THREE-PHASE DISTRIBUTION TRANSFORMERS

CONTENTS

1. SCOPE

This Technical Specification covers the requirements for construction and testing of oil-immersed three-phase Distribution Transformers.

2. KEYWORDS

Distribution Transformer, MV, LV

3. OPERATING CONDITIONS

3.1. Environmental conditions

These transformers shall be suitable for indoor or outdoor installation, depending on their rated power, under the following environmental conditions:

- Maximum ambient temperature: +40° C.
- Maximum average daily (24 hours) ambient temperature: +35° C.
- Maximum average annual ambient air temperature: +20° C.
- Minimum ambient temperature: -20° C.
- Altitude: up to 1000 meters above sea level

3.2. System characteristics

- Phases: 3 without neutral at the MV side
- Frequency: 50 Hz.
- Maximum MV system voltage : 17.5 kV , 24 kV.
- Nominal network voltage: MV: 6.6 kV, 15 kV, 20 kV.
  LV: 231/400 V.
- System short-circuit power: 250 MVA.
- Impulse withstand voltage (BIL): 125 kV, 1.2/50 μsec

4. STANDARDS - SPECIFICATIONS

The transformers shall be manufactured according to the recommendations of the Technical Specification herein and the following European Norms and Harmonization Documents:

HD 428.1 S1: 1992 :	Three phase oil immersed distribution transformers - General.
HD 428.3 S1: 1994 :	Three phase oil immersed distribution transformers - Highest voltage.
HD 428.4 S1: 1994 :	Three phase oil immersed distribution transformers - Power ratings.
HD 428.6 S1: 1996 :	Three phase oil immersed distribution transformers - Pressurised - Corrugated tank.
HD 596 S1 : 1996 :	Bushings up to 1000 V from 250 A to 5000 A, for liquid filled transformers.
HD 329 S1 : 1977 :	Test on hollow insulators for use in electrical equipment.

EN 60076-1 : 1997 : Three phase oil immersed distribution transformers - General.
EN 60076-2: 1997 : Three phase oil immersed distribution transformers - Temperature rise.
EN 60076-3: 2001 : Three phase oil immersed distribution transformers - Insulating level-Dielectric test - Clearance in air.
EN 60076-4: 2002 : Guide to the lightning impulse and switching impulse testing-Power transformer and reactors.
EN 60076-5: 2000 : Three phase oil immersed distribution transformers - Short-circuit withstand.
EN 60076-10: 2001: Three phase oil immersed distribution transformers - Sound level.
EN 50180: 1997 : Power transformer - Liquid filled transformer - Bushings above 1 kV to 36 kV.
EN 50216-1: 2002 : Three phase oil immersed distribution transformers - Reactor - Fitting.
EN 50216-2: 2002 : Three phase oil immersed distribution transformers - Reactor Fitting - Relay.
EN 50216-3: 2002 : Three phase oil immersed distribution transformers - Electrical insulating materials - Thermal endurance properties.
EN 50216-4: 2002 : Three phase oil immersed distribution transformers - Thermal pocket - Wheel assembly.
EN 50216-5: 2002 : Three phase oil immersed distribution transformers - Reactor Fitting - Liquid level - Pressure device.
EN 50216-6: 2002 : Three phase oil immersed distribution transformers - Reactor Fitting - Cooling - Radiator.
EN 60317-0-1:1998: General requirements, Enamelled round copper wire, grade 2.
EN 60317-0-2:1998: Rectangular copper wire, general.
EN 60317 - 8: 1998: Polyesterimide enameled round copper wire, class 180.
EN 60317-27: 1998: Paper tape covered rectangular copper wire.
EN 60317-28: 1996: Polyesterimide rectangular copper wire, class 180.
EN 61065: 1993 : Insulated liquid - Mineral oil - Flow properties.
EN 60599: 1999 : Insulated liquid - Mineral oil - Gas analysis.
EN 60567: 1992 : Insulated liquid - Mineral oil - Sampling of gas and oil.
EN 61181: 1993 : Insulated liquid - Dissolved gas analysis (DGA).
EN 60437: 1997 : Radio interference - Insulator - HV - Test.
EN 60507: 1993 : HV - Insulator - Pollution test.
EN 60672-2: 2000 : Insulating materials - Ceramic - Glass - Test method.
IEC 60296: 2003 : Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchgear.
ISO 2409 : 1995 : (ELOT 405) Paints and varnishes.
GR-88 : 1983 : Split bolt connector for copper conductors.
T.S. D/ECNOD182/94: Underground and overhead cable 12/20 kV with XLPE insulation.
T.S. PPC XK 11.02: Hot dip galvanization.
T.S. PPC XK 11.04:92: Electrolytical tin-plate procedure.
TK 11.01: 91 : Code of anchorage/ connection / joining fittings for overhead conductor networks and power cables.

Note: The requirements of this specification prevail over the requirements of the standards and specifications to which it refers. Regarding the standards, their most recent version shall be valid.
All materials that shall be used for the construction of the transformers shall be non toxic and environmentally friendly.

5. DESCRIPTION

5.1. General construction requirements

- All transformers provided under the same contract and with same rating values shall be manufactured in a way that enables the interchangeability of their components and parts.
  During the validity of the contract, no modification to the construction of the Transformers is permitted without prior approval by the Corporation.
- The Transformers shall be manufactured in such a way as to ensure their easy transportation (on road, by train or ships), so that after the arrival at their destination they can be immediately put in permanent operation with no assembly work required.

5.2. General characteristics

The Transformers shall have the characteristics specified in the Specification herein. The manufacturer's warranty regarding the operation of the Transformers, shall be based on these characteristics :

- Phases: 3
- Cooling: ONAN
- Maximum temperature rise according to EN 60076-2: 1997
  oil (measured with a thermometer at its highest level): 60 K.
- windings (measured by the resistance method): 65 K.

Note: The temperature rise is measured in Kelvin degrees (K).

5.3. Connections, Transformation ratio

The Transformers shall be of Single or Double ratio, with ratings as mentioned below.
The tolerances in ratio at the principal as well as at the rest taps, shall be according to what is mentioned in EN 60076-1:1997 for the principal tap.

5.3.1. Single ratio transformers: 20/0.4 kV.

5.3.1.1. Rated power in kVA:

50, 100, 160, 250, 400, 630, 1000, 1600, 2500.

5.3.1.2. Nominal Voltage

- Primary: 20000 V (MV)
- Secondary: 400 V (LV)

5.3.1.3.Tapping at the MV side

The following tapping shall be provided at the MV side: -5%, -2,5%, 0%, +2,5%, +5%, that is per 500 V.
Tap changing shall be performed with the transformer out of voltage, by means of an off-load Tap Changer, which is described in paragraph 5.10.

5.3.1.4.Short-circuit impedance (at 75 °C)

For Transformers with rated power up to and including 630 kVA, the short-circuit impedance shall be 4%, and for Transformers rated at 1000 kVA and up, it shall be 6%. The tolerance for the short-circuit impedance shall be ±10% in both cases.

5.3.1.5.Connection group (Angular displacement)

Connection group of Transformers with rated power 50 and 100 kVA: Yzn11 (Yzn1)

Primary Winding (MV) Secondary Winding (LV)

Connection group of Transformers with rated power 160 up to 2500 kVA: Dyn11(Dyn1)

Primary Winding (MV) Secondary Winding (LV)

5.3.1.6. Bushing arrangement on the cover and phase identifications

$A(H_3)$, $B(H_2)$, $C(H_1)$: MV Bushings

$a(x_3)$, $b(x_2)$, $c(x_1)$: LV Bushings

$n(x_0)$: LV Neutral Bushing

Note: Symbols **A, B, C** correspond to Medium voltage (MV), and symbols **a, b, c, n** correspond to Low voltage (LV) for connection groups Dyn11 and Yzn11. Connection groups Dyn1 and Yzn1 result if the phases of the MV and LV network respectively are connected to the Transformer

terminals according to the symbols provided in brackets, i.e. **H_1, H_2, H_3** for the MV and **x_1, x_2, x_3, x_0** for the LV, i.e. by interchanging the first (1st) with the (3rd) phase for both MV and LV.

5.3.2. Double ratio transformers: 20-15 / 0.4 kV

5.3.2.1. Rated power in kVA

50, 100, 160, 250, 400, 630, 1000

5.3.2.2. Nominal voltages

- Primary: Medium Voltage (MV): 20000 V 15000 V
- Secondary: Low Voltage (LV): 400 V 400 V

5.3.2.3. Tapping at the MV side

The following tapping shall be provided at the MV side:
At the 20000V voltage: -5%, -2.5%, 0%, +2.5%, +5%.
At the 15000V voltage: -6.66%, -3.33%, 0%, +3.33%, +6.66%.

Tap changing shall be performed with the transformer out of voltage by means of an off-load Tap Changer.Voltage change shall also be performed with the transformer out of voltage by means of a Voltage Selector. Both devices are described in paragraph 5.10.

5.3.2.4. Short-circuit impedance (at 75 ° C)

For Transformers with rated power up to and including 630 kVA the short-circuit impedance shall be 4%, and for Transformers rated at 1000 kVA and up, it shall be 6%. The tolerance of the short-circuit impedance shall be ±10% in both cases.

5.3.2.5. Connection group (Angular displacement)

Connection group of Transformers with rated power 50 and 100 kVA: Yzn11 (Yzn1)

Primary Winding (MV) Secondary Winding (LV)

Connection group of Transformers with rated power 160 up to 1000 kVA: Dyn11(Dyn1)

Primary Winding (MV) Secondary Winding (LV)

Note: Symbols **A, B, C** correspond to Medium voltage (MV), and symbols **a, b, c, n** correspond to the Low voltage (LV) for connection groups Dyn11 and Yzn11. Connection groups Dyn1 and Yzn1 result if the phases of the MV and LV networks respectively are connected to the Transformer terminals according to the symbols provided in brackets, as in the case of the single ratio transformers, that is, by interchanging the 1st with the 3rd phase for both MV and LV.

5.3.2.6. Bushing arrangement on the cover and phase identifications

$A(H_3)$, $B(H_2)$, $C(H_1)$: MV Bushings

$a(x3)$, $b(x_2)$, $c(x_1)$: LV Bushings

$n(x_0)$: LV Neutral Bushing

5.3.3. Double ratio transformers: 20-6,6 / 0.4 kV

5.3.3.1. Rated power in kVA

250, 400, 630

5.3.3.2. Nominal voltages

- Primary: Medium Voltage (MV): 20000 V 6600 V
- Secondary: Low Voltage (LV): 400 V 400 V

5.3.3.3. Tapping at the MV side

The following tapping shall be provided at the MV side:
At the 20000 V voltage: -2.5%, 0%, +2.5%, (19500, 20000, 20500 V)
At the 6600 V voltage: 0%, -2.5%, -5%, (6600, 6435, 6270 V)

Tap changing shall be performed with the transformer out of voltage by means of an off-load Tap Changer which is described in paragraph 5.10.
This Tap Changer shall have two separate positions, one for the 6600 V taps and another one for the 20000 V taps.
When the Transformer operates at 6600 V, its transfer to the 20000 V position must not be allowed, and vice versa.

5.3.3.4.Short-circuit impedance (at 75 ° C)

At the 20 kV voltage: 4%
At the 6.6 kV voltage: 4%

The tolerance for the short-circuit impedance shall be ±10% in both cases.

5.3.3.5.Connection group (Angular displacement)

Connection group of Transformers with rated power 250 up to 630 kVA: Dyn11 (Dyn1)

Primary Winding (MV) Secondary Winding (LV)

5.3.3.6.Bushing arrangement on the cover and phase identifications

$A(H_3)$, $B(H_2)$, $C(H_1)$: MV Bushings
$a(x_3)$, $b(x_2)$, $c(x_1)$: LV Bushings
$n(x_0)$: LV Neutral Bushing

5.4. Guaranteed losses at nominal voltage

The losses in load and in no-load operation shall be according to standard HD 428.1 S1:1992. The load losses shall correspond to column A of Table II for Transformers rated up to and including 400 kVA, while for Transformers 630 kVA and up they shall correspond to Column C of Table II. The losses of no-load operation and sound level shall correspond to column C' (reduced losses) of Table III. That means that the Transformers rated at 50 and up to 400 kVA shall have an A-C' pair of values and the Transformers rated at 630 and up to 2500 kVA shall have a C-C' pair of values. All these values shall be maximum values, with no-tolerance exceeding these values being allowed and they shall be mentioned in the offer. For the double ratio Transformers, both voltages are considered as nominal. For losses exceeding the nominal values see paragraph 6.6.

5.5. Sound level

The sound level of the Transformers shall not exceed the values specified in standard HD 428.1 S1: 1992 List C' for each rated power. The measurement shall be carried-out according to standard EN 60076-10: 2001.

5.6. Radio interference voltage

The radio interference voltage, measured according to EN 60437: 1997, shall not exceed in any Transformer the value of 250 μV at the frequency of one (1) MHz.

5.7. Windings

The Transformers shall have two windings (the number of coils of each winding is given by the manufacturer).
Both the MV and the LV windings shall be made of copper. The cross-sections of the circular Conductors shall be according to EN 60317-0-1: 1997, grade 2, EN 60317-8: 1997, class 180, and the cross-sections of the rectangular conductors shall be according to EN 60317-27:1998 with 0.45 mm thick insulation or according to EN 60317-0-2: 1998 and EN 60317-28: 1996, grade 2.
Copper foil may be used for the LV windings.

5.7.1. Insulation level of MV windings

	6.6 kV	15 kV	20 kV
- Power frequency withstand voltage for 1 min of r.m.s. value :	22 kV	38 kV	50 kV
- Full wave impulse withstand voltage, of shape 1,2/50 μs, peak value:	60 kV	110 kV	125 kV

- Chopped wave impulse withstand voltage with a peak value at least equal to that of the full wave for nominal voltages 6.6 kV and 15 kV.
  For the 20 kV it shall be equal to 137.5 kV according to EN 60076-3: 2001.

5.7.2. Insulation level of LV windings

Power frequency withstand voltage for 1 min, r.m.s. value : 10 kV.

5.7.3. Dielectric distances

The 20 kV winding parts that are under voltage shall have a minimum distance from the tank equal to 30 mm. The minimum distance of the LV winding from the core shall be 2.5 mm with intermediate insulation.
No insulation material between windings and tank as well as between tap changer and tank is allowed.

5.8. Bushings

The LV bushings (porcelain insulator + stud, nuts, washers and cover) shall be according to HD596 S1: 1996 and the MV shall be according to EN 50180: 1997. The LV and MV studs for up to 250 A shall be made of brass and the studs for higher currents shall be made of copper.
The distances between the centers of the LV bushings shall be 150 mm for currents up to 2000 A, and 165 mm for currents higher than 2000 A. The corresponding distances for the MV bushings shall be 265 mm.
For the 20 kV operating voltage, the minimum distance between bushing points under voltage from any earthed metallic parts shall be at least 22 cm. In the case of pole-mounted Transformers (50 and 100 kVA), the pole is considered to be earthed.
- The bushings shall be installed on the cover of the Transformer's tank in vertical position and shall be sealed with suitable gaskets.

5.8.1. Insulators

- The MV and LV insulators of the Transformers shall be made of high quality porcelain manufactured with the wet method without pores, and they shall have brown color glazing.
- The MV insulators shall be according to EN 50180:1997, type 2, with four sheds, in order to be always interchangeable. They shall deviate from this standard on the diameter of the sheds, which shall be 165 mm instead of 150 mm as provided in this standard, in order to have a resulting creeping distance of 53 cm. Moreover, for the 50 and 100 kVA transformers, the length of the insulator's neck shall be 160 mm instead of 80 mm.
- The LV insulators shall be according to HD 596 S1: 1996.

5.8.2. Plugs at the MV side

Transformers with rated power 630 up to 2500 kVA, shall be equiped with special plugs reception at the MV side of the tank cover instead of bushings. In particular, the 630 kVA Transformers shall be also manufactured with bushings when they are to be used in overhead networks.

5.8.3. Electrical characteristics

5.8.3.1. MV Insulators

a)	Full wave impulse (with an 1.2/50 μs shape) withstand voltage peak value:	170 kV
b)	Power frequency withstand voltage, wet , 1 min, r.m.s.value:	75 kV
c)	Minimum creeping distance:	53 cm

5.8.3.2. LV Insulators

a) Full wave impulse (with an 1.2/50 μs shape) withstand voltage, peak value: 30 kV
b) Power frequency withstand voltage, wet 1 min – r.m.s value: 10 kV

5.8.3.3. MV Plugs

a) Full wave impulse (with an 1.2/50 μs shape) withstand voltage, peak value: 125 kV
b) Power frequency withstand voltage, wet, 1 min, r.m.s. value: 55 kV

5.9. Bushing terminals

- The MV bushings shall be equipped with split bolt connectors suitable for stranded copper conductors with cross-section from 16 and up to 35 mm^2, according to drawing N° 430020560.
- The LV bushings (3 for the phases + 1 for the neutral) shall be equipped with clamp connectors suitable for stranded copper conductors with cross-sections as specified below, according to the rated power of each Transformer. Split bold connector type terminals shall only be used for the 50 kVA Transformers.

Rated power of Transformer in kVA	Cross-section of conductor (cable) in mm^2	
	Phases	Neutral
50	35 and 50	35 and 50
100	95 and 150	95 and 150
160	95 and 150	95 and 150
250	150 and 300	150 and 300
400	300	300
630	2x300	2x300
1000	4x300	4x300
1600		
2500		

- For the 50 kVA Transformers split bolt connectors shall be used according to drawing N° 430020572.

- For the 100 and 160 kVA Transformers, one terminal size (clamp type) suitable for the 95 mm^2 and 150 mm^2 cross-sections shall be used, according to drawing 430000057. The part of the terminals that will be adapting to the stud of the bushings shall have a M12 diameter and shall be manufactured with jointing tolerance (stud + terminal).

- For the 250 kVA Transformers, one terminal size suitable for the 150 mm^2 and 300 mm^2 cross-sections shall be used according to drawing N° 430015394, while for the 400 kVA Transformers a terminal suitable for the 300 mm^2 cross-section shall be used. The part of the terminal that will be adapting to the stud of the bushing shall have a M20 diameter and shall be manufactured with jointing tolerance (stud + terminal).

- For the 630 kVA Transformers, clamp type terminals suitable for stranded conductors with 2x300 mm^2 cross-section shall be used for the phases and neutral according to drawing N° 430015400. The part of the terminal that will be adapting to the stud of the bushings shall have a M30 diameter and shall be manufactured with jointing tolerance (stud + terminal).

- For the 1000 kVA Transformers, clamp type terminals suitable for stranded conductors with 4x300 mm^2 cross-section shall be used for the phases and neutral according to drawing N° 430021758. The part of the terminals that will be adapting to the stud of the bushings shall have a M42 diameter and shall be manufactured with jointing tolerance (stud + terminal).

The terminals of split bolt type connectors shall be manufactured according to PPC specification GR-88.
The non split type connectors terminals shall be made of copper alloy C-CuZn33Pb and shall be electrolytically tin plated with a thickness 30 μm.
The terminal bolts shall be made of stainless steel (18Cr8Ni).
The terminals shall be properly constructed so that the stud of the bushings does not rotate when the conductors are being connected. Joining shall be performed according to ISO 262:1973.
The terminals suitability shall be checked with tests as specified in paragraphs 6.2.5 to 6.2.8.

5.10. Tap changers – Voltage Selectors

All Transformers shall be equipped with tap changer for tapping at the MV side. The double ratio Transformers (i.e. those with two voltages), shall also be equipped with a voltage selector, for changing the ratio of the nominal voltages. Both the tap changer and the voltage selector shall be of robust construction and shall have a manually operated mechanism for changing taps and voltage. Their transmission mechanism shall be metallic.
The operation levers shall be installed on the cover of the Transformers' tank in a position that enables their use by the technicians and shall have a latching mechanism in every position, step by step.

The levers shall be made of metal and they must ensure a perfect tightness with the tank.
Each step of the lever shall be properly marked with the corresponding taps for the tap changer and the corresponding voltages for the selector in the case of double ratio Transformers. For the taps marking, a metallic disk with numbers corresponding to taps, as they appear on the nameplate, shall be mounted under the lever of the tap changer. For the voltages marking, another metallic disk shall also be mounted under the lever of the selector.
Both the tap changer and the selector shall be operated with the Transformer out of voltage. The lever of the tap changer shall be operating clockwise, moving from position 1 to positions 2, 3 etc.
The axis of the levers shall be made of stainless steel (18Cr8Ni).

5.11. Transformer tank and its accessories

5.11.1. Construction

The Transformer tanks shall be manufactured either with flat walls and cooling elements at least 400 mm wide, or with folded sheets. Their construction shall be robust and shall not permit oil leaks. In the first case, the walls shall be at least 4 mm thick and the cooling elements shall be welded on the walls with vertical reinforcements between them. In the second case, the folded sheet shall be at least 1.2 mm thick.
The tank shall be equipped with suitable lugs for lifting when it is empty.

In particular, for the 50 and 100 kVA Transformers, pole supporting lugs are required, according to drawing No 1, at the longer side of the tank on which the MV bushings are installed.
The tank cover shall be removable (by screws) with suitable gasket. The connections of all components that are screwed on the cover or on the tank shall also be made through suitable gaskets.
The gasket material shall be weather-proof and oil-proof at temperatures up to 110 °C.
All nuts and bolts of the tank cover shall have normal metric threads, according to ISO 4017 and ISO 898 respectively, withstand class 8.8.

5.11.2. Wheels – Hanging Lugs - Jack bosses

For the movement of the Transformers the following shall be provided:

- The 50 and 100 kVA Transformers shall have shaped steel feet at the tank base, with minimum height 50 mm.

- The tanks of the 630 kVA indoor Transformers and the tanks of transformers with higher rated power shall be equipped at their longitudinal sides with four suitable jack bosses enabling the use of a lifting jack in order to place rollers under the tank or to remove the wheels.

- The power transformers rated at 630 kVA and above that are to be installed indoors shall be equipped with four (4) double-direction wheels, according to HD 428.1. S1:1992. The distance between the centers of the wheels shall be 670 mm for the 630 kVA Transformers, 820 mm for the 1000 kVA up to 2000 kVA Transformers, and 1070 mm for the 2500 kVA Transformers.

- The covers of the Transformer tanks shall be equipped with suitable lifting lugs where it shall be possible to attach a steel wire rope in order to lift the whole Transformer without any warping of the cover.
  The lifting lugs shall be properly placed in order to ensure sufficient distance between the steel wire rope and bushings to avoid breaking of the insulators.

For the installation of the Transformers the following shall be provided:

- The 50 kVA Transformers shall be equipped with hanging lugs for single-pole mounting, according to drawing No 1.

- The 100 kVA power Transformers shall be equipped with both single-pole mounting hanging lugs according to drawing No 1 and with a suitable base for installation on a two-pole structure, according to drawing No 2.

- The 160, 250, 400 kVA Transformers, and the 630 kVA Transformers that are to be provided for outdoor installation, shall be equipped with a suitable base for installation on a two-pole structure according to drawing No 2.

5.11.3. Earthing terminals of the tank

The Transformer tank shall be equipped with two, split bolt type, earthing terminals according to drawing 430020559. These shall be installed diagonally on the external

surface of the tank wall, close to its bottom and they shall be suitable for copper conductors of 16 to 35 mm^2 cross-section.
The split bolt type connectors shall be tin plated and shall be screwed to the tank by a nut welded on the tank. The nut shall have round shape, M12 size, and be copper plated or made of stainless steel.

5.11.4. Removable earthing link of the tank (LV neutral connection)

The Transformers shall be equipped with a removable and flexible link made of tin plated copper sheets of at least 35 mm^2 total cross-section, which shall bridge the stud of the neutral bushing with the cover and the side wall of the tank. For this purpose, bolts of suitable cross-section shall be welded, one on the cover and one on the tank. The copper sheets shall be tightened with a screw made of stainless steel or brass, using two washers made of stainless steel or brass or copper.

5.11.5.Expansion tank

- The Transformers of 160 kVA and above are required to have a detachable expansion tank.
  The expansion tank shall have suitable height so that the oil level at 20 °C is at least 3 cm higher than the higher exhaust level of the MV bushing, and at 100 °C no oil overflow from the expansion tank is observed. At -20 °C the oil level shall be 35 mm higher from the bottom of the expansion tank.

5.11.6.Supplementary accessories

The Transformer tank shall be equipped with the following supplementary accessories:

- Oil drain plug, with filtering and sampling device according to DIN 42551.
- Oil filling plug
  For Transformers with expansion tank, the filling plug shall be installed on this tank and shall be manufactured according to DIN 42553/72. The plug shall be of the breathing type.
  For seal type Transformers of 50 and 100 kVA, the filling plug shall ensure perfect tightness and shall be installed on the Transformer's cover at a suitable position, not directly above the windings.
  The filling and drain plugs shall be installed diagonally on the Transformer's tank (at the first and the second end, respectively).
- Dial type thermometer with scale from 0 °C to 120 °C, of minimum diameter 100 mm and max value indicator, for measuring the oil temperature. This thermometer is required only for the Transformers of rated power 630 kVA and above.

- Oil level indicator
  The oil level indicator for Transformers without expansion tank shall be made of a metallic base with suitable slit, covered with a glass plate, resistant to high temperatures, externally marked with readings for -20 °C, 20 °C and 90 °C.
  This indicator shall be mounted on the larger side of the container with screws through a suitable gasket, so that it can be easily disassembled from the outside of the tank.
  At the Transformers with expansion tank and rated power up to 630 kVA the oil level indicator shall be a glass tube protected by two metallic ears and marked with readings for -20 °C, 20 °C and 90 °C.
  Magnetic type indicators shall be used for the indoor installed Transformers.

5.11.7. Sealed type construction of 50 and 100 kVA Transformers

The 50 and 100 kVA Transformers shall be of sealed type construction without expansion tank and without overpressure safety valve. However, the Transformer tank shall be able to withstand an average overpressure according to paragraph 6.2.9 (approximately 0.45 bar). Under the tank cover and up to the oil level, a 120 mm high air layer shall be provided. It is not permitted to use inert gas. For this purpose, the porcelain insulators shall have long neck and their length shall be 160 mm so that their lower end shall remain immersed in the oil by 25 mm (at least) at a temperature of 20 °C. The last point of the tap changer under voltage shall be immersed in the oil by 30 mm at least.

5.12. Overall dimensions of the Transformers

The overall dimensions of the Transformers shall not exceed the following limits:

- Dimensions for Transformers with rated power up to 400 kVA:
  Length: 160 cm
  Width: 130 cm
  Height: 200 cm

- Dimensions for Transformers with rated power 630 and 1000 kVA:
  Length: 190 cm
  Width: 130 cm
  Height: 230 cm

5.13. Transformer oil

The Transformers shall be filled with Transformer oil, which shall meet the requirements of IEC 60296: 2003, EN 61065: 1993 and shall have minimum dielectric strength 50 kV.

5.14. Finishing and painting

5.14.1.Surface preparation and cleaning

Any snags and rough edges shall be removed by grinding from all inner and outer surfaces of the Transformer tank and cover before paint is applied on them. Then the forrous oxides and welding residues shall be removed from them with the sandblasting method.
Following this work, all the above surfaces shall be degreased and freed from any types of chlorines.

5.14.2.Priming

Priming for protection against corrosion is required only at the external surfaces of the Transformer tank and cover. It shall be performed by two layers at an anticorrosive primer, which shall be a varnish made of non-toxic and environmentally friendly materials. Each layer shall be dried in a dust-free environment at a temperature of 20 °C to 25 °C, or in a furnace at 80 °C.
Each layer shall have a different color (e.g. the first shall be gray and the second green or yellow) and minimum thickness 40 μm.

5.14.3.Final painting

- The inner surface of the Transformers' tank and cover shall be painted with one layer of white colored, environmentally friendly, special oil-resistant paint without toxic materials, with minimum thickness 40 μm.

- The tank and cover shall be externally painted with two layer of environmentally friendly, non-toxic paint, with total thickness 80 μm (measured at dry condition) and shade per RAL 7033.
  This paint can be applied either by spraying or by immersing the whole Transformer in the varnish, after having isolated the component surfaces that do not require any painting.

- In general, the paints shall be anti-corrosive and the metallic parts shall be painted in a proper way with an approved and modern method. The painting shall be tested according to paragraph 6.2.3.

5.15. Zinc coating of steel materials, bolts, nuts, etc

All steel bolts, threaded parts, nuts, studs (if they are made of steel) that will be used in the assembly of the Transformers, must be zinc coated according to specification XK 11.04/92 if their diameter is greater than or equal to 10 mm. If their diameter is smaller, the zinc coating can be performed according to specification XK 11.01/87.

5.16. Drawings and Instructions

The manufacturer, shall submit together with his offer, the following :

- A general layout drawing (front view, plan view and side view) for each offered type of Transformer, which shall indicate its outer dimensions and shall show the positions of all components outside the tank with which the Transformer shall be equipped. This drawing shall indicate the total weight of the transformer, the weight of its live part (core + windings), the weight of oil and the free height required for the extraction of the live part from the tank.

- Drawings of terminals for all types of the offered LV and MV terminals and earthing split-bold connectors, which shall indicate the material used and the tin-coating thickness.

- Drawings for the nameplates of paragraph 7. These nameplates shall be made of stainless steel.

The manufacturer, prior to the commencement of the first partial delivery for each contract shall provide the following to the Corporation in six (6) photocopies:

- Drawing of the interconnections of the MV and LV windings for creation of the vector group.

- Constructional drawings of the MV and LV windings indicating the coil dimensions, the cross-sections of the conductors used, their weight, the number of turns, the type and dimensions of the insulating materials and their quality.

- Drawings of the tap changers and voltage selectors and of their levers and accessories.

- All drawings shall be in their final form and shall be signed by the manufacturer.

- The maintenance and operating instructions of the Transformers shall be delivered in twenty (20) copies.

5.17. Calculation of thermal ability of windings under short-circuit conditions

The thermal ability of the transformers to withstand short-circuits shall be proved with calculations at the nominal voltage, according to EN 60076-5: 2000. These shall be submitted together with the offer.
It is clarified that the calculations shall be performed for both, the MV and LV windings and for both voltages in case the transformer is of double-ratio type.

6. TESTS

6.1. Routine tests according to EN 60076-1: 1997

6.1.1. Measurement of the windings resistances.

6.1.2. Measurement of the transformation ratio, polarity check, angular displacement and phase sequence.

6.1.3. Measurement of the short-circuit impedance.

6.1.4. Measurement of load losses.

6.1.5. Measurement of no-load losses and exciting current at the nominal voltage.

6.1.6. Induced voltage test.

6.1.7. Power frequency voltage withstand test (separate source voltage withstand test).

6.1.8. Tightness test for the sealed type Transformers.
A certain pressure shall be applied as described in paragraph 6.2.9.

6.1.9. Measuring of dry paint thickness

Measurement of the dry paint thickness. This measurement may be performed by any method jointly accepted by the Corporation and the Supplier. The thicknesses of the layers of the primer and final paint shall be measured both at the inner and outer surface of the tank. These thicknesses shall not be less than the specified values.

6.2. Type Tests

The Type tests shall be carried out on finished Transformers (complete) at the manufacturer's factory or at the Corporation's laboratories. The time and the number of Transformers that shall undergo the type tests are mentioned in paragraph 6.4. (Acceptance procedure).

6.2.1. Temperature rise test

The temperature rise test shall be performed at the nominal voltage, according to EN 60076-2: 1997.

6.2.2. Full and chopped wave impulse voltage withstand test

The test shall be performed according to EN 60076-3: 2001, at the tap with the lower number of turns.

Further to the criteria specified in the above standard, for the verification of the results, the Transformer passed the impulse test shall then be subjected to induced and power frequency voltage withstand test with 100% of the value specified in the same standard for the routine tests. Should the Transformer fails to withstand the above tests, the impulse voltage test shall be considered as failed.
Note 1: For the transformers of double ratio, tests 6.2.1 and 6.2.2 shall be performed at both voltages.
Note 2: Prior to the performance of the tests of paragraphs 6.2.1 and 6.2.2, the transformer tap changer shall undergo 200 full operating cycles.

6.2.3. Paint tests

These tests shall be frequently performed during the tank painting stage, except of the corrosion test, which shall be performed once on each type of Transformer.

- corrosion withstand test
This test shall be performed by the salt fog method for a period of 240 hours on a 20x20 cm sample of steel surface.

- Adhesion test of the paint
This test shall be performed according to ISO 2409: 1995 (ELOT 405). No peeling at the paint layer is allowed when the device is loaded with a 5 kg mass.

6.2.4. Tests on the MV and LV insulators

Insulators, prior to their installation on the Transformers, shall be tested by a representative of the Corporation. The manufacturer is obliged to submit the test reports on the basis of which the LV and MV insulators were accepted from their manufacturer.
The test reports shall comply with the requirements of paragraph 5.8.3.

- Impulse voltage withstand test.
- Power frequency voltage withstand test, wet.
- Thermal stability test
- Porosity test

The first two tests shall be performed according to EN 60137: 1996.
The thermal stability test and the porosity test shall be performed according to HD 329 S1: 1977.

The Corporation reserves the right to repeat all or some of the above tests at its discretion. In case of tests failure, the insulators shall be rejected.

6.2.5. Tests on the MV and LV terminals

On one of the terminals (except the split bolt type), typical for each type of connectors with which the MV and LV bushings shall be equipped, and randomly selected from one of the transformers of the first lot, the following tests shall be performed:

6.2.6. Clamping test

Clamping of the cable conductor or of the bare copper conductor of the same cross-section shall be performed by applying a tightening moment M=2xd [Nm], where d is the diameter of the terminal in mm. This test shall be considered as successful if:

- No retreat of the nut is observed with the above tightening moment.
- No slipping of the conductor from the terminal is observed, if the cable is pulled with a force of 300 N.

6.2.7. Electrical aging tests on the MV and LV terminals

The electrical aging test shall be performed on the Transformer terminals according to Technical Specification TK 11.01: 91 "Code of anchorage / connection / joining fittings of overhead conductor networks and power cables". It is clarified that in the position of one of the conductors, a copper bar with a diameter equal to the diameter of the stud shall be connected.
If the terminal is suitable for two cable cross-sections, the voltage drop shall be separately measured for each cross-section, considering the connection of each cable as an indepentent terminal. In order to consider that the terminal passed the test, each connection alone shall comply with the requirements of the test.
In case of failure, the tests shall be repeated on three other terminals of the same type. These tests must be successful for both cables, otherwise all terminals of this type shall be rejected.

6.2.8. Alloy chemical analysis

The alloy composition of the terminals shall be tested with a mutually agreed between the Corporation and the Supplier method.

6.2.9. Determination of the pressure inside the tank

The tightness test for the tank of the 50 and 100 kVA Transformers, which is not specified in the EN standards, shall be performed as follows:

a) Type test
To determine the maximum pressure which is developped inside the tank when the Transformer operates at the nominal load, one Transformer shall be randomly selected from each type with the same nominal power and voltage ratio. This Transformer shall be filled with oil up to the normal level and its tank is sealed in such a way that the same pressure exists both inside and outside under conditions similar with the following:

- Temperature 20 °C.
- Atmospheric pressure 760 mm Hg.

After sealing the Transformer, the oil temperature is increased by placing the transformer inside an oven and after stabilizing the temperature 80 °C, the internal pressure Pm is measured. Alternatively, the pressure Pm can be measured during the thermal test, at the maximum temperature.

b) Routine test

The tightness test for the tank is performed on each Transformer of the same type in cold state, with pressure 1.2 x *Pm* in the following manner:

The pressure inside the tank is increased up to 1.2 x *Pm* within a period of about 1 min with dry air or nitrogen. That pressure shall be maintained stable for one hour.

The test is considered successful if during the one hour period no oil leakage warping or deformation of the tank is observed. A leakage may be observed by several ways (e.g. change of the manometer indication).

6.3. Special tests

The number of Transformers that shall be subjected to these tests is mentioned in paragraph 6.4.

6.3.1. Short-circuit withstand test

The dynamic short-circuit withstand test shall be performed according to EN 60076-5: 2000, but the reference value for the symmetrical short-circuit current shall not exceed in any case 25 times the value of the nominal current. This concerns Transformers with rated short-circuit impedance less than 4%. If the difference in Reactance measured after and before the test, exceeds the limits specified in the above standard for the corresponding type of winding (cylindrical or not cylindrical), the Transformer shall be rejected.

On the tested Transformer it is permitted to exceed the short-circuit impedance voltage above the 10% tolerance limit and up to the permitted limit for the difference of the reactance as provided in EN 60076-5: 2000.

For the Transformers of double ratio the test shall be performed at the voltage at which the tested Transformer has the lowest short-circuit impedance.

6.3.2. Sound level test

It shall be performed according to EN 60076-10: 2001

6.3.3. Radio interference level test

It shall be performed according to EN 60437: 1997.

6.3.4. Measurement of the no-load current harmonics

It shall be performed according to EN 60076-1:199

6.3.5. Measurement of the zero sequence impedance

Note: For the Transformers of double ratio, the sound level and radio interference tests shall be performed only at the 20 kV voltage.
The tests of paragraphs 6.3.2 to 6.3.5 shall be performed only once, at the delivery of the first lot.

6.4. Inspection and acceptance procedure

Any modification to the design of the Transformer is permitted only upon written approval by the Corporation.
The Type tests shall be performed at the rated voltage and only on the first lot, except the impulse test (full + chopped), which shall be performed on one Transformer from each lot.
The Special tests shall be performed only once, on the first lot.

-The Transformers purchased by the Corporation under this specification are subject to inspection by their qualified inspectors. These inspectors shall have access to all departments of the factory during the working hours and they shall be provided with all available accomondation for the inspection of the material.
The manufacture is required to provide to the inspectors advance notification periods for all tests, thus enabling them to attend the tests.
The supplier is required to submit certified copies of the reports of the final Routine and Type tests. These shall include information and test results regarding all the specified values.

-In particular, for the impulse tests the supplier is required to:
a) Keep a complete record of all impulse voltages that were applied to the Transformer terminals. The record shall include all preliminary and calibrating tests as well as the final tests. This record shall include oscillographs with their evaluation, the winding connections for the test, atmospheric conditions, etc., as well as any disruption or failure of the test, either inside or outside the Transformer. This impulse tests record and the drawings for the test circuits must be always available to the Corporation.

b) Take oscillographs of the impulse voltages applied to the Transformer terminals for all tests, preliminary, calibrating and final.

- All Transformers of the same type shall be delivered by partial deliveries in lots. The quantity of each lot shall be defined in each contract. In special cases, the lot quantity may be determined by the inspector.

-The Routine tests for each lot can be performed in the absence of the inspector at his discretion. In this case, the manufacturer shall submit to the inspector the tests reports, although the reliability of the measurements shall be verified by him by repeating 10% of the tests. In case of discrepancy between one test and the test reports, the tests shall be repeated on the whole lot.

-In case the results of the Routine tests for the first lot are acceptable, the inspector shall proceed to the performance of the Type tests and Special tests. For this purpose, two (2) pieces in the case of single ratio Transformers, or three (3) pieces in the case of double ratio Transformers from each lot shall be randomly selected from each lot. The following tests shall be performed on them:

-On the first one (single or double ratio) the Dynamic short-circuit withstand test shall be performed, followed by the no-load losses and excitation current test.
This test shall be performed at the laboratories of the PPC Test Center.

-On the second one, if it is of the single ratio type, the temperature rise test shall be performed at the nominal voltage, followed by the impulse test (full and chopped wave), the induced voltage test at 100% of the initial value, and the radio interference test. If it is a double ratio type Transformer, the second one shall undergo all the above tests, with the only difference being that the temperature rise test will be performed in the ratio with the highest losses.

-On the third Transformer, the impulse test (full and chopped wave) shall be performed and then the induced voltage test at 100% of the initial value and at the voltage ratio that was not used for the tests of the second sample.

- If all these tests are successful, the lot shall be accepted.
If the tests (one or more) fail on one of the two or three above Transformers, the lot shall be rejected, unless it is obvious that the failure was due to an accidental constructional defect.
In the last case, three more Transformers (of single or double ratio) shall be randomly selected from the same lot, which shall be subjected to the tests that the previous transformers failed.
If the failed test is the short-circuit test, it shall be repeated only on one Transformer instead of three. The lot shall be accepted on condition that all tests performed on the three new Transformers shall be successful, otherwise the lot shall not be accepted. Therefore, its Transformers shall not be accepted.
Following the first lot acceptable, according to the above procedure, the Special tests and the Type tests, except for the impulse test, shall not be repeated on the rest of the lots. The Corporation, however, reserves the right to repeat these tests at its discretion on one more lot and these shall be succesful. If even one of these tests fails, the tests shall be repeated on a new transformer according to the above mentioned procedure for the case of failure in a Type or Special test. In case of failure the Transformer lot shall not be accepted. The Corporation reserves the right to perform these tests on one of the following lots.
It is understood that if certain tests for the acceptance procedure are not performed on a lot, these tests shall be considered as successful.

6.5. Sample

The manufacturer, before the start of the mass production of the Transformers is obliged to supply one (1) Transformer for each rated power and ratio for visual inspection in a Corporation's workshop, and to comply with the comments of the sample inspection committee.

6.6. Performance of tests

- For the double ratio Transformers (20-15/0.4 kV or 20-6.6/0.4 kV) the tests mentioned in paragraphs 6.1.1 to 6.1.4 shall be performed at both voltages. The tests of paragraphs 6.1.5, 6.1.7 and 6.1.8 shall be performed only at the 20 kV voltage, while in the other voltage (15 or 6.6 kV) shall be performed as Type test for each lot, which shall be successful. If they fail, they shall also be performed at this voltage as Routine tests.

- The tests 6.1.1 to 6.1.5 shall be performed according to EN 60076-1: 1997 and the tests of paragraphs 6.1.6 and 6.1.7 according to EN 60076-3: 2001.

- The maximum tolerance limit for each type of losses shall be +7.5%. Any transformers presenting losses that exceed these tolerance limits (standard HD 428.1 S1/1992) shall be rejected. All transformers within the tolerance limits shall be accepted with a penalty clause provided for in the inquiry.

7. NAMEPLATES AND MARKING

The transformers shall be equipped with the following nameplates:

7.1. Transformer characteristics nameplate

This name plate shall contain the main characteristics of the Transformer and shall be mounted at the tank side, where the LV bushings of the Transformer are mounted.
The dimensions of the plate shall be 230x160 mm and the arrangement of its data shall be in accordance with the drawings 3, 4 and 5.
The connection diagram shall show the internal connections and the marking of the terminals.
The Transformer's serial number shall be printed on the plate, on the cover and on its live part (core + windings).

7.2. Operating nameplates for tap-changer and selector

Each lever of tap-changer or Voltage Selector, must be equipped with a nameplate on which the followings must be written in Greek capital letters:

Ο ΧΕΙΡΙΣΜΟΣ ΤΟΥ ΜΕΤΑΓΩΓΕΑ ΘΑ ΓΙΝΕΤΑΙ ΜΕ ΤΟ ΜΕΤΑΣΧΗΜΑΤΙΣΤΗ ΕΚΤΟΣ ΤΑΣΕΩΣ

Apart from this nameplate, each tap-changer and selector shall be equipped with a circular shaped plate having the same axis with that of the lever, fixed on the lever, with the tapping markings (1, 2, 3, 4, 5) of the tap changer and the voltage markings (1 for 20 kV and 2 for kV) or (1 for 20kV and 2 for 6,6 kV) of the voltage selector.

7.3. Phase marking

A print of reliefs engraving type for each phase shall be provided on the cover of the Transformer near the base of the MV and LV bushings. It is not permitted to use welded plates. The symbols for the phases are provided in paragraphs 5.3.1.6, 5.3.2.6 and 5.3.3.6.
All the above nameplates shall be made of stainless steel. The plate thickness shall be at least 1 mm.

8. PACKING

The Transformers, before they are loaded for shipment, shall be placed on a wooden base made of suitable beams. The base shall be properly screwed on the Transformer's base.
All three MV bushings shall be surrounded together by a protective cover made of foamy material.
If the Transformer is to be transported overseas, special packing is required.
The manufacturer shall be responsible for the design of this special packing and shall be approved by the Corporation.

9. DRAWINGS LIST

- Drawing 1: Hanging lugs of 25 to 100 kVA Transformers
- Drawing 2: Installation of 100 to 400 kVA Transformers on platform.
- Drawing 3: Indicative nameplate of 20/0.4 kV Transformers.
- Drawing 4: Indicative nameplate of 20-15/0.4 kV Transformers.
- Drawing 5: Indicative nameplate of 20-6.6/0.4 kV Transformers.
- Drawing N° 430020560: M12 split bolt connector (16-35 mm^2).
- Drawing N° 430020572: M12 split bolt connector (35-50 mm^2).
- Drawing N° 430000057: Terminal 95-150 mm^2.
- Drawing N° 430015394: Terminal 95-400 mm^2.
- Drawing N° 430015400: Terminal 2x300 mm^2.
- Drawing N° 430021758: Terminal 4x300 mm^2.
- Drawing N° 430020559: Earthing split bolt connector.

SUPPLIER .....

THREE-PHASE DISTRIBUTION TRANSFORMERS

TENDER ..... TYPE .....

1. TECHNICAL CHARACTERISTICS OF THE TRANSFORMERS

ITEMS		Specified values	Offered values
1.1.	Phases	3	.....
1.2.	Frequency	50 Hz	.....
1.3.	Cooling	ONAN	.....
1.4.	Altitude	Up to 1000 m above sea level	.....
1.5.	Nominal voltages Primary-Secondary	As specified	.....
1.6.	Rated power	Acc. to the inquiry	.....
1.7.	Connections	As specified	.....
1.8.	Max temperature rise:		
1.8.1.	Oil	60 °C	.....
1.8.2.	Windings	65 °C	.....
1.9.	Short-circuit impedance	4% or 6%	.....
1.10.	MV Windings	6.6 kV 15 kV 20 kV	6.6 kV 15 kV 20 kV
1.10.1.	Power frequency withstand voltage, dry, 1 min r.m.s. value :	22 kV 38 kV 50 kV	....
1.10.2.	Full wave impulse withstand voltage (with 1.2/50 µs shape) -peak value:	60 kV 110 kV 125 kV	.....

1.10.3. Choppd wave withstand voltage
-min peak value: 60 kV 110 kV 137,5 kV .....

1.11. LV Windings

Power frequency withstand voltage, dry , 1 min
r.m.s. value: 10 kV .....

1.12. MV Bushings

1.12.1 Full wave impulse withstand voltage (with 1.2/50 µs shape)
- peak value : 170 kV .....

1.12.2. Power frequency voltage withstand, wet, for 1 min
r.m.s. value: 75 kV .....

1.12.3. Min creepage distance : 53 cm .....

1.13. LV Bushings

1.13.1. Full wave impulse withstand (with 1.2/50 µs shape)
- peak value: 30 kV .....

1.13.2. Power frequency voltage withstand, wet, for 1 min
r.m.s. value : 10 kV .....

1.14. No-load losses at the nominal voltage of 20 kV Shall not exceed the values of paragraph 5.4 .....

1.15. On load losses at the nominal voltage of 20 kV Shall not exceed the values of paragraph 5.4 .....

2. ADDITIONAL INFORMATION

2.1. No-load losses (W)	20/0.4 kV	15/0.4 kV	6.6/0.4 kV
2.1.1. At nominal voltage	……	……	……
2.1.2. At 110% of the nominal Voltage	……	……	……

2.2 Total losses (W)

2.2.1. With load 100% of the rated power …… …… ……

2.2.2. With load 75% of the rated power …… …… ……

2.2.3. With load 50% of the rated power …… …… ……

2.3 Excitation current % of the rated current

2.3.1. At nominal voltage …… …… ……

2.3.2. At 110% of nominal voltage …… …… ……

2.4 Short-circuit voltage (%)

2.4.1. With load 100% of the rated power …… …… ……

2.4.2. With load 75% of the rated power …… …… ……

2.4.3. With load 50% of the rated power …… …… ……

2.5. Magnetic flux density …… …… ……

2.6. Voltage drop at nominal load at normal operation

2.6.1. With power factor cosφ=1 ....

2.6.2. With power factor cosφ=0.85 ....

2.7. Sound level at the 20/0,4 kV connection: .....

2.8. Power efficiency factor (only for the 20/0.4 kV connection) with power factor : cosφ =1 cosφ=0.85

2.8.1. At 100% of the rated power .....

2.8.2. At 75% of the rated power .....

2.8.3. At 50% της of the rated power .....

2.9 Approximate weights (kg)

2.9.1. Live part (core and windings) .....

2.9.2. Tank and accessories .....

2.9.3. Oil .....

2.9.4. Total Transformer weight .....

2.9.5. Weight of extraction of the heaviest unit from the tank

2.9.6. Total shipping weight (Transformer packed) .....

2.10. Drawings Drawing Number

2.10.1. General Transformer layout .....

2.10.2. Terminals of MV bushings .....

2.10.3. Terminals of LV bushings .....

2.10.4. Indicative nameplate .....

2.11. Differences from this specification (if any) .....

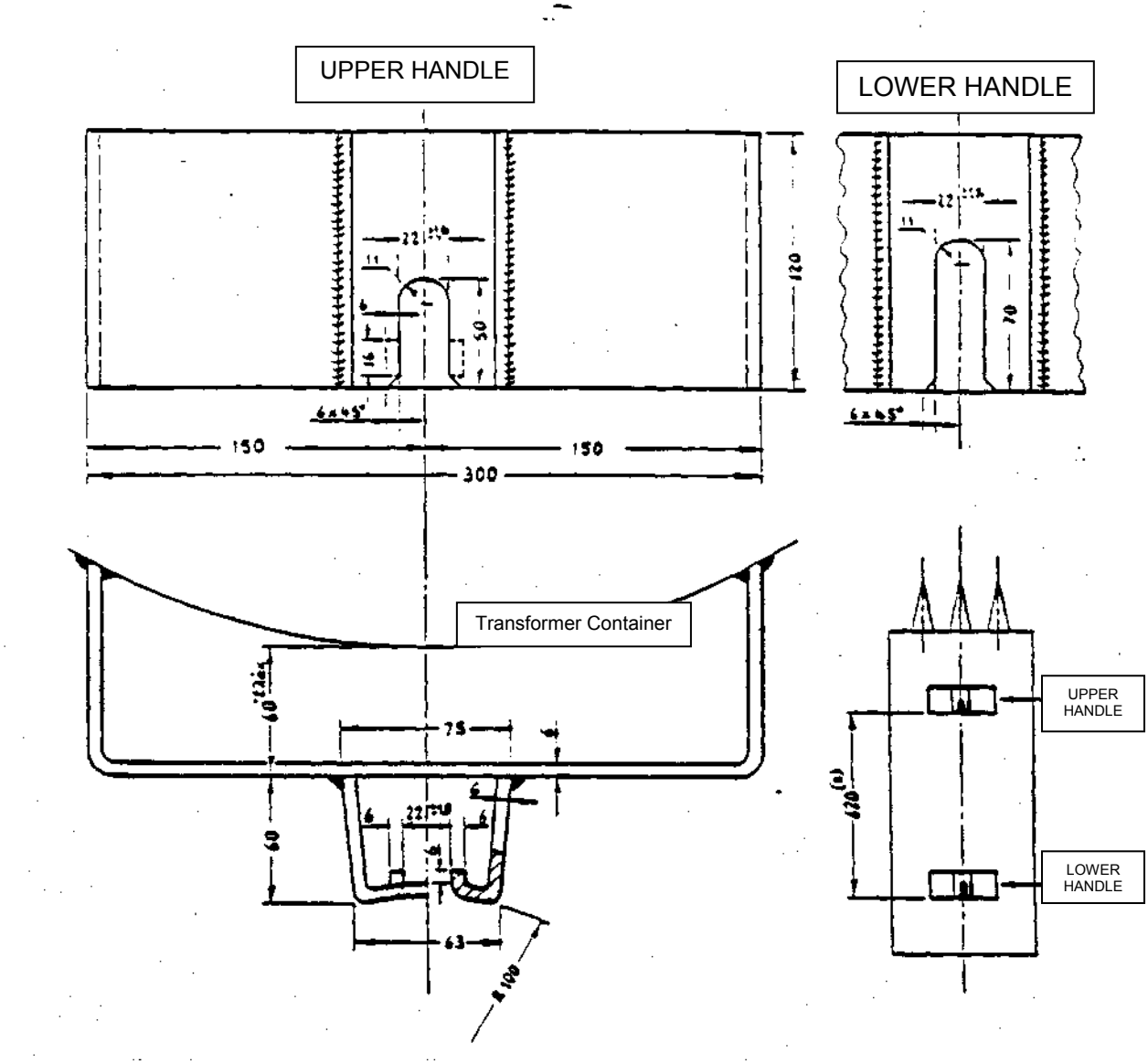
.....

.....

.....

PPC TECHNICAL SPECIFICATION

9.2.1 of HK 01.48



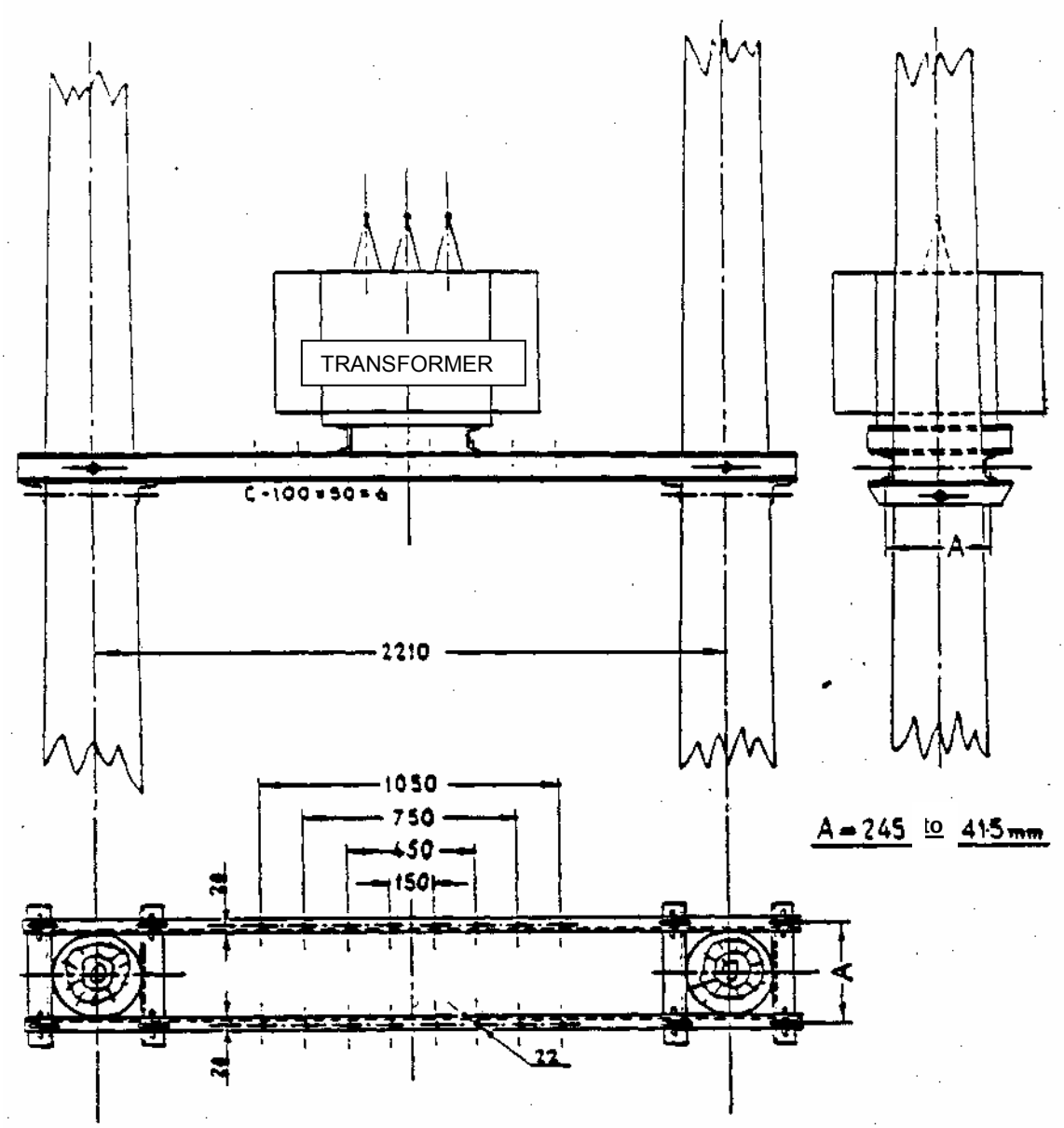
NOTES:

1. Dimension tolerances ±1,5 mm, unless specified otherwise in the drawing
2. The method of mounting the handles on the container is indicative
3. This distance may become 320 mm if the transformer container dimensions do not permit the 620 mm distance to be maintained

DRAWING TITLE	DRAWING No.
Suspension handles for 25 to 100 kVA transformers	1

PPC TECHNICAL SPECIFICATION

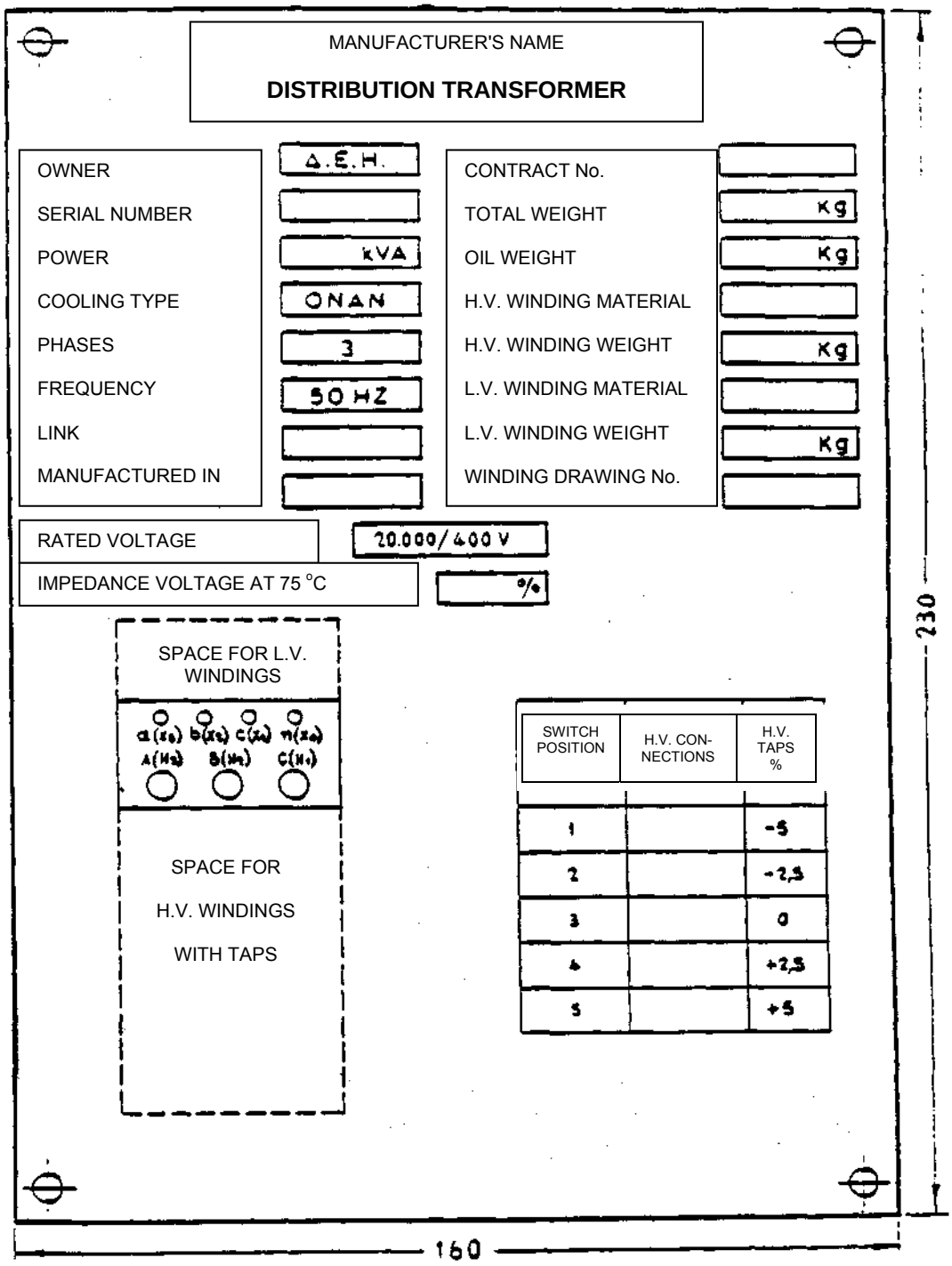
9.2.2 of HK 01.48



DRAWING TITLE	DRAWING No.
Mounting of 100 to 400 kVA power transformers on a gantry	2

PPC TECHNICAL SPECIFICATION

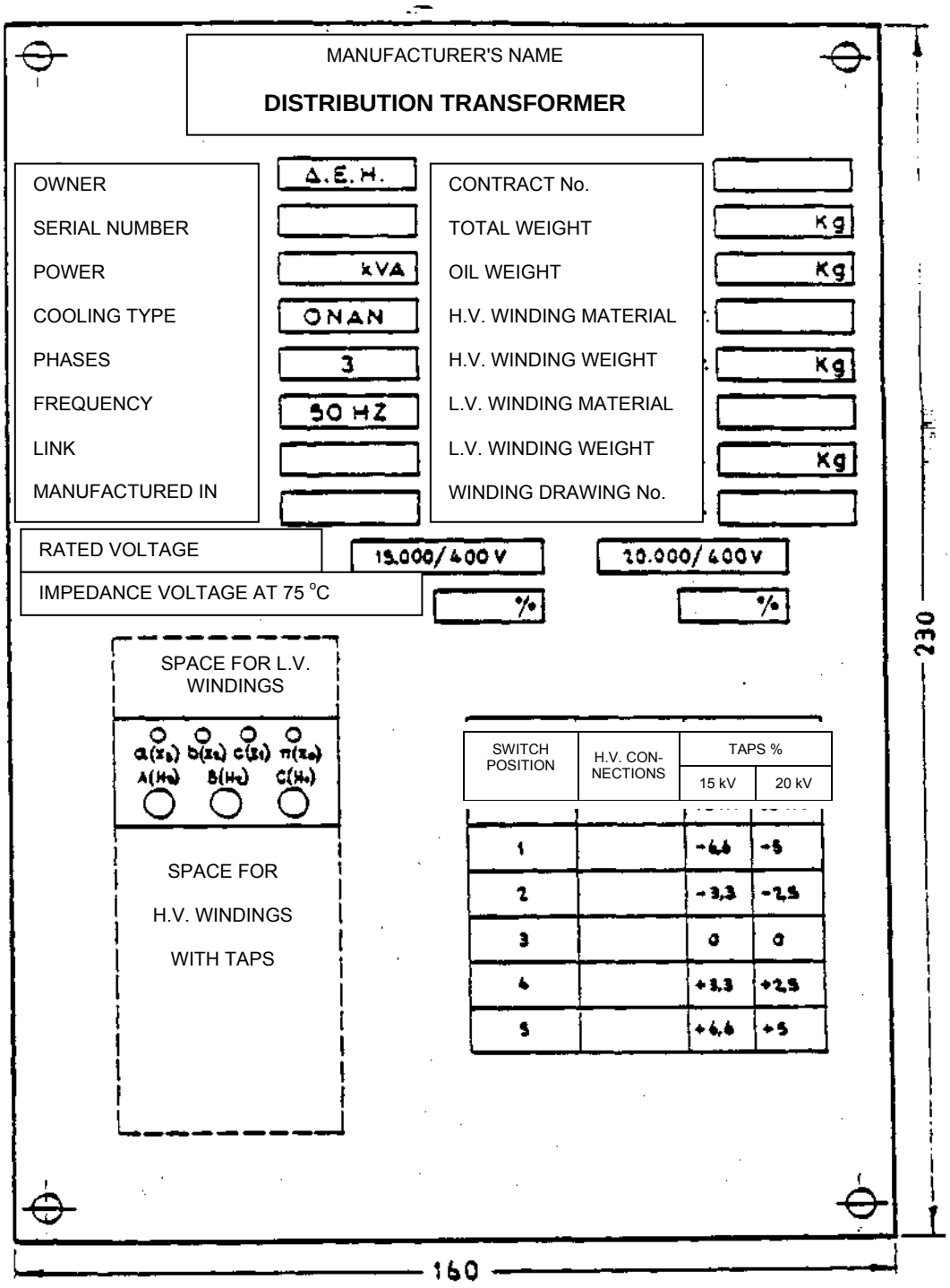
9.2.3 of HK 01.48



DRAWING TITLE	DRAWING No.
Nameplate of 20/0.4 kV distribution transformers	3

PPC TECHNICAL SPECIFICATION

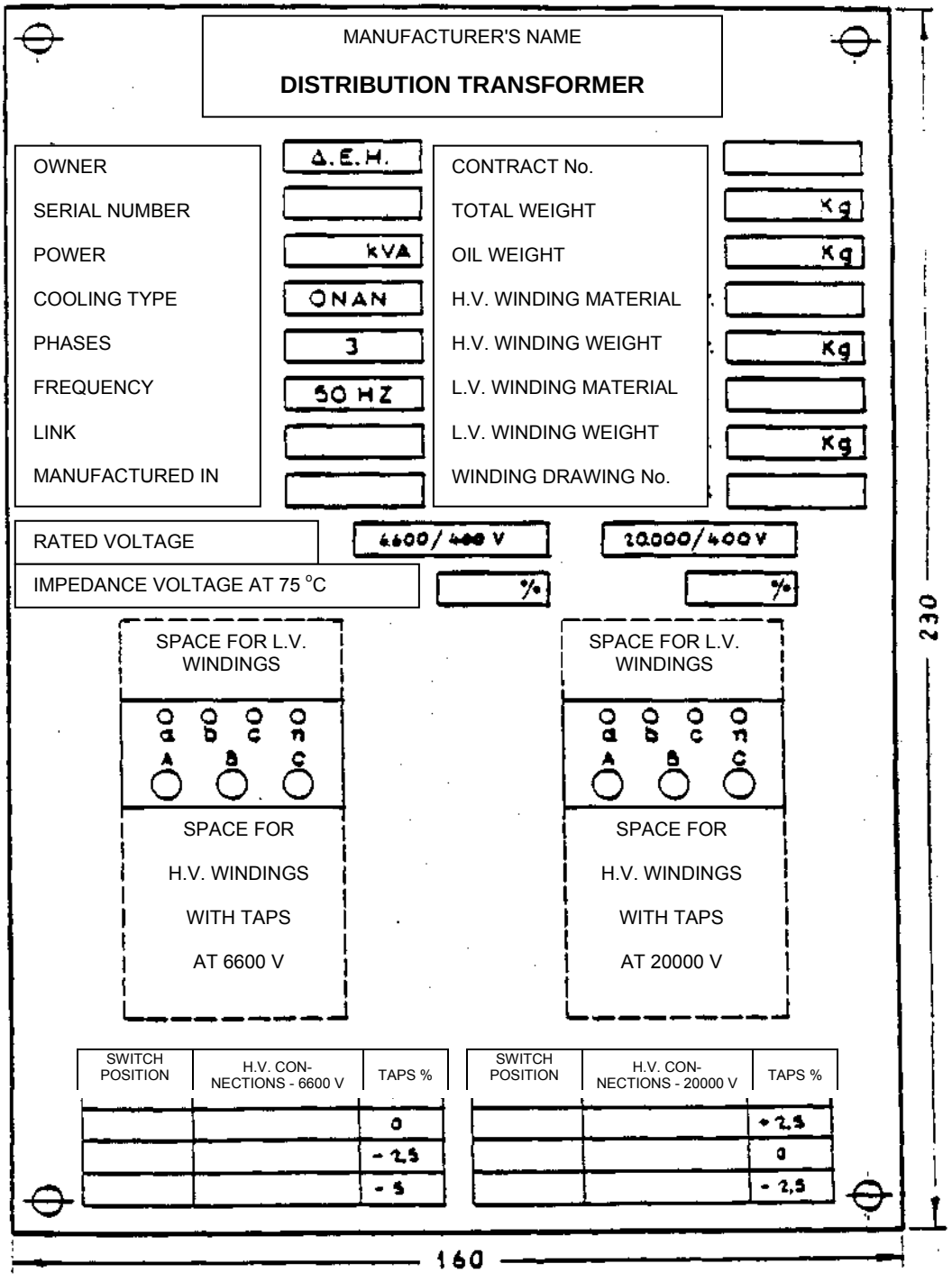
9.2.4 of HK 01.48



DRAWING TITLE	DRAWING No.
Nameplate of 20-15/0.4 kV distribution transformers	4

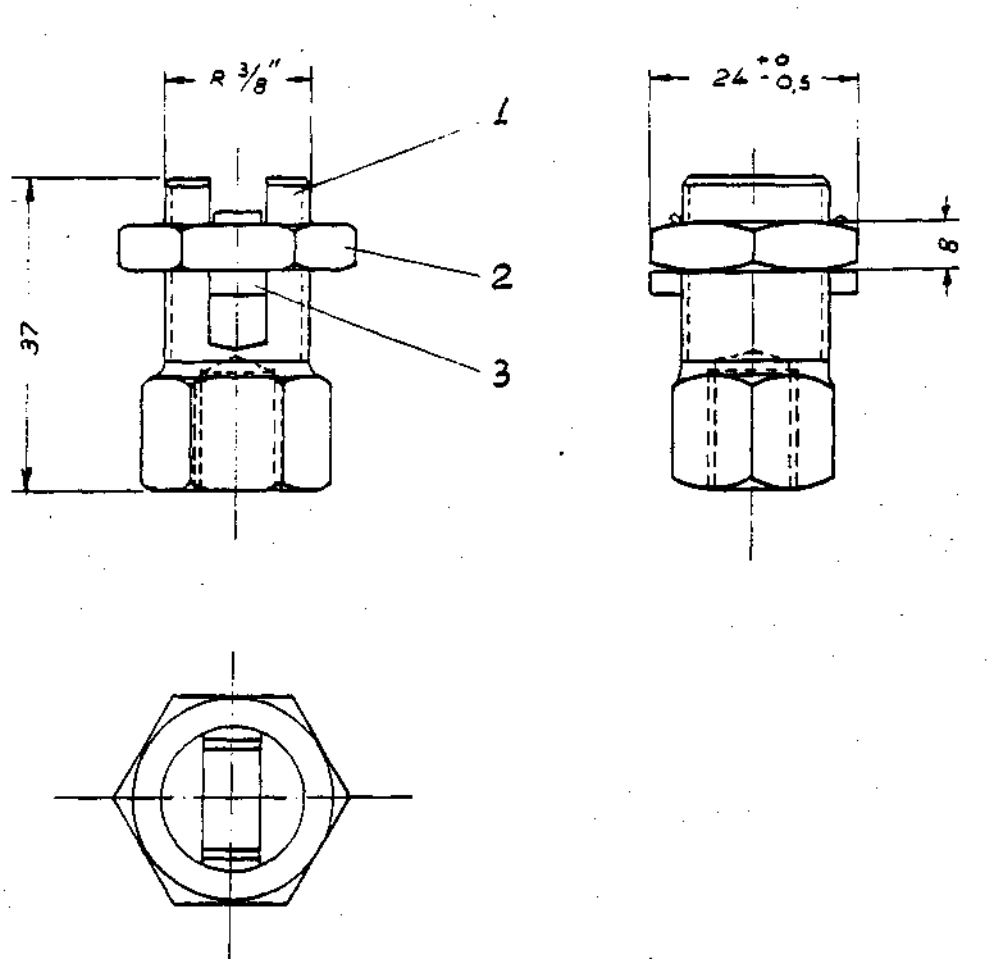
PPC TECHNICAL SPECIFICATION

9.2.5 of HK 01.48



DRAWING TITLE	DRAWING No.
Nameplate of 20-6.6/0.4 kV distribution transformers	5

Note: After the assembly, the ends of item No. 3 shall be opened, thus enabling it to be moved along by the nut



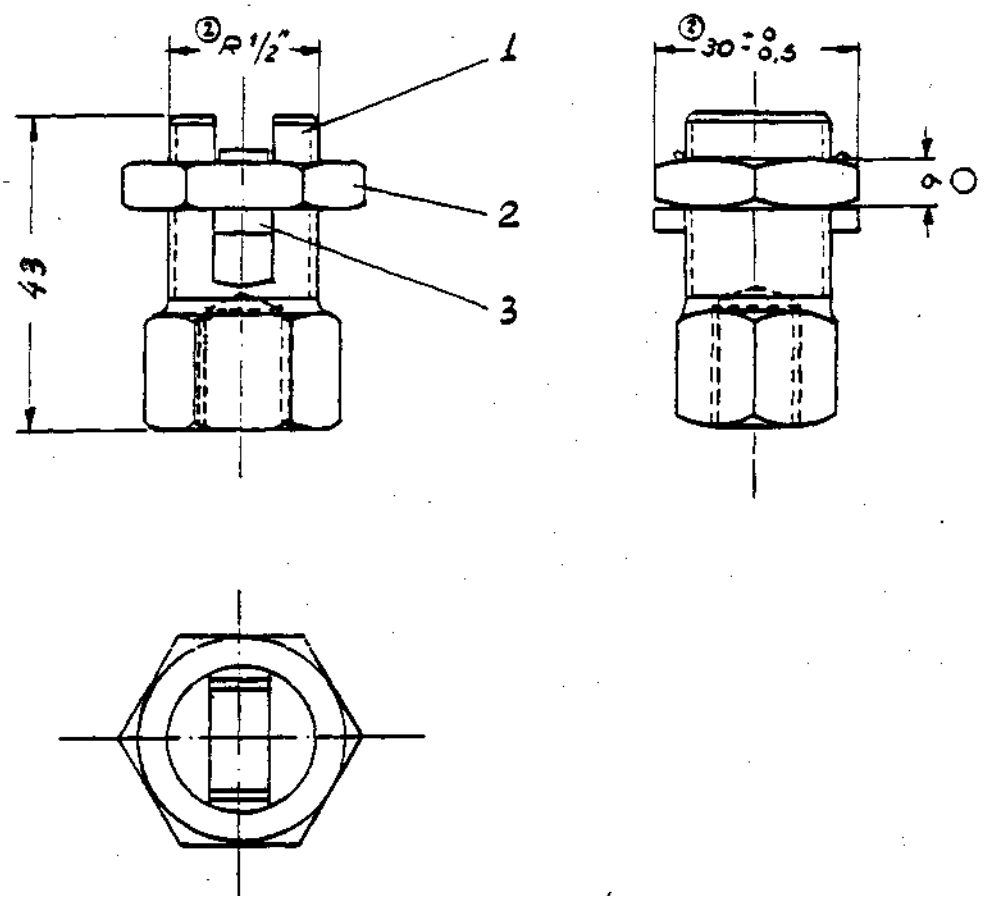
KAV: 430020560 for 25 ÷ 1000 kVA
transformers at M.V.

Weight kg

1	CONDUCTOR TIGHTENER			3			
		412959					
1	NUT R 3/8"		acc. to PPC GR88	2	Tinning 13µ		
1	BOLTED CONNECTOR			1			
		412958					
ITEM	NAME		MATERIAL	IDX.	SEMI-TREATED MATERIAL SPAC. SEMI- TR.		
		SPECIFICATION	CODE		ORDER RECOMMENDATION		

BOLTED CONNECTOR M12
(16-35 mm^2)
430020560

Note: After the assembly, the ends of item No. 3 shall be opened, thus enabling it to be moved along by the nut

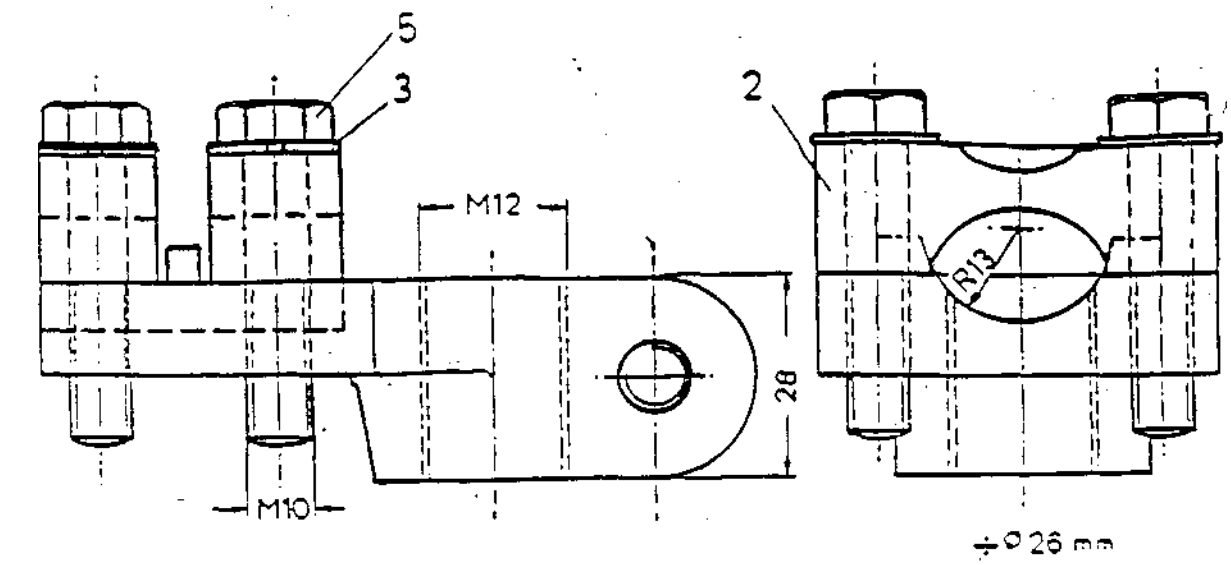


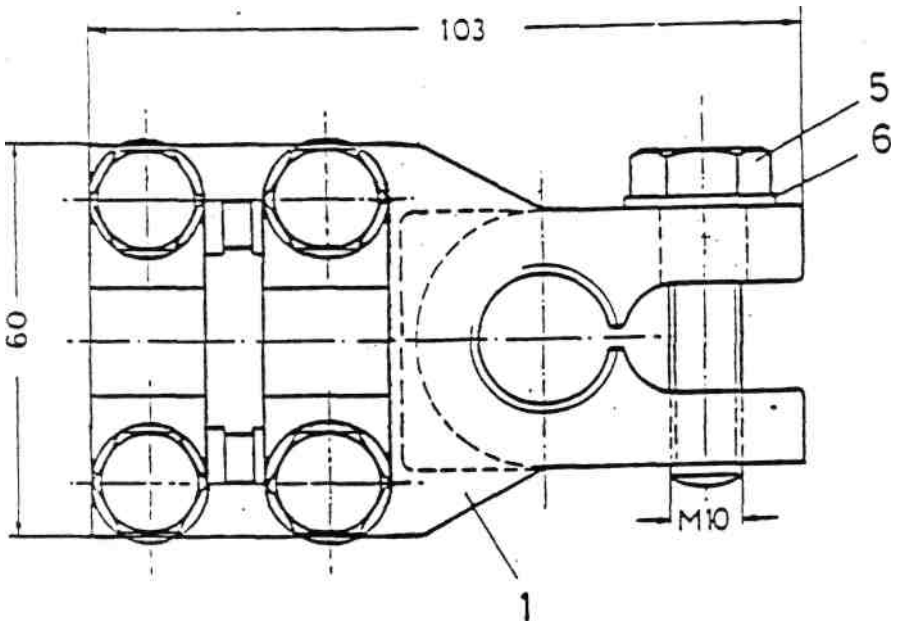
KAY: 430020572 for 50 kVA
transformers at L.V.

Weight 0.118 kg

1	CONDUCTOR TIGHTENER			3			
		400076					
1	NUT R 1/2"		acc. to PPC GR88	2	Tinning 13μ		
1	BOLTED CONNECTOR			1			
		400075					
ITEM	NAME		MATERIAL	IDX.	SEMI-TREATED MATERIAL SPAC. SEMI- TR.		
		SPECIFICATION	CODE		ORDER RECOMMENDATION		

BOLTED CONNECTOR M12
(35-50 mm^2)
430020572





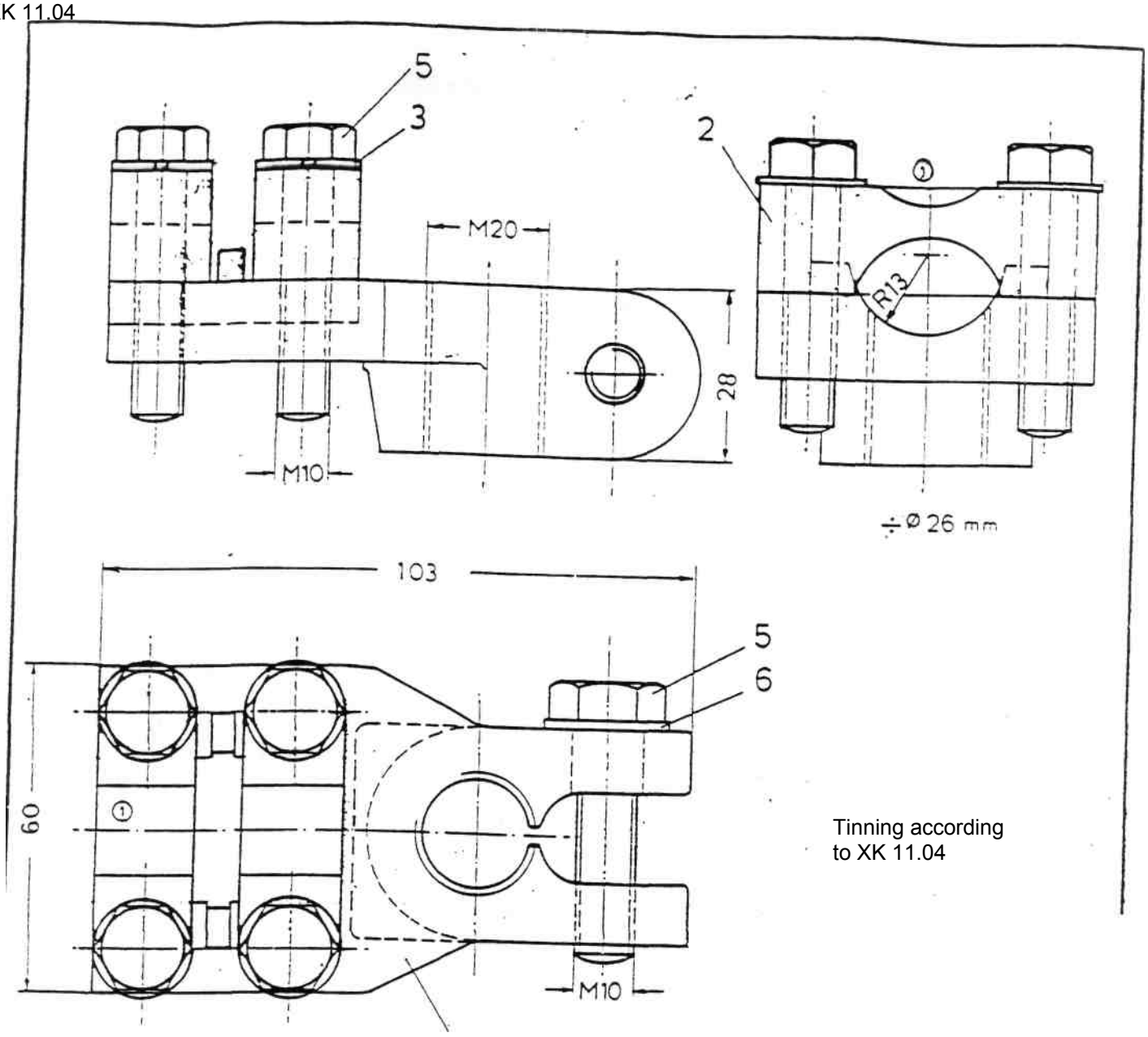
Tinning according
to XK 11.04

Weight ~ 0.94 kg

1	WASHER B10		F St.	6	YZK + bichr.	0.009
	DIN 6796	010537				
5	HEXAGONAL SCREW M10 X 40		8.8	5	STAINLESS STEEL	
	DIN 933	010582				
-	HEXAGONAL SCREW M X 45		5.6	4	TINNED	
	DIN 933					
4	GROVER B40		St	3	YZK + bichr.	0.01
	DIN 127					
2	TIGHTENER COLLAR			2	UNTREATED 010845	0.22
		408734				
1	TIGHTENER BODY			1	UNTREATED 010845	0.52
		412520				
ITEM	NAME		MATERIAL	IDX		WEIGHT
	SPECIFICATION	DRAWING NO.	CODE			kg

TERMINAL
95-150 mm^2
430000057

to XK 11.04

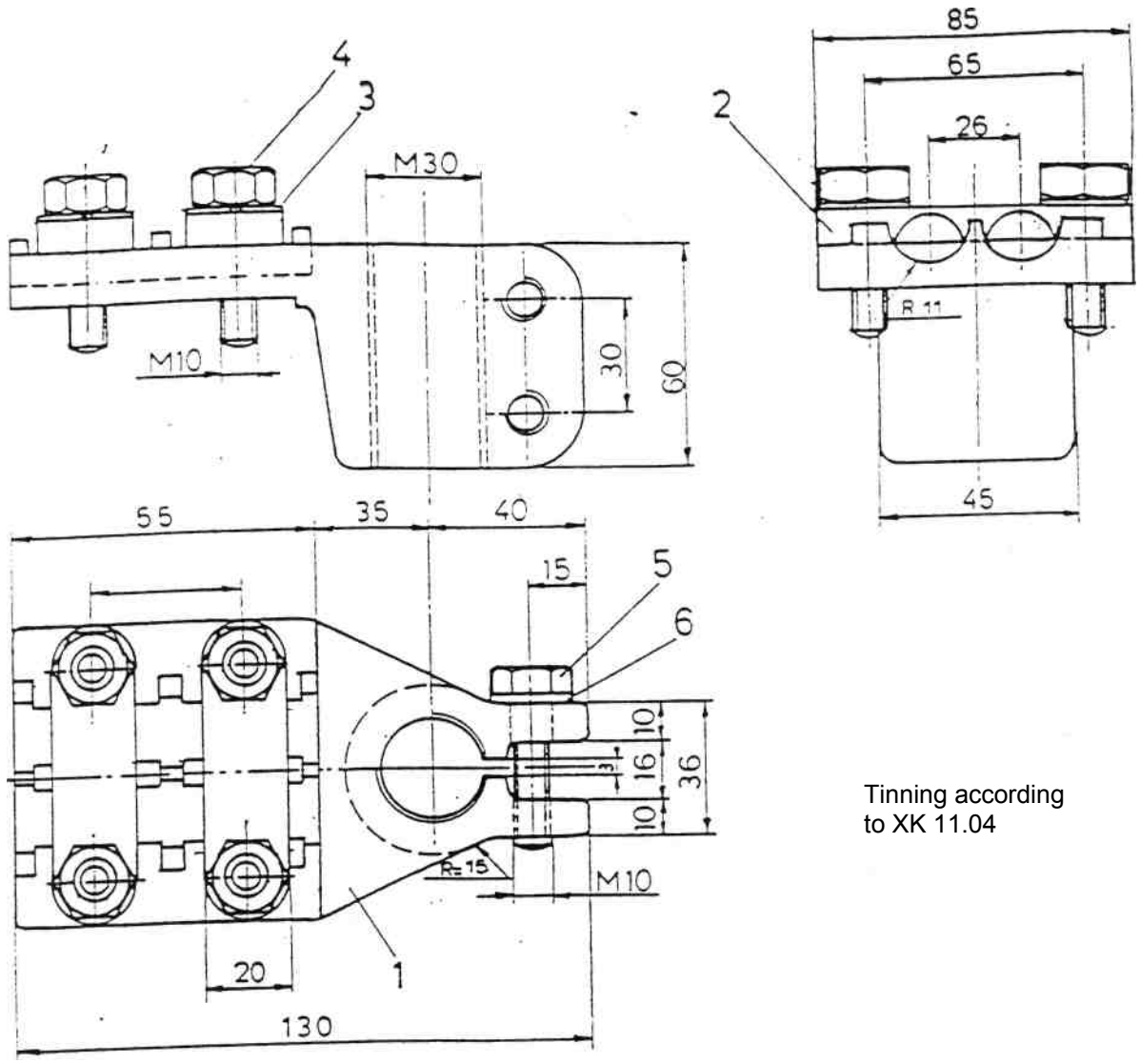


Tinning according
to XK 11.04

Weight ~ 0.94 kg

1	WASHER B10		F St.	6	Iridium treatment - ALG acc.	0.009
	DIN 6796	010537			DIN 267/9	
5	HEXAGONAL SCREW M10 X 40		8.8	5	STAINLESS STEEL	0.17
	DIN 933	010582				
-	HEXAGONAL SCREW M X 45		5.6	4	TINNED	
	DIN 933					
4	GROVER B40		St	3	Iridium treatment - ALG acc.	0.01
	DIN 127				DIN 267/9	
2	TIGHTENER COLLAR			2	UNTREATED 010845	0.22
		408734				
1	TIGHTENER BODY			1	UNTREATED 010845	0.52
		408733				
ITEM	NAME		MATERIAL	IDX		WEIGHT
	SPECIFICATION	DRAWING NO.	CODE			kg

TERMINAL
95-400 mm^2
430015394

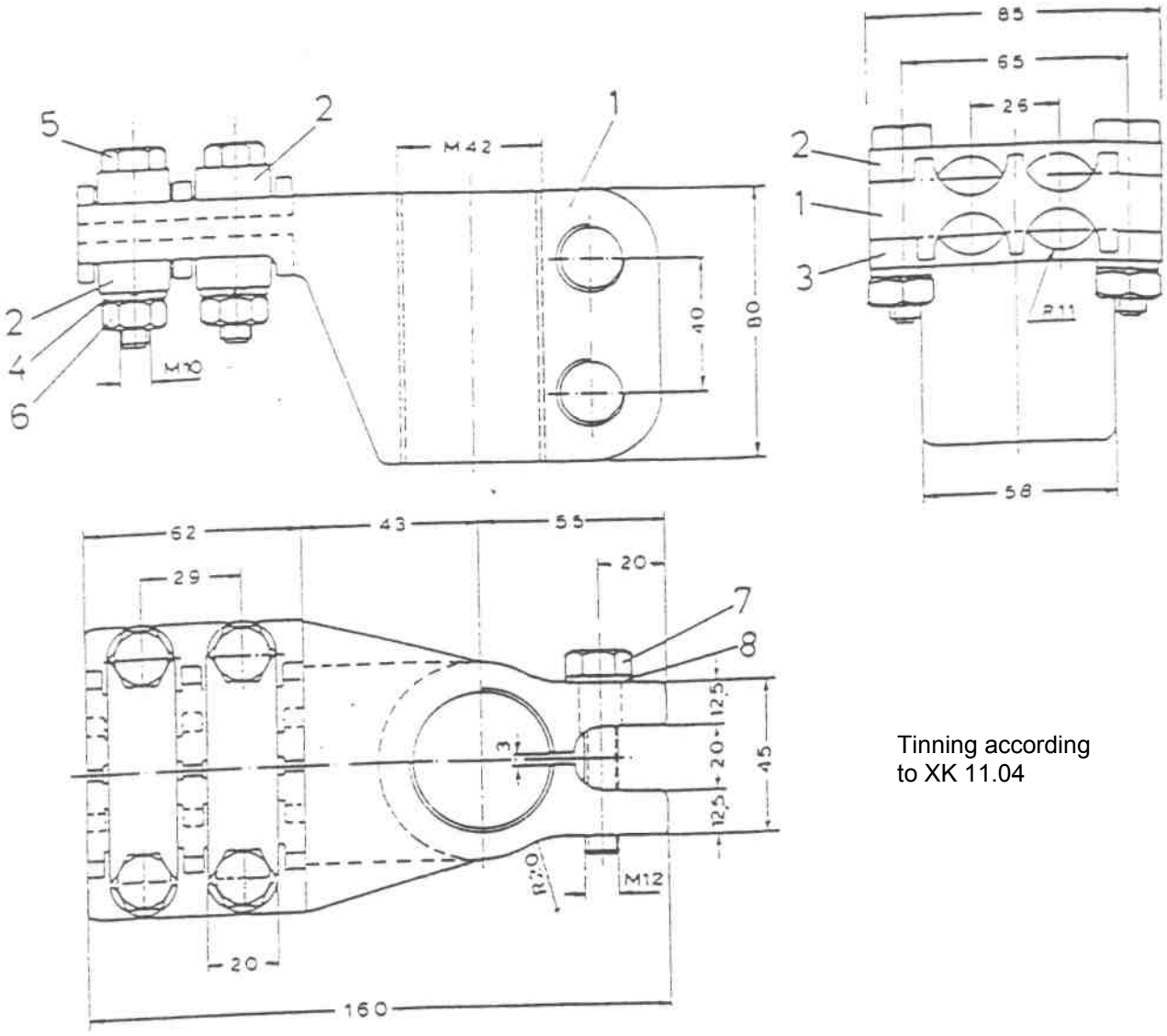


Tinning according
to XK 11.04

2	WASHER A 10.5		F St.	6	Iridium treatment - ALG acc.	
	DIN 125	010537	105/608		DIN 267/9	
6	HEXAGONAL SCREW M10 X 40		8.8	5	STAINLESS STEEL	
	DIN 933	010582				
-	HEXAGONAL SCREW M10 X 55		5.6	4		
	DIN 933					
4	GROVER B10		St	3	Iridium treatment - ALG acc.	
	DIN 127				DIN 267/9	
2	TIGHTENER COLLAR		G-CuZn33Pb	2	TINNED ≥ 30 µm	
		411413				
1	TIGHTENER BODY		G-CuZn33Pb	1	TINNED ≥ 30 µm	
		411412				
ITEM	NAME		MATERIAL	IDX	SEMI-TREATED MATERIAL SPAC. SEMI- TR.	WEIGHT
	SPECIFICATION	DRAWING NO.	CODE		ORDER RECOMMENDATION	kg

G - CuZn33Pb

TERMINAL
2 x 300 mm^2
430015400

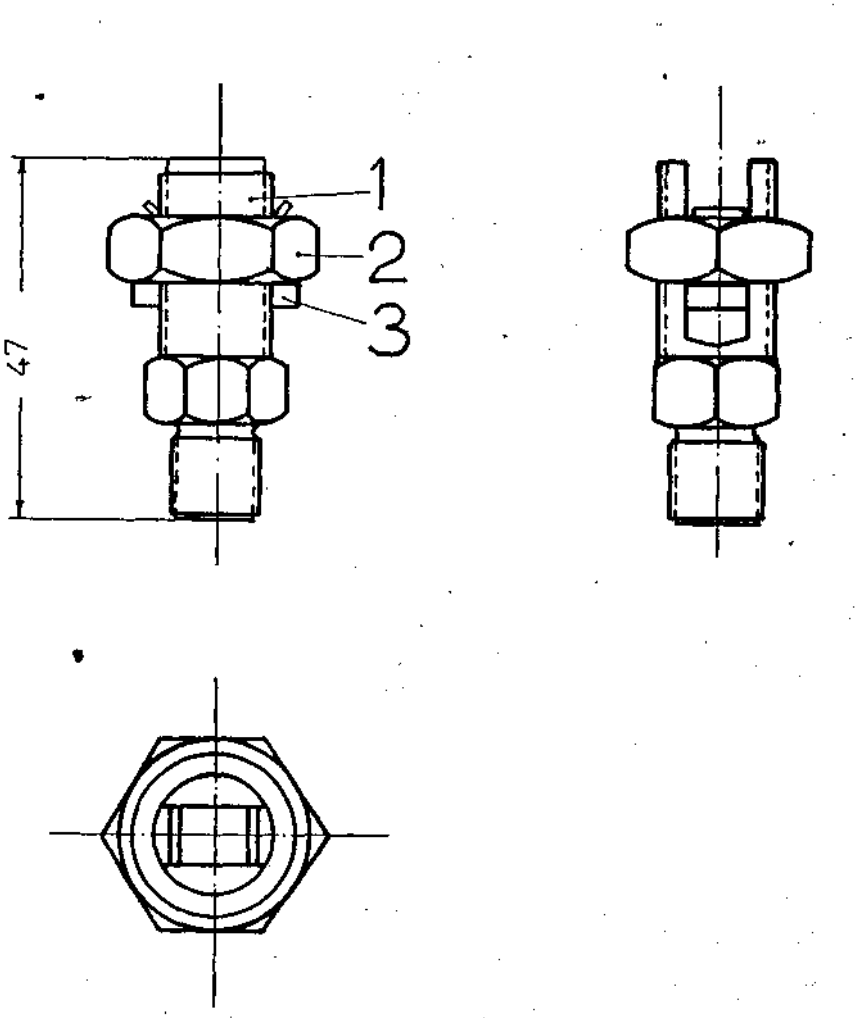


Tinning according to XK 11.04

Weight ~ kg

2	WASHER A 13		F St.	8	Iridium treatment - ALG acc.	
	DIN 125		105/645		DIN 267/9	
2	HEXAGONAL SCREW M12 X 45		8.8	7	STAINLESS STEEL	
	DIN 933	010479				
4	NUT M10		6.	6	Iridium treatment - ALG acc.	
	DIN 934	010291			DIN 267/9	
4	HEXAGONAL SCREW M10 X 80		5.6	5	STAINLESS STEEL	
	DIN 933		010443			
4	GROVER B10		St	4	Iridium treatment - ALG acc.	
	DIN 127		105/600		DIN 267/9	
-	TIGHTENER COLLAR		G-CuZn33Pb	3	TINNED ≥ 30 µm	
		412090				
4	TIGHTENER COLLAR		G-CuZn33Pb	2	TINNED ≥ 30 µm	
		411413				
1	TIGHTENER BODY		G-CuZn33Pb	1	TINNED ≥ 30 µm	
		414786			≥ 30 µm	
ITEM	NAME		MATERIAL	IDX	SEMI-TREATED MATERIAL SPAC. SEMI- TR.	WEIGHT
	SPECIFICATION	DRAWING NO.	CODE		ORDER RECOMMENDATION	kg

TERMINAL
4 x 300 mm^2
430021758



Note: After the assembly, the ends of item No. 3 shall be opened, thus enabling it to be moved along by the nut

Weight 0.074 kg

1	CONDUCTOR TIGHTENER			3			
1	NUT M16 x 1.5		CuZn40Pb2F37	2			
			DIN 17673				
1	BOLTED CONNECTOR SHAFT			1			
ITEM	NAME		MATERIAL	IDX.	SEMI-TREATED MATERIAL SPAC. SEMI- TR.		
		SPECIFICATION	CODE		ORDER RECOMMENDATION		

GROUNDING BOLTED CONNECTOR

430020559