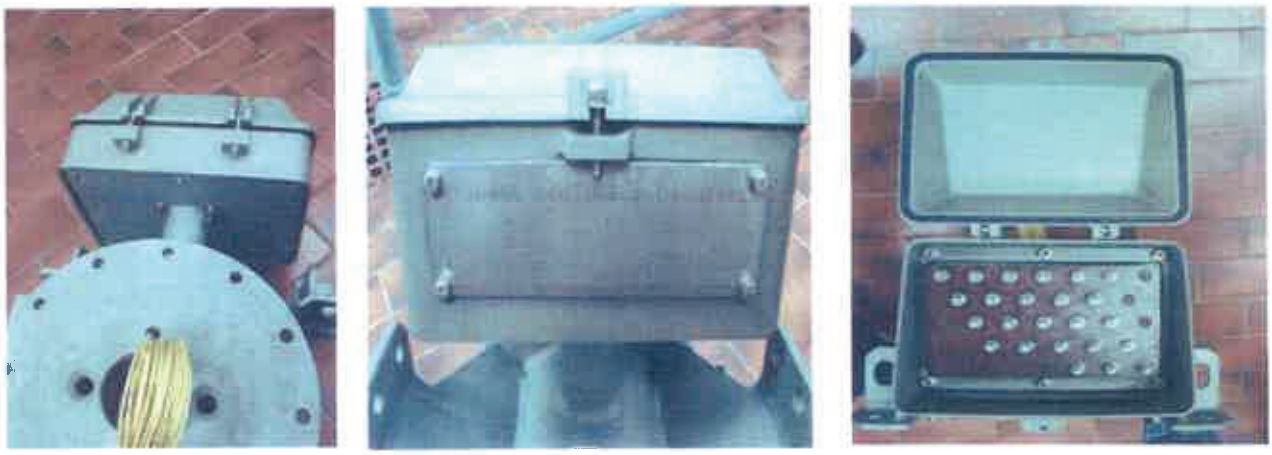

Picture 2: Photos of the **EUT before test as delivered on 28.02.2011**

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Picture 3: Photos on starting of dust resistance test on the EUT

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Picture 4: Photo on finish of dust resistance test on the EUT

Picture 5: **Photos on finish of dust resistance test on** the EUT

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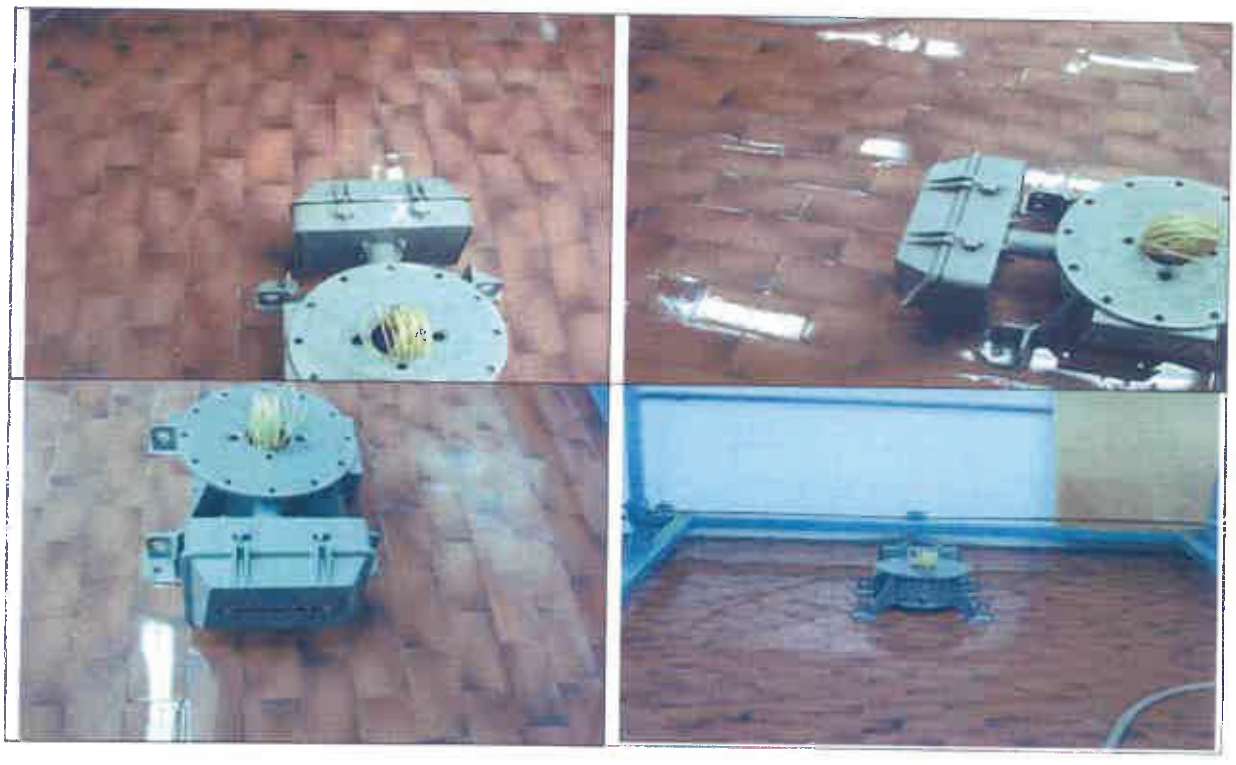
Picture 6: Water resistance test on the EUT



Picture 7: Water resistance test on the EUT

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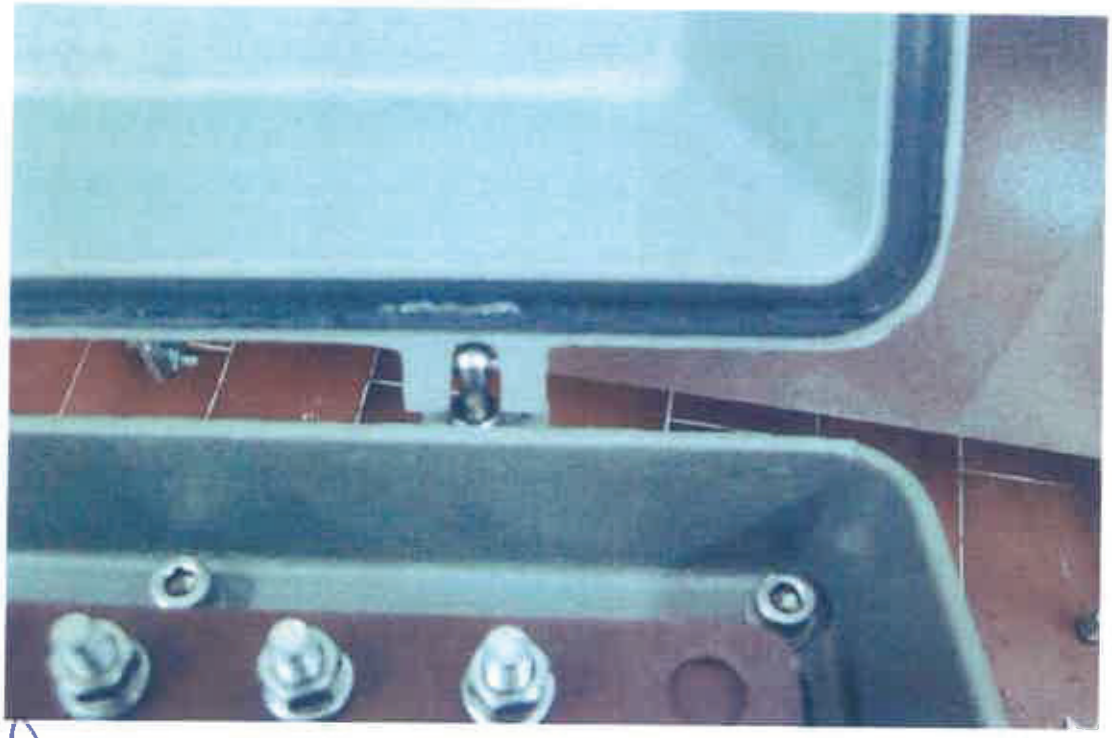
Picture 8: Results of water resistance test on the EUT

Picture 9: Results of water resistance test on the EUT



Picture 10: Results of water resistance test on the EUT

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Picture 11: Result of water resistance test on the EUT

Picture 12: Result of water resistance test at the EUT

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3. CONCLUSION

The sample of Secondary terminal box of CT and VT instrument transformers produced by Koncar instrument transformer Zagreb was tested in Laboratory for IP in Laboratory for EMC & Safety of Koncar Institute according request of norms EN 60529 :1991+A1 :2000 (IEC 60529 :1989 +A1:1999). Conclusion after performed tests is that EUT comply the requirements of protection degree IP65.

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Potvrda o akreditaciji
Accreditation Certificate

Ovime se utvrđuje da je
This is to recognize that

Končar - Institut za elektrotehniku d.d. Visokonaponski laboratorij
Fallerovo šetalište 22, HR-10000 Zagreb

osposobljen prema zahtjevima norme
is competent according to
HRN EN ISO/IEC 17025:2007
(ISO/IEC 17025:2005+Cor.1:2006;
EN ISO/IEC 17025:2005+AC:2006)
za/to carry out

Visokonaponska ispitivanja elektroenergetske opreme
High voltage testing on electrical equipment

u području opisanom u prilogu koji je sastavni dio ove potvrde o akreditaciji.
for the scope described in the annex which is the constituent part of this accreditation certificate.

Br./No.: 1035
Klasa/Ref.No.: 383-02/13-30/038
Urbroj/Id.No.: 589-02/11-14-32
Zagreb, 2014-09-13

Akreditacija istječe-Accreditation expiry: 2019-09-12
Prva akreditacija-Initial accreditation: 1999-11-30

HAA je potpisnica multilateralnog sporazuma s Europskom organizacijom za akreditaciju (EA)
HAA is a signatory of the European co-operation for Accreditation (EA) Multilateral Agreement

Ravnateljica:
Director General:
Mr. sc. Biserka Bajzek Brezak, dipl. ing.

HAA

Hrvatska akreditacijska agencija
Croatian Accreditation Agency

HAA-Ob-7/7-1/Izdanje/Issue 6

KONČAR
ZAGREB

Верно с оригиналом

Potvrda o akreditaciji
Accreditation Certificate

Ovime se utvrđuje da je
This is to recognize that

KONČAR - MJERNI TRANSFORMATORI d.d.
Sektor za kvalitetu, inspekciju/ovjeru i ispitivanje mjernih transformatora i umjeravanje mjerne opreme
Odjel ispitnog laboratorija MT i umjernog laboratorija MO
Josipa Mokrovića 10, HR-10090 Zagreb

osposobljen prema zahtjevima norme
is competent according to
HRN EN ISO/IEC 17025:2007
(ISO/IEC 17025:2005+Cor.1:2006,
EN ISO/IEC 17025:2005+AC:2006)
za/to carry out

Ispitivanje mjernih transformatora
Testing of instrument transformers

u području opisanom u prilogu koji je sastavni dio ove potvrde o akreditaciji.
for the scope described in the annex which is the constituent part of this accreditation certificate.

Br./No.: 1518
Klasa/Ref.No.: 383-02/15-30/010
Urbroj/Id.No.: 569-03/3-16-9
Zagreb, 2016-01-19

Akreditacija istječe-Accreditation expiry: 2021-01-18
Prva akreditacija-Initial accreditation: 2016-01-19

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Director General:
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HAA-Ob-7/7-1/izdanje/issue 6

3
d.d.
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REPUBLIC OF MACEDONIA
University "Ss. Cyril and Methodius" in Skopje
Institute of Earthquake Engineering and Engineering Seismology - Skopje
73 Salvador Aljende str., P.O. Box 101, Skopje 1000, Republic of Macedonia

Department
Dynamic Testing Laboratory (DYNLAB)
& Informatics

Report IZIIS 2012 - 40

Seismic Test-Qualification Report

Qualified to Level MODERATE ; 0.30 g ZPA of the RRS
High or Moderate

Combined Instrument Transformer VAU–123
Equipment Designation

123 kV
kV or equipment rating

Report Prepared by: Prof. Dr. Zoran Rakicevic
Igor Markovski, grad. el. eng.
Dejan Filipovski, grad. el. eng.

Date Signed or Revised: August, 2012

Address of Preparer:
Institute of Earthquake Engineering and Engineering Seismology - IZIIS
Salvador Aliende 73, P.O. Box 101, 1000 Skopje
Republic of Macedonia

Equipment Manufactured by:
KONČAR-Mjerni transformatori d.d.
Josipa Mokrovića 10, 10090 Zagreb, Croatia

This is to certify that the above-named equipment without support meets and exceeds all of the requirements according to the IEEE Std 693-2005

Заличено по чл.2 от ЗЗЛД

Signed.

Заличено по чл.2 от ЗЗЛД

Заличено по чл.2 от ЗЗЛД

REPUBLIC OF MACEDONIA
University "Ss. Cyril and Methodius" in Skopje
Institute of Earthquake Engineering and Engineering Seismology - Skopje
73 Salvador Aljende str., P.O. Box 101, Skopje 1000, Republic of Macedonia

Department
Dynamic Testing Laboratory (DYNLAB)
& Informatics

Report IZIIS 2012 - 40

Seismic Test-Qualification Report

Qualified to Level **MODERATE** (High or Moderate); **0.30** g ZPA of the RRS

Combined Instrument Transformer VAU–123
Equipment Designation

123 kV
kV or equipment rating

Report Prepared by: Prof. Dr. Zoran Rakicevic
Igor Markovski, grad. el. eng.
Dejan Filipovski, grad. el. eng.

Date Signed or Revised: August, 2012

Address of Preparer:
Institute of Earthquake Engineering and Engineering Seismology - IZIIS
Salvador Aliende 73, P.O. Box 101, 1000 Skopje
Republic of Macedonia

Equipment Manufactured by:
KONČAR-Mjerni transformatori d.d.
Josipa Mokrovića 10, 10090 Zagreb, Croatia

This is to certify that the above-named equipment without support meets and exceeds all of the requirements according to the IEEE Std 693-2005

Signed:_____

Director of IZIIS

Prof. Dr. Mihail Garevski

FOREWORD

According to the agreement No 08-894/1, from 31.05.2012 signed by the Investor: KONČAR Instrument Transformers Inc, Represented by: Boris Bojanic, member of a Managing Board, with a seat in Josipa Markovica 10, 10090 Zagreb, Croatia, and Contractor: Institute of Earthquake Engineering and Engineering Seismology, IZIIS – Skopje, University "St. Cyril and Methodius", Skopje, Represented by: Prof. Dr. Mihail Garevski, Director , with a seat in Salvador Aljende str. No. 73, Skopje, Republic of Macedonia, Seismic Qualification of the Transformer VAU-123, Time History Shaking Table Testing have been conducted.

For the purpose of these testing KONČAR Instrument transformers Inc provided one VAU-123, new, at the beginning of July 2012. The proposed experimental programme was fully realized in July 2012.

This Seismic Test - Qualification Report is prepared according to the Annex T of the IEEE Std.693-2005, based on the Laboratory Test Report IZIIS-Report 2012-35.

The presented results in the Seismic Qualification Tests are only valid for tested configuration of the combined transformer VAU-123, Manufactured by KONČAR Instrument Transformers Inc, from Zagreb, Croatia. Any modifications in assembling configuration, assembling parts and/or supporting structure are not covered by this seismic qualification.

The Seismic Test - Qualification Report counts 44 pages in total (including cover page, foreword, basic data and table of contents pages), and shall not be reproduced except in full, without written approval of the IZIIS Dynamic Testing Laboratory.

BASIC DATA OF TEST REPORT

CONTRACT:	No 08-894/1, date 31.05.2012 Skopje, Republic of Macedonia
ORDERING PARTY:	KONCAR Instrument Transformers Inc, Croatia
SUBJECT:	Seismic Qualification According to IEEE Std. 693-2005 of a Combined Transformer Type VAU-123
PERIOD OF REALIZATION:	July 1 –July 20, 2012
PLACE OF TESTING:	Dynamic Testing Laboratory (Dynlab), Institute of Earthquake Engineering and Engineering Seismology (IZIIS), Skopje, Republic of Macedonia
USED EQUIPMENT:	5 DOF 5 x 5 m MTS shaking table
USED STANDARDS:	IEEE Std. 693-2005
LABORATORY TEST REPORT:	IZIIS Report No 2012-35
DATE OF LAB TEST REPORT:	August 2012

DATE of Seismic Test - Qualification Report according to IEEE Std. 693-2005: July 2012

Total Number of Pages of the Seismic Test - Qualification Report: 44 pages (including cover page, foreword, basic data and table of content pages)

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1 KEY INFORMATION AND RESULTS

The purpose of this test was to qualify the KONCAR Combined Transformer Type VAU-123 (123 kV - 50 Hz) using the testing criteria established by the Institute of Electrical and Electronics Engineers (IEEE) in the Recommended Practice for Seismic Design of Substations Std. 693 – 2005. The tests were performed at the IZIIS Dynamic Testing Laboratory in Skopje, Republic of Macedonia.

The KONCAR Combined Transformer Type VAU-123 was qualified to the moderate seismic level (0.3 g ZPA of the RRS).

1.1 DESCRIPTION OF THE EQUIPMENT TO BE TESTED

The combined instrument transformer essentially consists of two measuring units: the inductive voltage transformer and the current transformer.

Combined instrument transformers are used to step-down current and voltage to defined values, and thus provide standardized, useable levels of current and voltage in a variety of power monitoring, measurement and protection applications while insulating the measurement and protection equipment from the high system voltage at the same time.

Combined transformer type VAU-123 (manufacturer: Končar – Instrument transformers, Inc., Zagreb) is outdoor type combined transformer with oil-impregnated paper insulation.

Končar combined instrument transformers are designed in compliance with IEC, ANSI/IEEE, GOST, AS, IS, CAN, or any other relevant standard.

The active part of the current transformer can accommodate several cores of various size and material. The cores can, depending on the required accuracy class, be made of cold-rolled grain-oriented magnetic steel, soft magnetic materials and nanocrystalline alloys.

The low voltage secondary winding is made of high-quality electrical copper wire insulated with thermal class F insulating varnish. It is uniformly wound around the core and enclosed in a frame made of high quality insulating material.

The cores and secondary winding reside inside an aluminium cast protective housing.

The primary windings is a multiple turns cable type made of fine copper wire class 6 according DIN VDE 0295/96 (IEC 60228) wound around the insulated cores housing (when having a single primary winding turn, the winding consists of a straight bar type conductor, or with external conductors for multiple turns).

The active part of the current transformer is located inside the aluminium cast transformer head which is designed in such a way to achieve minimal oil capacity.

The active part of the inductive voltage transformer has the magnetic core made of stacked silicone steel sheets. Open core (single limb) design ensures a linearized magnetizing characteristic of the transformer, which eliminates possibility of ferroresonance within the power system.

Secondary windings are wound with high-grade enamelled copper wire insulated with thermal class F directly onto the core, ensuring uniform flux density along the core height as well as phase displacement compensation. Furthermore, the large winding cross-section makes it capable of withstanding a secondary short circuit, thus contributing to transformer safety.

The advantage of the open core design lies in having the primary winding composed of multiple sections uniformly stacked vertically along the height of the transformer. This ensures controlled distribution of dielectric stress of inner and outer insulation.

Being composed of independent and insulated sections, primary winding is explosion safe to failures within primary winding turns. In an unlikely case of a between-turns or between-layers failure within primary winding, fault remains localized to only one section and cannot spread to complete primary winding. This ensures inherent explosion safety of VAU combined transformers.

Sectioned primary winding additionally ensures excellent cooling properties, which makes this transformer have high thermal output ability.

The insulation between the high voltage primary side and the low voltage secondary side is made of high quality insulating paper, grade P5318 / DIN 6740, dried and impregnated with transformer oil under high vacuum. The open-core type voltage transformer allows for a design in which the current and voltage active parts both use the same paper-oil insulation. The capacitor effect of the conductive screens inserted into the main insulation defines the optimum distribution of service voltage and makes this transformer resistant to atmospheric impulse voltages.

The transformer is hermetically closed, ensuring no contact between the oil and ambient air. Since there is no contact of oil with the atmosphere, the insulating properties are maximally preserved.

The transformer is filled with high quality inhibited transformer oil. The oil is degassed and dried in high vacuum ensuring residual humidity content of no more than 2 µg in one gram. In this way the maximum insulation dielectric properties are obtained. We guarantee the oil in our transformers does not contain polychlorinated biphenyls and terphenyls (PCB & PCT).

The insulator is made of high quality electro-grade porcelain, type C130 according IEC 60672-3 (it can be also made of porcelain type C120, or it can be composite insulator). It is cylindrically shaped and brown glazed. The creepage distance is set according to the ambient air pollution. The insulator is connected with transformer head and base through insulator flanges made of aluminium alloy AlSi10Mg(a).

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The transformer head is cast of aluminium alloy AlSi10Mg(a) which is additionally protected with paint. It is fitted with high quality metallic bellows made of stainless steel for the purpose of compensating the thermal oil dilatation.

The primary terminals are made of tin plated electrolytic copper (or it can be also made of aluminium). The terminal shape and type are designed according to the current ratings and applicable standards. The primary terminals are along with the primary connection links, mounted onto the transformer head.

Secondary terminals are M8 in size and are of the threaded bolt type made of stainless steel (other terminal types, materials and dimensions are available on request). The secondary terminals, along with optional protective devices are installed in the secondary terminal boxes. Cable glands or plates provide entry to the secondary terminal box and are designed in accordance with customers' needs.

The transformer base is made of welded structural steel plates – St 37-2, hot dip galvanized in accordance with ISO 1461-2009 (it can be also made of stainless steel or cast of aluminium alloy AlSi10Mg(a)) and additionally protected with paint. The base is equipped with the secondary terminal boxes, an oil sampling and filling valve, earthing screws and the transformer name plate. Four holes are provided for fastening the transformer onto the supporting structure.

1.1.1 GENERAL DATA OF A COMBINED TRANSFORMER

• Serial No.:	311000081
• Year of manufacture:	2012
• Type	VAU-123
• Rated voltage	U 123 kV
• Rated frequency	f_r 50 Hz
• Weight (total)	660 kg
• Temperature class	-60 ... +40 °C

1.2 DESCRIPTION OF EQUIPMENT CONFIGURATION

The Combined transformer was completely assembled according the dimensional drawing M106051 (Appendix A).

1.3 LEVEL TO WHICH THE EQUIPMENT HAS BEEN QUALIFIED

The KONCARVAU-123 has been qualified to the Moderate Seismic Qualification Level with ZPA=0.3g of RRS.

1.4 MODIFICATIONS REQUIRED TO PASS THE TEST

There was no modification required to pass the test.

1.5 ANOMALIES OR DAMAGE OBSERVED DURING THE TESTS

During and after the seismic test the current transformer showed neither damage nor loss of function.

1.6 LIST SUPPLEMENT WORK AND OPTIONS

There was no supplement work or options performed during testing.

1.7 LIST OF WITNESSES AND THE COMPANIES THE WITNESSES REPRESENTED

Mrs. Gordana Ivanovska, Koncaring, Skopje, Macedonia

1.8 TEST FACILITY, NAME, LOCATION, TELEPHONE AND FAX NUMBERS, EMAIL ADDRESS, TEST ENGINEERS NAME AND TITLE, AND TEST DATES

Test date: July 1 – July 20, 2012.

Laboratory location:

SS "Cyril and Methodius" University,
Institute of Earthquake Engineering and Engineering Seismology - IZIIS
73 Salvador Aljende Str.
1000 Skopje
Republic of Macedonia

Telephone: +389-2-3107701 Fax: +389-2-3112163

Test engineers:

Mr. Igor Markovski, Grad. Electrical Eng. email: igorm@pluto.iziis.ukim.edu.mk

Mr. Nikola Naumovski, Grad. Mechanical Eng. email: nikolan@pluto.iziis.ukim.edu.mk

Mr. Dejan Filipovski, Grad. Electrical Eng: email: dejan@pluto.iziis.ukim.edu.mk

Tests are supervised by:

Prof. Dr. Zoran Rakicevic, Grad. Civil Eng. email: zoran_r@pluto.iziis.ukim.edu.mk

1.9 DESCRIPTION OF SHAKE-TABLE TESTING EQUIPMENT (APPENDIX B)

The shake-table is described in Appendix B.

1.10 SUMMARY OF RESULTS OF SUPPLEMENTAL WORK (APPENDIX C)

There was no supplement work or options performed during testing.

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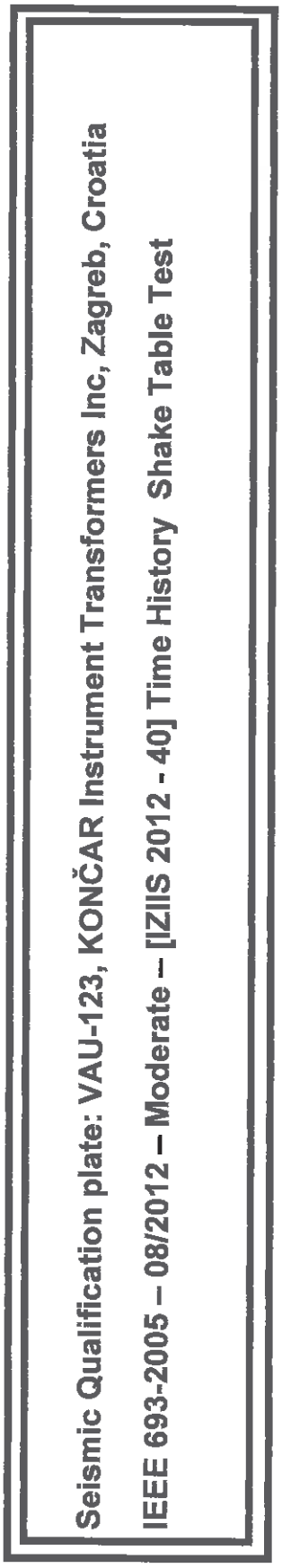
1.11 REPLICA OF IDENTIFICATION PLATE

Figure 1. Photo of The AGU-123 identification plate



Replica of Seismic qualification identification plate

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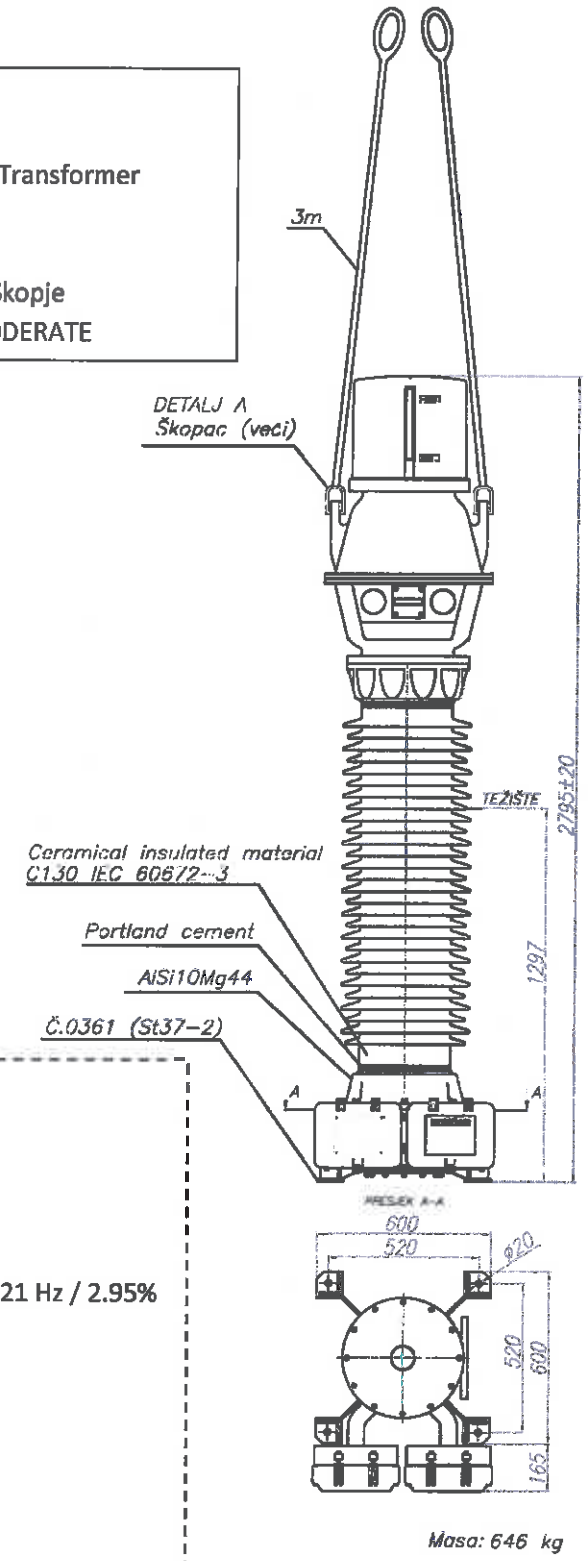
SEISMIC OUTLINE DRAWING

TYPE OF EQUIPMENT: VAU-123 Combined Transformer
EQUIPMENT VOLTAGE: 123 Kv
APPROVED BY: IZIIS
REPORT NUMBER: 2012-40, August 2012, Skopje
QUALIFIED BY IEEE 693 Std.-2005 Level MODERATE



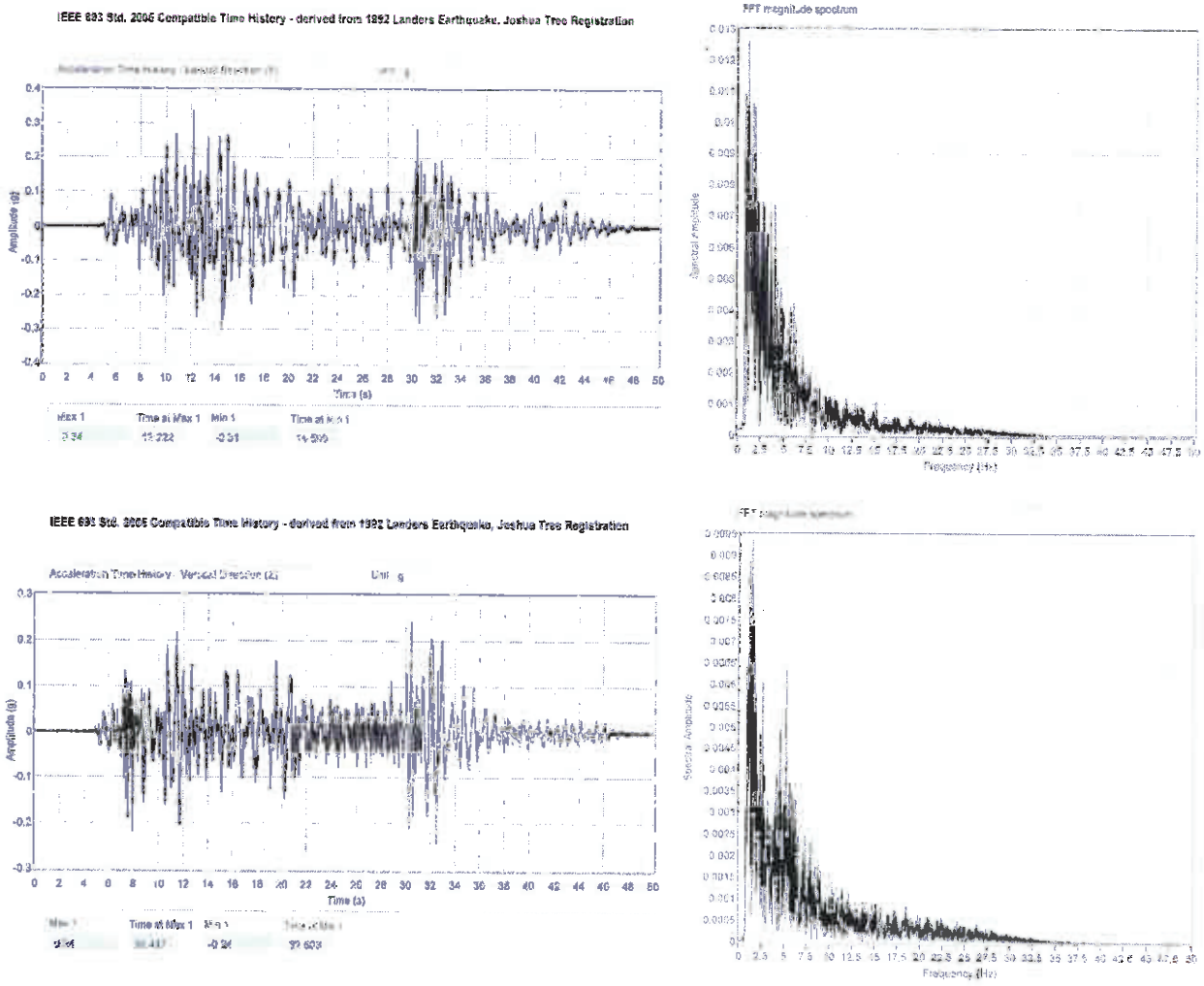
DATA:
TOTAL WEIGHT: 646 kg
CG OF EQUIPMENT ONLY:
X – 0
Y – 0
Z – 1297mm
NATURAL FREQUENCIES W/DAMPING: 8.21 Hz / 2.95%

MAXIMUM DEFLECTION: 6.85 mm
QUALIFIED BY: TIME HISTORY TEST

MANUFACTURED: KONCAR – INSTRUMENTATION TRANSFORMERS Inc.
DATE TESTED: 16.07.2012

Figure 2: Seismic outline drawing

1.12 PLOTS OF THE COMPARISON OF THE TRS TO THE RRS



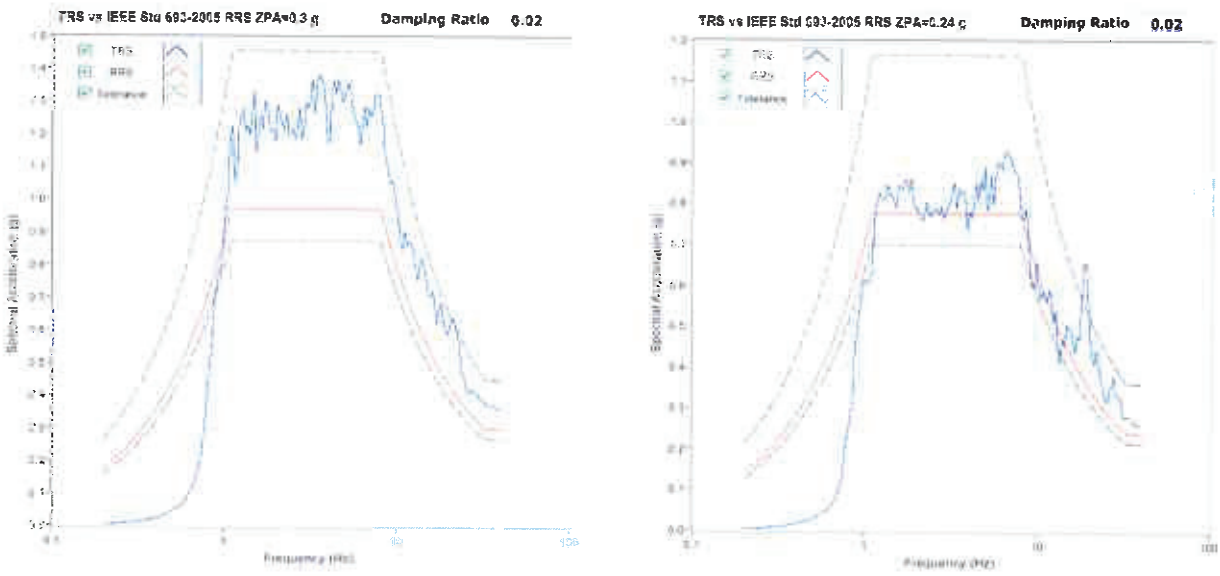


Figure 3: Input time history (Landers) and TRS vs RRS

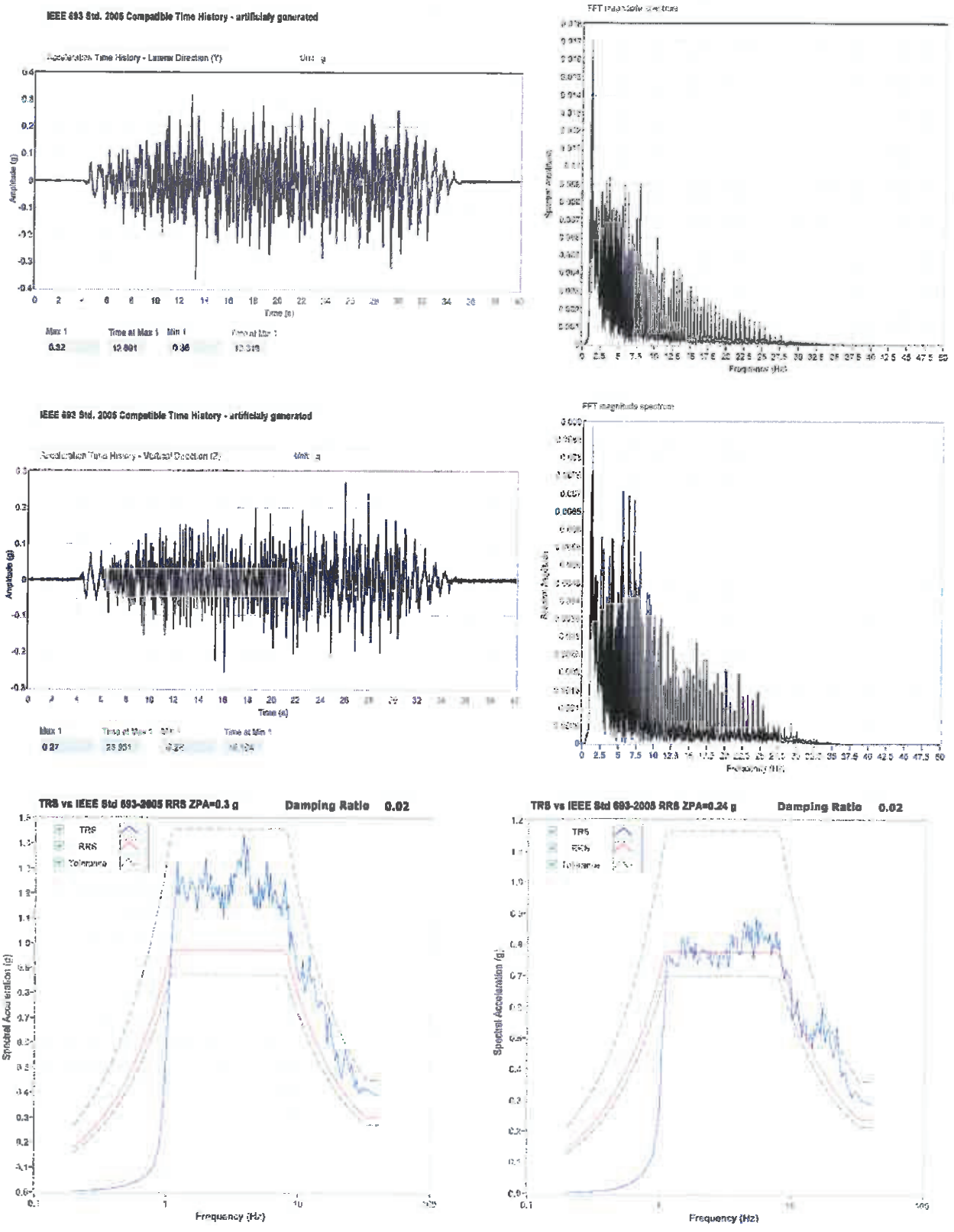


Figure 4: Input time history (Random) and TRS vs RRS

1.13 SUMMARY TABLE OF MAXIMUM CONTROLLING STRESS AND LOADS (APPENDIX G)

Table 1 : Maximum **Stresses** (TH-Time History)

Shake-Table Test-Summary of Maximum Stresses - Landers							
		σMAX (MPa)	σMIN (MPa)	τMAX (MPa)	Rm/2 (MPa)	(Rm/2)/σMAX	(Rm/2)/σMIN
		f1	f2		(F)	F/f1	F/f2
		TH	TH	TH		TH	TH
A1	SG01	12.63	12.08		185	14.65	15.31
A3	SG02	8.99	12.09		185	20.58	15.30
A2	SG03 SG04 SG05	13.57	15.49	13.97	185	13.63	11.94
A4	SG06 SG07 SG08	20.07	32.89	22.78	185	9.22	5.62
SG09		0.44	0.64		75	170.45	117.19
SG10		1.65	1.44		75	45.45	52.08
SG11		0.71	0.41		75	105.63	182.93
SG12		0.46	0.43		75	163.04	174.42
SG13		2.41	2.34		80	33.20	34.19
SG14		2.21	1.25		80	36.20	64.00
SG15		2.04	2.6		80	39.22	30.77
SG16		1.96	2.09		80	40.82	38.28

Table 1 : Maximum Stresses (TH-Time History) - Continued

Shake-Table Test-Summary of Maximum Stresses - Landers							
		σMAX (MPa)	σMIN (MPa)	τMAX (MPa)	Rm/2 (MPa)	(Rm/2)/σMAX	(Rm/2)/σMIN
		f1	f2		(F)	F/f1	F/f2
		TH	TH	TH		TH	TH
A1	SG01	10.19	9.09		185	18.16	20.35
A3	SG02	7.81	9.42		185	23.69	19.64
A2	SG03 SG04 SG05	11.85	16.44	13.86	185	15.61	11.25
A4	SG06 SG07 SG08	20.01	22.42	15.65	185	9.25	8.25
SG09		0.46	0.44		75	163.04	170.45
SG10		0.98	0.98		75	76.53	76.53
SG11		0.33	0.36		75	227.27	208.33
SG12		0.37	0.37		75	202.70	202.70
SG13		2.09	1.99		80	38.28	40.20
SG14		1.53	1.36		80	52.29	58.82
SG15		3.27	3.94		80	24.46	20.30
SG16		1.43	1.54		80	55.94	51.95

Table 2. Maximum Acceleration (TH-Time History)

	Direction	TH-Landers (g)	TH-Random (g)
ACC01	Y	0.34	0.35
ACC02	Z	0.23	0.29
ACC03	Y	0.57	0.48
ACC04	Z	0.23	0.29
ACC05	Y	0.87	0.71
ACC06	Z	0.26	0.3
ACC07	X	0.68	0.51
ACC08	Y	0.34	0.36
ACC09	Z	0.24	0.27

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2 MAIN TEST RESULTS AND TEST CONFIGURATION

2.1 INSTRUMENTATION DIAGRAM SHOWING THE LOCATION OF ALL INSTRUMENTS

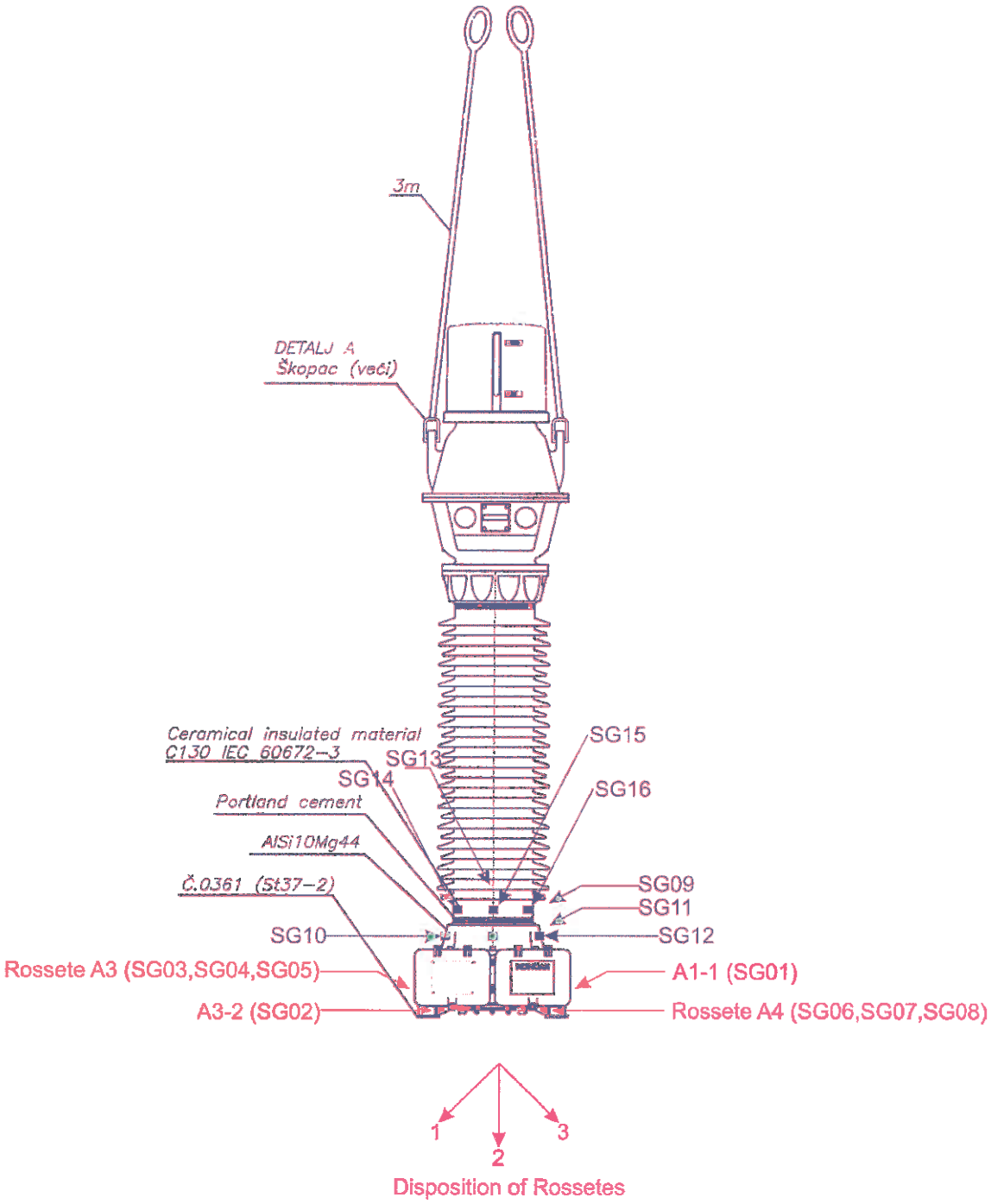

Figure 5: Rossetes and strain gages

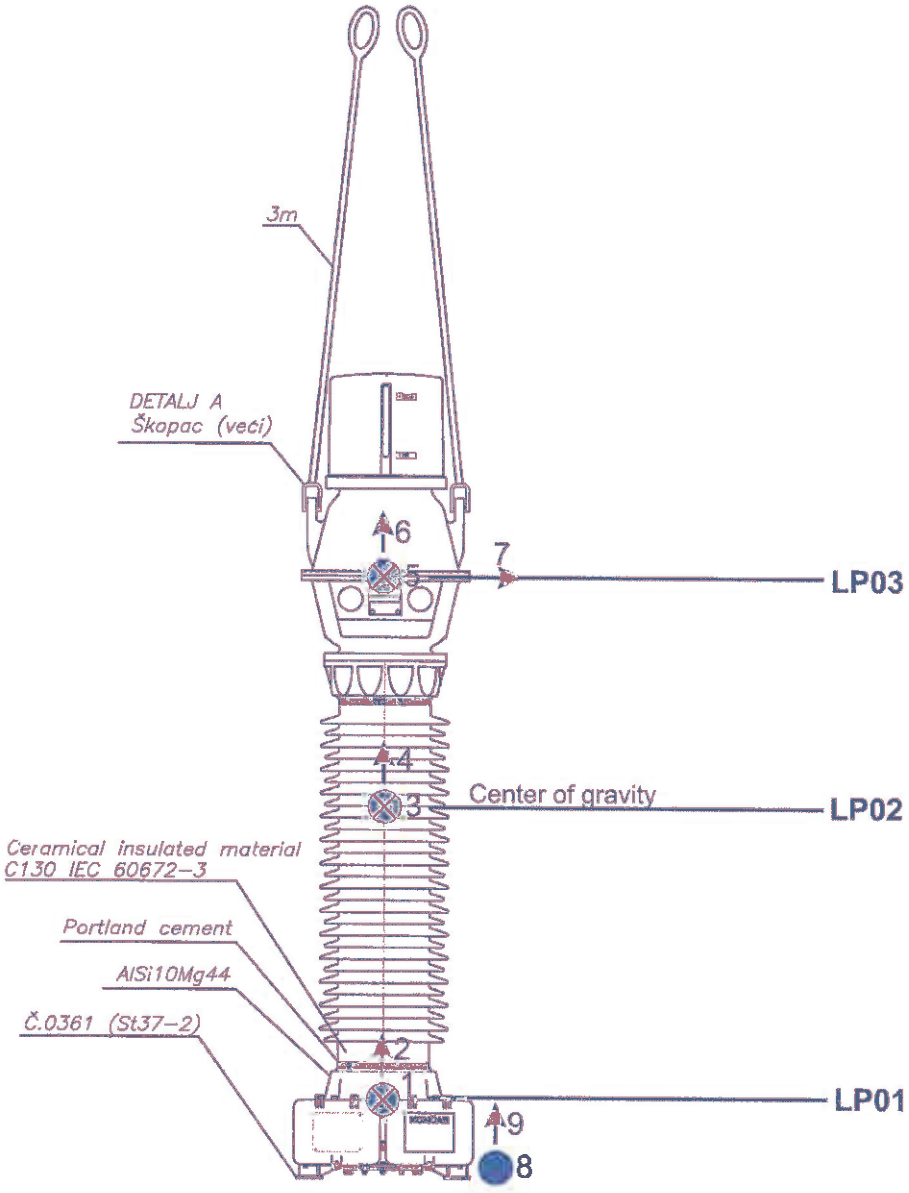

Figure 6: Accelerometers and Linear Potentiometers

Table 6. Identification of instrumentation TEST SET UP – Accelerometars & LP'S

TEST SET UP - ACCELEROMETERS			
Channel	**Transducer**	**Identification**	**Direction**
1	Accelerometer	ACC1	Y
2	Accelerometer	ACC2	Z
3	Accelerometer	ACC3	Y
4	Accelerometer	ACC4	Z
5	Accelerometer	ACC5	Y
6	Accelerometer	ACC6	Z
7	Accelerometer	ACC7	X
11	Accelerometer	ACC8	Y
12	Accelerometer	ACC9	Z
8	LP	LP1	Y
9	LP	LP2	Y
10	LP	LP3	Y

Table 7. Identification of instrumentation TEST SET UP Strain Gauges

TEST SET UP – STRAIN GAGES					
Channel	Location		Transducer	ID	Strain gauge
13	A1-1	Transformer base - Structural steel St37-2	Rectangular Rosette	SG01	1
14	A3-3	Transformer base - Structural steel St37-2	Rectangular Rosette	SG02	3
15	A2	Transformer base - Structural steel St37-2	Rectangular Rosette	SG03	1
16				SG04	2
17				SG05	3
18	A4	Transformer base - Structural steel St37-2	Rectangular Rosette	SG06	1
19				SG07	2
20				SG08	3
21	SG09	Aluminum flange	Strain Gage	SG09	1
22	SG10	Aluminum flange	Strain Gage	SG10	1
23	SG11	Aluminum flange	Strain Gage	SG11	1
24	SG12	Aluminum flange	Strain Gage	SG12	1
25	SG13	Ceramic Insulator	Strain Gage	SG13	1
26	SG14	Ceramic Insulator	Strain Gage	SG14	1
27	SG15	Ceramic Insulator	Strain Gage	SG15	1
28	SG16	Ceramic Insulator	Strain Gage	SG16	1

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2.2 TEST METHOD

2.2.1 RESONANT FREQUENCY SEARCH TESTS

For resonant frequency search tests a sine sweep frequency search was conducted for each axis (Y, Z) independently. Resonant frequency search tests were performed at the beginning of testing (initial) for first and second G configuration and after the time history tests.

The tests were performed, in accordance with IEEE Std.693-2005:

In horizontal direction

- frequency range: 0.5 ÷ 35 Hz;
- sweep rate: 1 octave/min;
- peak excitation level: 0.05 g

In vertical direction

- frequency range: 0.8 ÷ 35 Hz;
- sweep rate: 1 octave/min;
- peak excitation level: 0.05 g

Strain gauge measure positions were acquired.

Damping is calculated by measuring half-power bandwidth. This method calculates damping by measuring width of respective resonance peak at its half-power point in frequency domain.

$$\xi = \frac{f_2 - f_1}{2 \cdot f_r} \cdot 100$$

where:

- ξ damping of corresponding mode expressed as % of critical damping
- f_r is the resonance frequency value
- f_1 and f_2 are the frequency values corresponding to the "half-power points", determined from the peak value of FRF – Frequency Response Function at f_r divided by $\sqrt{2}$

2.2.2 TIME HISTORY TESTS

Bi-axial time history tests, in accordance with IEEE 693 Std.-2005, were carried out with simultaneous but independent inputs into the horizontal Y and vertical Z axes, each producing the High Required Response Spectrum (RRS) along the respective reference axis calculated with 1/24 octave of frequency bandwidth and 2% damping and prescriptions reported in IEEE Std. 693-2005.

For time history tests two IEEE Std. 693-2005 compatible input acceleration time histories obtained directly from IEEE have been used. First derived form 1992 Landers Earthquake, Joshua tree registration, the second artificially generated.

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1. Landers

Main characteristics of the reference time history

- peak accelerations: ..... 0.3 g (Y) and 0.24 g(Z)
- frequency range: .....0.5 – 37 Hz
- strong part of time history: ..... ≥ 20 s
- time history duration: ..... 45 s
- sampling rate: .....100 Hz

Main characteristics of the filtered time history (used as input for shaking table):

- sampling rate: .....512 Hz
- frequency range: .....1.0 – 35 Hz
- Number of points: 23040
- duration: ..... 45 s

2. Random

Main characteristics of the reference time history

- peak accelerations: ..... 0.3 g (Y) and 0.24 g(Z)
- frequency range: .....1 – 35 Hz
- strong part of time history: ..... ≥ 20 s
- time history duration: ..... 31 s
- sampling rate: .....200 Hz

Main characteristics of the filtered time history (used as input for shaking table):

- sampling rate: .....512 Hz
- frequency range: .....1.0 – 35 Hz
- Number of points: 15872
- duration: ..... 31 s

Test Response Spectra (TRS) were computed from the digital recordings of the control accelerometers ACC08 and ACC09, located at the geometrical centre of the shaking table, with 1/24 octave of frequency bandwidth and for 2% damping.

2.3 TEST SEQUENCE

- Resonant search tests: uniaxial sweep sine excitation applied, in Y and Z directions, independently
- Bi-axial time history (Landers)
- Resonant search tests: uniaxial sweep sine excitation applied, in Y and Z directions, independently
- Bi-axial time history (Random)
- Resonant search tests: uniaxial sweep sine excitation applied, in Y and Z directions, independently

2.4 LIST OF THE PERFORMED TESTS FROM IZIIS

Table 8: Sequential order of performed tests – Test SET-UP

Test ID	Test type	Axis	Test parameters	Note
Test 1	Sine sweep test	Y	f: 0.5÷35 Hz, a=0.05 g sweep rate: 1 oct/min	
Test 2	Sine sweep test	Z	f: 0.8÷35 Hz, a=0.05 g sweep rate: 1 oct/min	
Test 4	IEEE 693-2005 Time History Seismic test Landers	YZ	RRS: Damping 2% (Y and Z) Ref. peak acc.: 0.3 g (Y) and 0.24 g(Z)	
Test 5	Sine sweep test	Y	f: 0.5÷35 Hz, a=0.05 g sweep rate: 1 oct/min	
Test 6	Sine sweep test	Z	f: 0.8÷35 Hz, a=0.05 g sweep rate: 1 oct/min	
Test 9	IEEE 693-2005 Time History Seismic test Random	YZ	RRS: Damping 2% (Y and Z) Ref. peak acc.: 0.3 g (Y) and 0.24 g(Z)	
Test 10	Sine sweep test	Y	f: 0.5÷35 Hz, a=0.05 g sweep rate: 1 oct/min	
Test 11	Sine sweep test	Z	f: 0.8÷35 Hz, a=0.05 g sweep rate: 1 oct/min	

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2.5 INSTALLATION (SUPPORT AND ANCHORAGE)

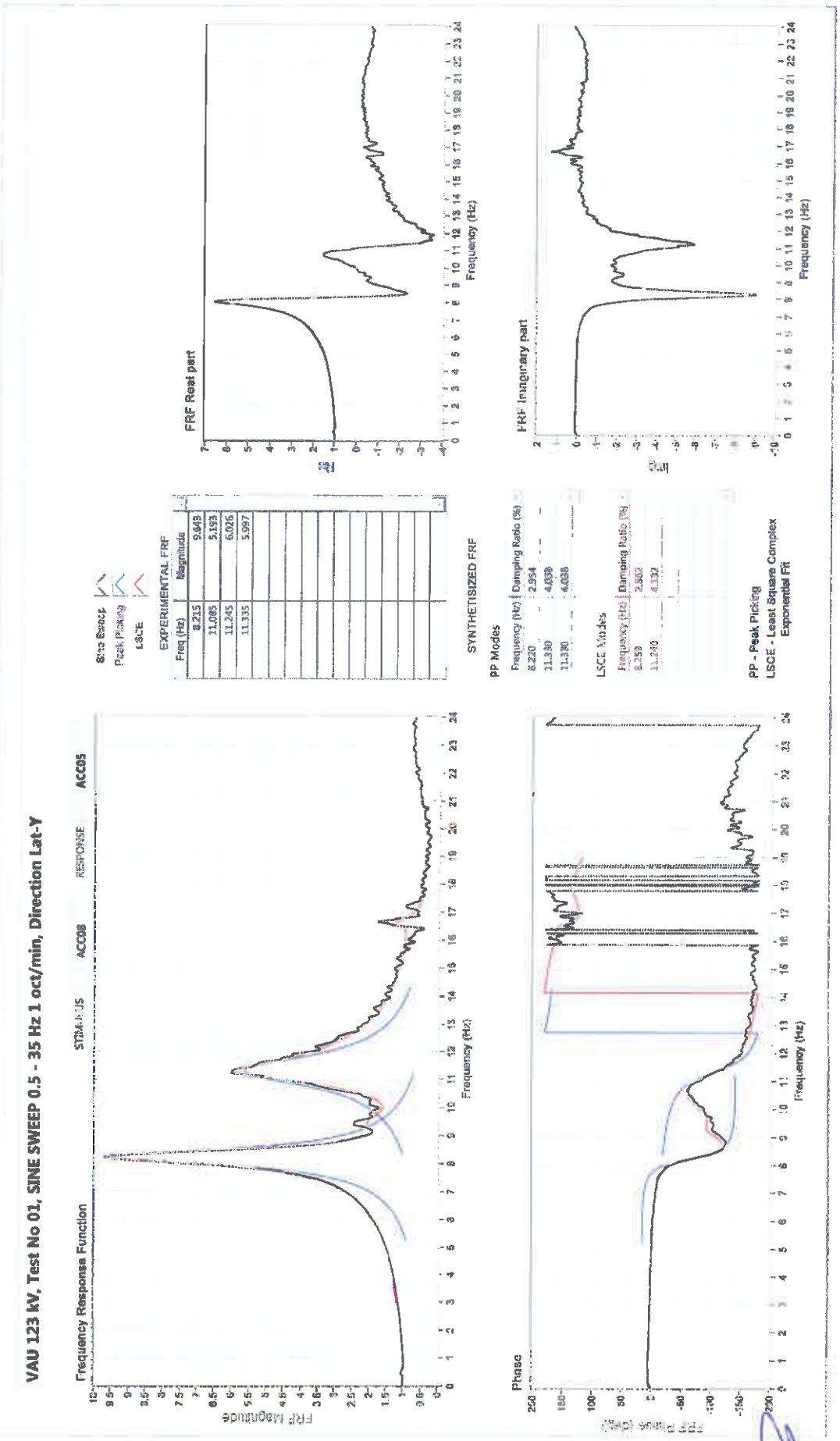
Figure 7: Test SET UP

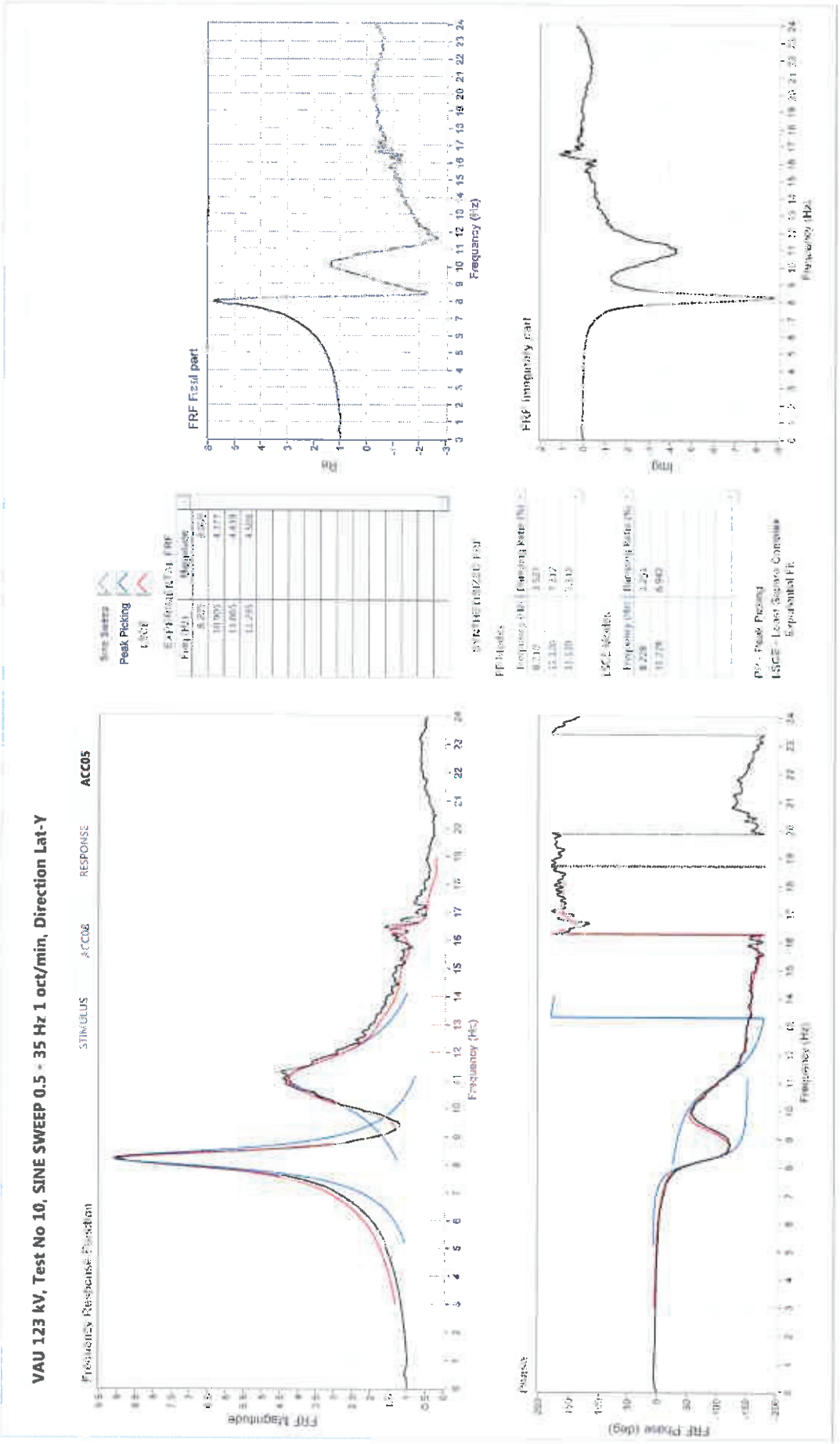
3 DETAILED TEST RESULTS AND SUPPORTING DATA

3.1 RESONANT SEARCH TESTS

Table 10: Main resonance frequencies and correspponding damping

	INITIAL TEST		FINAL TEST	
Lateral	TEST 1		TEST 10	
Measuring point	FREQ. (Hz) Y	DAMPING %	FREQ. (Hz) Y	DAMPING %
ACC 5	8.21	2.95	8.22	3.52


VAU 123 kV, Test No 01, SINE SWEEP 0.5 - 35 Hz 1 oct/min, Direction Lat-Y
Frequency Response Function
STRAIN
ACC08
RESPONSE
ACC05
FRF Magnitude
Frequency (Hz)
Phase
Sine Sweep
Peak Picking
LSCE
EXPERIMENTAL FRF
Freq (Hz) | Magnitude
8.215 | 9.643
11.085 | 5.193
11.245 | 6.026
11.335 | 5.997
SYNTHETISIZED FRF
PP Modes
Frequency (Hz) | Damping Ratio (%)
8.220 | 2.954
11.330 | 4.038
11.330 | 4.038
LSCE Modes
Frequency (Hz) | Damping Ratio (%)
8.259 | 2.962
11.249 | 4.132
PP - Peak Picking
LSCE - Least Square Complex Exponential Fit
FRF Real part
FRF Imaginary part


VAU 123 kV, Test No 10, SINE SWEEP 0.5 - 35 Hz 1 oct/min, Direction Lat-Y
Frequency Response Function
STIMULUS
ACC06
RESPONSE
ACC05
FRF Magnitude
Frequency (Hz)
FRF Phase (deg)
FRF Real part
FRF Imaginary part
Peak Picking
Sine Sweep

3.2 INPUT TIME HISTORIES (TABLE ACCELERATIONS)

3.2.1 TEST 5 - LANDERS

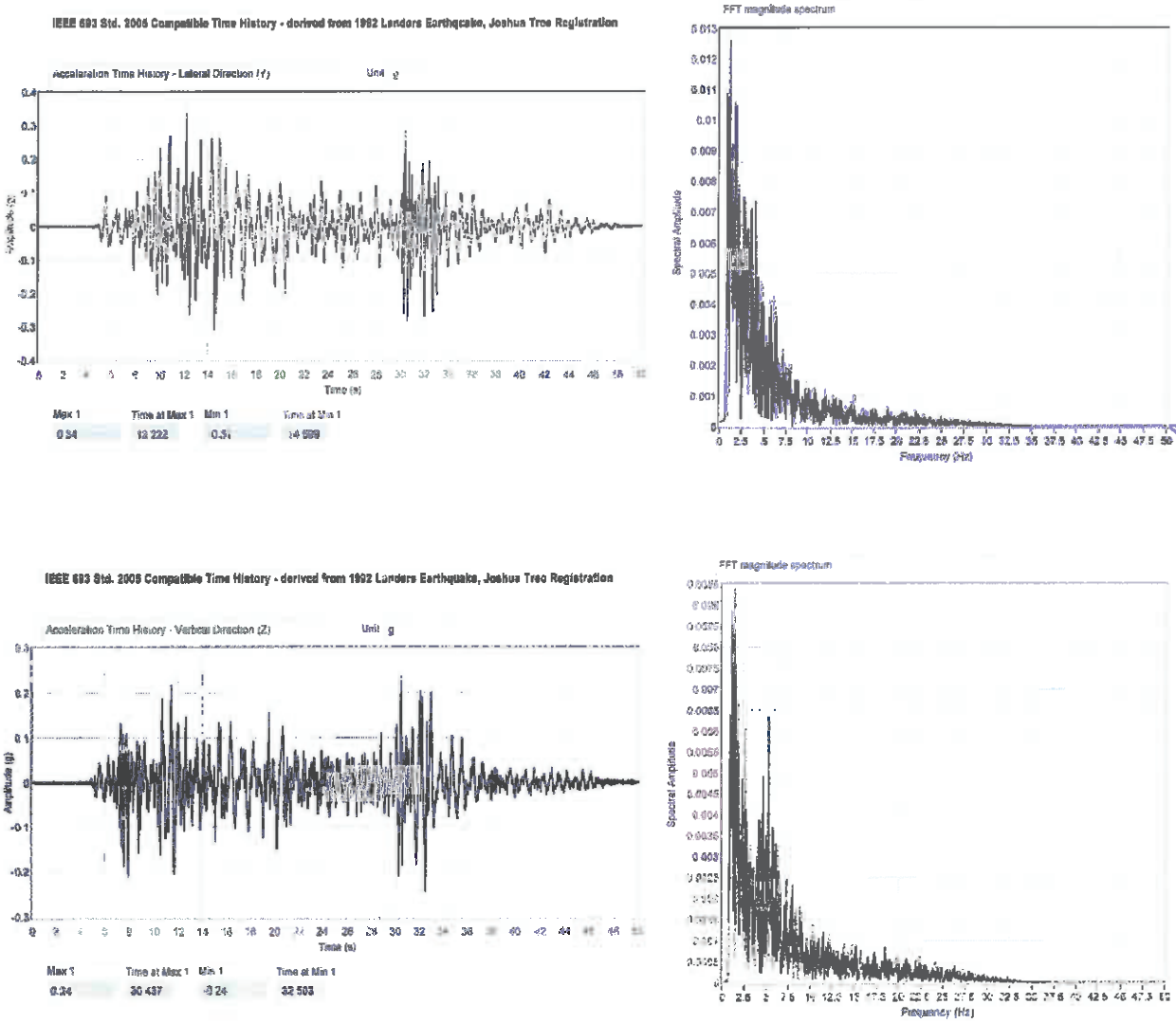


Figure 8: Acceleration Input Time Histories in Horizontal and Vertical Direction and corresponding Fourier Magnitude Spectra for Landers excitation

3.2.2 TEST 9 - RANDOM

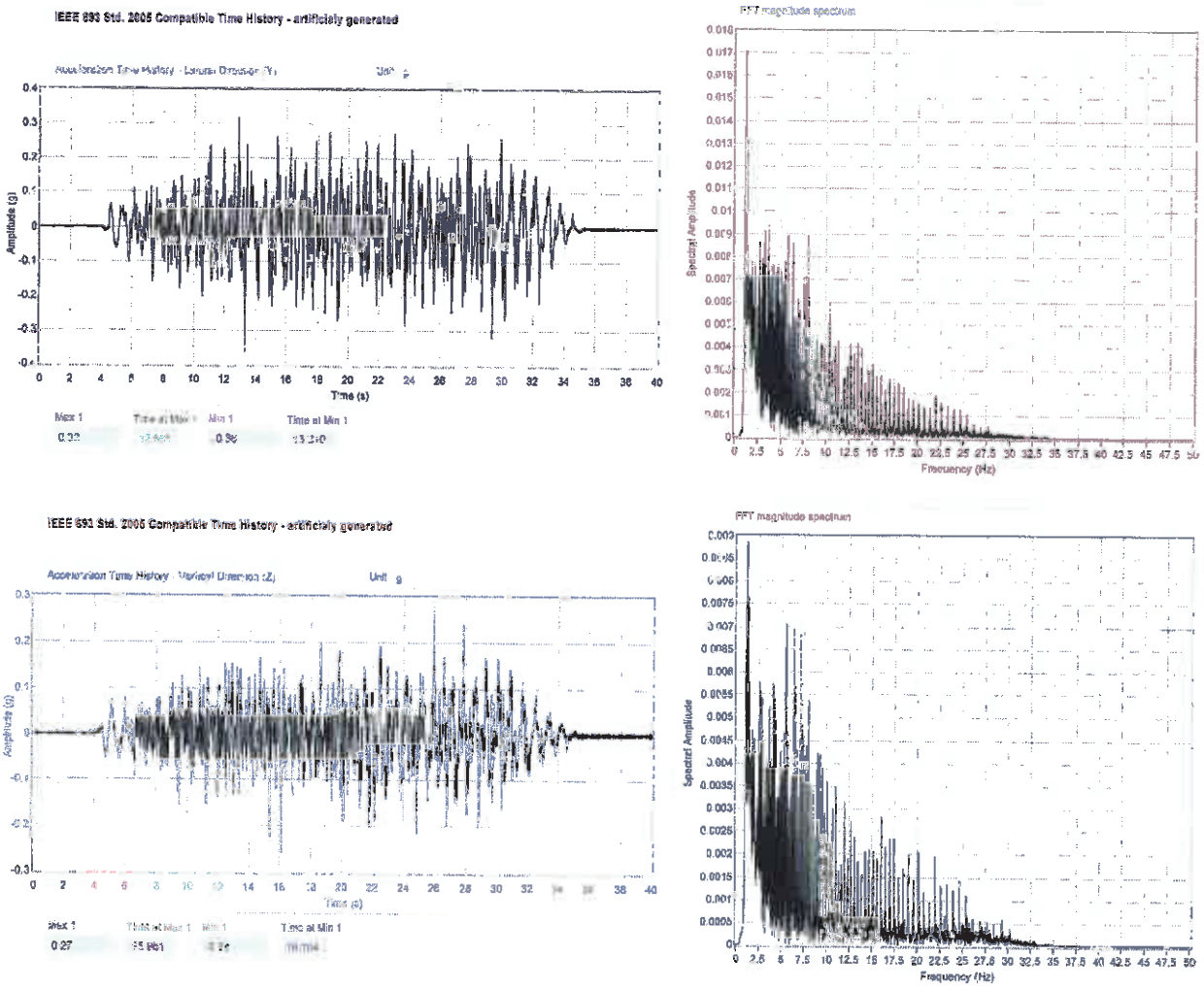


Figure 9: Acceleration Input Time Histories in Horizontal and Vertical Direction and corresponding Fourier Magnitude Spectra for Random excitation

3.3 TABULATED LIST OF MAXIMUM ACCELERATIONS,STRESSES,AND DISPLACEMENT AT MEASURING POINTS OF ALL CONTROLLING TESTS.

Table 11: List of Maximum Stresses

σ_{MAX} (MPa)		
POSITION	TH	
A4	32.89	TEST4
SG10	1.65	TEST4
SG15	3.94	TEST9

Table 12: List of Maximum Accelerations

max a (g)			
POSITION	TH		Direction
ACC05	0.87	TEST 4	Y
ACC06	0.3	TEST9	Z
ACC07	0.68	TEST4	X

3.4 SUMMARIZED ANCHORAGE LOADS

3.5 VIDEOS

Video recordings of all conducted tests: resonant frequency search and time history tests, have been done simulteneously (digitally triggered) with the acquisition of response channels, using the telepresence system installed at IZIIS alaboratory. Total three IP cameras from three different angles were used.

4 CONCLUSION

Having in mind all experimental results and above stated it can be certified that the Current transformer VAU-123, manufactured by KONCAR, From Zagreb, Croatia with supporting structure meets and exceeds all of the requirements of the IEEE Std. 693-2005 regarding the Moderate Level of Seismic Qualification with ZPA=0.3g of the RRS.

5 REFERENCE

IEEE 693 Std.-2005, Recommended practices for seismic design of substations. The Institute of Electrical and Electronics Engineers, Inc., 3 Park Avenue, New York, NY 10016-5997, USA. ISBN 0-7381-4845-8 SS95391.

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6 APPENDIX A: DRAWINGS DESCRIBING EQUIPMENT THAT WAS TESTED

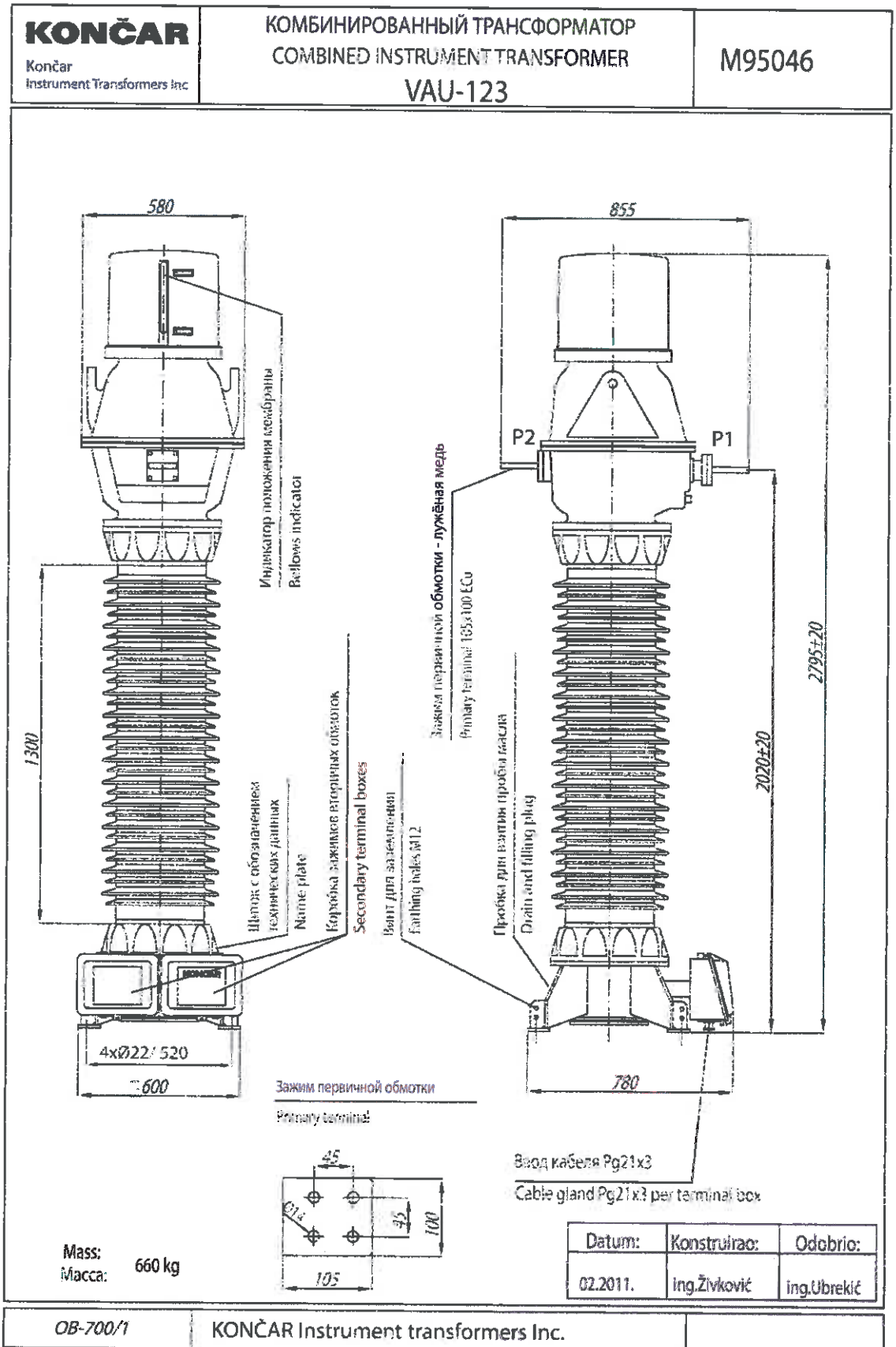

Figure 10: Technical drawing of tested VAU-123 transformer

Figure 11: Disposition of the tested transformer - Test SET-UP

7 APPENDIX B: DESCRIPTION OF THE SHAKE TABLE

7.1 IZIIS' SEISMIC TESTING SYSTEM

Figure 12: IZIIS' seismic shaking table – top view on the left, below the table on the right

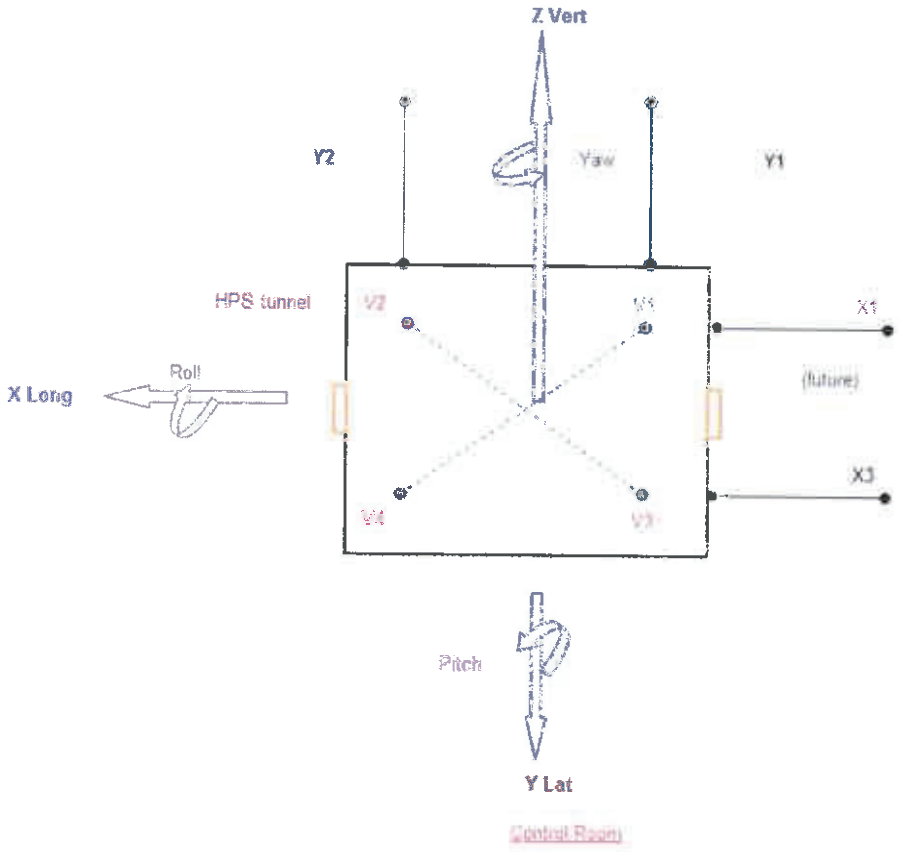

Figure 13: Degrees of freedom (actuators in X-longitudinal direction are not installed)

The seismic shaking table has the following characteristics:

- size in plane 5.0 x 5.0 m.
- shaking table mass is 33.0 t
- pay load 40.0 t
- 5 degree-of-freedom (DOF)
- 2 lateral (Y1-Y2) and 4 vertical actuators (V1-V4)
- MTS Digital Controller 469D
- Total mass of the supporting structure - 1200 t
- 3 hydraulic power supplies with a maximum flow of 1,250l/min
- The required electric power to feed the three pumps is 1,020 A
- Operational since 1980

Table 13: Kinematic quantities for zero pay load

Direction	displacement	velocity	acceleration
Y	±125 mm	±1.0 m/s	±3.0 g
Z	±60 mm	±0.5 m/s	±1.5 g
Roll	±2.0 deg	±13 deg/s	±200 deg/s2
Pitch	±2.0 deg	±13 deg/s	±200 deg/s2
Yaw	±2.0 deg	±26 deg/s	±200 deg/s2

- MTS Digital Controller 469D:
  - The newest state-of-the-art digital controller from MTS
  - Main Features:
    - Degree of Freedom Control
    - Three Variable Control (TVC)
    - Adaptive Control
    - Differential Pressure Stabilization
    - Force Balance Compensation
  - System - Control transducers:
    - Accelerometers:

      Endevco Model 7290E-10 - total 9

      Sensitivity 0.2V/g full range ± 10.0g frequency response DC to 500 Hz
    - LVDT:

      MTS - built-in in each actuator
    - Pressure transducer:

      MTS Pressure transducer measures the differential pressure (ΔP) on the piston - for control stability and rough force measurement
  - Installed end of March 2011

- Data acquisition system (DAS)
  - National Instruments (NI) PXI modular system:

    PXI-1006 18-slot 3U chassis 5.0 g

    PXI-4472, 9 modules (A/D) - Simultaneous acquisition of 8-channels with sampling speeds up to 102.4 kS/s. 24 bit A/D delta-sigma input range ± 10V

    PXI-6713, 1 module (D/A) - 8-channel output board. The resolution of the D/A converter is 12 bits, output rate up to 1MS/s and the output range ±10V

    MXI-3 PCI to Compact PCI Kit, PCI-8330, PXI-8330
  - NI 9237 - 20 modules

    4-Channel, ±25 mV/V, 24-Bit Simultaneous Bridge Module up to 50 kS/s per channel, Anti-Aliasing Filters
  - NI 9234 – 3 modules.

    24-Bit Sigma-Delta ADCs, 51.2 kS/s Max Sampling Rate, 4 Input Simultaneous, Software Selectable IEPE and AC/DC Coupling, Anti-Aliasing Filters, 102 dB Dynamic Range
  - DELL Precision 350 Workstation
- Transducers for measuring points
  - KYOWA MCD-8A AND MCD-16A - Multi conditioner system for stain gage and accelerometers

    Accelerometers:
    - KYOWA AS-5GB

      Sensitivity 1V/g full range ± 5.0g frequency response DC to 100 Hz
    - KYOWA AS-20GB

      Sensitivity 1V/g full range ± 20g frequency response DC to 250 Hz
    - KISTLER 8712A5M1

      Sensitivity 1V/g full range ± 5.0g frequency response 0.5 Hz to 8000 Hz
    - PCB 333B50

      ceramic shear ICP® accel, 1000 mV/g, 0.5 to 3k Hz, full range ± 5.0g
  - Linear Potentiometers
    - HSI Model 1850
    - Sensitivity 0.13mV/V/inch full range 15 inch

8 APPENDIX C: DATA AND CALCULATIONS SUPPORTING SUMMARY OF RESULTS AND DETERMINATION OF CONTROLLING VARIABLES

No calculation necessary.

9 APPENDIX D: INSTRUMENTATION CALIBRATION DATA

Calibration Certificates for accelerometers are provided as separate sheets

10 APPENDIX E: PICTURES AND PHOTOS SHOWING TEST SET UP AND INSTRUMENTATION

Figure 14: Strain gauges, accelerometers and LP's instrumentation set-up

Table 14: List of NI PXI-4472 channels – acceleration transducers and system transducers

Channel	Name	Transducer	Manufacturer	Model	Serial No	Cal.Val.	Dir
1	ACC01	Accelerometer	Kistler	8712A5M1	2034334	1027 mV/g	Y
2	ACC02	Accelerometer	Kistler	8712A5M1	2034337	1020 mV/g	Z
3	ACC03	Accelerometer	Kistler	8712A5M1	2034339	1016 mV/g	Y
4	ACC04	Accelerometer	Kistler	8712A5M1	2034341	1014 mV/g	Z
5	ACC05	Accelerometer	Kistler	8712A5M1	2034338	1013 mV/g	Y
6	ACC06	Accelerometer	Kistler	8712A5M1	2034333	1011 mV/g	Z
7	ACC07	Accelerometer	Kistler	8712A5M1	2034335	1019 mV/g	X
8	LP01	Linear Potentiometer	HSI	Model 1850	14606-004	15.5 mv/mm	Y
9	LP02	Linear Potentiometer	HSI	Model 1850	14606-007	14.8 mv/mm	Y
10	LP03	Linear Potentiometer	HIS	Model 1850	14606-003	15.9 mv/mm	Y
11	ACC08	Accelerometer	PCB	333B50	LW49313	1012 mV/g	Y
12	ACC09	Accelerometer	PCB	333B50	LW49360	1004 mV/g	Z
13	A1-1	Strain Gage	Kyowa	KFC-5-DA-11	Y1738-338	1mV/με	
14	A3-3	Strain Gage	Kyowa	KFC-5-DA-11	Y1738-338	1mV/με	
15	A2-1	Strain Gage	Kyowa	KFC-5-DA-11	Y1738-338	1mV/με	
16	A2-2	Strain Gage	Kyowa				Z
17	A2-3	Strain Gage	Kyowa				
18	A4-1	Strain Gage	Kyowa	KFC-5-DA-11	Y1738-338	1mV/με	
19	A4-2	Strain Gage	Kyowa				Z
20	A4-3	Strain Gage	Kyowa				
21	SG09	Strain Gage	Kyowa	KF6-5-120-C1-11	Y3516S	1mV/με	Z
22	SG10	Strain Gage	Kyowa	KF6-5-120-C1-11	Y3516S	1mV/με	Z
23	SG11	Strain Gage	Kyowa	KF6-5-120-C1-11	Y3516S	1mV/με	Z
24	SG12	Strain Gage	Kyowa	KF6-5-120-C1-11	Y3516S	1mV/με	Z
25	SG13	Strain Gage	Kyowa	KFRP-5-120-C1-3	Y139	1mV/με	Z
26	SG14	Strain Gage	Kyowa	KFRP-5-120-C1-3	Y139	1mV/με	Z
27	SG15	Strain Gage	Kyowa	KFRP-5-120-C1-3	Y139	1mV/με	Z
28	SG16	Strain Gage	Kyowa	KFRP-5-120-C1-3	Y139	1mV/με	Z
29	SYS DIS-Y Fbk	SYSTEM LVDT	MTS		SYSTEM	66.67 mm/V	Y

30	SYS ACC-Y Fbk	SYSTEM Feedback	Endevco	7290E-10	SYSTEM	3398 mv/g	Y
31	SYS DIS-Z Fbk	SYSTEM LVDT	MTS		SYSTEM	133.3 mm/V	Z
32	SYS ACC-Z Fbk	SYSTEM Feedback	Endevco	7290E-10	SYSTEM	6796 mv/g	Z
33	SYS ACC-Y CST	SYSTEM ACC	Endevco	7290E-10	SYSTEM	3398 mv/g	Y
34	SYS ACC-Z CST	SYSTEM ACC	Endevco	7290E-10	SYSTEM	3398 mv/g	Z
35	SYS ACC-Z REF	SYSTEM ACC	Endevco	7290E-10	SYSTEM	6796 mv/g	Y
36	SYS ACC-Y REF	SYSTEM ACC	Endevco	7290E-10	SYSTEM	3398 mv/g	Z

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11 APPENDIX F: CALCULATIONS SUPPORTING DETERMINATION OF FREQUENCIES AND DAMPING AND REFERENCE TO SOURCE DATA IN TEST LABORATORY REPORT

Resonant frequencies and damping in each mode were calculated directly from experimentally obtained FRFs, as well as using two techniques for modal parameter estimation. The first one is Peak-Picking (PP) method that extracts a mode from pre-computed signal's FRF. It is a frequency domain Single-Degree-of Freedom (SDOF) modal analysis method suitable to estimate uncoupled and lightly damped modes. The second method applies Least Square Complex Exponential Fit (LSCE) for simultaneously extract multiple modes from pre-computed signal's FRF. It is a time domain Multiple-Degree-of Freedom (MDOF) modal analysis method suitable for estimating modes in a wide frequency band.

Damping is calculated by measuring half-power bandwidth. This method calculates damping by measuring width of respective resonance peak at its half-power point in frequency domain.

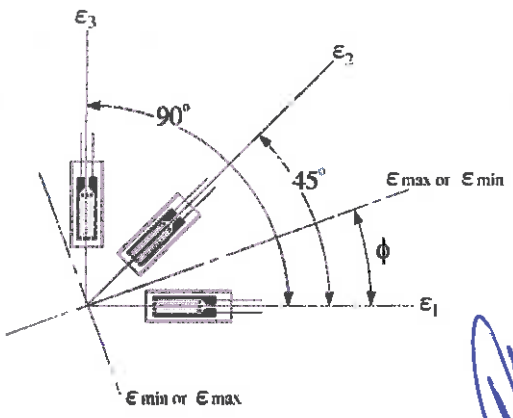
$$\xi = \frac{f_2 - f_1}{2 \cdot f_r} \cdot 100$$

where:

- ξ damping of corresponding mode expressed as % of critical damping
- f_r is the resonance frequency value
- f1 and f2 are the frequency values corresponding to the "half-power points", determined from the peak value of FRF – Frequency Response Function at f_r divided by $\sqrt{2}$

12 APPENDIX G: CALCULATION SUPPORTING DATA IN TABLE LISTING MAXIMUM ACCELERATIONS, STRESSES AND DISPLACEMENTS AND CITATIONS OF SOURCE DATA

Calculation of principal strains and stresses from measured strains from full rosette



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Maximum Principal Strain

$$\varepsilon_{MAX} = \frac{\varepsilon_1 + \varepsilon_3}{2} + \frac{1}{\sqrt{2}}\sqrt{(\varepsilon_1 - \varepsilon_2)^2 + (\varepsilon_2 - \varepsilon_3)^2}$$

Minimum Principal Strain

$$\varepsilon_{MIN} = \frac{\varepsilon_1 + \varepsilon_3}{2} - \frac{1}{\sqrt{2}}\sqrt{(\varepsilon_1 - \varepsilon_2)^2 + (\varepsilon_2 - \varepsilon_3)^2}$$

Maximum Principal Stress

$$\sigma_{MAX} = \frac{E}{2}\left[\frac{\varepsilon_1 + \varepsilon_3}{1-\nu} + \frac{\sqrt{2}}{1+\nu}\sqrt{(\varepsilon_1 - \varepsilon_2)^2 + (\varepsilon_2 - \varepsilon_3)^2}\right] = \frac{E}{1-\nu^2}(\varepsilon_{MAX} + \nu\varepsilon_{MIN})$$

Minimum Principal Stress

$$\sigma_{MIN} = \frac{E}{2}\left[\frac{\varepsilon_1 + \varepsilon_3}{1-\nu} - \frac{\sqrt{2}}{1+\nu}\sqrt{(\varepsilon_1 - \varepsilon_2)^2 + (\varepsilon_2 - \varepsilon_3)^2}\right] = \frac{E}{1-\nu^2}(\nu\varepsilon_{MAX} + \varepsilon_{MIN})$$

Maximum Shear Stress

$$\tau_{MAX} = \frac{\sigma_{MAX} - \sigma_{MIN}}{2}$$

Acute angle from Grid 1 to the principal axis (counterclockwise if positive, clockwise if negative)

$$\phi_{MAX,MIN} = \frac{1}{2}\tan^{-1}\left(\frac{2\varepsilon_2 - \varepsilon_1 - \varepsilon_3}{\varepsilon_1 - \varepsilon_3}\right)$$

if $\varepsilon_1 > \varepsilon_3$ *then* $\phi_{MAX,MIN} = \phi_{MAX}$

if $\varepsilon_1 < \varepsilon_3$ *then* $\phi_{MAX,MIN} = \phi_{MIN}$

13 APPENDIX H: ANCHORAGE LOADS

TEST 4 - LANDERS			Comb 1		Comb 2		Comb 3	
m	h_{CG}	b	a_Y	a_Z	a_Y	a_Z	a_Y	a_Z
(t)	m	m	(g)	(g)	(g)	(g)	(g)	(g)
0.646	1.297	0.520	0.569	0.128	0.044	0.207	0.357	-0.232

Comb 1

$F_{SF} = -m \times g$	-6.34	kN	$F_{SF,b} = F_{SF} / 4$	-1.58	kN
$F_Y = m \times a_y$	3.61	kN	$F_{Y,b} = F_Y / 4$	0.90	kN
$F_Z = m \times a_z$	0.81	kN	$F_{Z,b} = F_Z / 4$	0.20	kN
$M_X = F_Y \times h_{CG}$	4.68	kNm	$F_{t,b} = \pm M_X / (b \times 2)$	4.50	kN

Total axial force per bolt (tension-positive, compression-negative)

$F_{t1} = F_{SF,b} + F_{Z,b} + F_{t,b}$	**3.12**	**kN**
$F_{t2} = F_{SF,b} + F_{Z,b} - F_{t,b}$	-5.88	kN

Total shear force per bolt

$F_v = F_{Y,b}$	**0.90**	**kN**

Comb 2

$F_{SF} = -m \times g$	-6.34	kN	$F_{SF,b} = F_{SF} / 4$	-1.58	kN
$F_Y = m \times a_y$	0.28	kN	$F_{Y,b} = F_Y / 4$	0.07	kN
$F_Z = m \times a_z$	1.31	kN	$F_{Z,b} = F_Z / 4$	0.33	kN
$M_X = F_Y \times h_{CG}$	0.36	kNm	$F_{t,b} = \pm M_X / (b \times 2)$	0.35	kN

Total axial force per bolt (tension-positive, compression-negative)

$F_{t1} = F_{SF,b} + F_{Z,b} + F_{t,b}$	-0.91	kN
$F_{t2} = F_{SF,b} + F_{Z,b} - F_{t,b}$	-1.60	kN

Total shear force per bolt

$F_v = F_{Y,b}$	0.07	kN

Comb 3

$F_{SF} = -m \times g$	-6.34	kN	$F_{SF,b} = F_{SF} / 4$	-1.58	kN
$F_Y = m \times a_y$	2.26	kN	$F_{Y,b} = F_Y / 4$	0.57	kN
$F_Z = m \times a_z$	-1.47	kN	$F_{Z,b} = F_Z / 4$	-0.37	kN
$M_X = F_Y \times h_{CG}$	2.93	kNm	$F_{t,b} = \pm M_X / (b \times 2)$	2.82	kN

Total axial force per bolt (tension-positive, compression-negative)

$F_{t1} = F_{SF,b} + F_{Z,b} + F_{t,b}$	0.87	kN
$F_{t2} = F_{SF,b} + F_{Z,b} - F_{t,b}$	-4.77	kN

Total shear force per bolt

$F_v = F_{Y,b}$	0.57	kN

Design Resistance for bolt M20

Tension Resistance - $F_{t,Rd}$

A_S	2.45	cm^2
Rm	515	MPa
$0.9 \times Rm \times A_s / 1.25$	**113.56**	**kN**

Shear Resistance - $F_{V,Rd}$

A	3.14	cm^2
$0.6 \times Rm \times A / 1.25$	**97.03**	**kN**

Combined Shear and Tension

$F_V / F_{V,Rd} + F_t / (1.4 \times F_{t,Rd}) \leq 1.0$

Comb 1 Combined Shear & Tension

0.0309 ≤ **1**

TEST 9 - RANDOM			Comb 1		Comb 2		Comb 3	
m	h_{CG}	b	a_Y	a_Z	a_Y	a_Z	a_Y	a_Z
(t)	m	m	(g)	(g)	(g)	(g)	(g)	(g)
0.646	1.297	0.520	0.479	0.036	0.189	0.279	0.173	-0.292

Comb 1

$F_{SF} = -m \times g$	-6.34	kN	$F_{SF,b} = F_{SF} / 4$	-1.58	kN
$F_Y = m \times a_y$	3.04	kN	$F_{Y,b} = F_Y / 4$	0.76	kN
$F_Z = m \times a_z$	0.23	kN	$F_{Z,b} = F_Z / 4$	0.06	kN
$M_X = F_Y \times h_{CG}$	3.94	kNm	$F_{t,b} = \pm M_X / (b \times 2)$	3.79	kN

Total axial force per bolt (tension-positive, compression-negative)

$F_{t1} = F_{SF,b} + F_{Z,b} + F_{t,b}$	**2.26**	**kN**
$F_{t2} = F_{SF,b} + F_{Z,b} - F_{t,b}$	-5.31	kN

Total shear force per bolt

$F_V = F_{Y,b}$	**0.76**	**kN**

Comb 2

$F_{SF} = -m \times g$	-6.34	kN	$F_{SF,b} = F_{SF} / 4$	-1.58	kN
$F_Y = m \times a_y$	1.20	kN	$F_{Y,b} = F_Y / 4$	0.30	kN
$F_Z = m \times a_z$	1.77	kN	$F_{Z,b} = F_Z / 4$	0.44	kN
$M_X = F_Y \times h_{CG}$	1.55	kNm	$F_{t,b} = \pm M_X / (b \times 2)$	1.49	kN

Total axial force per bolt (tension-positive, compression-negative)

$F_{t1} = F_{SF,b} + F_{Z,b} + F_{t,b}$	0.35	kN
$F_{t2} = F_{SF,b} + F_{Z,b} - F_{t,b}$	-2.64	kN

Total shear force per bolt

$F_V = F_{Y,b}$	0.30	kN

Comb 3

$F_{SF} = -m \times g$	-6.34	kN	$F_{SF,b} = F_{SF} / 4$	-1.58	kN
$F_Y = m \times a_y$	1.10	kN	$F_{Y,b} = F_Y / 4$	0.27	kN
$F_Z = m \times a_z$	-1.85	kN	$F_{Z,b} = F_Z / 4$	-0.46	kN
$M_X = F_Y \times h_{CG}$	1.42	kNm	$F_{t,b} = \pm M_X / (b \times 2)$	1.37	kN

Total axial force per bolt (tension-positive, compression-negative)

$F_{t1} = F_{SF,b} + F_{Z,b} + F_{t,b}$	-0.68	kN
$F_{t2} = F_{SF,b} + F_{Z,b} - F_{t,b}$	-3.41	kN

Total shear force per bolt

$F_V = F_{Y,b}$	0.27	kN

Design Resistance for bolt M20

Tension Resistance - $F_{t,Rd}$

A_S	2.45	cm^2
Rm	515	MPa
$0.9 \times Rm \times A_s / 1.25$	**113.56**	**kN**

Shear Resistance - $F_{V,Rd}$

A	3.14	cm^2
$0.6 \times Rm \times A / 1.25$	**97.03**	**kN**

Combined Shear and Tension

$F_V/F_{V,Rd} + F_t/(1.4 \times F_{t,Rd}) \leq 1.0$

Comb 1 Combined Shear & Tension

0.0233 ≤ **1**

14 APPENDIX I: MECHANICAL PROPERTIES OF MATERIAL WHERE STRAINS WERE MEASURED

Table 15: Mechanical Properties

	E-Modul [Mpa]	Poisson-ratio	Rm [Mpa]
Transformer Base			
St37-2	210000	0.3	370
Insulator flange			
AlSi10Mg(a)	74000	0.3	150
Insulator - Porcelain			
Porcelain type C130 (IEC 60672-3)	100000	0.3	160
Set Screws			
AISI 321	200000	0.3	515

HIGH GRADE

Nytro Lyra X

High performance insulating oil

An inhibited high-grade oil, Nytro Lyra X conforms to IEC 60296 Edition 4.0 – including the fulfilment of specific requirements for special applications. Developed and formulated to deliver strong resistance to oil degradation. Nytro Lyra X provides excellent oxidation stability for a longer transformer life with less maintenance.

Designed for heavy duty

This product has been specially developed for use in oil-filled electrical equipment – including power and distribution transformers, rectifiers, circuit breakers and switchgears.

Performance and benefits

Very good heat transfer. Thanks to low viscosity and viscosity index, this high grade offers extremely good heat transfer characteristics, ensuring heat is efficiently removed from core and windings.

Excellent oxidation stability. Developed and formulated to deliver superb resistance to oil degradation, this grade provides excellent oxidation stability for enhanced transformer life and minimum maintenance.

Very good low temperature properties. Naphthenic characteristics allow the transformer to start at the lowest possible temperature – without using pour point depressants.

High dielectric strength. This insulating oil both meets and exceeds the toughest demands on dielectric strength – when stored and handled correctly.

Product description

Nytro Lyra X fulfils the requirements for IEC 60296 Edition 4.0 fully inhibited oil. Nynas classify this product as a high grade.

Nytro Lyra X is rigorously analysed and passes the following corrosion tests:
- ASTM D1275 method B
- IEC 62535
- DIN 51353

In accordance with IEC 60296 Edition 4.0, all additives are declared.

There's more to us than this

We're delighted you chose one of our transformer oils. If you have any questions about other products and services, get in touch with your local Nynas contact. Besides top quality oils, we offer a wide range of services, including rapid delivery worldwide, sample analysis, training, seminars and much more. All you have to do is ask. Find out more at www.nynas.com

NYNAS

PRODUCT DATA SHEET

Nytro Lyra X

PROPERTY	UNIT	TEST METHOD	SPECIFICATION LIMITS MIN	SPECIFICATION LIMITS MAX	TYPICAL DATA
1 - Function					
Viscosity, 40°C	mm^2/s	ISO 3104		12.0	9.3
Viscosity, -30°C	mm^2/s	ISO 3104		1800	926
Pour point	°C	ISO 3016		-40	-48
Water content	mg/kg	IEC 60814		30	<20
Breakdown voltage					
- Before treatment	kV	IEC 60156	30		40-60
- After treatment	kV	IEC 60296	70		>70
Density, 20°C	kg/dm^3	ISO 12185		0.895	0.870
DDF at 90°C		IEC 60247		0.005	<0.001
2 - Refining/stability					
Appearance		IEC 60296	Clear, free from sediment		complies
Acidity	mg KOH/g	IEC 62021		0.01	<0.01
Interfacial tension	mN/m	EN 14210	40		50
Total sulphur content	%	ISO 14596		0.05	0.01
Corrosive sulphur		DIN 51353	non-corrosive		non-corrosive
Potentially corrosive sulphur		IEC 62535	non-corrosive		non-corrosive
Corrosive sulphur		ASTM D 1275 B	non-corrosive		non-corrosive
DBDS	mg/kg	IEC 62697-1		not detectable	not detectable
Antioxidant	wt %	IEC 60666	0.08	0.4	0.38
Metal passivator additives	mg/kg	IEC 60666		not detectable	not detectable
2-Furfural and related compounds content	mg/kg	IEC 61198		0.05	<0.05
Aromatic content	%	IEC 60590			5
3 - Performance					
Oxidation stability at 120°C,500 h		IEC 61125 C			
Total acidity	mg KOH/g			0.3	0.06
Sludge	wt %			0.05	<0.02
DDF at 90°C				0.050	0.020
4 - Health, safety and environment (HSE)					
Flash point, PM	°C	ISO 2719	135		152
PCA	wt %	IP 346		3	<3
PCB		IEC 61619	not detectable		not detectable

Nytro Lyra X is an inhibited insulating oil with extremely good electrical and excellent ageing properties meeting IEC 60296 Ed.4 (2012). special applications.

Severely Hydrotreated Insulating Oil
Issuing date: 2012-04-01

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Nytro Lyra X

SAFETY DATA SHEET

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Product name	Nytro Lyra X
Product description	Insulating oil
Product type	Liquid.

1.2 Identified uses

Identified uses

Manufacture of substance- Industrial
Distribution of substance- Industrial
Formulation and (re)packing of substances and mixtures- Industrial
Use as functional fluids e.g. cable oils, transfer oils, coolants, insulators, refrigerants, hydraulic fluids in industrial equipment including maintenance and related material transfers.
Use as functional fluids e.g. cable oils, transfer oils, coolants, insulators, refrigerants, hydraulic fluids in professional equipment including maintenance and related material transfers.
Use in formulations in lubricants- Industrial
Use as lubricant in open and closed systems - Professional

Uses advised against	Reason
None known.	-

1.3 Details of the supplier of the safety data sheet

Nynas AB
P.O. Box 10700
SE-121 29 Stockholm
SWEDEN
+46 8 602 12 00
www.nynas.com

e-mail address of person responsible for this SDS: ProductHSE@nynas.com

1.4 Emergency telephone number

National advisory body/Poison Centre

Telephone number	+44 (0) 1235 239 670
Hours of operation	24 hour service

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Product definition: Mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]
Asp. Tox. 1, H304
Aquatic Chronic 3, H412

Classification according to Directive 1999/45/EC [DPD]
R52/53

Environmental hazards: Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

2.2 Label elements

Hazard pictograms

Signal word: Danger

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SECTION 2: Hazards identification

Hazard statements — May be fatal if swallowed and enters airways.
Harmful to aquatic life with long lasting effects.

Precautionary statements

Prevention — Avoid release to the environment.

Response — IF SWALLOWED: Immediately call a POISON CENTER or physician. Do NOT induce vomiting.

Storage — Not applicable.

Disposal — Dispose of waste product or used containers according to local regulations.

2.3 Other hazards

Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII — No.

Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII — No.

SECTION 3: Composition/information on ingredients

Substance/mixture — Mixture

Product/ingredient name	Identifiers	%	Classification 67/548/EEC	Classification Regulation (EC) No. 1272/2008 [CLP]	Type
Distillates (petroleum), hydrotreated light naphthenic	REACH #: 01-2119480375-34 EC: 265-156-6 CAS: 64742-53-6 Index: 649-466-00-2	50 - 100	Not classified.	Asp. Tox. 1, H304	[1] [2]
Distillates (petroleum), hydrotreated light paraffinic	REACH #: 01-2119487077-29 EC: 265-158-7 CAS: 64742-55-8 Index: 649-468-00-3	0 - 50	Not classified.	Asp. Tox. 1, H304	[1] [2]
Lubricating oils (petroleum), C20-50, hydrotreated neutral oil-based	REACH #: 01-2119474889-13 EC: 276-738-4 CAS: 72623-87-1 Index: 3.1: 649-483-00-5 3.2: 649-438-00-5	0 - 50	Not classified.	Asp. Tox. 1, H304	[1] [2]
Distillates (petroleum), hydrotreated heavy paraffinic	REACH #: 01-2119484627-25 EC: 265-157-1 CAS: 64742-54-7 Index: 649-467-00-8	0 - 50	Not classified.	Asp. Tox. 1, H304	[1] [2]
Lubricating oils (petroleum), C15-30, hydrotreated neutral oil-based	REACH #: 01-2119474878-16 EC: 276-737-9 CAS: 72623-86-0 Index: 649-482-00-X	0 - 30	Not classified.	Asp. Tox. 1, H304	[1] [2]
2,6-di-tert-butyl-p-cresol	REACH #: 01-2119555270-46 EC: 204-881-4 CAS: 128-37-0	<0.4	N; R50/53 See Section 16 for the full text of the R-phrases declared above.	Aquatic Acute 1, H400 Aquatic Chronic 1, H410 See Section 16 for the full text of the H statements declared above.	[1]

SECTION 3: Composition/information on ingredients

Annex I Nota L applies to the base oil(s) in this product. Nota L - The classification as a carcinogen need not apply if it can be shown that the substance contains less than 3 % DMSO extract as measured by IP 346.

Type

[1] Substance classified with a health or environmental hazard
[2] Substance with a workplace exposure limit
[3] Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII
[4] Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII

SECTION 4: First aid measures

4.1 Description of first aid measures

Eye contact	Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If irritation, blurred vision or swelling occurs and persists, obtain medical advice from a specialist.
Inhalation	If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing. If casualty is unconscious and: If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Immediately obtain specialist medical assessment and treatment for the casualty. Call a physician.
Skin contact	Remove contaminated clothing and shoes. Wash with soap and water. Handle with care and dispose of in a safe manner. Seek medical attention if skin irritation, swelling or redness develops and persists. Accidental high pressure injection through the skin requires immediate medical attention. Do not wait for symptoms to develop.
Ingestion	Always assume that aspiration has occurred. Do not induce vomiting as there is high risk of aspiration. Never give anything by mouth to an unconscious person. Seek professional medical attention or send the casualty to a hospital. Do not wait for symptoms to develop.
Protection of first-aiders	No action shall be taken involving any personal risk or without suitable training. Before attempting to rescue casualties, isolate area from all potential sources of ignition including disconnecting electrical supply. Ensure adequate ventilation and check that a safe, breathable atmosphere is present before entry into confined spaces.

4.2 Most important symptoms and effects, both acute and delayed

Potential acute health effects

Eye contact	Eye contact may cause redness and transient pain.
Inhalation	Inhalation of oil mist or vapours at elevated temperatures may cause respiratory irritation.
Skin contact	No known significant effects or critical hazards.
Ingestion	Nausea or vomiting. Aspiration hazard if swallowed. Can enter lungs and cause damage. Ingestion (swallowing) of this material may result in an altered state of consciousness and loss of coordination.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician	Due to low viscosity there is a risk of aspiration if the product enters the lungs. Ingestion (swallowing) of this material may result in an altered state of consciousness and loss of coordination. Treat symptomatically.
Specific treatments	Always assume that aspiration has occurred.

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media	Use dry chemical, CO_2, water spray (fog) or foam.
Unsuitable extinguishing media	Do not use direct water jets on the burning product; they could cause splattering and spread the fire. Simultaneous use of foam and water on the same surface is to be avoided as water destroys the foam.

SECTION 5: Firefighting measures

5.2 Special hazards arising from the substance or mixture

Hazards from the substance or mixture	In a fire or if heated, a pressure increase will occur and the container may burst. This substance will float and can be reignited on surface water.
Hazardous combustion products	Incomplete combustion is likely to give rise to a complex mixture of airborne solid and liquid particulates, gases, including carbon monoxide, H2S, SOx (sulfur oxides) or sulfuric acid and unidentified organic and inorganic compounds.

5.3 Advice for firefighters

Special precautions for fire-fighters	Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.
Special protective equipment for fire-fighters	Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

For non-emergency personnel	Keep non-involved personnel away from the area of spillage. Alert emergency personnel. Except in case of small spillages, the feasibility of any actions should always be assessed and advised, if possible, by a trained, competent person in charge of managing the emergency. Stop leak if safe to do so. Avoid direct contact with the product. Stay upwind/keep distance from source. In case of large spillages, alert occupants in downwind areas. Eliminate all ignition sources if safe to do so. Spillages of limited amounts of product, especially in the open air when vapours will be usually quickly dispersed, are dynamic situations, which will presumably limit the exposure to dangerous concentrations. Note : recommended measures are based on the most likely spillage scenarios for this material; however, local conditions (wind, air temperature, wave/current direction and speed) may significantly influence the choice of appropriate actions. For this reason, local experts should be consulted when necessary. Local regulations may also prescribe or limit actions to be taken.
For emergency responders	Small spillages: normal antistatic working clothes are usually adequate. Large spillages: full body suit of chemically resistant and thermal resistant material should be used. Work gloves providing adequate chemical resistance, specifically aromatic hydrocarbons. Note : gloves made of PVA are not water-resistant, and are not suitable for emergency use. Safety helmet, antistatic non-skid safety shoes or boots. Goggles and /or face shield, if splashes or contact with eyes is possible or anticipated. Respiratory protection : A half or full-face respirator with filter(s) for organic vapours (and when applicable for H2S) a Self Contained Breathing Apparatus (SCBA) can be used according to the extent of spill and predictable amount of exposure. If the situation cannot be completely assessed, or if an oxygen deficiency is possible, only SCBA's should be used.
6.2 Environmental precautions	Water polluting material. Prevent product from entering sewers, rivers or other bodies of water. If necessary dike the product with dry earth, sand or similar non-combustible materials. In case of soil contamination, remove contaminated soil and treat in accordance with local regulations. In case of small spillages in closed waters (i.e. ports), contain product with floating barriers or other equipment. Collect spilled product by absorbing with specific floating absorbents. If possible, large spillages in open waters should be contained with floating barriers or other mechanical means. If this is not possible, control the spreading of the spillage, and collect the product by skimming or other suitable mechanical means. The use of dispersants should be advised by an expert, and, if required, approved by local authorities.

SECTION 6: Accidental release measures

6.3 Methods and materials for containment and cleaning up

Small spill	Stop leak if without risk. Absorb spilled product with suitable non-combustible materials.
Large spill	Large spillages may be cautiously covered with foam, if available, to limit vapour cloud formation. Do not use water jet. When inside buildings or confined spaces, ensure adequate ventilation. Transfer collected product and other contaminated materials to suitable containers for recovery or safe disposal.
6.4 Reference to other sections	See Section 1 for emergency contact information. See Section 8 for information on appropriate personal protective equipment. See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

The information in this section contains generic advice and guidance. The list of Identified Uses in Section 1 should be consulted for any available use-specific information provided in the Exposure Scenario(s).

General information	Obtain special instructions before use. Keep away from heat/sparks/open flames/ hot surfaces. - No smoking. Use and store only outdoors or in a well-ventilated area. Avoid release to the environment.
7.1 Precautions for safe handling	
Protective measures	Do not ingest. Avoid contact with skin. Avoid breathing fume/mist. Do not breathe vapour. Use personal protective equipment as required. Prevent the risk of slipping. Take precautionary measures against static discharge. Avoid splash filling of bulk volumes when handling hot liquid product. Note: see section 8 for personal protective equipment and section 13 for waste disposal.
Advice on general occupational hygiene	Ensure that proper housekeeping measures are in place. Contaminated materials should not be allowed to accumulate in the workplaces and should never be kept inside the pockets. Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Wash hands thoroughly after handling. Change contaminated clothes at the end of working shift.
7.2 Conditions for safe storage, including any incompatibilities	Storage area layout, tank design, equipment and operating procedures must comply with the relevant European, national or local legislation. Storage installations should be designed with adequate bunds in case of leaks or spills. Cleaning, inspection and maintenance of internal structure of storage tanks must be done only by properly equipped and qualified personnel as defined by national, local or company regulations. Use personal protective equipment as required. Store separately from oxidising agents. Recommended materials for containers, or container linings use mild steel, stainless steel. Not suitable : Some synthetic materials may be unsuitable for containers or container linings depending on the material specification and intended use. Compatibility should be checked with the manufacturer. Keep only in the original container or in a suitable container for this kind of product. Keep containers tightly closed and properly labelled. Protect from sunlight. Empty containers may contain harmful, flammable/combustible or explosive residue or vapours. Do not cut, grind, drill, weld, reuse or dispose of containers unless adequate precautions are taken against these hazards.

SECTION 8: Exposure controls/personal protection

The information in this section contains generic advice and guidance. The list of Identified Uses in Section 1 should be consulted for any available use-specific information provided in the Exposure Scenario(s).

8.1 Control parameters

Occupational exposure limits

Product/ingredient name	Exposure limit values
Oil mist	**AFS 2005:17 (Sweden, 12/2011).** TWA: 1 mg/m³ 8 hour(s). Form: mist and fume STEL: 3 mg/m³ 15 minute(s). Form: mist and fume

Recommended monitoring procedures: If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to European Standard EN 689 for methods for the assessment of exposure by inhalation to chemical agents and national guidance documents for methods for the determination of hazardous substances.

Derived effect levels

Product/ingredient name	Type	Exposure	Value	Population	Effects
Distillate (petroleum), hydrotreated light naphthenic	DNEL	Long term Inhalation	5,4 mg/m³	Workers	Local
Distillate (petroleum), Hydrotreated Light Paraffinic	DNEL	Long term Inhalation	5,4 mg/m³	Workers	Local
Distillates (petroleum), hydrotreated heavy paraffinic	DNEL	Long term Inhalation	5,4 mg/m³	Workers	Local

Predicted effect concentrations

No PECs available.

8.2 Exposure controls

Appropriate engineering controls: Mechanical ventilation and local exhaust will reduce exposure via the air. Use oil resistant material in construction of handling equipment. Store under recommended conditions and if heated, temperature control equipment should be used to avoid overheating.

Individual protection measures

Hygiene measures: Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Ensure that eyewash stations and safety showers are close to the workstation location. Wash contaminated clothing before reuse.

Eye/face protection: If potential exists for splashing, use goggles.

Skin protection

Hand protection: Wear oil-resistant protective gloves (e.g. nitril rubber). PVC gloves. Neoprene gloves.

Body protection: Wear protective clothing if there is a risk of skin contact. Change contaminated clothes at the end of working shift.

Other skin protection: Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection: Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator. Use a properly fitted, particulate filter respirator complying with an approved standard if a risk assessment indicates this is necessary.

Environmental exposure controls: Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

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SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

Appearance

Physical state	Liquid.
Colour	Light yellow
Odour	Odourless/Light petroleum.
Odour threshold	Not available.
pH	Not applicable.
Melting point/freezing point	-48°C
Initial boiling point and boiling range	>250°C
Flash point	Closed cup: >140°C [Pensky-Martens.]
Evaporation rate	Not available.
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	Not available.
Vapour pressure	160 Pa @ 100 °C
Vapour density	Not available.
Density	0,87 g/cm³ [15°C]
Solubility(ies)	Insoluble in water.
Partition coefficient: n-octanol/ water	Not available.
Auto-ignition temperature	>270°C
Decomposition temperature	>280°C
Viscosity	Kinematic (40°C): 0,093 cm²/s (9,3 cSt)
Explosive properties	Not available.
Oxidising properties	Not available.
DMSO extractable compounds for base oil substance(s) according to IP346	< 3%

SECTION 10: Stability and reactivity

10.1 Reactivity	No specific test data related to reactivity available for this product or its ingredients.
10.2 Chemical stability	Stable under normal conditions.
10.3 Possibility of hazardous reactions	Under normal conditions of storage and use, hazardous reactions will not occur.
10.4 Conditions to avoid	Oxidising agent.
10.5 Incompatible materials	Keep away from extreme heat and oxidizing agents.
10.6 Hazardous decomposition products	Incomplete combustion is likely to give rise to a complex mixture of airborne solid and liquid particulates, gases, including carbon monoxide, H2S, SOx (sulfur oxides) or sulfuric acid and unidentified organic and inorganic compounds.

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

SECTION 11: Toxicological information

Product/ingredient name	Result	Species	Dose	Exposure
Distillate (petroleum), hydrotreated light naphthenic	LC50 Inhalation Dusts and mists	Rat	>5,53 mg/l	4 hours
	LD50 Dermal	Rabbit	>5000 mg/kg	-
	LD50 Oral	Rat	>5000 mg/kg	-
Distillate (petroleum), Hydrotreated Light Paraffinic	LC50 Inhalation Dusts and mists	Rat	>5,53 mg/l	4 hours
	LD50 Dermal	Rabbit	>5000 mg/kg	-
	LD50 Oral	Rat	>5000 mg/kg	-
Lubricating oils (petroleum), C20-50, hydrotreated neutral oil-based	LC50 Inhalation Dusts and mists	Rat	>5,53 mg/l	4 hours
	LD50 Dermal	Rabbit	>5000 mg/kg	-
	LD50 Oral	Rat	>5000 mg/kg	-
Distillates (petroleum), hydrotreated heavy paraffinic	LC50 Inhalation Dusts and mists	Rat	>5,53 mg/l	4 hours
	LD50 Dermal	Rabbit	>5000 mg/kg	-
	LD50 Oral	Rat	>5000 mg/kg	-
Lubricating oils (petroleum), C15-30, hydrotreated neutral oil-based	LD50 Dermal	Rabbit	>5000 mg/kg	-
	LD50 Oral	Rat	>5000 mg/kg	-
2,6-di-tert-butyl-p-cresol	LD50 Dermal	Rat	>2000 mg/kg	-
	LD50 Oral	Rat	>2000 mg/kg	-

Irritation/Corrosion

Skin — Based on available data, the classification criteria are not met.

Eyes — Based on available data, the classification criteria are not met.

Respiratory — Based on available data, the classification criteria are not met.

Sensitiser

Skin — Based on available data, the classification criteria are not met.

Carcinogenicity

Conclusion/Summary — Based on available data, the classification criteria are not met.

Aspiration hazard

Product/ingredient name	Result
Distillate (petroleum), hydrotreated light naphthenic	ASPIRATION HAZARD - Category 1
Distillate (petroleum), Hydrotreated Light Paraffinic	ASPIRATION HAZARD - Category 1
Lubricating oils (petroleum), C20-50, hydrotreated neutral oil-based	ASPIRATION HAZARD - Category 1
Distillates (petroleum), hydrotreated heavy paraffinic	ASPIRATION HAZARD - Category 1
Lubricating oils (petroleum), C15-30, hydrotreated neutral oil-based	ASPIRATION HAZARD - Category 1

Potential acute health effects

Inhalation — Inhalation of oil mist or vapours at elevated temperatures may cause respiratory irritation.

Ingestion — Nausea or vomiting. Aspiration hazard if swallowed. Can enter lungs and cause damage. Ingestion (swallowing) of this material may result in an altered state of consciousness and loss of coordination.

Skin contact — No known significant effects or critical hazards.

Eye contact — Eye contact may cause redness and transient pain.

Potential chronic health effects

SECTION 11: Toxicological information

Chronic effects	No known significant effects or critical hazards.
Carcinogenicity	No known significant effects or critical hazards.
Mutagenicity	No known significant effects or critical hazards.
Teratogenicity	No known significant effects or critical hazards.
Developmental effects	No known significant effects or critical hazards.
Fertility effects	No known significant effects or critical hazards.
Other information	Not available.

Specific hazard

SECTION 12: Ecological information

12.1 Toxicity

Product/ingredient name	Result	Species	Exposure
Distillate (petroleum), hydrotreated light naphthenic	Acute IC50 >100 mg/l	Algae	48 hours
	Acute LC50 >100 mg/l	Fish	96 hours
Distillate (petroleum), Hydrotreated Light Paraffinic	Acute IC50 >100 mg/l	Algae	48 hours
	Acute LC50 >100 mg/l	Fish	96 hours
Lubricating oils (petroleum), C20-50, hydrotreated neutral oil-based	Acute IC50 >100 mg/l	Algae	48 hours
	Acute LC50 >100 mg/l	Fish	96 hours
Distillates (petroleum), hydrotreated heavy paraffinic	Acute EC50 >100 mg/l	Fish	96 hours
	Acute IC50 >100 mg/l	Algae	48 hours
Lubricating oils (petroleum), C15-30, hydrotreated neutral oil-based	Acute LC50 >100 mg/l	Fish	96 hours
2,6-di-tert-butyl-p-cresol	Acute EC50 1440 µg/l Fresh water	Daphnia - Daphnia pulex - Neonate	48 hours

Conclusion/Summary: Harmful to aquatic life with long lasting effects.

12.2 Persistence and degradability

Product/ingredient name	Aquatic half-life	Photolysis	Biodegradability
Distillate (petroleum), hydrotreated light naphthenic	-	-	Inherent
Distillate (petroleum), Hydrotreated Light Paraffinic	-	-	Inherent
Lubricating oils (petroleum), C20-50, hydrotreated neutral oil-based	-	-	Inherent
Distillates (petroleum), hydrotreated heavy paraffinic	-	-	Inherent
Lubricating oils (petroleum), C15-30, hydrotreated neutral oil-based	-	-	Inherent
2,6-di-tert-butyl-p-cresol	-	-	Not readily

Conclusion/Summary: Inherently biodegradable.

12.3 Bioaccumulative potential

Conclusion/Summary: The product has a potential to bioaccumulate.

12.4 Mobility in soil

Mobility: High mobility in soil predicted, based on log Kow > 3.0.

12.5 Results of PBT and vPvB assessment

No.

No.

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SECTION 12: Ecological information

12.6 Other adverse effects	Insoluble in water. Spills may form a film on water surfaces causing physical damage to organisms. Oxygen transfer could also be impaired.

SECTION 13: Disposal considerations

The information in this section contains generic advice and guidance. The list of Identified Uses in Section 1 should be consulted for any available use-specific information provided in the Exposure Scenario(s).

13.1 Waste treatment methods

Product

Methods of disposal	Where possible (e.g. in the absence of relevant contamination), recycling of used substance is feasible and recommended. This substance can be burned or incinerated, subject to national/local authorizations, relevant contamination limits, safety regulations and air quality legislation. Contaminated or waste substance (not directly recyclable): Disposal can be carried out directly, or by delivery to qualified waste handlers. National legislation may identify a specific organization, and/or prescribe composition limits and methods for recovery or disposal.
Hazardous waste	Within the present knowledge of the supplier, this product is not regarded as hazardous waste, as defined by EU Directive 91/689/EEC.

Packaging

Methods of disposal	The generation of waste should be avoided or minimised wherever possible. Was packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

SECTION 14: Transport information

International transport regulations

This product is not regulated for carriage according to ADR/RID, ADN, IMDG, ICAO/IATA.

14.7 Transport in bulk according to Annex I of MARPOL 73/78 and the IBC Code	Mineral oil.

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Substances of very high concern

None of the components are listed.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles	Not applicable.

Other EU regulations

Europe inventory	All components are listed or exempted.
15.2 Chemical Safety Assessment	This product contains substances for which Chemical Safety Assessments are still required.

SECTION 16: Other information

Revision comments	Not available.

Indicates information that has changed from previously issued version.

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SECTION 16: Other information

Abbreviations and acronyms

ATE = Acute Toxicity Estimate
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
DNEL = Derived No Effect Level
EUH statement = CLP-specific Hazard statement
PNEC = Predicted No Effect Concentration
RRN = REACH Registration Number

Procedure used to derive the classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Classification	Justification
Asp. Tox. 1, H304	Calculation method
Aquatic Chronic 3, H412	Calculation method

Full text of abbreviated H statements

H304 May be fatal if swallowed and enters airways.
H400 Very toxic to aquatic life.
H410 Very toxic to aquatic life with long lasting effects.
H412 Harmful to aquatic life with long lasting effects.

Full text of classifications [CLP/GHS]

Aquatic Acute 1, H400 AQUATIC TOXICITY (ACUTE) - Category 1
Aquatic Chronic 1, H410 AQUATIC TOXICITY (CHRONIC) - Category 1
Aquatic Chronic 3, H412 AQUATIC TOXICITY (CHRONIC) - Category 3
Asp. Tox. 1, H304 ASPIRATION HAZARD - Category 1

Full text of abbreviated R phrases

R50/53- Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R52/53- Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Full text of classifications [DSD/DPD]

N - Dangerous for the environment

Date of printing 2013-10-28.

Date of issue/ Date of revision 2013-10-28.

Date of previous issue 2013-08-14.

Version 3

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Identification of the substance or mixture

Product definition	Mixture
Product name	Nytro Lyra X

Section 1: - Title

Short title of the exposure scenario	Use in formulations in lubricants- Industrial (2,6-di-tert-butyl-p-cresol)
List of use descriptors	**Identified use name:** Use in formulations in lubricants- Industrial **Process Category:** PROC01, PROC02, PROC03, PROC04, PROC05, PROC08a, PROC08b, PROC09 **Substance supplied to that use in form of:** As such **Sector of end use:** SU03, SU10 **Subsequent service life relevant for that use:** No. **Environmental Release Category:** ERC02 **Market sector by type of chemical product:** PC17, PC24, PC25
Environmental contributing scenarios	
Health Contributing Scenarios	

Number of the ES	Not applicable.
Industry Association	Not applicable.
Generic exposure scenario	Not applicable.
Processes and activities covered by the exposure scenario	Covers the use of formulated lubricants within closed or contained systems including incidental exposures during material transfers, operation of machinery/engines and similar articles, equipment maintenance and disposal of wastes.
Additional information	Industrial

Section 2: - Exposure controls

Product characteristics	solid Melting/Freezing Point (°C): 69.8
Concentration of substance in mixture or article	≤100%
Amounts used	Annual site tonnage (tonnes/year): 110 t/a
Frequency and duration of use	Continuous release.(d/a): 300
Environment factors not influenced by risk management	Local freshwater dilution factor: 10 Receiving surface water flow is 18000 m³/d. Local marine water dilution factor: 100
Other given operational conditions affecting environmental exposure	Not applicable.
Technical conditions and measures at process level (source) to prevent release	% Release fraction to wastewater from process (initial release prior to RMM): 0.2 % Release fraction to air from process (initial release prior to RMM): 0.01 % Release fraction to soil from process (initial release prior to RMM): 0
Technical on-site conditions and measures to reduce or limit discharges, air emissions and releases to soil	On-site wastewater treatment required. Ensure all waste water is collected and treated via a waste water treatment plant. Floors should be impervious, resistant to liquids and easy to clean.
Organisational measures to prevent/limit release from site	Ensure operatives are trained to minimise exposures.
Conditions and measures related to municipal sewage treatment plant	Size of industrial sewage treatment plant (m3/d): 2000

Section 2: - Exposure controls

Conditions and measures related to external treatment of waste for disposal	No special measures are required. General information, See section 13 for waste disposal information.
Conditions and measures related to external recovery of waste	See section 13 for waste disposal information.

Contributing scenario controlling worker exposure for 0:	
Product characteristics	Melting/Freezing Point (°C): 69.8
Concentration of substance in mixture or article	≤100%
Physical state	solid
Dust	Solid, medium dustiness.
Frequency and duration of use	Exposure duration per day: 8 h (full shift). Exposure duration per year: 230 d
Human factors not influenced by risk management	Respiratory (m³/d): 10
Other given operational conditions affecting workers exposure	The product should be handled at room temperature.
Technical conditions and measures at process level (source) to prevent release	No special measures required.
Technical conditions and measures to control dispersion from source towards the worker	Handle only in a place with local exhaust ventilation (or other adequate ventilation).
Organisational measures to prevent/limit releases, dispersion and exposure	Ensure operatives are trained to minimise exposures.
Conditions and measures related to personal protection and hygiene	
Personal protection	Wear protective clothing. See Section 8 of the safety data sheet (personal protective equipment).

Section 3: - Exposure estimation and reference to its source

Website:	Not available.

Exposure estimation and reference to its source - Environment: 2:	
Exposure assessment (environment):	Used EUSES model.(v2.1).
Exposure estimation	Risk characterisation ratio (PEC/PNEC): <1

Exposure estimation and reference to its source - Workers: 1:	
Exposure assessment (human):	Used ECETOC TRA model (May 2010 release). (04/2010)
Exposure estimation	Risk characterisation ratio DNELs <1

Section 4: - Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Environment	Not available.
Health	Not available.

Environment	Not applicable.
Health	Wear protective gloves/protective clothing/eye protection/face protection. Wear respiratory protection. See Section 8 for information on appropriate personal protective equipment

Identification of the substance or mixture

Product definition	Mixture
Product name	Nytro Lyra X

Section 1: - Title

Short title of the exposure scenario	Use as lubricant in open and closed systems- Professional (2,6-di-tert-butyl-p-cresol)
List of use descriptors	**Identified use name:** Use as lubricant in open and closed systems - Professional **Process Category:** PROC01, PROC02, PROC03, PROC04, PROC05, PROC07, PROC08a, PROC08b, PROC09, PROC10, PROC11, PROC13 **Substance supplied to that use in form of:** As such **Sector of end use:** SU22 **Subsequent service life relevant for that use:** No. **Environmental Release Category:** ERC08a, ERC08d, ERC09a, ERC09b **Market sector by type of chemical product:** PC17, PC24
Environmental contributing scenarios	
Health Contributing Scenarios	

Number of the ES	Not applicable.
Industry Association	Not applicable.
Generic exposure scenario	Not applicable.
Processes and activities covered by the exposure scenario	Covers the use of formulated lubricants in closed and open systems including transfer operations, operation of engines and similar articles, reworking on reject articles, equipment maintenance and disposal of waste oil.
Additional information	Professional

Section 2: - Exposure controls

Product characteristics	solid Melting/Freezing Point (°C): 69.8
Concentration of substance in mixture or article	≤2%
Amounts used	Annual site tonnage (tonnes/year): ≤0.16 t/a (Closed system) ≤0.03 t/a (open systems)
Frequency and duration of use	Continuous release.(d/a): 300
Environment factors not influenced by risk management	Local freshwater dilution factor: 10 Receiving surface water flow is 18000 m³/d. Local marine water dilution factor: 100
Other given operational conditions affecting environmental exposure	Not applicable.
Technical conditions and measures at process level (source) to prevent release	% Release fraction to wastewater from process (initial release prior to RMM): 0.2 % Release fraction to air from process (initial release prior to RMM): 0.01 % Release fraction to soil from process (initial release prior to RMM): 1
Technical on-site conditions and measures to reduce or limit discharges, air emissions and releases to soil	On-site wastewater treatment required. Ensure all waste water is collected and treated via a waste water treatment plant. Floors should be impervious, resistant to liquids and easy to clean.
Organisational measures to prevent/limit release from site	Ensure operatives are trained to minimise exposures.

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Section 2: - Exposure controls

Conditions and measures related to municipal sewage treatment plant	Size of industrial sewage treatment plant (m3/d): 2000
Conditions and measures related to external treatment of waste for disposal	No special measures are required. See section 13 for waste disposal information.
Conditions and measures related to external recovery of waste	See section 13 for waste disposal information.

Contributing scenario controlling worker exposure for 0:	
Product characteristics	Melting/Freezing Point (°C): 69.8
Concentration of substance in mixture or article	≤2%
Physical state	solid
Dust	Solid, medium dustiness.
Frequency and duration of use	Exposure duration per year: 230 days Exposure duration per day: 8 h (full shift).
Human factors not influenced by risk management	Respiratory m³/d: 10
Other given operational conditions affecting workers exposure	The product should be handled at room temperature. Lubricants (Closed system)
Technical conditions and measures at process level (source) to prevent release	No special measures required.
Technical conditions and measures to control dispersion from source towards the worker	Handle only in a place with local exhaust ventilation (or other adequate ventilation).
Organisational measures to prevent/limit releases, dispersion and exposure	Ensure operatives are trained to minimise exposures.
Conditions and measures related to personal protection and hygiene	
Personal protection	Wear protective clothing. See Section 8 of the safety data sheet (personal protective equipment).

Section 3: - Exposure estimation and reference to its source

Website:	Not available.

Exposure estimation and reference to its source - Environment: 2:	
Exposure assessment (environment):	Used EUSES model. (v2.1)
Exposure estimation	Risk characterisation ratio (PEC/PNEC): <1

Exposure estimation and reference to its source - Workers: 1:	
Exposure assessment (human):	Used ECETOC TRA model (May 2010 release).
Exposure estimation	Risk characterisation ratio DNELs <1

Section 4: - Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Environment	Not available.
Health	Not available.

Section 4: - Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Environment	Not available.
Health	Wear protective gloves/protective clothing/eye protection/face protection. Wear respiratory protection. See Section 8 for information on appropriate personal protective equipment.

Industrial

Identification of the substance or mixture

Product definition	Mixture
Product name	Nytro Lyra X

Identified uses	Sector of uses [SU]:	Process categories [PROC]:	Product categories [PC]:	Article categories [AC]:	Environmental release categories [ERC]:	SpERC
Manufacture of substance -Industrial	3, 8, 9	1, 2, 3, 4, 8a, 8b, 15	Not applicable.	Not applicable.	1, 4	ESVOC SpERC 1.1.v1
Distribution of substance- Industrial	3	1, 2, 3, 4, 8a, 8b, 9, 15	Not applicable.	Not applicable.	1, 2, 3, 4, 5, 6a, 6b, 6c, 6d, 7	ESVOC SpERC 1.1b. v1
Formulation and (re) packing of substances and mixtures -Industrial	3, 10	1, 2, 3, 4, 5, 8a, 8b, 9, 14, 15	Not applicable.	Not applicable.	2	ESVOC SpERC 2.2.v1
Uses in Coatings - Industrial	3	1, 2, 3, 4, 5, 7, 8a, 8b, 10, 13, 15	Not applicable.	Not applicable.	4	ESVOC SpERC 4.3a. v1
Uses in Coatings - Professional	22	1, 2, 3, 4, 5, 8a, 8b, 10, 11, 13, 15, 19	Not applicable.	Not applicable.	8a, 8d	ESVOC SpERC 8.3a. v1
Use as functional fluids e.g. cable oils, transfer oils, coolants, insulators, refrigerants, hydraulic fluids in industrial equipment including maintenance and related material transfers. -Industrial	3	1, 2, 3, 4, 8a, 8b, 9	Not applicable.	Not applicable.	7	ESVOC SpERC 7.13a. v1
Use as functional fluids e.g. cable oils, transfer oils, coolants, insulators, refrigerants, hydraulic fluids in industrial equipment including maintenance and related material transfers. - Professional	22	1, 2, 3, 8a, 9, 20	Not applicable.	Not applicable.	9a, 9b	ESVOC SpERC 9.13b. v1

Section 1: - Title

Short title of the exposure scenario	Insulating oil (classified as Asp. Tox. 1, H304 only; IP346<3%; <20.5cSt@40oC)
List of use descriptors	**Identified use name:** Manufacture of substance- Industrial Distribution of substance- Industrial Formulation and (re)packing of substances and mixtures- Industrial Use as functional fluids e.g. cable oils, transfer oils, coolants, insulators, refrigerants, hydraulic fluids in industrial equipment including maintenance and related material transfers. Use as functional fluids e.g. cable oils, transfer oils, coolants, insulators, refrigerants, hydraulic fluids in professional equipment including maintenance and related material transfers. **Subsequent service life relevant for that use:** No. **Market sector by type of chemical product:** Not applicable. **Article category related to subsequent service life:** Not applicable.

Section 1: - Title

Environmental contributing scenarios

Health Contributing Scenarios

Number of the ES	
Industry Association	Concawe
Generic exposure scenario	01, 01a, 02, 13a, 13b
Processes and activities covered by the exposure scenario	01- Manufacture of the substance or use as a process chemical or extraction agent within closed or contained systems. Includes incidental exposures during recycling/ recovery, material transfers, storage, sampling, associated laboratory activities, maintenance and loading (including marine vessel/barge, road/rail car and bulk container). 01a- Bulk loading (including marine vessel/barge, rail/road car and IBC loading) of substance within closed or contained systems, including incidental exposures during its sampling, storage, unloading, maintenance and associated laboratory activities. 02- Formulation, packing and re-packing of the substance and its mixtures in batch or continuous operations, including storage, materials transfers, mixing, tabletting, compression, pelletisation, extrusion, large and small scale packing, sampling, maintenance and associated laboratory activities. 13a- Use as functional fluids e.g. cable oils, transfer oils, coolants, insulators, refrigerants, hydraulic fluids in industrial equipment including maintenance and related material transfers. 13b- Use as functional fluids e.g. cable oils, transfer oils, coolants, insulators, refrigerants, hydraulic fluids in professional equipment including maintenance and related material transfers.
Additional information	

Section 2: - Exposure controls

Product characteristics	Substance is complex UVCB. Predominantly hydrophobic
Frequency and duration of use	Continuous release.
Environment factors not influenced by risk management	Local freshwater dilution factor: 10 Local marine water dilution factor: 100
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used.
Technical on-site conditions and measures to reduce or limit discharges, air emissions and releases to soil	Risk from environmental exposure is driven by freshwater sediment. No wastewater treatment required. Prevent discharge of undissolved substance to or recover from onsite wastewater.
Risk management measures - Water	Treat on-site wastewater (prior to receiving water discharge) to provide the required removal efficiency of [3] (%): 0 If discharging to domestic sewage treatment plant, provide the required onsite wastewater removal efficiency of [3] (%): 0
Organisational measures to prevent/limit release from site	Do not apply industrial sludge to natural soils. sludge should be incinerated, contained or reclaimed.
Conditions and measures related to external treatment of waste for disposal	During manufacturing, no waste of the substance is generated.
Conditions and measures related to external recovery of waste	During manufacturing, no waste of the substance is generated.

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Section 2: - Exposure controls

Contributing scenario controlling worker exposure for 0:	
Product characteristics	Liquid, vapour pressure < 0.5 kPa at STP.
Concentration of substance in mixture or article	Covers percentage substance in the product up to 100% (unless stated differently).
Physical state	liquid
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently).
Other given operational conditions affecting workers exposure	Operation is carried out at elevated temperature (> 20°C above ambient temperature). Assumes a good basic standard of occupational hygiene is implemented. Aspiration hazard if swallowed. Aspiration means the entry of a liquid substance directly into the trachea and lower respiratory tract. Aspiration of hydrocarbon substances can result in in severe acute effects such as chemical pneumonitis, varying degree of pulmonary injury or death. This property relates to the potential for low viscosity material to spread quickly into the deep lung and cause severe pulmonary tissue damage. Classification of a hydrocarbon substance for aspiration hazard is made on the basis of reliable human evidence or on the basis of physical properties. Do not induce vomiting as there is high risk of aspiration. If swallowed, call a Poison Control Centre or doctor immediately. Contributing scenarios - Operational conditions and risk management measures General exposures (closed systems) Handle substance within a closed system. General exposures (closed systems) with sample collection Handle substance within a closed system. Wear suitable gloves tested to EN374. Process sampling Sample via a closed loop or other system to avoid exposure. Laboratory activities Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure. Wear suitable gloves tested to EN374. Bulk transfers Ensure material transfers are under containment or extract ventilation. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training. Equipment cleaning and maintenance Drain down and flush system prior to equipment break-in or maintenance. Retain drain-downs in sealed storage pending disposal or for subsequent recycle. Clear spills immediately. Wear chemical-resistant gloves (tested to EN374) in combination with specific activity training. Bulk product storage Store substance within a closed system.Wear suitable gloves tested to EN374.
Conditions and measures related to personal protection and hygiene	
Personal protection	See Section 8 of the safety data sheet (general health and safety measures). See Section 8 of the safety data sheet (personal protective equipment).

Section 3: - Exposure estimation and reference to its source

Website:	Not applicable.

Section 3: - Exposure estimation and reference to its source

Exposure estimation and reference to its source - Environment: 2:	
Exposure assessment (environment):	Not available.
Exposure estimation	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model.

Exposure estimation and reference to its source - Workers: 1:	
Exposure assessment (human):	Not available.
Exposure estimation	The ECETOC TRA tool has been used to estimate workplace exposures unless otherwise indicated.

Section 4: - Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Environment	Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures. Required removal efficiency for wastewater can be achieved using onsite/offsite technologies, either alone or in combination. Required removal efficiency for air can be achieved using on-site technologies, either alone or in combination. Further details on scaling and control technologies are provided in SpERC factsheet. Scaled local assessments for EU refineries have been performed using site-specific data and are attached in PETRORISK file - "Site-Specific Production" worksheet.
Health	The CLP hazard statement H304: May be fatal if swallowed and enters airways (the DPD risk phrase R65: Harmful: may cause lung damage if swallowed) relates to potential for aspiration , a non-quantifiable hazard determined by physico-chemical properties (i.e. kinematic viscosity) that can occur during ingestion and also if it is vomited following ingestion. A DNEL (derived no effect levels) cannot be derived. This general qualitative CSA (chemical safety assessment) approach aims to reduce/ avoid contact or incidents with the substance. However, implementation of risk management measures (RMMs) and operational conditions (OCs) need to be proportional to the degree of concern for the health hazard presented by the substance. Exposures should be controlled to at least the levels that represent an acceptable level of risk such that the implementation of the chosen RMMs will ensure that the likelihood of an event occuring due to the substance hazard is negligible, and the risk is considered to be controlled to a level of no concern. There are no routine anticipated exposures by ingestion related to any supported uses of the substance. The risk arising from aspiration hazard is solely related to the physico-chemical properties of the substance. The risk can therefore be controlled by implementing risk management measures tailored to this specific risk. For any substance, classifies as H304 (R65), these measures should be communicated via the safety data sheet by use of the following phrase: Do not ingest. If swallowed then seek immediate medical assistance.

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Certificate of Analysis

PRODUCT:	Nytro Lyra X	**DELIVERED FROM:**	Shoretank 555
BATCH NO:	100-7-T443-151029B	**DATE BATCH:**	12-november-2015
BATCH REF NO:	N2015/15213/LN18198	**LOCATION:**	LBC - Antwerp

Analysis from shoretank performed by Inspectorate Antwerp NV:

Analysis	Method	Unit	Results
Density at 15°C (vac.)	ASTM D4052 / ISO 12185	kg/dm3	0,8663
Density at 20°C (vac.)	ASTM D4052 / ISO 12185	kg/dm3	0,8632
Viscosity at 40°C	ASTM D445 / ISO 3104	mm²/s	9,750
Flash point, PM	ASTM D93A / ISO 2719	°C	152
Colour ASTM	ASTM D1500		L 0,5
Neutralization value	ASTM D974 / IEC 62021	mgKOH/g	< 0,01
Inhibitor content	IEC 60666	% b.w..	0,39
Interfacial tension at 25°C	ASTM D971 / EN 14210	mN/m	49,1

Ag-corrosion*	DIN 51353		non-corr.
Cu-corrosion*	ASTM D1275B		non-corr.
Corrosive sulphur*	IEC 62535		non-corr.

RECEIVER:	KONCAR MJERNI TRANSFORMATORI D ZAGREB CROATIA		
TRUCK:	VZ 955 GZ	**ANALYSIS:**	13.05 Hrs. 02-december-2015
N ORDER NO:	AT 343642	**DATE LOADING:**	02-december-2015
C ORDER NO:	355-1774	**OUR REF:**	N2015- 16434
QUANTITY:	22,900 M.Ton	**LAB REF:**	LN / 19602
SEALS IN USE:	2477931 -> 935		
REMARKS:			

Results obtained by Inspectorate Antwerp NV on a representative sample after loading:

Analysis	Method	Unit	Results
Breakdown Voltage	IEC 60156	kV	54
Tan delta at 90°C	IEC 60247	decimals	0,0001
Water (Karl Fischer)	IEC 60814	ppm	15
Visual appearance	ASTM D4176		Clear&Bright, free from suspended matter

All test results in this CoA comply with specified limits in the corresponding Nynas AB Product Data Sheet (PDS).
PCB compounds shall be none detectable, in accordance with methods ASTM D4059 or IEC 61619.
For the latest PDS edition or for complete Nynas AB specifications regarding specific products, please visit www.nynas.com or contact your local sales contact.

Sign by Inspectorate Antwerp N.V. on behalf of Nynas AB

Заличено по чл.2 от ЗЗЛД

"KONCAR - Mjerni transformatori"
d.d.
ZAGREB, Josipa Mokrovića 10

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