Client	**ELTAS Transformatör Sanayi Ve Ticaret Anonim Şirketi** **Izmir – TURKEY**
Test equipment	Complete column of a three-phase 500 kVA dry-type power transformer
Tests carried out	Fire behaviour test F1 class
Standards/Specifications	IEC 60076-11, 2004 clause 28.3 to 28.8
Test date	**from** February 5, 2008 **to** February 5, 2008

The test results relate only to the sample tested.

No. of pages	16	**No. of pages annexed**	
Issue date	February 6, 2008		
Prepared	Unit LABORATORIES – Roberto Mariani		
Verified	Unit LABORATORIES – Franco Pizzi		
Approved	Area COMPONENTS – Virginio Scarioni		

CESI S.p.A.
Energy Division
Technical Area Components
"Testing Laboratories"
Manager

Test witnessed by
Mr. Ahmet Gure (ELTAS Transformatör Sanayi Ve Ticaret Anonim Şirketi, Izmir TURKEY)
Mr. Yusuf Aygun (ELTAS Transformatör Sanayi Ve Ticaret Anonim Şirketi, Izmir TURKEY)

Identification of the tested object
Not requested.

Measurement uncertainties
The measurement uncertainties of the test results reported in this document are the following:

voltage:	± 5 %
current:	± 5 %
time:	± 5 %
temperature:	± 2°C up to 100°C
	± 2% above 100°C up to 500°C
	± 3%C above 500°C

The measurement uncertainties are estimated at the level of twice the standard deviation (corresponding, in the case of normal distribution, to a confidence level about 95 %) and have to be considered as maximum values.

Test results
The values obtained and the general performance are considered to comply with the reference Standard (see page 1).

Laboratory information

Test location	CESI – Via Rubattino 54 – Milan
CESI testing team	Mr. Claudio Signorini, Mr. Paolo Sironi
Test laboratory	P173
Activity code	80246Q

Table of contents

1 LIST OF INSTRUMENTS USED FOR THE TEST

- Data Acquisition System HP 34970A, equipped with no. 3 board for the Analogic / Digital conversion of voltage and temperature input signal, CESI number 38941;
- fan tacoanemometer f.s. 10 m/s, minimum resolution 0,25 m/s, CESI number 22009;
- optical density measuring device, 1,7 m from the test chamber ceiling, CESI number 008235;
- thermocouples COE-CLERICI type K (full scale 1200 °C) CESI number 14066, 14068, 14069, 14071, 14072, 14035, 14033, 14990, 14992, 38229, 38230, 38231;
- electronic weighting device area / weighing platform, CESI number 11471, 11789;
- electronic thermometer TERSID graduated scale from –15 °C to + 50 °C, resolution 0,1 °C, CESI number 13769.

2 TEST ASSEMBLY

The tested object was placed over the alcohol container.
The distance between the bottom of the alcohol container and the floor of the chamber was 300 mm.
The distance between the middle of the windings and the rear wall of the chamber was 600 mm.
The distance between the radiant panel and the outer winding surface was 175 mm.
The bottom of the radiant panel was 500 mm over the chamber floor.

3 ATMOSPHERIC CONDITIONS

External temperature before the test	+ 10,9 °C
External temperature after the test	+ 10,1 °C
Temperature of the test chamber / tested object before the test	+ 10,9 °C

4 TEST SET UP

The test set up comply with the IEC 60076-11 (2004) Standard is identified by CESI as “Plant P173”.
It is mainly composed by:

- vertical metallic chamber, 4 m high, 1 m wide and 2 m deep, with an air-inlet duct and a cylindrical chimney for the smoke outlet;
- radiant panel with 24 resistor of 1 kW each one, buried in white ceramic material;
- cylindrical container for the ethylic alcohol with external diameter equal to the MV winding external diameter min. at least 40 mm.

5 THERMOCOUPLES POSITIONS

no. 1 – radiant panel, lower side;
no. 2 – radiant panel, upper side;
no. 3 – air inlet;
no. 4 – tested object, front side, about 100 mm from the bottom;
no. 5 – tested object, front side, in the middle;
no. 6 – tested object, front side, about 100 mm from the top;
no. 7 – tested object, in the duct between the windings, about 100 mm from the top;
no. 8 – tested object, in the duct between the windings, in the middle;
no. 9 – tested object, in the duct between the windings, about 100 mm from the bottom;
no. 10 – on the surface of LV windings, at the top;
no. 11 – on the surface of MV windings, at the top;
no. 12 – at the measuring section of the air outlet.

6 TEST PROCEDURE

6.1 Characteristic of the tested object

The dry-type transformer characteristics were:

Number of phases	3
Rated voltage of the high-voltage winding (primary winding)	10,5 ± 2 x 2,5 % / 0,4 kV
Rated frequency	50 Hz
Rated power	500 kVA
Cooling method	AN
Overall dimension	0,6 x 0,617 x 0,85 (h) m
M.V. external diameter	435 mm
L.V. internal diameter	237 mm
Total mass	347 kg

The alcohol container utilized had the following dimensions:

External diameter	535 mm
Internal diameter	197 mm
Amount of alcohol utilized	5,82 l

6.2 Test execution

After the installation of the tested object in the test chamber, the test began with the ignition of the alcohol, at the same time the 24 radiant panel resistor were supplied (about 380 V) in order to obtain a thermal flux of about 3 W/cm^2 towards the sample, and the forced air purifier were started.

The radiant panel, placed about 175 mm far from the front side of the winding, was switched “OFF” 40 minutes later, in the meanwhile the alcohol burnt for approximately 30 minutes.

Temperature, electrical power, visible light transmittance and air speed were recorded throughout the test and reported in the following pages.

7 TEST RESULTS

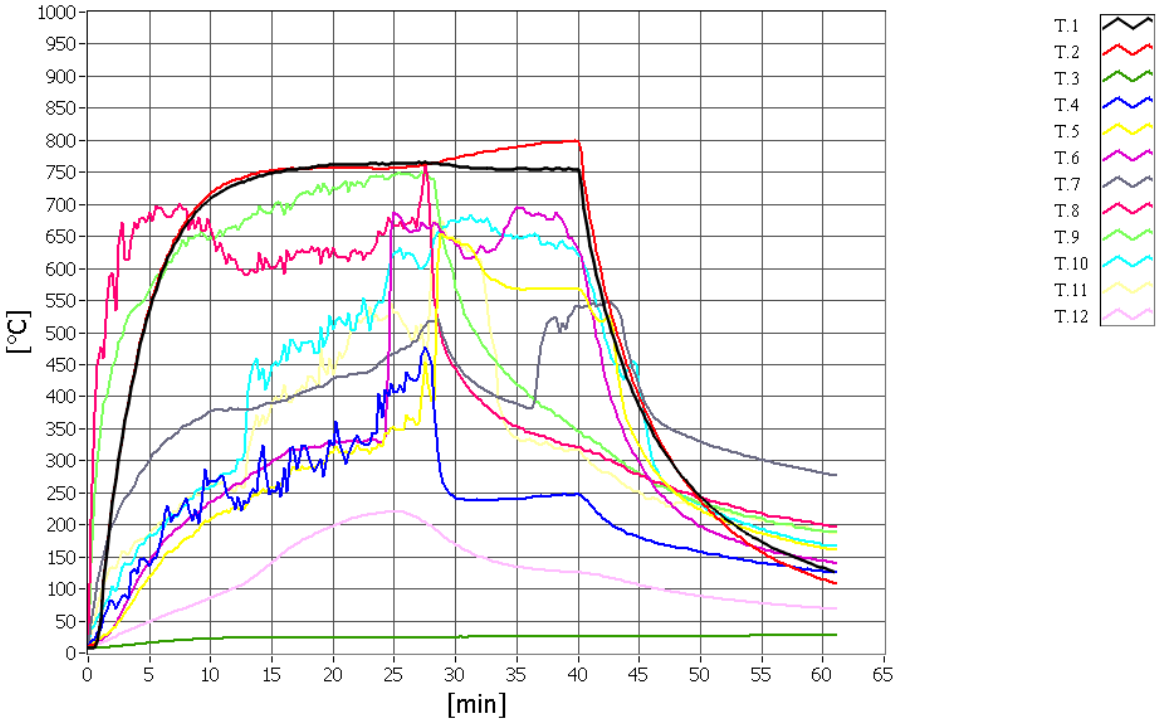
7.1 Temperature tables

Time [min]	T.1 [°C]	T.2 [°C]	T.3 [°C]	T.4 [°C]	T.5 [°C]	T.6 [°C]	T.7 [°C]	T.8 [°C]	T.9 [°C]	T.10 [°C]	T.11 [°C]	T.12 [°C]
0,00	8	11	8	11	11	11	11	10	10	11	10	12
1,50	161	161	9	67	30	27	174	552	402	82	119	20
3,00	363	363	11	90	62	74	241	616	511	139	156	33
4,50	500	505	15	147	106	130	288	678	550	169	177	45
6,00	593	599	17	179	142	170	325	695	583	197	205	57
7,50	653	659	20	221	171	197	349	701	632	221	231	68
9,00	692	699	21	202	193	219	366	679	652	256	245	79
10,50	716	724	22	269	216	242	380	626	651	266	263	90
12,00	731	739	23	225	225	262	380	614	666	284	252	102
13,50	741	747	24	256	247	281	381	597	685	448	345	119
15,00	748	753	24	253	258	299	388	599	691	447	390	142
16,50	754	756	24	320	283	318	400	612	692	490	390	164
18,00	757	755	24	309	288	320	409	625	720	484	432	181
19,50	761	757	24	309	304	328	421	633	726	494	435	194
21,00	763	757	24	295	313	330	431	620	737	510	471	206
22,50	763	756	24	327	316	331	437	614	727	555	523	215
24,00	763	755	24	367	323	328	456	653	744	545	521	219
25,50	764	757	24	419	347	680	473	672	748	632	525	220
27,00	765	760	24	435	360	658	494	694	744	602	488	209
28,50	763	765	24	315	610	668	523	518	693	657	670	190
30,00	759	772	24	242	643	639	453	443	570	674	642	169
31,50	756	778	25	238	624	618	422	403	503	676	628	154
33,00	756	783	25	238	583	629	404	378	461	659	490	144
34,50	755	788	25	239	569	679	392	358	428	652	343	136
36,00	755	792	25	242	567	685	382	343	401	653	333	132
37,50	756	795	25	244	568	676	515	334	381	640	328	128
39,00	755	798	25	247	569	664	506	325	361	635	315	126
40,50	693	739	25	242	561	602	540	316	339	607	307	125
42,00	551	584	25	211	518	451	542	306	320	510	282	120
43,50	457	480	26	193	403	356	523	293	299	433	266	113
45,00	385	400	26	180	324	299	417	279	280	417	251	106
46,50	331	338	26	171	278	252	364	265	260	285	241	100
48,00	288	289	26	165	249	225	346	255	249	249	234	94
49,50	254	249	26	160	228	204	333	245	237	236	230	90
51,00	226	217	26	153	214	188	323	236	229	220	225	86
52,50	203	191	26	148	202	177	314	229	221	209	218	82
54,00	184	170	27	143	192	168	306	221	211	200	211	79
55,50	168	152	27	139	184	160	299	215	205	190	205	76
57,00	155	137	27	135	176	154	292	210	201	182	200	74
60,00	143	125	27	131	169	148	286	205	194	175	196	72

7.2 Test chamber calibration results

CESI protocol no.: A8003455
Average inlet air speed: 1,94 m/s

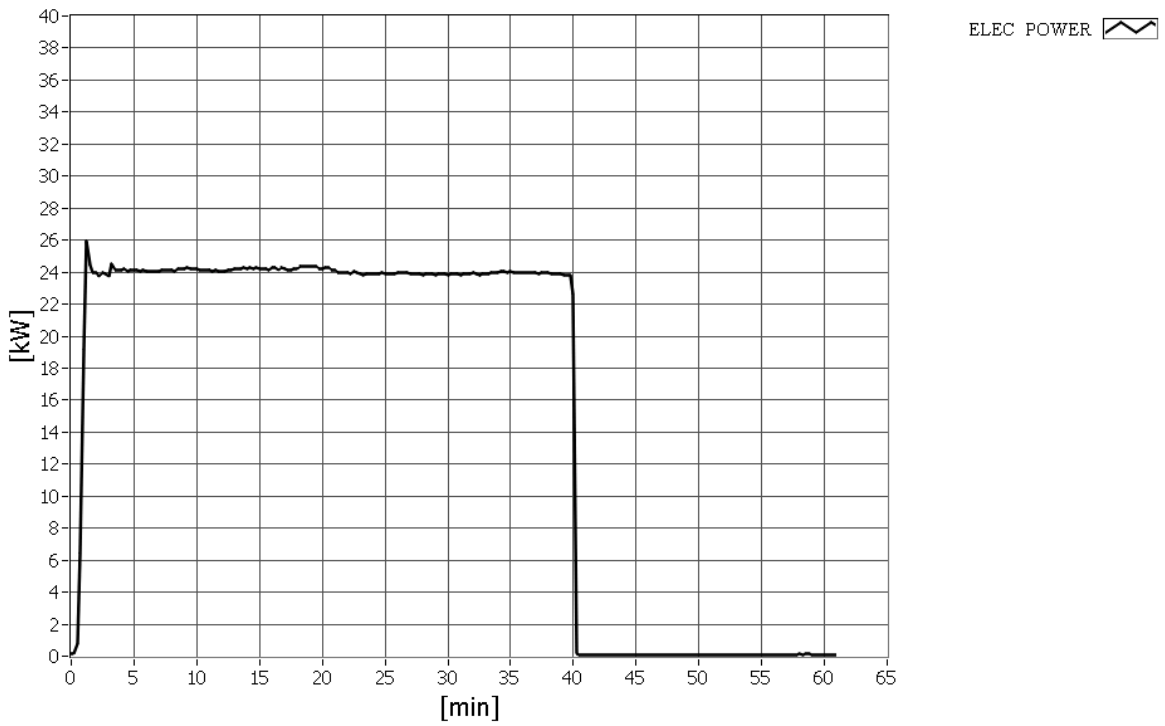
7.3 Temperature diagram



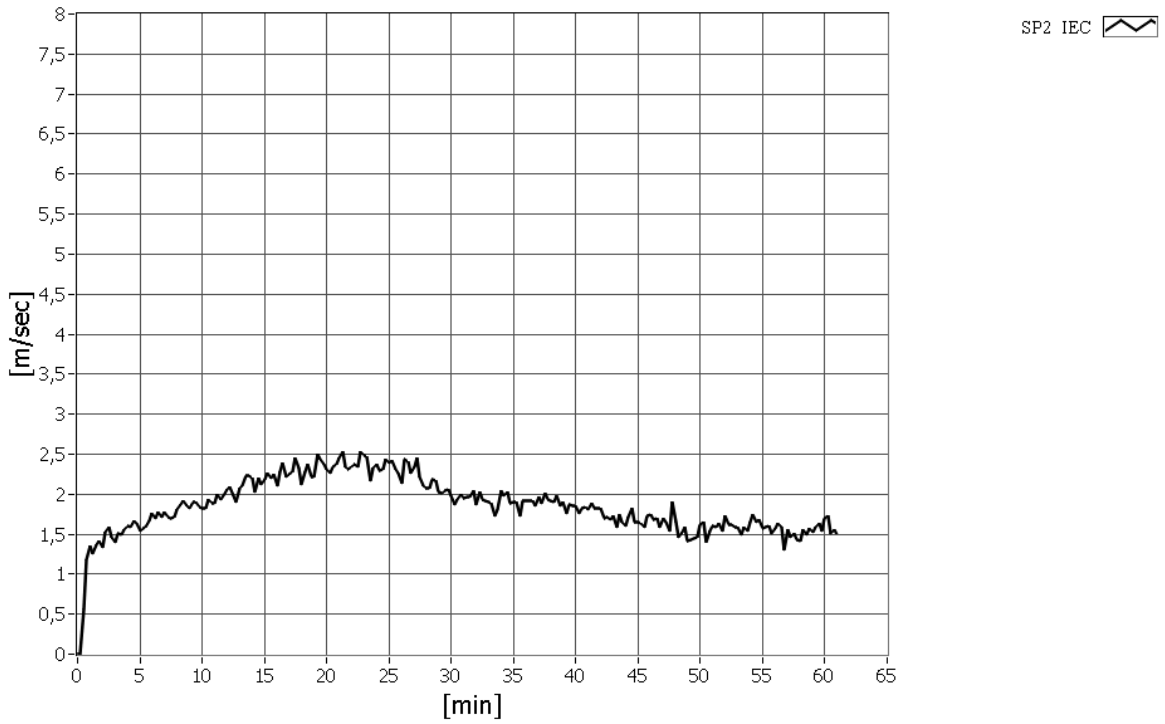
7.4 Table of radiant panel electric power, air speed, visible light transmittance

Time [min]	EL_POWER [kW]	SP2_IEC [m/sec]	TRANSM [%]
0,00	0,12	0,00	100
1,50	24,42	1,36	99
3,00	23,74	1,40	99
4,50	24,07	1,66	100
6,00	24,05	1,77	99
7,50	24,16	1,71	94
9,00	24,22	1,83	75
10,50	24,13	1,93	49
12,00	24,06	2,05	40
13,50	24,24	2,23	67
15,00	24,20	2,19	88
16,50	24,15	2,39	97
18,00	24,23	2,13	98
19,50	24,35	2,43	99
21,00	24,13	2,45	100
22,50	24,03	2,34	99
24,00	23,86	2,37	99
25,50	23,88	2,31	97
27,00	23,87	2,34	89
28,50	23,89	2,19	77
30,00	23,84	1,98	88
31,50	23,89	1,97	93
33,00	23,89	1,91	95
34,50	24,04	2,03	96
36,00	23,97	1,91	97
37,50	23,94	2,02	96
39,00	23,92	1,90	95
40,50	0,12	1,83	95
42,00	0,11	1,82	97
43,50	0,12	1,75	97
45,00	0,12	1,66	97
46,50	0,12	1,70	95
48,00	0,12	1,64	97
49,50	0,12	1,45	97
51,00	0,12	1,61	98
52,50	0,12	1,61	99
54,00	0,12	1,65	99
55,50	0,12	1,60	99
57,00	0,12	1,55	99
60,00	0,12	1,49	100

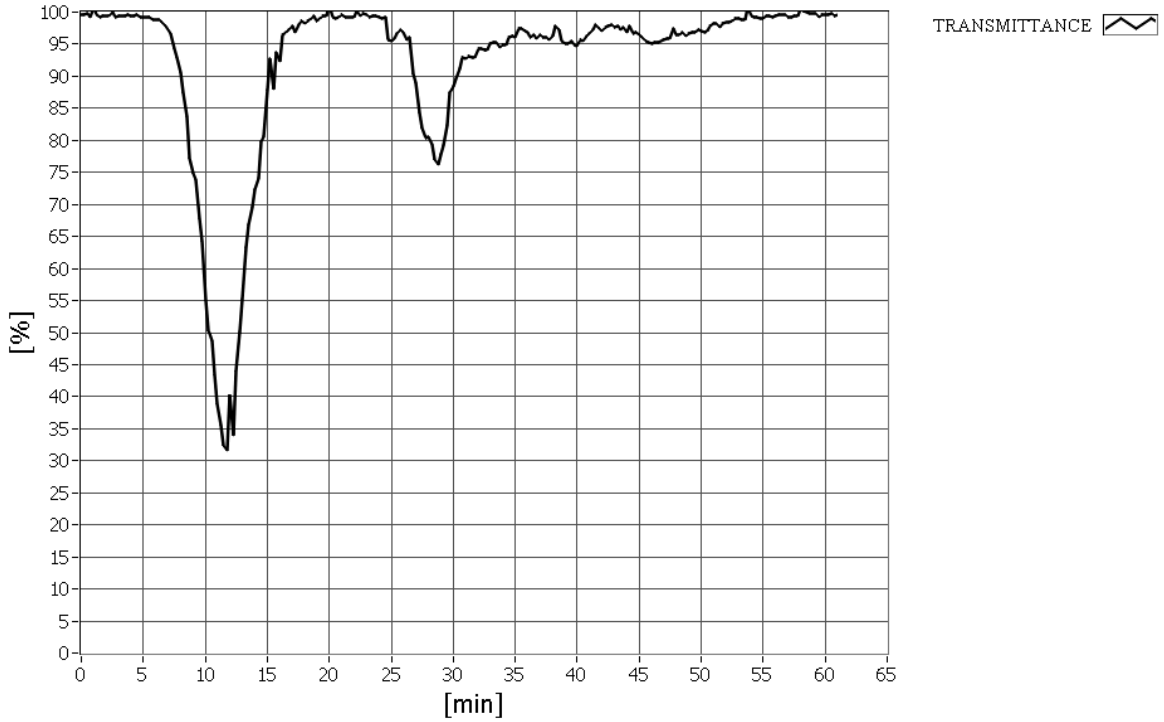
7.5 Radiant panel electric power diagram



7.6 Air speed diagram



7.7 Visible light transmittance diagram



8 EVALUATION OF THE TEST

Weight of the sample before the test	347 kg
Weight of the sample after the test	342 kg
Smoke outlet maximum temperature	220 °C (T_{ext} = +24 °C)
Smoke outlet maximum temperature-rise	θ = 196 K
Smoke outlet maximum temperature-rise admitted by the standard	θ_m = 420 K
Smoke outlet temperature after 45 min.	106 °C (T_{ext} = +26 °C
Smoke outlet temperature-rise after 45 min	θ = 80 K
Smoke outlet maximum temperature-rise after 45 min. admitted by the standard	θ_m = 140 K
Smoke outlet temperature after 60 min.	69 °C (T_{ext} = +26 °C
Smoke outlet temperature-rise after 60 min	θ = 43 K
Smoke outlet maximum temperature-rise after 60 min. admitted by the standard	θ_m = 80 K
$I_{min.}$	31,6 % (measured after 12 minutes)
I_{avg}	96,03 %
Minimum I_{avg} admitted by the standard	20 %

Legenda:
I_{min} = minimum visible light transmittance inside the air-oulet chimney
I_{avg} = arithmetic mean of the visible light transmittance from 20th to 60th minute during the test
T_{ext} = external temperature

NOTE: According to IEC 60076-11 (2004) clause 28.3 document:

$$T = X^{1/P}$$

where P = 1 m (lenght of the optical path in the smoke outlet)

$X = I_{avg} = 0{,}9603$

and consequently T = X = 96,03 %

Test results: positive.

9 TESTED OBJECT PICTURES

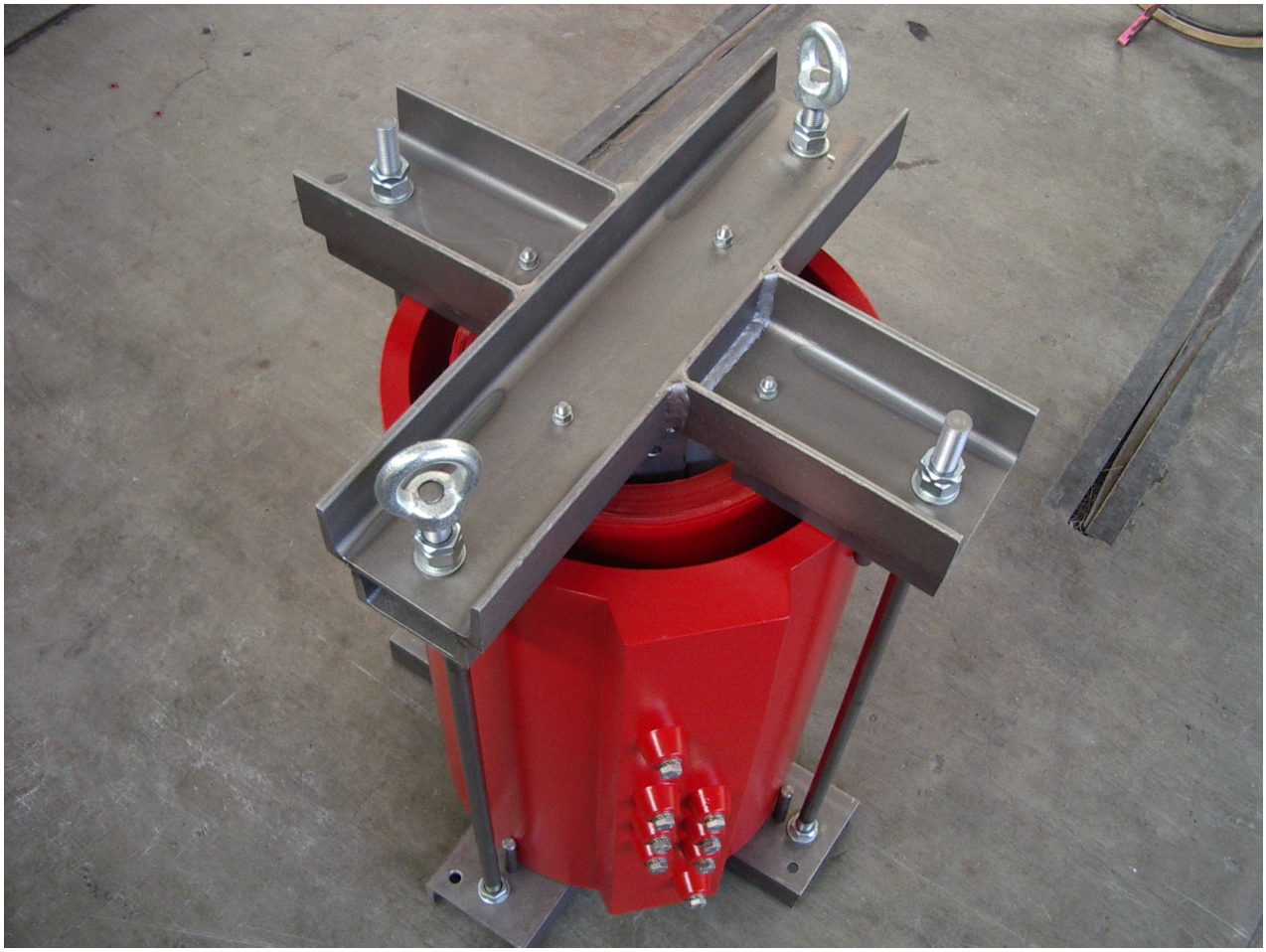


Photo no. 1

Photo no. 2

Photo no. 3

Photo no. 4

Photo no. 5