

OPERATION MANUAL
POWER INVERTER PLANT
«ALPHA-INVERTER»
of 1000 - 2500 kVA rated power



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Introduction

This operation manual has information on the design, specification and instructions for proper and safe operation, maintenance, transportation, storage and utilisation of the Alpha-Inverter power inverter plant of the rated power range from 1000 to 2500 kVA (hereinafter referred to as "Equipment"). The Equipment is intended for operation in conditions stipulated in the paragraph 1.1.1.3 of this operation manual.

The operation manual is designed for service personnel who have undergone appropriate training and knowledge testing on the respective rules for the technical operation of power plants and electrical grids as well as rules for labor protection (safety rules) for operation of electrical installations in force in the country of installation.

Attention!

In case of any difficulties when operating the Equipment, please contact the manufacturer, Global Energy Solutions LLP.

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1. Description and operation

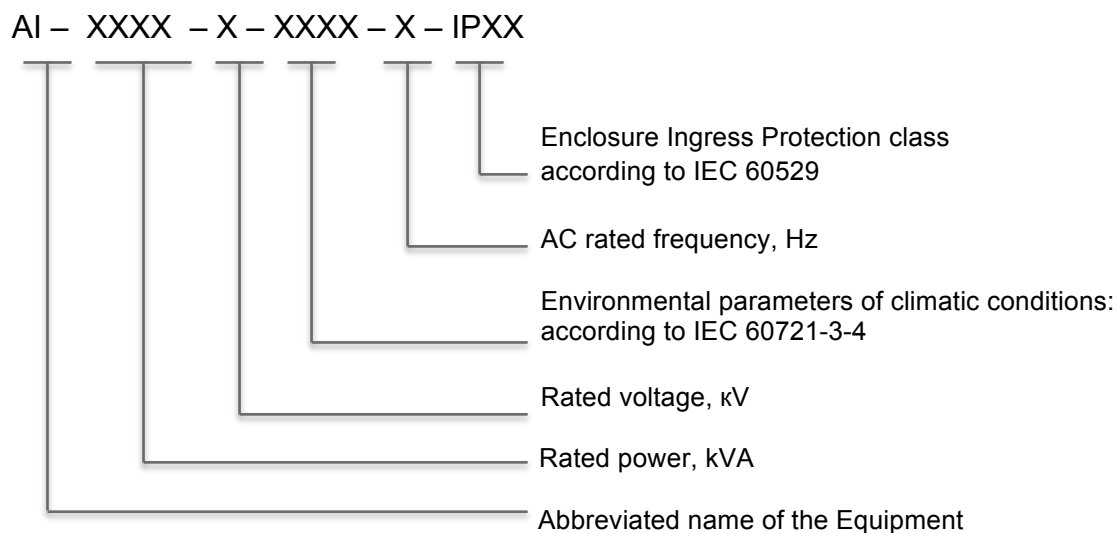
1.1. Description and operation of product

1.1.1. Product designation

1.1.1.1. The Equipment is intended to generate additional power with a minimum guaranteed ratio of 1.8, or 80% due to the internal circuit of the Equipment, which is described in section 1.1.4. Additional power is generated when electricity is consumed from the public network or produced by any source of generation. The Equipment enables a consumer to save 45% of electricity costs while maintaining the same level of power consumption or increase electricity consumption by 80% while keeping the installed power capacity unchanged, or enables a generation company to increase power generation by 80%.

The Equipment is intended for operation in a three-phase alternating current systems with a frequency of 50/60 Hz and at voltage of 0.4 kV.

1.1.1.2. Reference designation coding structure:



The Equipment of 2500 kVA rated power, 0.4 kV rated voltage, 50Hz rated frequency, intended to be installed at non-weatherprotected locations with 4K2 class of climatic conditions, IP55 enclosure protection class will have a reference designation coding as follows: "AI-2500-0.4-4K2-50-IP55".

1.1.1.3. Environmental parameters of climatic conditions:

The Equipment is designed to be installed at non-weatherprotected locations with 4K2 class of climatic conditions according to IEC 60721-3-4 standard.

The Equipment is intended for operation in areas with a temperate climate:

- the maximum ambient temperature 40°C;
- the minimum ambient temperature minus 45°C;
- relative air humidity up to 80% (for 15°C), upper value of 95% (for 25°C and at lower temperatures without moisture condensation);
- the setting altitude up to 1000 m above sea level;
- non-explosive, not containing conductive dust environment.

The Equipment is not designed to operate in conditions of shaking, vibration, shock or a chemically active environment.

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1.1.2. Specifications

1.1.2.1. Main electrical characteristics of the Equipment:

Parameter name	Parameter value				
Rated power, kVA	1000	1250	1600	2000	2500
Rated frequency, Hz	50				
Metal enclosure IP class	IP 55				
Dimensions (LxWxH), mm	2176x1160x1820				
Total weight, kg	1680				
Sanitary zone around the Equipment, m	1,5				

1.1.2.2. Key technical characteristics that should be maintained during the operation of the Equipment:

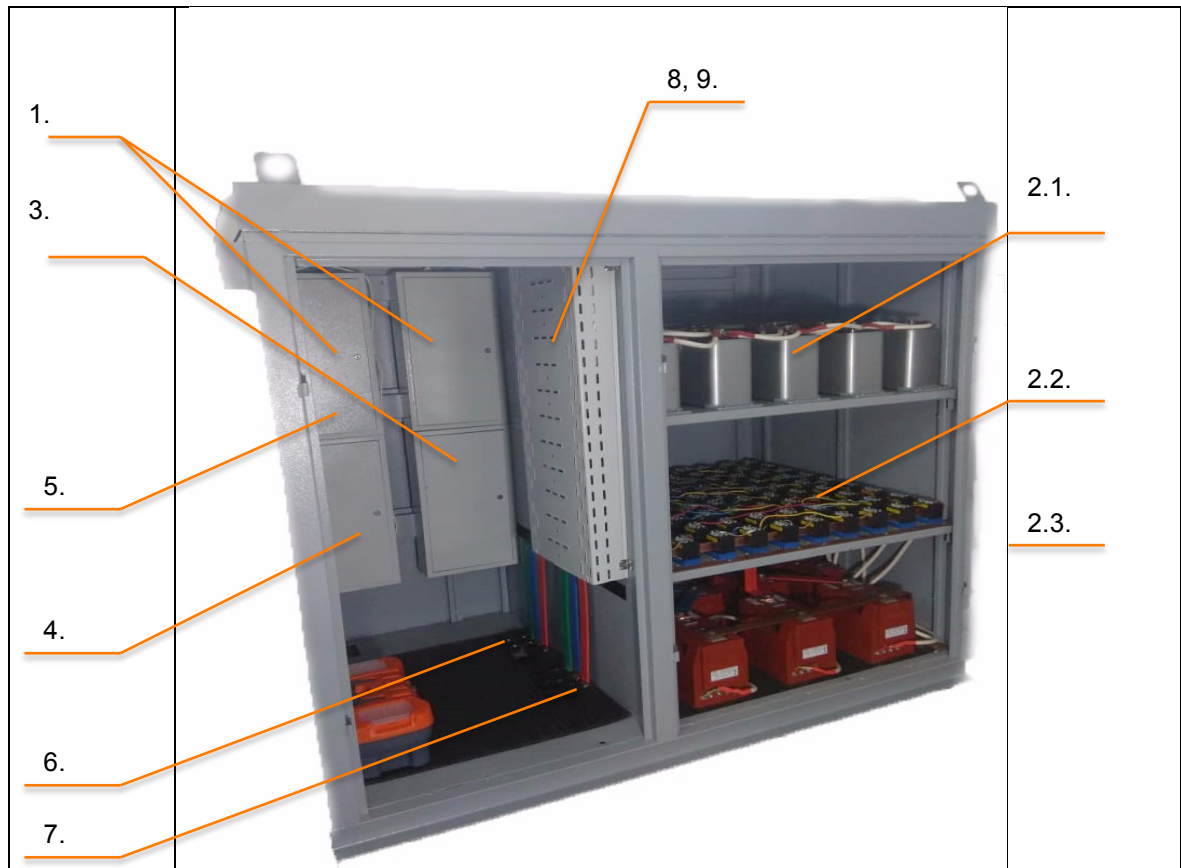
Parameter name	Parameter value
Input voltage	380V / 50 Hz
Output voltage	380V / 50 Hz
Phase A voltage	220V / 50 Hz
Phase B voltage	220V / 50 Hz
Phase C voltage	220V / 50 Hz
Sum of AB phases (Input/Output)	380V / 50 Hz
Sum of BC phases (Input/Output)	380V / 50 Hz
Sum of AC phases (Input/Output)	380V / 50 Hz
Sum of ABC phases (Input/Output)	380V / 50 Hz
Grounding requirements	3 ohm, IEC 60364-5-54:2011 capacity not less than 1.5 KAh
Resistance of the Equipment internal circuit	0,3 - 0,6 ohm

1.1.2.3. Average useful life of the Equipment – 20 years.

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1.1.3. Product composition

1.1.3.1. The Equipment consists of the following components:



1. PIC microcontrollers and SCADA-bus base control unit
2. Impulse unit:
 - 2.1 Cascade impulse generator;
 - 2.2. Spark gap control unit;
 - 2.3 Transformation unit
3. Three-phase input meter
4. Three-phase output meter
5. Wireless router*
6. Input busbar
7. Output busbar
8. Security system
9. Fire alarm system

* For remote control and monitoring of the Equipment in operation

Spare parts, tools, fixtures and measuring devices:

1. Equipment toolbox

1.1.4. Device and operation

1.1.4.1. Cascade-impulse generator consists of three-phase cosine-type power-factor correction capacitors having a rated voltage of 0.38kV and 0.4kV produced in accordance with the manufacturer's specifications under the requirements of IEC 60871-1:2014. Capacitor fuses meet the requirements of IEC 60871-4:2014.

1.1.4.2. The spark gap control unit consists of BH-0,66 KV type rated voltage current transformers that meet with the requirements of IEC 61869-2:2012.

1.1.4.3. Transformation unit consists of 9 induction transformers produced in accordance with the manufacturer's specifications under the requirements of IEC 61869-2:2012.

1.1.4.4. AC gets into an impulse unit where it is converted into DC and then back into AC. A cascade-impulse generator produces spark gaps that are collected into a cascade in a spark gap control unit from where the additionally generated electric power, that exceeds the incoming one in more than 1.8 times, is transmitted to a consumer through the transformation unit with a frequency of 50 Hz.

1.1.5. Measuring instruments and tools

1. Insulating mat.
2. Electrician gloves.
3. Three-phase meter - 2 items – to measure input and output electricity consumption.
4. Multimeter - to measure the circuit resistance of the main circuits and secondary switching circuits and check the absence of breaks in the circuit.
5. Anti static wrist.
6. Insulated tools.
7. Small tools:
 - a). Flat-headed and cross-headed screwdrivers;
 - b). Wrench;
 - c). Pliers;
 - d). Terminal clamp pliers;
 - e). Insulation remover.

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1.1.6. Marking and sealing

1.1.6.1. Marking of the Equipment should be in compliance with the requirements listed below.

1.1.6.2. Each unit of the Equipment must have a plate indicating the factory serial number.

1.1.6.3. Each plate should contain the following data:

- abbreviated name of the Equipment;
- rated power, kVA;
- modification type;
- serial number;
- production date;
- dimensions, mm;
- total weight, kg.

1.1.6.4. Transportation marking should meet the requirements of ISO 7000.

In addition to the basic symbols, the following signs must be located: “Sling here”, “Center of gravity”.

1.1.6.5. Marking method - according to the technology of the manufacturer.

1.1.6.6. The Equipment has the following warning signs: «Warning: Electricity», «Warning: Strictly forbidden to open», «Do not open without special permission»; instruction with the key technical parameters of the Equipment and the rules for connection and maintenance; informative signs: «Input meter», «Output meter», «Input 380V/50Hz», «Output 380V/50Hz», «Grounding».

1.1.6.7. The Equipment is equipped with a security system that is activated in case of unauthorised access to the impulse unit.

1.1.6.8. The Equipment has factory QR codes on all capacitors of a cascade-impulse generator, and induction transformers of a transformation unit, the numbering and list of which is indicated in the Equipment Installation and Commissioning Act.

1.1.7. Packaging

1.1.7.1. The Equipment units are transported separately.

1.1.7.2. The Equipment is wrapped in a air-bubble and polythene film.

1.1.7.3. The terminal wires are removed from the capacitors for the period of transportation and are installed when connected.

1.1.7.4. The Equipment toolbox is wrapped in a air bubble and polythene film and fixed inside the Equipment case.

1.1.7.5. The technical documentation is wrapped in a moisture-proof package and enclosed in a packing place or sent to a customer by mail. A set of technical documentation includes: technical data sheet and operation manual.

1.1.7.6. The Equipment has 3 doors which are supplied with locks.

2. Intended use

2.1. Operational limitations

2.1.1. Equipment must not be thrown.

2.1.2. **Attention: Do not install the Equipment in an area at risk of flooding.**

2.1.3. **Attention: The Equipment must not be opened until the representative of the manufacturer arrives to connect it. Otherwise, any claims to quality and / or incomplete will be rejected.**

2.2. Product connection requirements

2.2.1. The following requirements for connecting the Equipment to the electrical grid should be met:

- three-phase connection with specifications according to the rated power of the Equipment;
- automatic switch transfer corresponding to the rated power of the Equipment;
- connection of the Equipment to the grounding loop at the installation site;
- **Attention: ensure grounding of no more than 3 ohm in accordance with IEC 60364-5-54:2011 and capacity rate of no less than 1.5 KAh;**
- ensure a sanitary zone around the Equipment of at least 1.5 meters;
- power cos phi of substation is not less than 0.9;
- from the place of input-output of the network to the installation site of the Equipment a 4x240 aluminum FRLS cable or an equivalent must be laid at both directions, each end of the cable must leave the ground for at least 3 m.

2.3. Prepare product for use

2.3.1. **Attention: The Equipment should only be operated by a personnel who have Electrical Access Permit with voltage up to 1000 Volts.**

2.3.2. The Equipment must be installed on a flat ground in an open area or in a ventilated area in compliance with the sanitary zone specified in the clause 1.1.2.1. and requirements for indoors installation of high-voltage electrical equipment.

2.3.3. Connect the input to a terminal strip through crimped tinned terminals not allowing a wire to contact a housing.

2.3.4. **Attention: Check that the input and output phase sequence is the same: ABC -> ABC.**

2.3.5. Once the Equipment is connected, check the parameters against the values indicated in the table of the clause 1.1.2.2.

2.3.6. **Attention: ensure grounding of no more than 3 ohm in accordance with IEC 60364-5-54:2011 and capacity rate of no less than 1.5 KAh.**

2.3.7. After grounding the Equipment, check the parameter values against the table indicated in the clause 1.1.2.2.

2.3.8. **Attention: in case the values of parameters deviate from the values in the table, DO NOT START UP the Equipment until deviations are eliminated.**

2.3.9. Make sure there is no damage to the cable insulation.

2.3.10. Make sure there are no foreign objects inside the case.

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2.4. Product operation

2.4.1. Security measures:

2.4.1.1. Security measures are similar to the regulations for operation of transformer substations 10/0.4.

2.4.1.2. Attention: The Equipment should be serviced by specialists who have Electrical Access Permit with voltage up to 1000 Volts.

2.4.1.3. Prior to opening the service door of the Equipment, lay a insulating mat and put on electrician gloves.

2.4.2. It is strictly forbidden to:

2.4.2.1. Perform work on and make and break the Equipment connected to the electrical grid at least on one side.

2.4.2.2. Start up the Equipment without connection to earth ground.

2.4.3. Periodic measurements of the Equipment in operation:

2.4.3.1. Take readings of the technical parameters of the Equipment specified in the clause 1.1.2.2 not less than once a month.

2.4.3.2. In case of deviations of the technical parameters of the Equipment operation, refer to the table of possible malfunctions, the reasons and ways to eliminate them, presented in the clause 2.4.4. or contact the manufacturer's service department.

2.4.4. Possible malfunctions, causes and remedies are presented in the table below:

Nature of a fault	Fault location	Possible causes and remedies
The Equipment does not operate	Automatic switch transfer is triggered (if installed).	Incorrect equipment connection or asymmetrical phase connection. Check the connection according to the clauses 2.3.4. and 2.3.5.
The Equipment turns off spontaneously	Automatic switch transfer is triggered or fuses blow out (if installed)	The ground is not connected or the grounding capacitance exceeds 3 Ohm and / or does not comply with IEC 60364-5-54:2011 specified in cl. 1.1.2.2. Bring the grounding to the specified requirements.
Heated output cable	The temperature of the output cable is significantly higher than the temperature of the input cable.	Cable specifications do not meet the requirements specified in section 2.2.1. Bring the cable to the specified requirements.

3. Maintenance

3.1. Product maintenance

3.1.1. General instructions

3.1.1.1. The list and frequency of maintenance work under normal operating conditions are listed in the Table «List and frequency of maintenance work».

3.1.1.2. Dust must be removed with a vacuum cleaner or dry compressed air.

3.1.1.3. In case of a rapid accumulation of dust, increase the frequency of cleaning.

3.1.1.4. When contacting the manufacturer's service center, please hold ready information from the plate including the serial number of the Equipment.

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TABLE: LIST AND FREQUENCY OF MAINTENANCE WORK

List of work	Frequency		
	Once a month	Once a year	Once in 8 years
1. Frequency of maintenance work:			
1.1. External inspection of equipment:			
a. a. check the absence of mechanical damage to the cable input and output;	✓	✓	
2.1. Equipment performance monitoring unit			
a. measure key technical parameters and compare with target values of cl. 1.1.2.2. ;	✓	✓	
b. remove dust and dirt;		✓	
c. check the tightness of connections on the input and output busbar;	✓	✓	
d. check the connections of earthing switches with grounded elements: measure the transient resistance;		✓	
e. check the phase-zero circuits in electrical installations up to 1 kV with a neutral grounding;		✓	
f. carry out an external inspection of the cables clamp for cracks, corrosion, mechanical damage;	✓	✓	
g. check the operability of input and output electricity meters;		✓	
h. check the operation of the alarm system for an unauthorized access;		✓	
i. measure the insulation resistance of the input and output busbar;			✓
j. test isolation of input and output busbar with increased voltage;			✓
k. measure the insulation resistance of the load switches;			✓
l. test isolation of overload switches.			✓

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3.1. Cascade impulse generator:	Once a month	Once a year	Once in 8 years
a. remove dust and dirt;		✓	
b. conduct an external inspection of the capacitors for tightness and the absence of deformation and damage to the body: swelling, sagging, etc. Measurements should be made with an accuracy of ± 2 mm.;	✓	✓	
c. check the condition of paint coatings of enclosures and metal coatings of contact surfaces;		✓	
d. conduct an external inspection for leak detection (drip , etc) of a liquid dielectric;	✓	✓	
e. conduct an external inspection for the integrity of the capacitor insulators;	✓	✓	
f. wipe insulators and capacitors;		✓	
g. conduct an external inspection for the absence of damage to the capacitor terminals;	✓	✓	
h. check the reliability of the capacitor terminals mounting;		✓	
i. check the reliability of the contact connections: check the tightness of the bolts;		✓	
j. carry out an external inspection of the cables clamp for cracks, corrosion, mechanical damage;	✓	✓	
k. check the connection cable for melting;	✓	✓	
l. measure the capacitance of each capacitor and compare it with the target values in the table «Capacitor target capacities» of clause 3.1.1.5.;		✓	
m. measure the capacitor discharge resistor;		✓	
n. assess the need for cable replacement;			✓
o. conduct a high voltage capacitor test in accordance with the standards established by IEC 60384;			✓
p. conduct a test of capacitor batteries in accordance with the standards established by IEC 60384.			✓

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4.1. Spark-gap control unit:	Once a month	Once a year	Once in 8 years
a. remove dust and dirt;		✓	
b. conduct an external inspection of transformers to check for the absence of cracks and chips on the surface of the insulation;	✓	✓	
c. check transformer mounting;		✓	
d. check the reliability of contact connections;	✓	✓	
e. measure the insulation resistance of transformers in accordance with the standards established by IEC 61558;			✓
f. test isolation of transformers with increased voltage in accordance with the norms established by IEC 61558;			✓
g. carry out tests in accordance with IEC 61558.			✓
5.1. Transformation unit:			
a. tighten contact connections;	✓		
b. remove dust and dirt;		✓	
c. conduct an external inspection of transformers to check for the absence of cracks and chips on the surface of the insulation;	✓	✓	
d. check transformer mounting;			✓
e. carry out tests in accordance with IEC 61558.			✓

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3.1.1.5. Capacitor target capacities:

Capacitor type	Capacities, uF
0.38kV	514
0.38kV	301
0.38kV	230.5
0.38kV	550
0.38kV	291
0.38kV	577
0.38kV	810
0.38kV	892
0.38kV	1170
0.4kV	407
0.4kV	210
0.4kV	268
0.4kV	614
0.4kV	311
0.4kV	514

3.1.2. Security measures

3.1.2.1. Maintenance of the Equipment should be carried out in full compliance with this operation manual, the respective local regulations and requirements regarding the rules for electrical installations, the rules for technical operation of electrical installations, the rules for labor protection during the operation of electrical installations, as well as other applicable local codes and regulations.

3.1.2.2. Personnel performing maintenance of the Equipment must clearly understand and know the purpose of the individual parts, their interaction and working condition during operation.

3.1.3. Product maintenance procedure

3.1.3.1. Maintenance of the Equipment should be carried out in full compliance with this operation manual, the respective local regulations and requirements regarding the rules for electrical installations, the rules for the technical operation of electrical installations, the rules on labor protection during operation of electrical installations, as well as other applicable local rules and regulations that take into account the specifics of a particular location, climatic zone, the customer specifics and other factors.

3.1.3.2. The operation mode of the Equipment should be monitored by taking readings of the technical parameters of the Equipment in operation specified in the clause 1.1.2.2 at least once a month. Under normal operating conditions the parameters must match the specified values.

3.1.3.3. Equipment in operation must be subject to periodic inspections. During the inspection attention should be paid to the condition of the inputs, outputs, busbars, cables, and equipment grounding.

4. Maintenance

BH-0.66 KV and 10KV type rated voltage current transformers, which are the key components of the Equipment, do not need maintenance and should be inspected in accordance with IEC 60044-8. The recommended inspection interval is 8 years.

5. Storage

5.1. The climatic storage conditions:

- the maximum ambient temperature 50°C;
- the minimum ambient temperature minus 50°C;
- relative air humidity up to 80% (for 20°C), upper value of 95% (for 25°C);

5.2. The permissible storage period of the Equipment in the original packaging prior to commissioning is two years.

6. Transportation

6.1. The Equipment is transported and stored in the factory packaging in an upright position.

6.2. When loading, transporting and unloading the Equipment, it is necessary to comply with the requirements set forth in the operation manual.

6.3. The Equipment is delivered to a customer by rail or road. The Equipment may be transported by river, sea, or air transport.



Picture. Transportation by road.

6.4. Immediately after arriving at a place of destination, before unloading the Equipment, the representatives of a customer and a transportation company, should inspect the package and ensure that there are no mechanical damages. Upon detection of mechanical damage, it is necessary to draw up a inspection report.

6.5. When loading, transporting and unloading the Equipment, observe the following requirements:

- The Equipment can only be moved in an upright position;
- To prevent strong vibrations, oscillations of the Equipment during transportation;
- Transportation of the Equipment is carried out in accordance with the requirements of the relevant regulatory documents. The weight of the Equipment is indicated in a waybill documentation and on the Equipment plate;

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- it is necessary to ensure reliable fastening of the Equipment to exclude movements of the Equipment on the platform;
- unloading of the Equipment must be carried out by mechanisms and devices, the carrying capacity of which corresponds to the mass of the product;
- the angle of inclination of the sling from the vertical should be no more than sixty degrees.

6.6. Moving Equipment by forklift: When using a forklift, it is necessary to lift the Equipment by inserting the forklift under the lower supporting channels of the Equipment.

6.7. Moving Equipment by crane: lifting Equipment is carried out using four slinging clips. The angle made by the two sling chains should not be more than 60 degrees.

7. Utilisation

7.1. Parts and components of the Equipment do not emit any hazardous substances or pose any danger to the environment and human health during operation and storage thereof.

7.2. The capacitor's case, terminals, impregnation liquid, current transformers and the removable parts thereof after their life cycle should be consigned for utilisation to a designated company that has licences and experience to carry out such works.

8. Manufacturer's warranty

8.1 Warranty period – 3 (three) years from the date of commissioning.

The warranty is valid on condition that a consumer observes the rules and requirements specified in this operation manual.

8.2. The warranty does not cover damage to Equipment due to and in the case of:

- improper operation and / or violation of the requirements of this operation manual, and / or;
- altering or missing of QR codes installed on capacitors in the cascade-impulse generator and induction transformers of a transformation unit of the Equipment;
- violations of the norms of storage of Equipment, and / or;
- accidental, negligent or intentional (vandalism, theft, etc.) actions or inactions by end user or third parties;
- unauthorized changes and modifications to the Equipment and / or its components, and / or;
- force majeure circumstances: natural disasters, fires, earthquakes, lightning, military actions, etc.

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