CAUTION!

When MV equipment is operating, certain components are live, other parts may be in movement and some may reach high temperatures. Therefore, the use of this equipment poses electrical, mechanical and thermal risks.

In order to ensure an acceptable level of protection for people and property, and in compliance with applicable environmental recommendations, Ormazabal designs and manufactures its products according to the principle of integrated safety, based on the following criteria:

- Elimination of hazards wherever possible.
- Where elimination of hazards is neither technically nor economically feasible, appropriate protection functions are incorporated in the equipment.
- Communication about remaining risks to facilitate the design of operating procedures which prevent such risks, training for the personnel in charge of the equipment, and the use of suitable personal protection equipment.
- Use of recyclable materials and establishment of procedures for the disposal of equipment and components so that once the end of their useful lives is reached, they are duly processed in accordance, as far as possible, with the environmental restrictions established by the competent authorities.

Consequently, the equipment to which the present manual refers complies with the requirements of section 11.2 of the forthcoming IEC standard 62271-1. It must therefore only be operated by appropriately qualified and supervised personnel, in accordance with the requirements of standard EN 50110-1 on the safety of electrical installations and standard EN 50110-2 on activities in or near electrical installations. Personnel must be fully familiar with the instructions and warnings contained in this manual and in other recommendations of a more general nature which are applicable to the situation according to current legislation.

The above must be carefully observed, as the correct and safe operation of this equipment depends not only on its design but also on general circumstances which are in general beyond the control and responsibility of the manufacturer. More specifically:

- The equipment must be handled and transported appropriately from the factory to the place of installation.
- All intermediate storage should occur in conditions which do not alter or damage the characteristics of the equipment or its essential components.
- Service conditions must be compatible with the equipment rating.
- The equipment must be operated strictly in accordance with the instructions given in the manual, and the applicable operating and safety principles must be clearly understood.
- Maintenance should be performed properly, taking into account the actual service and environmental conditions in the place of installation.

The manufacturer declines all liability for any significant indirect damages resulting from violation of the guarantee, under any jurisdiction, including loss of income, stoppages and costs resulting from repair or replacement of parts.

Guarantee

The manufacturer guarantees this product against any defect in materials and operation during the contractual period. In the event that defects are detected, the manufacturer may opt either to repair or replace the equipment. Improper handling of this equipment and its repair by the user shall constitute a violation of the guarantee.

Registered Trademarks and Copyrights

All registered trademarks cited in this document are the property of their respective owners. The intellectual property of this manual belongs to the manufacturer.

In view of the constant evolution in standards and design, the characteristics of the elements contained in this manual are subject to change without prior notification.

These characteristics, as well as the availability of components, are subject to confirmation by Ormazabal’s Technical - Commercial Department.
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1. DESCRIPTION AND MAIN CHARACTERISTICS

Ormazabal's PFS-55, PFS-75 and PFS-93 are walk-in type Underground Transformer Substations designed according to Standard EN 62271-202 for use in public MV electrical distribution networks of up to 36 kV, and may contain 1 or 2 transformers of up to 1000 kVA.

1. Medium Voltage (MV) Switchgear.  
   (Example for the CGMCOSMOS cubicle system, 24 kV).
2. Power transformer.
3. Low Voltage Board.
4. Transformer cover.
5. Material cover.
6. Lifting eyes.
7. Personnel access door.
8. Ventilation.

Figure 1.1: Main parts of PFS-75-2T with vertical ventilation
Depending on the ventilation system used in the Transformer Substations, there are 2 versions that allow for different configurations\(^1\):

- **PFS-55-H, PFS-75-H and PFS-93-H**: the ventilation grilles are horizontal, at level 0 (see Figure 1.2).

- **PFS-55-V, PFS-75-V and PFS-93-V**: the ventilation grilles are in vertical ventilation shafts (see Figure 1.3).

---

\(^1\) Withstands the weight of 2 specific loads of up to 4.5 t.
1.1. MECHANICAL CHARACTERISTICS

The dimensions and weights of the PFS-55, PFS-75 and PFS-93 Transformer Substation models, including 1000 kVA transformers, are:

<table>
<thead>
<tr>
<th>Model</th>
<th>PFS-55</th>
<th>PFS-75</th>
<th>PFS-93</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H</td>
<td>V</td>
<td>H</td>
</tr>
<tr>
<td>Ventilation type</td>
<td>Body*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height [mm]</td>
<td>3200</td>
<td>3200</td>
<td>3200</td>
</tr>
<tr>
<td>Ventilation</td>
<td>0</td>
<td>565</td>
<td>0</td>
</tr>
<tr>
<td>Width [mm]</td>
<td>7090</td>
<td>6000</td>
<td>9090</td>
</tr>
<tr>
<td>Depth [mm]</td>
<td>4500</td>
<td>4500</td>
<td>3200</td>
</tr>
<tr>
<td>Weight [kg]</td>
<td>61000</td>
<td>58500</td>
<td>56000</td>
</tr>
</tbody>
</table>

(*) Including floor

2. TRANSPORT

Transport must be done with a low loader truck with a platform height of less than 1000 mm.

Obtaining the permit and organising the route for overhead obstacles (the total transport height ranges between 3800 mm and 4500 mm) must be planned in advance.

2.1. ACCESS

The site must be visited in advance to check if vehicles can have access and if there is sufficient space for the unloading operation, taking into account the distances to overhead lines, slopes, etc.
3. STORAGE

The following conditions must be taken into account for storage:

- The ground on which the Transformer Substation is temporarily stored must meet the same specifications as the ground on which the definitive installation is made.
- The storage must be in an area free of machinery to prevent the Transformer Substation from being hit.

*Figure 3.1: Storage conditions*
4. **INSTALLATION**

4.1. **LOCATION**

The exact site of the Transformer Substation must be defined, indicating alignment levels and the height to the reference points, level 0, finish of surrounding area, rainwater outlets (in the case of horizontal ventilation) and the position of the access covers.

4.2. **PLANNING**

The spaces available for the crane and the transport truck must be marked out on the location sketch or drawing.

⚠️ **CAUTION:**

Pay special attention to the position of the crane to ensure the support jacks are not too close to the excavation, which could lead to collapses. The support jacks must be more than 3000 mm from the excavation.

The existence of any circumstance or object that could impede or obstruct the smooth operation of the installation must be indicated (posts, cables, ditches, walls, pipelines, etc.), marking their positions on the drawing with the corresponding measurements.

4.3. **PERSONNEL REQUIRED**

Depending on the conditions of the excavation, the assembly manager must decide on the personnel required for the work to be completed correctly.

4.4. **PREPARING THE GROUND**[^2]

The minimum health and safety requirements for construction sites should be considered.

Bear in mind the following instructions when preparing the ground:

- Before starting to excavate the ground, carry out a preliminary study of it for information on its stability and the possible existence of underground pipes.
- The maximum water table level must not be above - 800 mm.
- If the installation is performed before site development, fence a safety area at 2000 mm around the Transformer Substation so that it is protected during the development operations.
- As a general rule, maintain a 3000 mm area around the excavation free of loads and vehicle traffic.
- Avoid accumulating excavated material and equipment next to the edge of the excavation, taking the necessary precautions to prevent the walls from caving in and materials falling inside.
- When the excavation is equal to or deeper than 2000 mm, protect the crown edges with a regulatory handrail.
- No material must be stored on the roofs of the Transformer Substation.

[^2]: See section 6.1. Installation Diagrams of this General Instruction document.
The perimeter of the Transformer Substation must be adapted so that landslides and rainwater do not accumulate on the Transformer Substation roof.

Flattening operations using a vibratory roller must be performed at a distance of over 2000 mm from the vertical walls of the Transformer Substation. The inner area (between the Transformer Substation and the area already developed) must be flattened using a rammer or a duplex type roller. The transmission of overloads to the walls must be avoided in all flattening operations.

In the event of rain and puddles, qualified technicians must carefully inspect the excavation before the work is resumed. Immediately pump out any water that may be present inside the excavation in order to prevent the stability of the slope from being altered.

At least one ladder must be provided for each team. This ladder must exceed the edge of the excavation by 1000 mm.

Engine driven machines that generate gases such as CO must not be placed inside the excavation unless adequate equipment is used to extract the gases.

The operators that work inside the excavation must be properly trained and informed and must use a safety hat as well as the appropriate protective clothing for each specific hazard.

Figure 4.1: Storage conditions
Depending on the type of ground, the recommended gradient of the slopes is as follows:

<table>
<thead>
<tr>
<th>Type of ground</th>
<th>Excavations in virgin soil or very old homogeneous embankments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Angle to horizontal</td>
</tr>
<tr>
<td>Hard rock</td>
<td>80º</td>
</tr>
<tr>
<td>Soft or cracked rock</td>
<td>55º</td>
</tr>
<tr>
<td>Rubble, rocky or stony</td>
<td>45º</td>
</tr>
<tr>
<td>Strong soil (mix of sand and clay with stone and vegetable matter)</td>
<td>45º</td>
</tr>
<tr>
<td>Recently dug or recent embankments</td>
<td>35º</td>
</tr>
</tbody>
</table>

4.4.1. Base Concreting

To ensure correct levelling and to reinforce the installation base of Transformer Substations PFS-55, PFS-75 and PFS-93 and the distribution of electrical earths, a reinforced concrete slab with a thickness of at least 200 mm must be provided at the base of the excavation, on which a 50 mm thick layer of sand is spread evenly by ruler\(^3\).

Four ends of the reinforcing mesh must be left exposed on the concrete slab for connection to the earth collector.

The mesh must be 100 x 100 mm square made of iron with an 8 mm\(^2\) cross-section.

4.5. LEVELLING PROCESS

The final 0 level must be defined in advanced before the levelling process is carried out.

At least the following tools must be used for levelling:

- 1 Spirit level.
- 1 Square-end spade.
- 1 Ladder (5000 mm in length).
- 8 Levelling tools.

**CAUTION:**

Incorrect levelling may cause the base of Transformer Substations PFS-55, PFS-75 and PFS-93 to break, with the subsequent inlet of water.

**NOTE:**

See Figures 7.1 to 7.6 in section 7. Additional Information of this General Instruction document.

---

\(^3\) See section 7.1. Installation Diagrams of this General Instruction document.
4.6. HANDLING

Transformer Substations PFS-55, PFS-75 and PFS-93 must be handled by 2 cranes with a minimum individual load capacity of 240 t.

**CAUTION:**
The minimum individual load capacity of each crane must be 240 t.

Transformer Substations PFS-55, PFS-75 and PFS-93 include DEHA 32T inserts located at the top of the buildings (ref. DEHA 6000-32-0700) for their correct handling using an appropriate lifting beam, slings and hooks to ensure they are hoisted in the most balanced manner possible.

**Figure 4.2:** Details of hoisting for Transformer Substations PFS-55, PFS-75 and PFS-93

**Figure 4.3:** Correct coupling of DEHA hooks
4.7. SECURING AND FILLING

To ensure Transformer Substations PFS-55, PFS-75 and PFS-93 are correctly anchored to the ground (given that they could float if the excavation was filled with water, after removing more volume than their weight), the excavation must be immediately filled with soil to the height of the cable inlets, immediately after the positioning and levelling process at the very latest. Gravel, sand, soil or similar, or even «lean» concrete (FCK 140 kp/cm² type or similar) can be used for the fill. To do so, use a maximum volume of 5 m³ (approximately one truckload), depending on the excavation in question.

4.8. RAINWATER DRAINAGE

A rainwater drainage system must be connected to the water outlets fitted to the ventilation boxes for models PFS-55, PFS-75 and PFS-93 with horizontal ventilation.

Connection to the rainwater drainage system must be made when positioning the Transformer Substation over the excavation.

The connection must prevent the water from returning to the Transformer Substation through the drainage system. Where this is difficult to achieve, a non-return valve, a water collection pit or an alternative device should be installed.

Materials and dirt accumulated in the bottom of the rainwater drainage chambers must be regularly removed.

4.9. REMOVAL AND SEALING OF THE TRANSFORMER COVERS

If the transformer is not supplied inside the Transformer Substation, the following considerations must be taken into account for correct handling and sealing of the transformer covers:

1. The materials for handling and new sealing of the cover are included in the Transformer Substation: eyebolts, Roundex rubber and Lanco sealant.
2. Remove the sealant and the rubber from the edge of the cover using a sharp tool (cutter, electrician's knife, etc.) so that it can be easily removed.
3. Fit the eyebolts to the cover and then remove it.
4. Check that the rubber profile used to support the cover is intact and complete. This is important in order to ensure a correct seal.
5. Handle the transformer (anchorage, connections, etc.).
6. Replace the concrete cover, particularly ensuring it is correctly positioned on the rubber profile mentioned in point 4.
7. Insert the Roundex rubber profile supplied with PFS-55, PFS-75 or PFS-93 into the gap between the perimeter wall of the cover and the enclosure, pressing it into the groove in order to adjust it.
8. Using a putty knife, cover the gap around the cover using Lanco sealant as evenly as possible and trying to leave as little porosity as possible in order to compact the rubber and the sealant and to ensure it is correctly attached to the sides of the profile.

---

[4] The earthing ring must be produced before this operation is performed. To do so, see section 4.12. Earthing Network of this General Instruction document.
4.10. CABLE ACCESS AND SEALING

Transformer Substations **PFS-55, PFS-75** and **PFS-93** have holes with Medium Voltage (3 accesses) and Low Voltage (4 smaller-diameter accesses) feedthroughs for the entry and exit of cables, which are supplied closed. Proceed as indicated below in order to perform the sealing operation correctly:

1. Select the most suitable cable inlet.
2. Cut off the corresponding lugs for the cut-off line, paying attention to the diameter of the cable. For easier identification, each lug has the corresponding diameter printed on it.

The following table indicates the diameters of the most common cables with dry insulation:

<table>
<thead>
<tr>
<th>Cross-section [mm²]</th>
<th>MV cables 12 / 20 kV</th>
<th>LV cables 0.6 / 1 kV (RV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ø [mm]</td>
<td>Ø cut-off</td>
</tr>
<tr>
<td>400</td>
<td>43,1</td>
<td>40</td>
</tr>
<tr>
<td>240</td>
<td>37,1</td>
<td>35</td>
</tr>
<tr>
<td>185</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>150</td>
<td>32,5</td>
<td>35</td>
</tr>
<tr>
<td>120</td>
<td>31</td>
<td>35</td>
</tr>
<tr>
<td>95</td>
<td>29,5</td>
<td>35</td>
</tr>
</tbody>
</table>
| (*) 50 mm² insulated earthing cable always to be used when run outdoors.
3. Insert the corresponding «non-ferrous» stainless steel clamp (supplied with the kit) and then insert the cable.

4. Close the clamp in the position indicated in Figure 4.3 (behind the notch).

5. Should the feedthrough be accidentally cut in the wrong place, contact Ormazabal’s Technical - Commercial department.

**CAUTION:**
Do not use polyurethane foam or any other type of sealant.

Transformer Substations **PFS-55, PFS-75 and PFS-93** are fitted with an internal earthing circuit to connect the different parts to the external earthing network.

There are 2 earth disconnection boxes inside the enclosure:

- Protective earthing circuit (metal part earthing).
- Operational earthing circuit (transformer neutral earthing).

**4.11.1. Protective Earthing**

The protective earthing line (metal part earthing) includes the earthing of the enclosure, the different electrical equipment (MV cubicles, metal frame of the LVB, transformer cell, MV cable shields) and other metal parts in the installation.

The metal reinforcement of the enclosure body is connected directly to the protective disconnection box.

**4.11.2. Operational Earthing**

The operational earthing line (neutral) connects the LVB neutral busbar to its disconnection box fitted inside the Transformer Substation. The protective and operational earthing connections can be made on site once the characteristics of the ground and the operating conditions of the Transformer Substation have been determined.

**CAUTION:**
The neutral bar on the LVB is not connected to the protective earth connection bar (metal parts).
In principle, the protective earth and the operational earth are independent.

The Transformer Substation project must include a section corresponding to the earthing installation (check the Utility's standard project), as well as a justification of its size.

The copper braided wire cross-section, the terminations' contact surface and tightening torques must be suitable for a fault current delimited by network protections.

### 4.12. EARTHING NETWORK

For the protective earthing (metal parts) electrode in **PFS-55, PFS-75** and **PFS-93**, 2 earthing rings connected to each other are recommended:

1. **A perimeter ring at the bottom of the excavation** at a distance of approx. 400 mm from the concrete enclosure perimeter of the Transformer Substation. This perimeter ring must be connected to the base plate at the bottom of the excavation at least on 2 points (Figure 4.4).

2. **A perimeter ring at a distance of 1000 mm** from the perimeter of the Transformer Substation, at a **height of – 800 mm** below level 0 (Figure 4.4).

Both rings must be connected together using bare copper cable and the 2 rings are connected to the protective earthing point (in the corresponding breaker box) of the underground Transformer Substation.

**Bare copper cable with a cross-section of 50 mm²** is recommended for the protective earthing circuit, including the electrode.

The figure below shows the recommended configuration of the external earthing network:
5. SEQUENCE OF OPERATIONS

5.1. ACCESS TO THE SUBSTATION

Transformer Substations **PFS-55**, **PFS-75** and **PFS-93** have a cast aluminium personnel access cover, made up of the following parts:

1) **Aluminium door** painted black, with non-slip surface.

2) **Register cover** built into the main door, which hides and protects the lock. This assembly includes the following parts:

   2.1) A **box** with an auxiliary cover that includes an M16 bolt, built into the register cover.

   The register cover must be correctly closed for the unit to be sealed.

   2.2) Padlocks and locks are optionally available for closure support inside the box.
The Transformer Substation is accessed as follows:

1) Open the cover by turning the bolt shown in Figure 5.2 using an **Ormazabal** wrench supplied with the Transformer Substation.

2) Turn the register cover indicated in Figure 5.3 so that the lock or padlock can be accessed more easily.

3) Open the lock according to the specifications indicated by the Transformer Substation Supplier.

4) The door has 2 pneumatic shock absorbers that push to open it. This way, when the lock is opened, the door is pushed upwards and left open at 75° with the protection meshes almost in their correct position.

5) Leave the side protection meshes in position, pulling them sideways (according to arrows A), inserting the U-shaped hooks at the bottom of the mesh into the perimeter rail of the frame, as shown in

![Figure 5.6: Side mesh anchorage points](image)

6) Lift the door or central mesh at the points indicated in close-up B of Figure 5.7, pulling it in the direction indicated by the arrows A until it is vertical and housing the 2 moorings on the metal frame of the lower mesh into the perimeter rail of the frame at points C shown in Figure 5.8.

![Figure 5.7: Position of central mesh](image)  ![Figure 5.8: Central mesh anchorage points](image)
7) To open the central mesh door, pull vertically until the anchors are released (close-up D Figure 5.9) and turn outwards on the hinge.

5.2. CABLE AND SLAB CONFIGURATION

The floor inside the Transformer Substation on which the appropriate operations on the MV switchgear and the LV board are performed is made up of differently sized polyester slabs that are laid on bedplates secured to the floor of the building.

5.3. COMMISSIONING

Once Transformer Substation PFS-55, PFS-75 or PFS-93 is in place, the incoming and outgoing feeder functions must be made for the Medium Voltage line functions, along with the Low Voltage cable supplies.

Check that the transformer MV is suitable for the installation project. This information is printed on the transformer nameplate and in the test protocol.

6. MAINTENANCE

6.1. CLEANING

Once Transformer Substation PFS-55, PFS-75 or PFS-93 has been installed, the groove of the access covers must be cleaned properly.

Repeat the cleaning process whenever any dirt accumulated at the personnel entrance may jeopardise the seal of the Transformer Substation cover.

The boxes of models PFS-55, PFS-75 and PFS-93 with horizontal ventilation should be regularly cleaned.

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7. ADDITIONAL INFORMATION

7.1. INSTALLATION DIAGRAMS

7.1.1. PFS-55-H

1) As a requirement for the installation, the bearing capacity of the ground supporting the Transformer Substation must be greater than 1 kg/cm².

2) A concrete slab at least 200 mm thick will be positioned at the base of the pit, onto which a 30 to 50 mm thick layer of sand will be spread evenly by ruler.

3) Four ends of the reinforcing mesh must be left exposed on the concrete slab for connection to the earth collector.

4) Install the enclosure slightly above level 0.

5) For installation on sloping ground or areas with electricity lines, please consult Ormazabal's Technical - Commercial Department.

CAUTION:

To prevent the pit from caving in, it must be filled with earth in as soon as possible up to the level of the cable entry/exit.

NOTE: Maximum level of water table: - 800 mm.

NOTE: Level A: natural slope depending on ground.

NOTE: Dimensions in mm.
7.1.2. PFS-55-V

NOTE: Level A: natural slope depending on ground.

NOTE: Dimensions in mm.

CAUTION: To prevent the pit from caving in, it must be filled with earth in as soon as possible up to a maximum level of the cable ducts.

1) As a requirement for the installation, the bearing capacity of the ground supporting the Transformer Substation must be greater than 1 kg/cm².

2) A concrete slab at least 200 mm thick will be positioned at the base of the pit, onto which a 30 to 50 mm thick layer of sand will be spread evenly by ruler.

3) Four ends of the reinforcing mesh must be left exposed on the concrete slab for connection to the earth collector.

4) Install the enclosure slightly above level 0.

5) For installation on sloping ground or areas with electricity lines, please consult Ormazabal's Technical - Commercial Department.
7.1.3. PFS-75-2T-H

CAUTION:
To prevent the pit from caving in, it must be filled with earth in as soon as possible up to the level of the cable entry/exit.

NOTE: Maximum level of water table: - 800 mm.

NOTE: Level A: natural slope depending on ground.

NOTE: Dimensions in mm.

1) As a requirement for the installation, the bearing capacity of the ground supporting the Transformer Substation must be greater than 1 kg/cm².

2) A concrete slab at least 200 mm thick will be positioned at the base of the pit, onto which a 30 to 50 mm thick layer of sand will be spread evenly by ruler.

3) Four ends of the reinforcing mesh must be left exposed on the concrete slab for connection to the earth collector.

4) Install the enclosure slightly above level 0.

5) For installation on sloping ground or areas with electricity lines, please consult Ormazabal’s Technical - Commercial Department.
7.1.4. PFS-75-2T-V

1) As a requirement for the installation, the bearing capacity of the ground supporting the Transformer Substation must be greater than 1 kg/cm².

2) A concrete slab at least 200 mm thick will be positioned at the base of the pit, onto which a 30 to 50 mm thick layer of sand will be spread evenly by ruler.

3) Four ends of the reinforcing mesh must be left exposed on the concrete slab for connection to the earth collector.

4) Install the enclosure slightly above level 0.

5) For installation on sloping ground or areas with electricity lines, please consult Ormazabal’s Technical - Commercial Department.

Figure 7.4: PFS-75-V excavation diagrams

CAUTION:
To prevent the pit from caving in, it must be filled with earth in as soon as possible up to a maximum level of the cable ducts

NOTE: Level A: natural slope depending on ground.

NOTE: Dimensions in mm.
7.1.5. PFS-93-1T/2T-H

1) As a requirement for the installation, the bearing capacity of the ground supporting the Transformer Substation must be greater than 1 kg/cm².

2) A concrete slab at least 200 mm thick will be positioned at the base of the pit, onto which a 30 to 50 mm thick layer of sand will be spread evenly by ruler.

3) Four ends of the reinforcing mesh must be left exposed on the concrete slab for connection to the earth collector.

4) Install the enclosure slightly above level 0.

5) For installation on sloping ground or areas with electricity lines, please consult Ormazabal’s Technical - Commercial Department.

NOTE: Maximum level of water table: - 800 mm.

NOTE: Level A: natural slope depending on ground.

NOTE: Dimensions in mm.
7.1.6. PFS-93-1T/2T-V

Figure 7.6: PFS-93-1T/2T-V excavation diagram

**CAUTION:**
To prevent the pit from caving in, it must be filled with earth in as soon as possible up to a maximum level of the cable ducts.

1) As a requirement for the installation, the bearing capacity of the ground supporting the Transformer Substation must be greater than 1 kg/cm².

2) A concrete slab at least 200 mm thick will be positioned at the base of the pit, onto which a 30 to 50 mm thick layer of sand will be spread evenly by ruler.

3) Four ends of the reinforcing mesh must be left exposed on the concrete slab for connection to the earth collector.

4) Install the enclosure slightly above level 0.

5) For installation on sloping ground or areas with electricity lines, please consult **Ormazabal’s Technical - Commercial Department.**