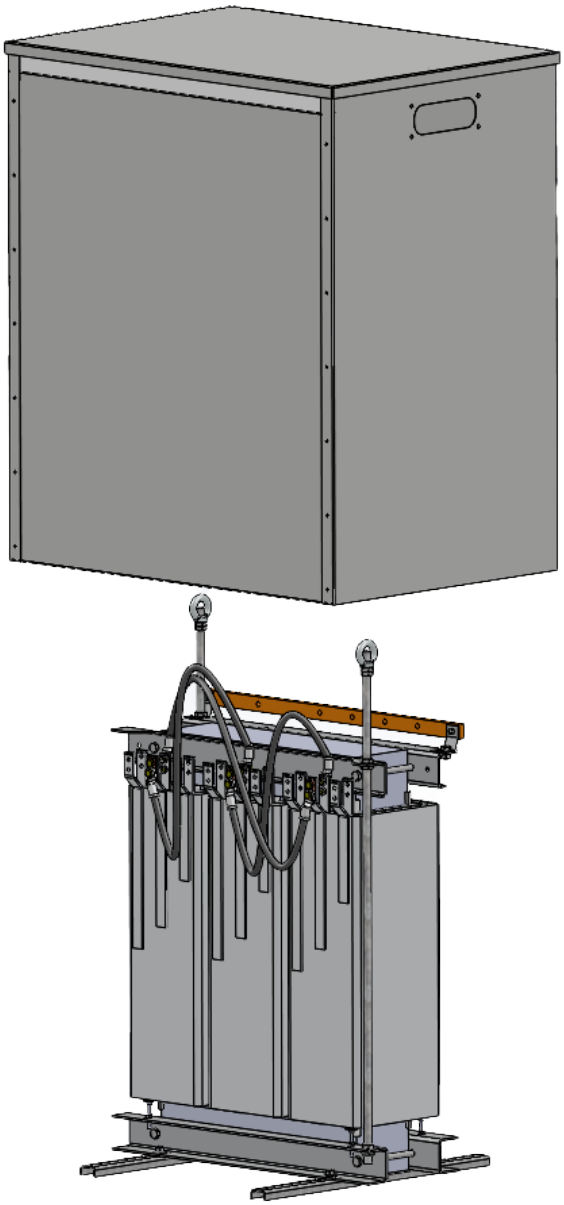
TRAMO

Three-phase transformer

Technical specification & Installation guideline



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CE

MADE IN SWEDEN BY TRAMO ETV
100% PREMIUM QUALITY

TRAMO

Index

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OVERVIEW IMAGE

1. Lifting eye

2. Bakelite suspension

3. Neutral busbar

4. Cable lug

5. Insulator

6. Core

7. Top bracket

8. Winding

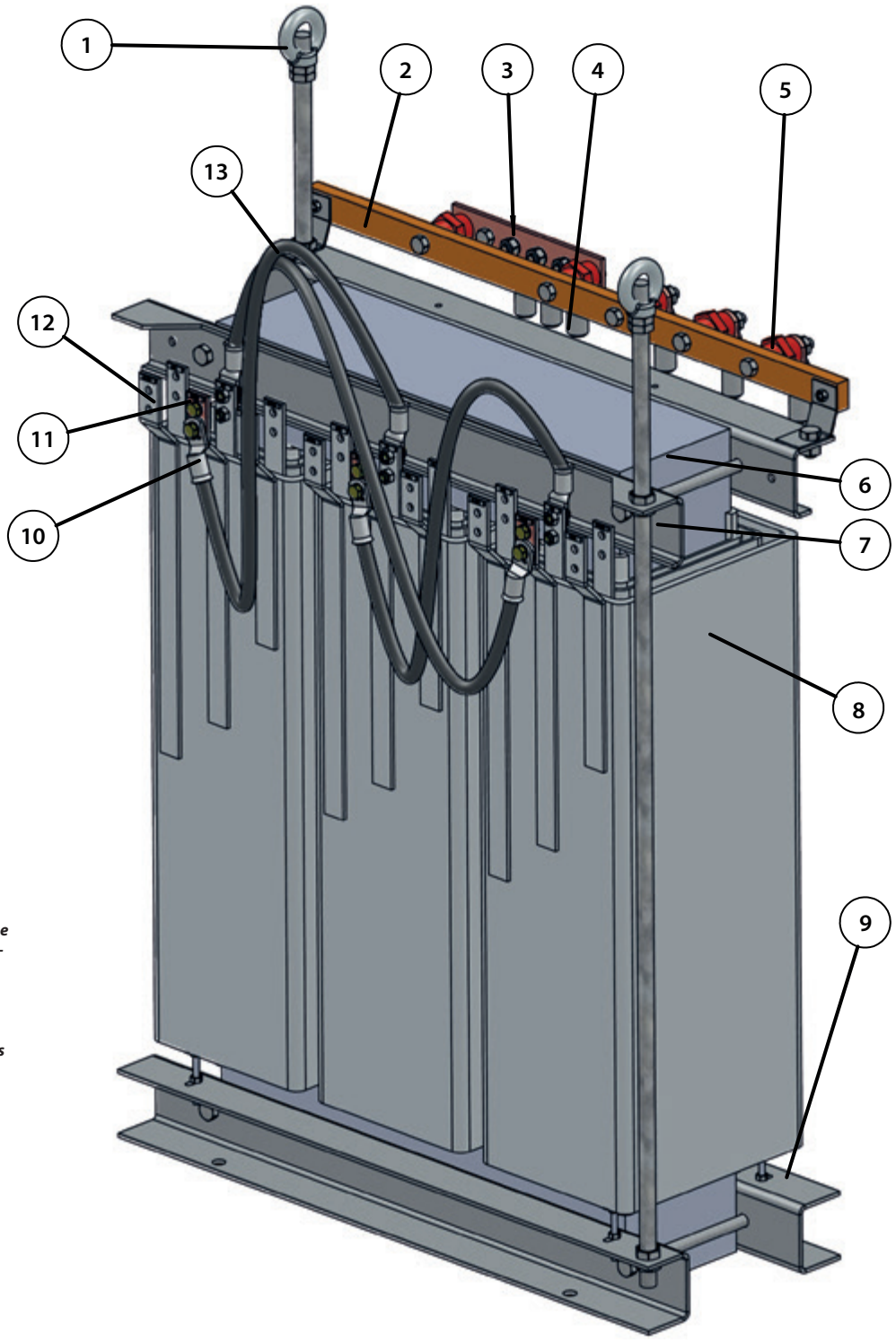
9. Base bracket

10. Cable lug-jumper

11. Cupal plate

12. Tap changer

13. Jumper delta connection



**** This overview image illustrates a transformer with connection cable lugs and connection busbar. Find information about different connections under 3.3***

I - GENERAL

1.1 INTRODUCTION

Tramo-ETV AB develops and manufactures transformers, power supply units, chokes and filters.

This publication is intended to guide users in the installation and operation of three-phase transformers manufactured by Tramo.

This document serves as a guideline. All installations must be carried out by qualified personnel and always in accordance with national laws and regulations.

This manual is a general document. For complete information, please refer to the datasheet and drawings for the respective transformers.

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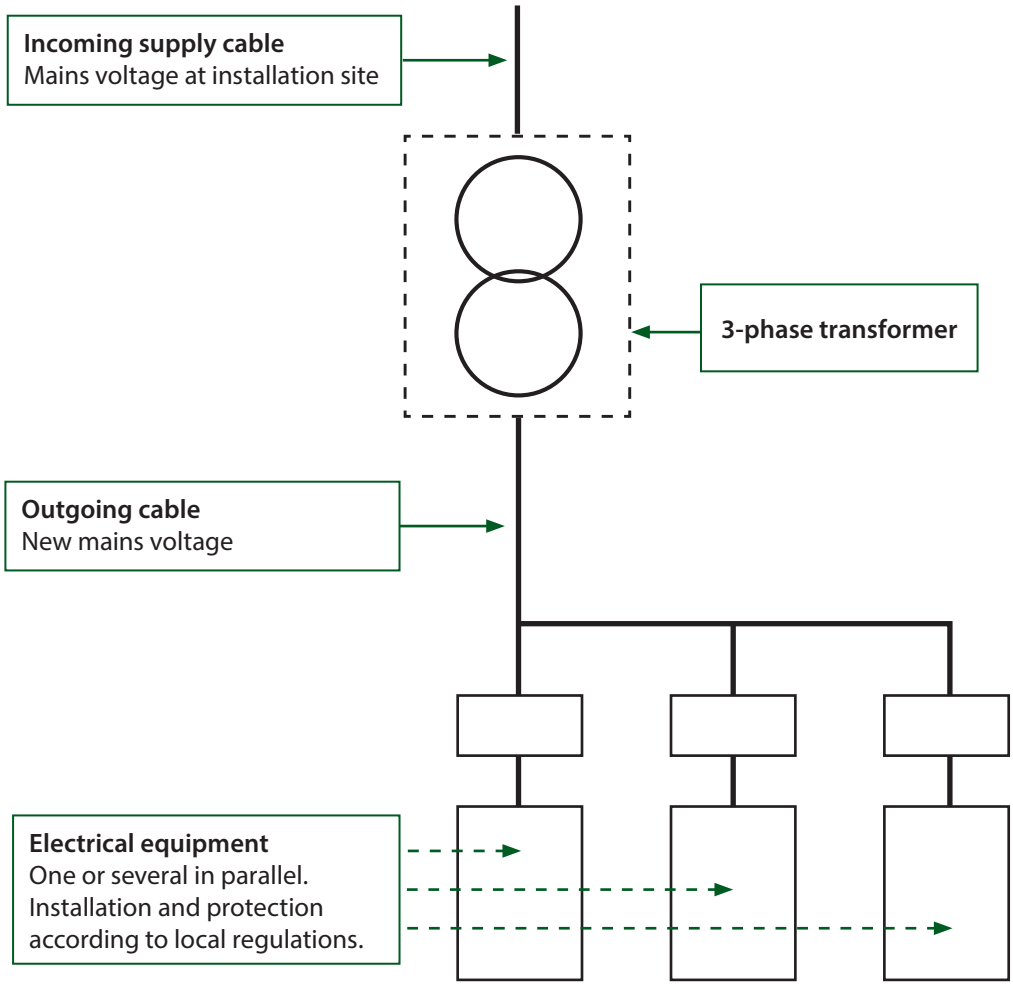
1.2 USAGE

The three-phase transformer operates in series with the line, converting the voltage from one level to another. The apparent power on the primary side is equal to that on the secondary side. This means that the current the transformer can handle is determined by the voltage and apparent power.



1.3 PRODUCT OVERVIEW

The three-phase transformer is available for linear loads up to 250 kVA. It can be designed for all types of low-voltage applications. Multitap or voltage regulation can be customized according to customer requirements. The standard enclosure is IP23 across the entire range, with IP54 available upon request.

The transformer is designed and manufactured in accordance with IEC 60076 and IEC 61558, along with any associated standards if required. The temperature class is either B (130°C) or F (155°C), depending on the apparent power.

II - TRANSPORTION AND UNPACKING

2.1 PACKAGING AND TRANSPORTION

The packaging must be appropriately designed to ensure safe transport. Different types of packaging can be used depending on the size of the transformer. For larger transformers, wooden pallets with protective collars or simply plastic wrapping on a pallet are used to facilitate loading and unloading, while cardboard packaging is used for smaller transformers to prevent damage caused by impacts with foreign objects.

The protective collars also help reduce the risk of damage during transport.Although transformers have a sturdy and robust design, they are not resistant to strong impacts or shocks during transport. In addition to the guidelines provided here, transformers must be handled with care and stored in a dry place.

It is a good practice to secure the transformer to the transport vehicle using straps or fixed structures.

If the transformers are equipped with wheels, they must be removed before transport.

2.2 LIFTING AND MOVING THE TRANSFORMER

Unloading the transformer is rarely included in the price, meaning it is the buyer's/customer's responsibility to arrange for unloading at the delivery destination.

During unloading a lifting beam (traverse) must be used. This is illustrated in figure 2.1.

We cannot guarantee that the transformer's enclosure will withstand lifting with a lifting strap as shown in Figure 2.2.

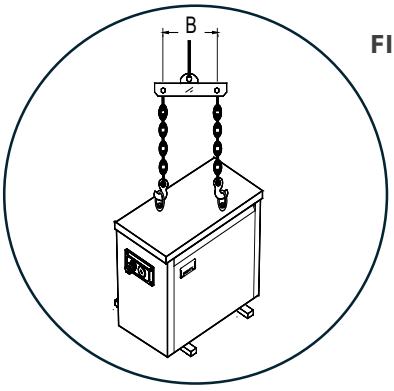


FIGURE 2.1

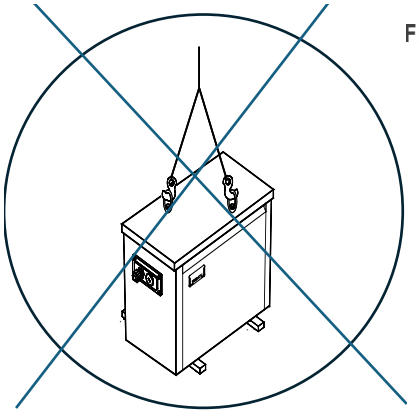
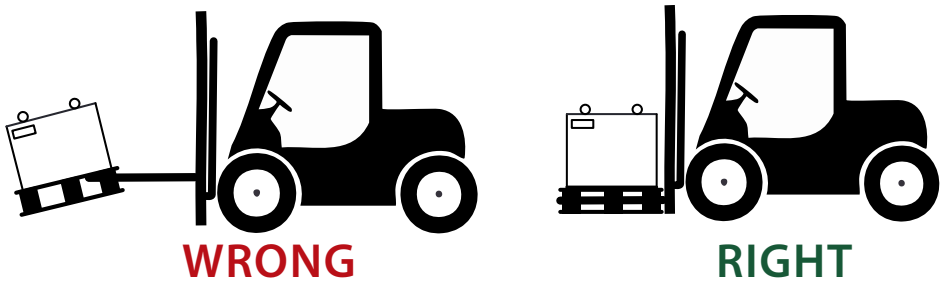


FIGURE 2.2

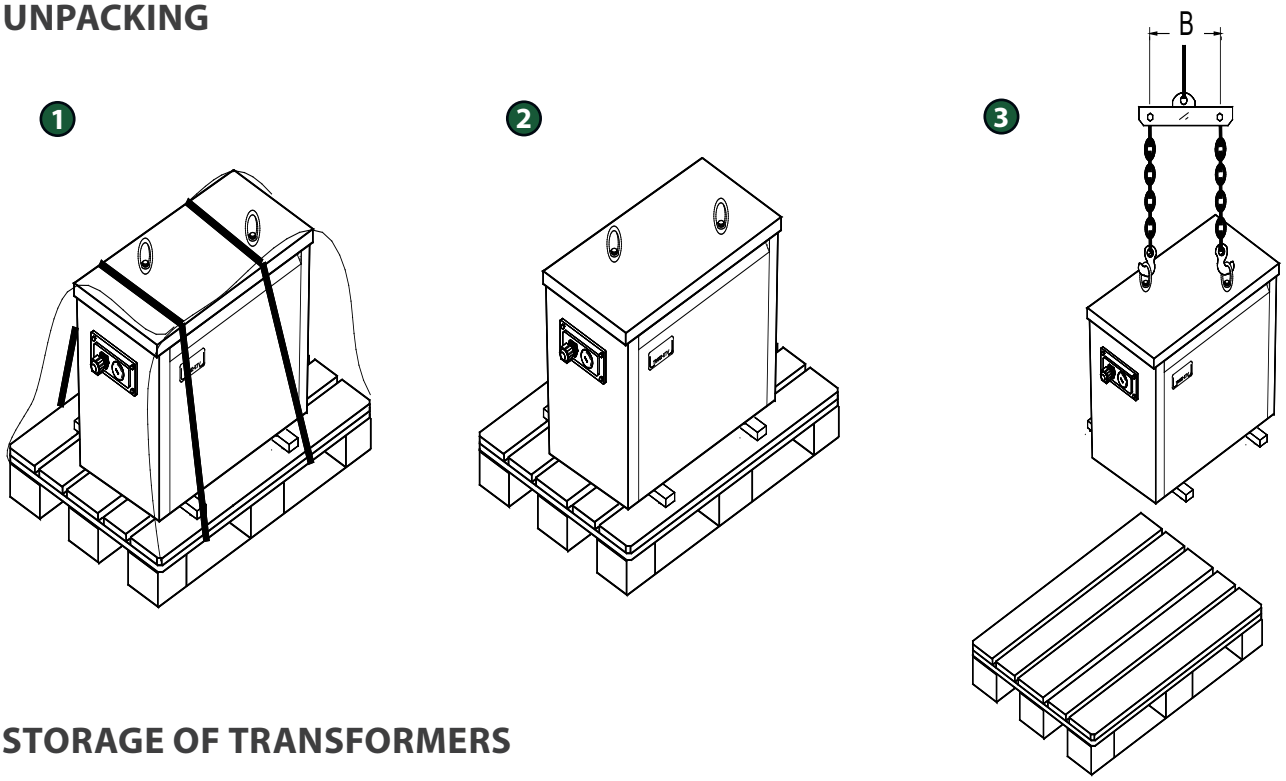
Figure 2.3 illustrates the correct use of a forklift to prevent damage to the transformer. Before putting the transformer into operation, it is essential to ensure that the windings or other critical components have not been damaged during transport or storage.

FIGURE 2.3



Before lifting with a forklift, the forks must be positioned under the entire length of the transformer. Failure to do so may result in the transformer tipping over.

2.3 UNPACKING



2.4 STORAGE OF TRANSFORMERS

Transformers should be stored in a dry, well-ventilated area to prevent moisture absorption. The storage location must be protected from dust, direct sunlight, and extreme temperatures. If stored for an extended period, the transformer should be periodically inspected to ensure that no condensation or damage has occurred. Transformers should remain upright and securely placed to avoid mechanical stress or tipping over.

III - THE TRANSFORMER

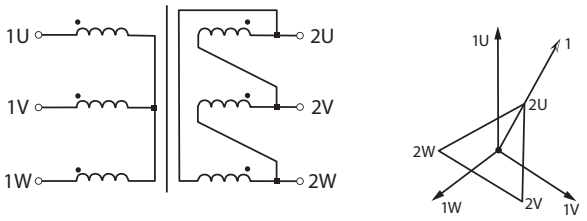
The transformer has been designed and manufactured by Tramo-ETV AB to meet the international IEC standard requirements as specified in:

IEC 60076-11:2018 | Power Transformers – Part 11: Dry-Type Transformers

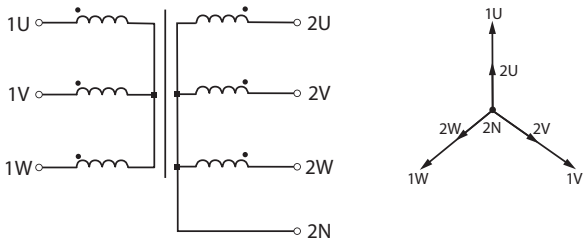
For the European market, the CE marking requirements are fulfilled in accordance with EN 60076-11:2018 – Power Transformers, Part 11: Dry-Type Transformers, as applicable.

3.1 VECTOR GROUP

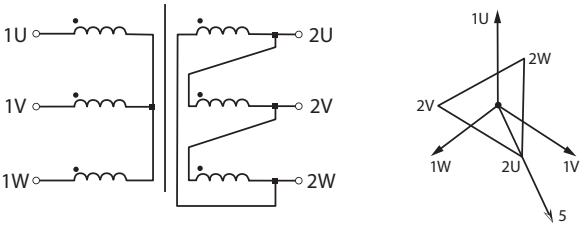
Yd1



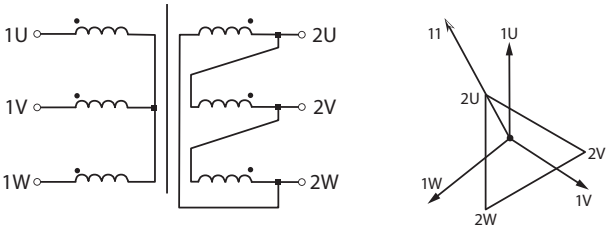
Yyn0



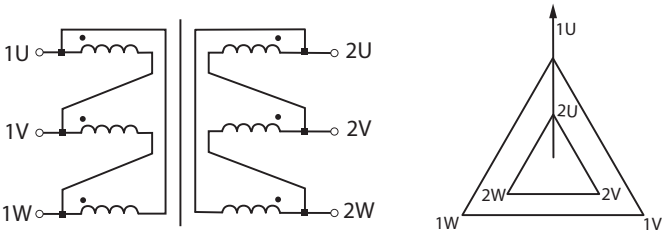
Yd5



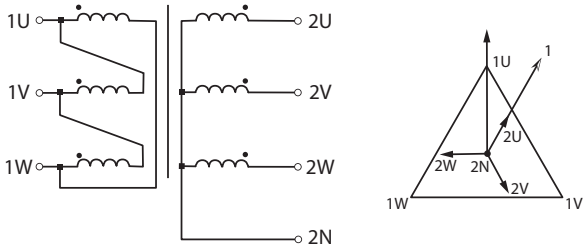
Yd11



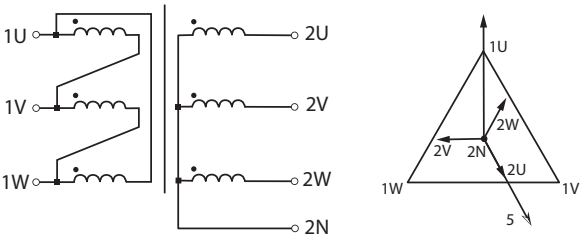
Dd0



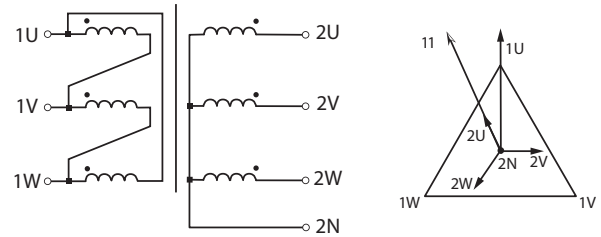
Dyn1



Dyn5



Dyn11



3.2 PROTECTION INDEX

Depending on the type of transformer and the customer's requirements, Tramo-ETV offers three different protection options. The IP classification system is developed according to IEC 60529.

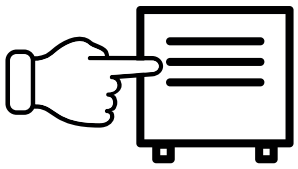
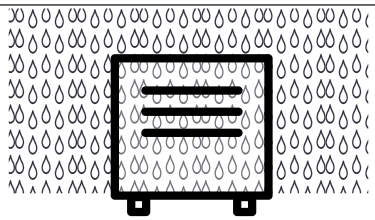
3.2.1 IP00

Without protection against solid objects or water.

IP-00 SYMBOLS	
IP0X	IP0

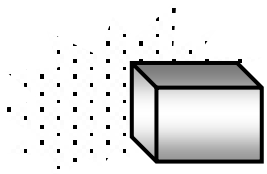
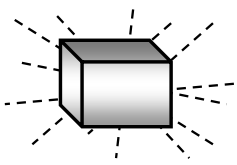
3.2.2 IP23

IP23 means that the enclosure must protect against accidental contact with hazardous parts using a finger and against solid objects larger than 12 mm in diameter. It must also provide protection against water spray at an angle of up to 60° from the vertical.

IP-23 SYMBOLS	
IP2X	IPX3
	

3.2.3 IP54

IP54 means that the enclosure must be dust-proof and provide protection against water splashes from all directions.

IP-23 SYMBOLS	
	

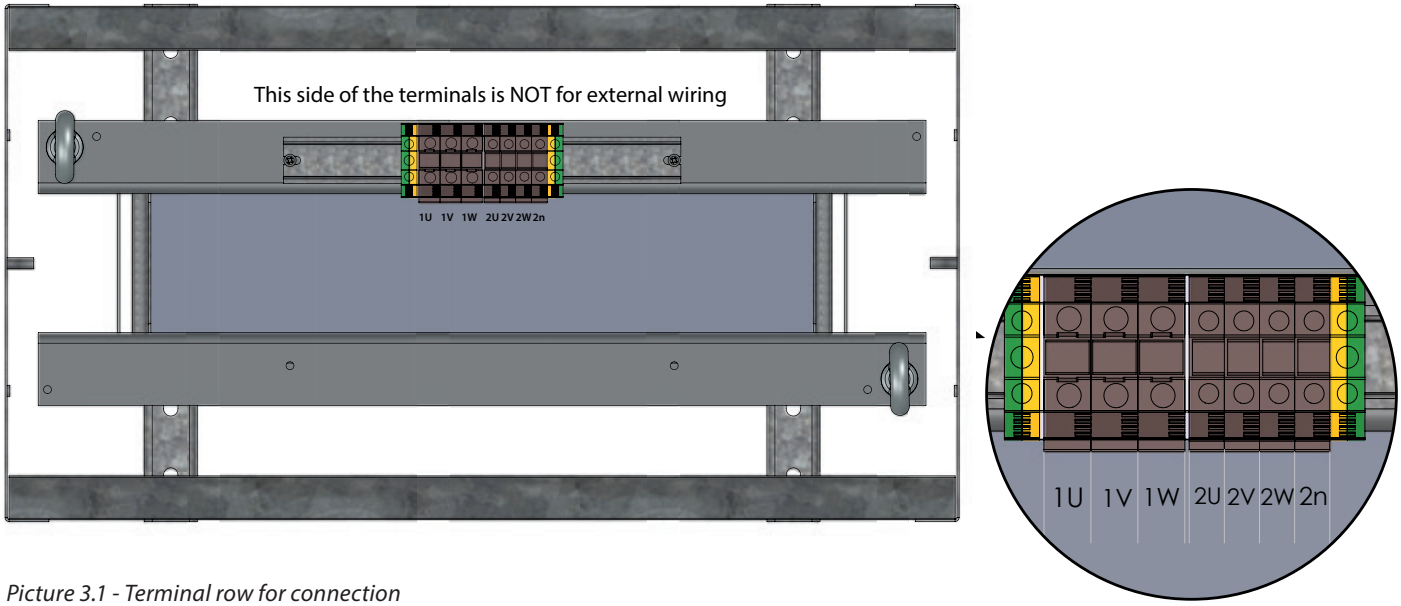
3.3 DIFFERENT TYPES OF CONNECTION

Depending on the type of transformer and the customer's requirements, we offer three different connection options: terminal blocks, cable lugs or busbars.

3.3.1 CONNECTION TERMINAL BLOCKS

Terminal blocks are the most common interface for the transformers. They are selected to handle both the internal connection to the transformer and the correct dimensioning for external cabling. The terminal blocks are also chosen to withstand the rated voltage and nominal current. In picture 3.1, a terminal row for a Dyn-connected transformer is shown. The three larger terminals are in this case for the primary side (1UVW).

The four smaller terminals are for connecting the transformer's secondary (2UVW + 2N). Double ground terminals are provided for enclosed transformers, as shown in the picture. If the transformer is unenclosed, the terminal row will have only a single ground terminal.



Picture 3.1 - Terminal row for connection

It is of utmost importance that the terminal blocks are tightened with the correct torque to ensure the product's performance. If the terminals are tightened too hard, there is a risk of damaging the mechanical characteristics of the conductors. If they are tightened too loosely, heat generation in the terminal may occur.

The size of the terminal blocks ranges from conductor areas of 4mm^2 to 185mm^2. For certain sizes, two types of models may be present in the transformers. Be sure to check which model is installed in your transformer and tighten according to table 3.1.

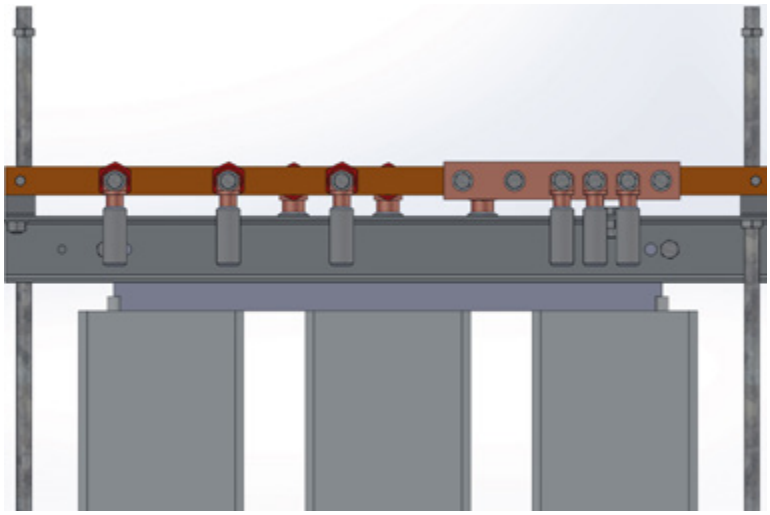
TABLE 3.1 TERMINAL ROW FOR CONNECTION

Max conductor area	Model	Stripping length (mm)	Tighteing torque (Nm)
4	WDU 2.5	10	0,4-0,8
6	WDU 4	10	0,5-1,0
10	WDU 6	12	0,8-1,6
16	WDU 10	12	1,2-1,9
16	WDU 16	16	3,0-4,0
35	WDU 35	18	4,0-5,0
50	WDU 50N	24	3,5-6,0
50	UKH 50	24	6-8
70	WDU 70N/35	22	8-12
70	UKH 70	24	8-10
95	UKH 95	33	15-20
120	WDU95N/120N	27	12-20
150	UKH 150	40	25-30

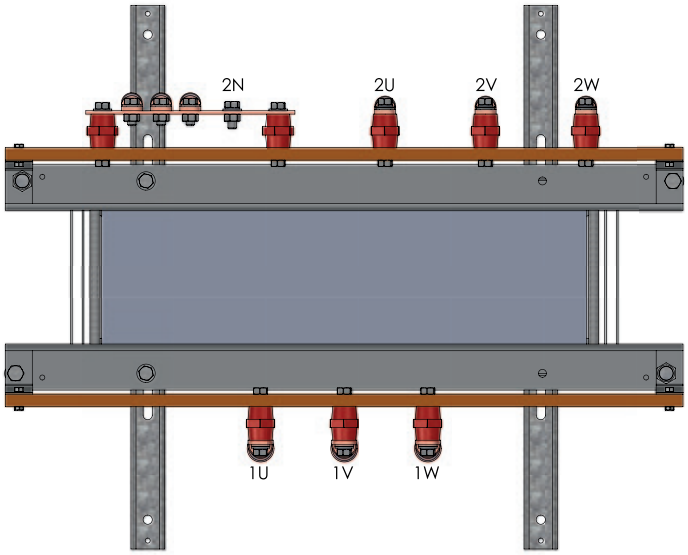
3.3.2 CONNECTION CABLE LUGS

The cable lugs are internally connected to the transformer windings and mounted on insulators, allowing the installer to connect external cabling. They are designed based on the current rating and internal wire dimensions of the transformer, ensuring an easy connection to the installation cable in copper.

The pictures below 3.2 and 3.3 shows a Dyn-connected transformer with the primary (1UVW) and the secondary windings (2UVW+2N).



Picture 3.2 - Example of busbars connected on insulators and busbar in copper



Picture 3.3 Top-view of Dyn-connected transformers with cable lugs.

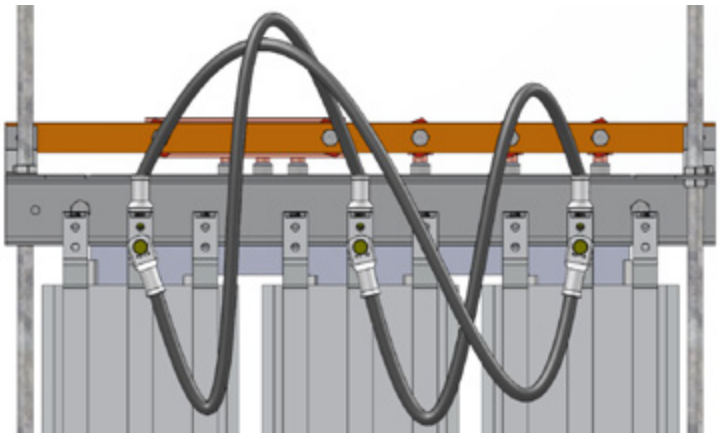
See Table 3.1 for technical details of internal cable lugs. The tightening torque for each bolt is specified in Table 3.4.

TABLE 3.2 DIMENSIONS CABLE LUGS

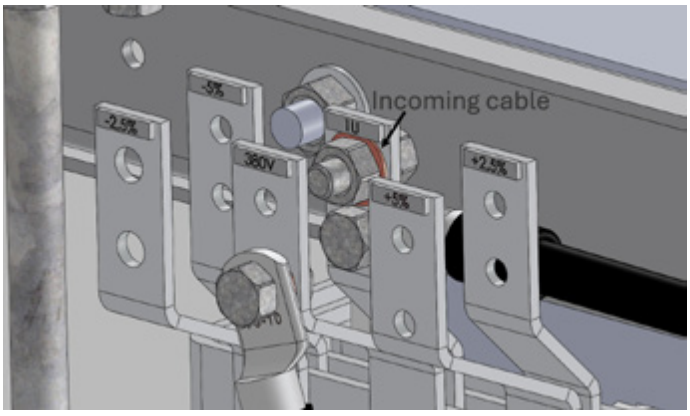
Cable lug	Area (mm^2)	Dimension hole (mm)	Type of bolt
AKK50-10	50	10	M10
AKK70-10	70	10	M10
AKK95-10	95	10	M10
AKK120-10	120	10	M10
AKK150-12	150	12	M10
AKK185-12	185	12	M10
AKK240-12	240	12	M10

3.3.3 CONNECTION BUSBAR - VOLTAGE REGULATION

When the transformer is equipped with busbars inside the windings, cables are used to facilitate the delta connection. The beginning of one coil winding is connected to the end of another coil winding. The specific coils that are connected depend on the vector group used. This means that the wiring should not be altered between coils. See picture 3.4 - Delta-connection.



Picture 3.4 - Delta-connection



Picture 3.5 - Off-load tap changer

When the transformer is equipped with an off-load tap changer, this means that the voltage regulation can be manually adjusted when the transformer is turned off. By changing the connection between the tap and the jumper, the user can select the voltage to which the transformer should be adapted. In Picture 3.3, a cable is shown connected to the 380V busbar, indicating that the transformer is set for an input voltage of 380V.

If the input voltage is changed to, for example, 361V, the connection should instead be made to the busbar marked "-5%", as specified in Table 3.3. Similarly, if the input voltage is higher, such as 399V, the connection should be made to the busbar marked "+5%". Table 3.3 summarizes how the connection should be made based on the input voltage..

3.3.4 PROCEDURE FOR CHANGING VOLTAGE

1. Disconnect the transformer
- Ensure that the transformer is disconnected and that no voltage remains.
- Lock the breaker or use another safety interlock to prevent re-energization during the work.

2. Identify the Existing Connection
- Locate the internal wire that is connected to 1U - this should not be moved.
- Check which voltage tap is currently connected.

3. Disconnect the Existing Connection
- Unscrew the cable and cupal plate from the current voltage tap.
- Be careful to keep track of bolts and washers.

4. Move the Connection to the New Voltage Tap
- Select the voltage tap that corresponds to the desired voltage according to the example in Table 3.3.
- Mount the cable and cupal plate on the new tap.
- Secure the cable lug according to Table 3.5 and tighten the bolts to the correct torque.

5. Connect the Incoming Cable
- Ensure that the incoming cable is also connected to 1U

6. Repeat for All Phases
- Perform the same process for all three phases L1 (1U), L2 (1V), & L3 (1W). Verify that all connections are properly secured.

7. Final Inspection and Re-Energization
- Double-check that all connections are correctly placed and properly tightened.
- Ensure that no tools or loose objects are left inside the transformer.
- Reset the safety interlock and reconnect the voltage.
- Monitor the operation to ensure everything functions as expected.

TABLE 3.3 INPUT VOLTAGE CONNECTED TO BUSBAR

Input Voltage	Connect to busbar
	1U (Do not change)
361 V	-5 %
371 V	-2,5 %
380 V	380 V
389 V	+2,5 %
399 V	+5 %

**** This example uses input voltage of 380V ±2 x 2,5 % to illustrate the function.***

The internal cable as jumper for the delta connection, is connected with cable lugs. See the different sizes in Table 3.4 and tighten the torque as specified in Table 3.5

TABLE 3.4 DIMENSIONS CABLE LUGS DELTA-CONNECTION

Cable lug	Area (mm^2)	Dimension hole (mm)	Type of bolt
RKS16-8	16	8	M8
RKS25-8	25	8	M8
RKS35-8	35	8	M8
RKS50-10	50	10	M10
RKS70-10	70	10	M10
RKS95-10	95	10	M10
RKS120-10	120	10	M10

3.3.5 TIGHTENING TORQUE

All bolts are tightened to the specified torque according to SS-EN 29898-1 (Grade 8.8). When connecting the input and output cables, ensure that the correct tightening torque is applied.

TABLE 3.5 TIGHTENING TORQUE ACCORDING TO SS-EN 29898-1 8.8

Type of bolt	Tightening torque (Nm)
M6	9,8
M8	24
M10	47
M12	81

3.4 POSSIBLE ACCESSORIES

The following options are available upon request and can be added to the transformer:

- Wheels
- Copper bar for ground protection
- Bottom entry for cable
- Flanges
- PT100
- PT100 with terminal block
- PT100, TI54-monitor with junction box

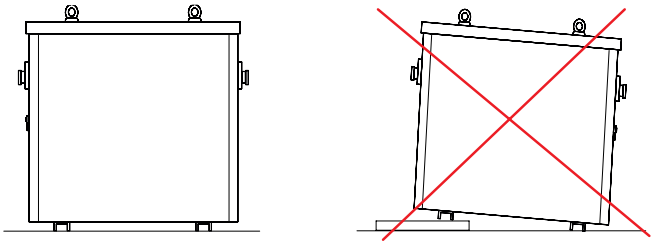
For further details, or if you are looking for something else, please contact tech@tramoetv.se and we'll be happy to assist you.

IV - INSTALLATION

The transformer must be positioned and installed in a way that prevents unintended contact between personnel and live parts, while also allowing for proper heat dissipation generated by the transformer.

Upon receiving the transformer, the packaging must be removed to detect any potential transport damage. This must be done immediately upon delivery, regardless of when the transformer will be installed. Inspect the transformer and ensure that all parts are included.

FIGURE 4.1

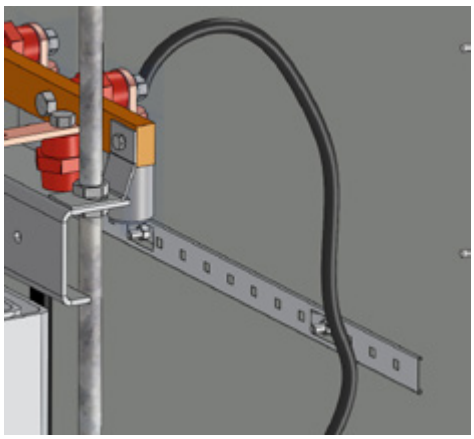


It is extremely important to check that the transformer has not been damaged in any way during transport.

Bolts, nuts, washers, and other objects from the surrounding equipment may accidentally fall into the winding channels during connection, installation work, or storage. Before commissioning, it is essential to check that no foreign objects have been left inside the transformer, as such objects could cause serious damage when the voltage is applied. The transformer must be placed on a level surface in an upright position. It must not be tilted or placed on uneven ground, as shown in Figure 4.1.

In the case of bottom cable entry, ensure that the cables do not come into contact with the transformer. Use the mounting rale as a strain relief to prevent stress on the connections. See fig 4.2

FIGURE 4.2 MOUNTING RAIL FOR CABLES



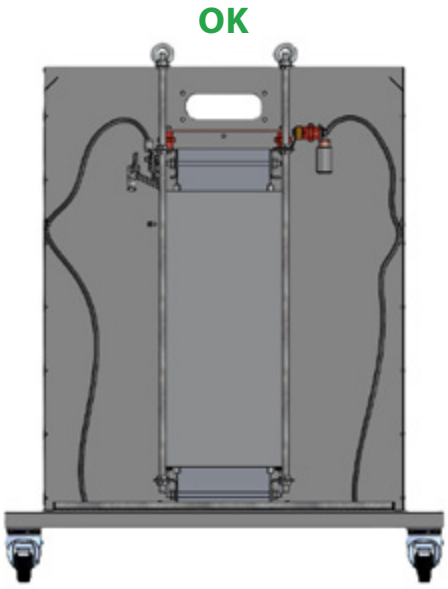
In the case of bottom cable entry, ensure that the cables do not come into contact with the transformer. Use cables with strain relief to prevent stress on the connections.

Make sure that there is a minimum distance of 35mm between the cables and the transformer accoring to according to IEC 60664-1:2020.

TABLE 4.1

Highest voltage for the equipment (Low Voltage)	Insulation level according to IEC-60076-11	Insulation distance according to IEC-60664-1:2020
1 kV	3 kV	35mm

FIGURE 4.3 MINIMUM DISTANCE



4.1 VENTILATION

To ensure the correct lifespan of the transformer, the heat generated in the core and windings must be effectively dissipated to prevent exceeding temperature limits. If air circulation is insufficient, the transformer may overheat, potentially triggering the thermal protection system. As electric current passes through the windings, along with the core magnetizing current, electrical losses occur, leading to localized heating of the windings and core.

The transformer is designed for natural cooling, keeping its temperature within the maximum limits specified by the standards.

For proper installation and effective ventilation, the height difference between the thermal axis of the transformer and the center of the exhaust opening must be sufficient. Follow the guidelines in Figure 4.2 to ensure optimal cooling.

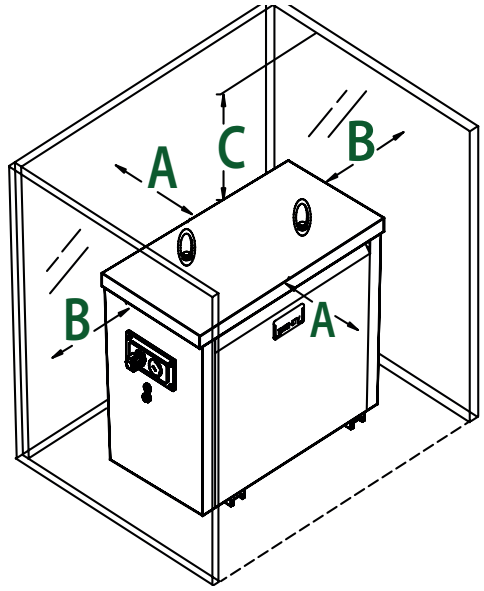


TABLE 4.2

Minimum free space for ventilation
A 500 mm
B 300 mm
C 1 000 mm

4.2 EARTHING CONNECTIONS

The installation must be carried out in compliance with current standards, applicable laws, and these instructions. Tramo-ETV is not responsible for the transformer installation. Outside the enclosure, beneath the cable entry plates, there are two earthing points for external connection.

These earthing points can be used for equipotential bonding or to establish a proper ground connection, especially if the transformer is supplied via a long cable, or in both cases.

4.3 OVERLOAD AND SHORT CIRCUIT PROTECTION

The transformer is designed and manufactured to withstand only limited abnormal conditions, such as over-voltage, overloading, and short circuits. Therefore, it must be protected against the thermal and dynamic effects caused by continuous overloading and secondary short circuits using appropriate fuses that can disconnect the transformer if the current exceeds its rated limit. The protection settings and the selection of fuses on both the primary and secondary sides must be determined based on the rated currents specified on the transformer's rating plate.

Additionally, the high inrush current should be considered. When the transformer is energized, a high magnetizing current is induced in the primary winding, reaching up to 2 times the rated current, even when no load is connected to the secondary side. Therefore, it is recommended to use slow-blow fuses or a protection relay with an adjustable tripping delay. Additionally, we suggest limiting the number of switch-on operations to reduce the impact of inrush currents.

4.4 INSPECTION BEFORE COMMISSIONING

Before the transformer is put into operation, it must be inspected to ensure that the installation and connections have been carried out correctly.

A. Cleaning of windings and winding channels. Remove dust and dirt by blowing with low-pressure dry compressed air and using dry cloths.

B. Preheating the Transformer. Preheating must be performed if condensation has formed during storage or transport. This is best done using a hot air blower or a similar device.

C. Checking the correct function of the temperature sensors. To verify proper operation, simply measure the resistance of the sensors in the junction box on the transformer.

D. Check the tightening of the low-voltage connections, including all external connections and tap changer links.

E. Inspect the windings to ensure they have not been damaged during delivery. Look carefully to ensure the windings are not bent inwards towards the core, or that the varnish and insulation material have been damaged, exposing the copper or aluminium.

F. Check the insulation between the windings and the insulation to ground using an insulation tester.

G. Verify that all connections are properly configured for the specified supply voltage by referring to the nameplate on the transformer.

H. Check the tap changer settings to ensure they correspond to the specified supply voltage and load voltage.
If the supply voltage exceeds the allowed value for the selected tap, no-load losses and transformer noise levels will increase.

I. Verify that the grounding connection is properly attached at the designated points on the transformer.

J. After installation, check the connections and settings if the unit has a junction box (refer to the provided information for this unit).

K. It is strictly forbidden to place low-voltage and/or high-voltage cables, metal parts, or any other objects near the windings. The windings are live parts, and cables installed too close to them can cause serious damage to the transformer.

L. Check that all bolts and nuts are properly tightened. This is especially important if the transformer has undergone multiple transport stages with several loading and unloading operations. (Refer to the manual for the correct tightening torque values.)

M. Carefully check that the windings have not been damaged during transport.

N. Ensure that the cooling channels in the windings are free from packaging materials, such as plastic, paper, packing tape, and other foreign objects.

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V - MAINTENANCE

5.1 PERIODIC MAINTENANCE

Dry-type transformers generally require minimal maintenance. However, regular inspections during operation can help prevent faults and extend the transformer's service life. Under normal operating conditions, it is recommended to perform the following maintenance tasks at least once or a year:

For the entire duration of the work, the five safety rules – subsequently also called safety measures – in accordance with EN 50110-1 (section "Dead working") must be observed in the specified order. The rules are:
1. Disconnect main and auxiliary circuits
2. Secure against re-connection
3. Verify that the installation is dead
4. Carry out earthing and short-circuiting
5. Cover or fence off adjacent live parts

Before beginning the work, verify that the transformer surfaces have cooled down to below 40°C.

The annual maintenance tasks are as follows:

- Ensure the power supply is disconnected before starting any maintenance.
- Clean the windings to remove dust, condensation, dirt, and debris.
- Clear the cooling and ventilation channels to maintain proper airflow.
- Inspect and tighten all tap connections and output terminal connections.
- Check and secure all bolts, including those on reinforcing plates, end plate rings, and accessories.
- Verify the operation of thermal safety devices, such as temperature probes and the temperature control unit, ensuring proper connections.
- Inspect transformer safety devices, including fuses, to confirm they are functioning correctly.

Regular maintenance following these steps will help ensure reliable transformer performance and longevity.

5.2 EXTRAORDINARY MAINTENANCE

In the event of exceptional incidents, such as short circuits, overvoltages, or external factors like natural disasters, landslides, or flooding, it is essential to conduct a thorough inspection before returning the transformer to service. Before proceeding, contact Tramo for technical support. We will provide the necessary guidance to assess the transformer's condition and ensure its performance remains unaffected.

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5.3 END-OF-LIFE AND DISPOSAL

When a low-voltage transformer reaches the end of its operational life, it is essential to handle its decommissioning, dismantling, and disposal in a safe and environmentally responsible manner.

Separation of Components: The transformer consists of several materials, which should be separated for proper recycling and disposal:

- Copper/Aluminum windings – Can be recycled.
- Core steel laminations – Can be melted down and reused.
- Insulating materials (paper, varnish, resins) – Should be disposed of according to regulations.
- Enclosure (steel or aluminum housing) – Can be recycled as scrap metal.
- Plastic and rubber components should be sorted and recyled if possible.

Ensure that the disposal process adheres to local environmental laws and waste disposal regulations. Maintain records of the disposal process, especially for hazardous materials, to comply with auditing and environmental reporting.

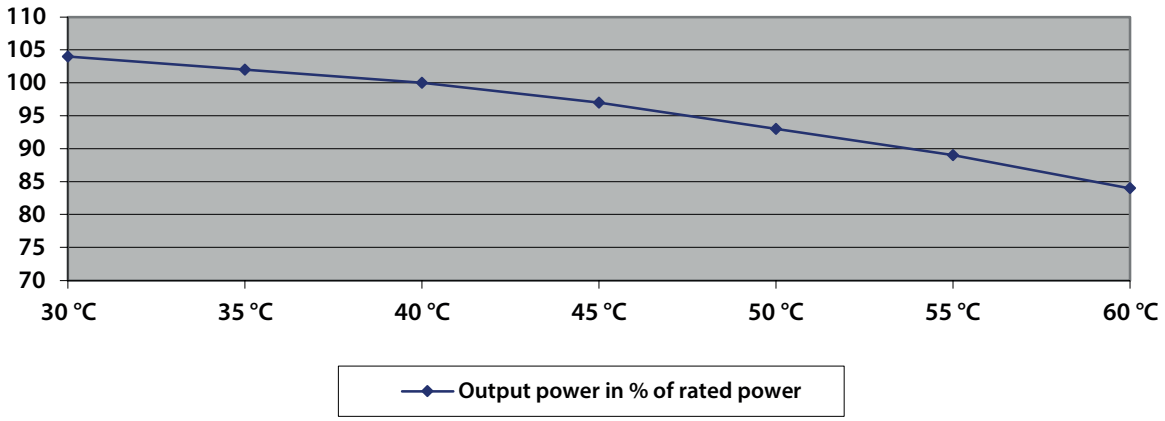
By following this structured End-of-Life process, a low-voltage transformer can be safely decommissioned and recycled while minimizing environmental impact and complying with regulations.

VI - DERATING DIAGRAMS

6.1 OUTPUT POWER VS. AMBIENT TEMPERATURE

The maximum usable output power of the transformer depends on the ambient temperature at the installation site. Adjustment according to figure 5.1 is necessary to ensure proper operation.

FIGURE 6.1



6.2 OUTPUT POWER VS. INSTALLATION HEIGHT

The maximum output power of the transformer decreases when the installation height exceeds 1000 m above sea level due to thinner air, which reduces cooling efficiency. Adjustment according to figure 5.2 is necessary.

FIGURE 6.2