IG-126-GB
version 06

PFS-48
UNDERGROUND TRANSFORMER SUBSTATION

LIB
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WARNING!

While any MV equipment is operating, some components are live, others may be moving, and some parts may become very hot. Consequently, there may be electrical, mechanical and thermal hazards associated with its use.

In order to provide an acceptable level of protection for both persons and goods and taking into account the applicable recommendations regarding the environment, Ormazabal develops and manufactures its products according to the principle of integrated safety, based on the following criteria:

- Removing hazards whenever possible.
- When this is not technically or economically viable, by incorporating suitable safeguards in the equipment itself.
- Providing information on remaining risks, in order to assist in the design of operational procedures to prevent such risks, training operational staff in their use, and using appropriate personal protection facilities.
- Using recyclable materials and establishing equipment and component processing procedures so that when these have reached the end of their service life they are appropriately handled so as to respect, as far as possible, the environmental criteria established by the proper organizations.

Consequently, the specifications given in section 11.2 of the future IEC 62271-1 standard will be taken into account when working on or near the equipment specified in this manual, and, in accordance with the EN 50110-1 Standard concerning safety in electrical installations and EN 50110-2 Standard applicable to all types of activity on, with or close to electrical installations, only duly trained and supervised personnel may work on, with, or near it when they are completely familiar with the instructions and warnings contained in this manual and any other general instructions that may apply according to current legislation.

This must be carefully taken into account, because the safe and proper operation of this equipment depends not only on its design, but on circumstances which are generally outside the scope and responsibility of the manufacturer, especially:

- Proper transport and handling of the equipment, from the factory gate to the installation site.
- Any intermediate storage being in conditions that do not change or adversely affect the assembly’s properties or its component parts.
- Service conditions being compatible with the specified properties of the equipment.
- Handling and operation being carried out strictly in accordance with the instruction manual, and with a clear understanding of the relevant operational and safety principles.
- Provision of proper maintenance, given the actual service and environmental conditions at the place of installation.

Consequently, the manufacturer will not be responsible for any significant indirect damage caused by any violation of the guarantee under any jurisdiction, including the loss of profits, times of inactivity, reparation costs or replacement of materials.

Guarantee

The manufacturer guarantees that this product will be free from any defects regarding materials and operation for the duration of the contract. If any defect is detected, the manufacturer may choose to repair or replace the equipment. Inappropriate handling of the equipment and any repairs carried out by the user will be considered to be a violation of the guarantee.

Trademarks and Copyrights

All the registered trademarks mentioned herein are the property of their respective owners. The copyright of this manual belongs to the manufacturer.

As a result of the continuous evolution of standards and new designs, the characteristics of elements included in this specification are subject to change without prior notice.

These characteristics, as well as material availability, are only valid if confirmed by Ormazabal’s Technical and Commercial Department.
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1. DESCRIPTION AND MAIN CHARACTERISTICS

The **PFS-48** by Ormazabal is an Underground Transformer Substation with indoor operation, designed in accordance with the EN 61330 standard, for use on public electrical networks of up to 36 kV, with the possibility of containing a transformer up to 1000 kVA.

![Overview of PFS-48 with horizontal ventilation](image)

**Figure 1.1:** Overview of PFS-48 with horizontal ventilation

1: MV Switchgear (CGMCOSMOS, CGM-CGC or CGM.3 systems)
2: Power Transformer
3: Low Voltage Board
4: Transformer Cover
5: Material Cover
6: Lifting Eyebolts*
7: Personnel Access Cover
8: Ventilation

* Supplied with PFS-48, but not inserted into the covers
There are two versions with different configurations:\(^1\):

- **PFS-48-H**, in which the ventilation grilles are located on a horizontal plane at level 0.
- **PFS-48-V**, in which the grilles are located in ventilation shafts.

### 1.1. MECHANICAL CHARACTERISTICS

The dimensions of the **PFS-48** range models, including one transformer of 1000 kVA, are as follows:

<table>
<thead>
<tr>
<th>Model</th>
<th>PFS-48</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. covers</td>
<td>1 cover</td>
</tr>
<tr>
<td>N. ventilations</td>
<td>2 grilles</td>
</tr>
</tbody>
</table>

### 2. TRANSPORT

The Transformer Substation is always transported on a low loader truck with a height below 1 m.

The route and the corresponding permits must be planned in advance, given the possible obstacles to the height (the total height of the Transformer Substation mounted on a truck varies between 3.80 m and 4.50 m)

### 2.1. ACCESS

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

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\(^1\) PFS-62 supports two punctual loads up to 4.5 T.
3. INSTALLATION

3.1. LOCATION

The site must be defined exactly, indicating the alignment and altitude at the reference points, level 0, the surrounding land, rainwater drainage (for horizontal ventilation) and the position of the access covers.

3.2. PLANNING

The available free spaces for placing the crane and the truck used for transport should be marked out using the site plan or sketch.

Special attention should be paid to siting the crane in a way that the hydraulic jacks supporting it are not too close to the excavation and cause the sides to cave in; they should be more than 3 m away from the hole.

Any object or circumstance which may impede or obstruct the smooth operation of the installation (posts, cables, ditches, walls, water or gas mains, drains or cable ducts etc.) should be noted by marking their positions on the plan.

3.3. PERSONNEL REQUIRED

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

3.4. PREPARING THE GROUND

3.4.1. Size of the Excavation\(^2\)

The size of the excavation varies in accordance with the ground.

We recommend that consideration be given to the minimum provisions for health and safety at construction work sites.

The following shall be taken into account:

- Before commencing the excavation, a preliminary study of the ground must be completed to check its stability and the possible existence of conduits.
- The accumulation of the excavated material and equipment next to the edge of the excavation shall be avoided and precautions shall be taken to prevent the walls from caving in or the aforementioned material and equipment from falling to the bottom.
- As a general rule, a 3 m area around the excavation shall be kept free of loads and vehicles traffic.
- When the excavation has 2 m or above, the edges shall be protected with a regulation barrier.
- In the event of rain and puddles, the excavation shall be thoroughly checked by a competent technician before carrying on the works. Water rising or falling into the excavation shall be immediately bailed out to preserve the stability of the walls.

\(^2\) See section 6.2. *Installation Plans*. 
There shall be at least one ladder for each work team. The ladder must reach at least 1 m above the edge of the excavation.

Machines driven by combustion engines that generate gases such as CO shall not be installed inside the excavation unless the equipment required to extract the gases is used.

Personnel working inside the excavation shall be duly trained and informed and wear a safety helmet and the protective clothing required for each specific risk.

The following table indicates the inclination the walls recommended according to the ground type:

<table>
<thead>
<tr>
<th>Ground type</th>
<th>Excavations on virgin ground or very old even embankments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard rock</td>
<td>Angle with horizontal 80º Slope 5/1</td>
</tr>
<tr>
<td>Soft or cracked rock</td>
<td>55º 7/5</td>
</tr>
<tr>
<td>Rocky or stony ground, rubble</td>
<td>45º 1/1</td>
</tr>
<tr>
<td>Strong soil (mixture of sand and clay) mixed with stone and decayed vegetable matter</td>
<td>45º 1/1</td>
</tr>
<tr>
<td>Recently excavated or recent embankments</td>
<td>35º 7/10</td>
</tr>
</tbody>
</table>

### 3.4.2. Concreting the Base

To guarantee a correctly levelled and reinforced base of PFS-48, together with the appropriate distribution of electrical earths, the base of the excavation must be concreted, in accordance with the attached plans[^3], with four ends left visible on the surface for the earth connection. The thickness of the concretes shall be 0.2 m (approximately 5 m³ of concrete).

The reinforcing mesh shall comprise a 100 x 100 mm mesh with 8 mm² cross-section iron rods.

Leave approximately 50 mm for filling with levelling sand and for seating.

### 3.5. LEVELLING PROCESS

For this operation and those of the above sections, the finish level 0 must be defined in advance.

The following tools shall be used:

- 1 bubble spirit level
- 1 square shovel
- 1 5-m ladder
- 8 levelling tools

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[^3]: See section 6.2. Installation Plans.

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**VERY IMPORTANT**

Incorrect levelling could cause the base of PFS-48 to break and let water in.
3.6. HANDLING

PFS-48 is provided with DEHA inserts for its correct handling with a lifting beam, slings and hooks to guarantee that the lifting operation is as balanced as possible.

For the transverse balancing, the lifting beam has a number of holes (numbered) at the end (this end shall be positioned on the side of the cover and LV output):

![Diagram of PFS-48 Lifting Process]

Figure 3.1: Correct coupling of the DEHA hooks

![Diagram of PFS-48 Lifting Process]

Figure 3.2: PFS-48 Lifting Process
3.7. ANCHORING AND BACKFILLING PROCESS

To guarantee the correct anchoring of PFS-48 to the ground (given that it floats if the excavation is filled with water, since it displaces more volume than its weight), the excavation must be backfilled up to the cable incoming at most after the installation and levelling process. It may be filled with gravel, sand, soil, or similar, or even with "weak" concrete (FCK of 140 kp/cm² or similar).

A maximum of 5 m³ (approximately 1 truck) shall be used, depending on the excavation.

3.8. RAINWATER DRAINAGE

For PFS-48 models with horizontal ventilation, a rainwater drainage system must be connected to the water outlets in the ventilation grilles.

The connection to the rainwater drainage system must be made while the Transformer Substation is being installed in the excavation.

The connection must prevent the water from returning to the Transformer Substation through the drainage system. If difficulties are encountered, we recommend the installation of the vertical solution, a water collecting pit or another alternative system.

In addition, the materials and dirt that accumulate at the bottom of the rainwater drains must be removed regularly.

3.9. EXTRACTION AND SEALING OF THE TRANSFORMER COVERS

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

1) The materials required to handle and re-seal the covers are included inside the Transformer Substation. These materials are eyebolts, Roundex rubber seal and Lanco sealant.

2) Remove the sealing joint and the rubber around the cover using a sharp tool (cutter, electrician's knife, etc.) to enable the removal of the cover.

3) Fit the eyebolts on the cover and remove it.

4) Check that the rubber seal for the cover is intact and complete. It is important that this is so, in order to guarantee that the Transformer Substation is watertight.

5) Install the transformer (anchoring, connections, etc.).

6) Once it has been installed, put the concrete cover back on making sure that it is correctly positioned on the rubber seal mentioned in point 4.

[4] Before carrying out this section, the earth ring must be made. See chapter 3.12. Earth Connection Network.
7) Insert the Roundex rubber seal supplied with **PFS-48** in the gap between the perimeter wall of the cover and the enclosure, pressing it down to the bottom of the gap to make it fit.

8) Use a spatula to close off the gap around the cover with Lanco sealant. Apply the sealant evenly, leaving as little porosity as possible in order to compact the rubber and the sealant to ensure that it is correctly adhered to the sides of the perimeter.

**3.10. CABLE ACCESS AND SEALING**

The equipment has holes for the incoming and outgoing of cables. These holes are supplied closed with MV feedthrough (3 accesses) and LV feedthrough (4 smaller diameter accesses). To seal the accesses correctly, proceed as follows:

a. Select the most appropriate cable incoming.

b. Cut the corresponding protuberances to the diameter of cable along the cutting line. Each protuberance has its diameter printed on it to make identification easier.

![Figure 3.3: View of the Cable Access and Sealing](image)
The following table shows the most common cable diameters with dry insulation:

<table>
<thead>
<tr>
<th>MV CABLES</th>
<th>MV CABLES</th>
<th>LV CABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/20 kV</td>
<td>18/30 kV</td>
<td>0,6/1 kV</td>
</tr>
<tr>
<td>Section [mm²]</td>
<td>∅ [mm]</td>
<td>∅ for cutting [mm]</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>150</td>
<td>32.5</td>
<td>35</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<p>| Section [mm²]        | ∅ [mm]               | ∅ for cutting [mm] |
| 400                  | 48.5                 | 45           |
| 240                  | 42.5                 | 40           |</p>
<table>
<thead>
<tr>
<th>150</th>
<th>37.5</th>
<th>35</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
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<tr>
<td>-</td>
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</tbody>
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<tr>
<th>Section [mm²]</th>
<th>∅ [mm]</th>
<th>∅ for cutting [mm]</th>
</tr>
</thead>
</table>

| -                    | -                    | -           |

| -                    | -                    | -           |

*50 mm² insulated earth cable recommended for the outlet.

3.11. PROTECTION CIRCUIT AND EARTH CONNECTION

PFS-48 is provided with an internal earthing circuit to allow the different elements to be connected to the external earthing circuit.

Inside the enclosure, there are two earth disconnection boxes corresponding to:

- Protection earthing circuit (metallic parts).
- Service earthing circuit (transformer zero-sequence earth).

3.11.1. Protection Earth Connection

The protection earthing circuit (metallic parts) includes the earth connection of the enclosure of the different pieces of electrical equipment (MV cubicles, LVB frame, transformer tank, MV cable screens) and other metal elements present in the installation.

The wire reinforcement of the enclosure is directly connected to the protection disconnection box.

**VERY IMPORTANT:**
Do not use polyurethane foam or any other kind of sealant.
3.11.2. Service Earth Connection

The service earthing circuit (zero-sequence) connects the LVB zero-sequence busbar to its disconnection box located inside the Transformer Substation. The protection earth connection and service earth connection can be made on site once the characteristics of the land and the operating conditions of the substation have been determined.

**VERY IMPORTANT:**
LVB zero-sequence bar is not connected to the protection earth connection bars (metallic parts).

In principle, the protection earthing circuit and the service earthing circuit are independent.

The Transformer Substation project must include the section on the earth connection (check standard project of the Utility), as well as the justification of its sizing.

The copper connector cross-section, the contact surface of terminals and tors must be suitable for a default current delimited by Network protections.

3.12. EARTH CONNECTION NETWORK

The use of following elements is recommended to implement the protection earthing electrode (metallic parts) in PFS-48:

- One **perimeter ring in the base of the excavation** at an approximate distance of 0.4 m from the Transformer Substation concrete enclosure perimeter. This perimeter ring must be connected to at least two points on the excavation base.
- Another **perimeter ring at a distance of 1 m** from the Transformer Substation perimeter at a **depth of 0.8 m** under level 0.

Both rings must be connected with each other with a bare copper wire and the assembly of these two rings is connected to the protection earth connection (in the corresponding disconnection box) of the underground TS.

It is recommended to use **bare copper wire of 50 mm²** cross-section to make the protection earthing circuit, including the electrode.
Figure 3.4 shows the diagram of the recommended external earthing circuit.

![Figure 3.4: Recommended external earthing circuit](image)

### 4. SEQUENCE OF OPERATIONS

#### 4.1. ACCESS TO THE TRANSFORMER SUBSTATION

PFS-48 is provided with a cast aluminum personnel access cover, which consists of:

1) One **aluminum cover** painted with black nonslip paint.

2) A second **cover**, called “**register**”, incorporated in the main cover, which hides and protects the locking. This assembly has the following elements:
2.1) One box with an auxiliary cover that includes a M16 screw in the register cover.

It is important to lock the register cover properly so that the assembly is watertight.

![Figure 4.2: Register Cover](image)

2.1) There are supports inside the box for different types of locking, such as padlocks and locks.

![Figure 4.3: Locking with padlock](image)  ![Figure 4.4: Locking with lock](image)  ![Figure 4.5: Locking with lock](image)

To access the Transformer Substation the steps below must be followed:

1) Open the cover by turning the screw shown in Figure 4.2 with an ORMAZABAL key supplied with the Transformer Substation.

2) Turn the register cover as in Figure 4.3 to enable the operation on the lock or padlock.

3) Open the lock following the instructions of the utility or local office where the Transformer Substation is to be installed.

4) The cover is provided with two pneumatic dampers that carry out the pushing to open it. This way, when the lock opens, the cover is pushed up and lifted at 75° with the protection mesh nearly in its right position.
5) Leave the side protection meshes correctly in place, by fitting them (as shown by arrows A), inserting the “U” shape hooks provided at the bottom of the meshes in the perimeter frame, as in points B marked in Figure 4.6.

6) Lift the cover or middle mesh by the points marked as “B” in Figure 4.7, pulling it in the direction indicated by arrows A until it stays vertical and placing the two anchors of the bottom mesh metal frame in points C marked in Figure 4.8.

7) To open the cover of the middle mesh, pull upwards until the hooks are released (View “D” Figure 4.9) and turn outwards on the hinge.
4.2. CONFIGURATION OF CABLES AND SLABS

Once inside the Transformer Substation, the floor where the operations on the MV switchgear and LV Board are carried out is made up of polyester slabs of different sizes placed on the enclosure’s floor.

The slabs need to be removed first in order to configure the MV and LV cables.

Figure 4.11 shows the recommended positioning of the cables, according to the PFS-48 electrical diagram:

Once the MV and LV cables have been positioned, the slabs need to be placed in its original position, according to the configuration shown in the figure 4.12:

- **CGMCOSMOS Electrical Equipment:**

![Figure 4.10: Polyester slab](image)

![Figure 4.11: Cable configuration in PFS-48](image)

![Figure 4.12: Configuration of slabs in PFS-48 with CGMCOSMOS cubicles (24 kV)](image)
### CGM-CGC/CGM.3 Electrical Equipment:

![Diagram of CGM-CGC/CGM.3 Electrical Equipment](image)

**Figura 4.13**: Configuration of slabs in PFS-48 with CGM-CGC/CGM.3 cubicles (36 kV)

### 4.3. COMMISSIONING[^5]

Once **PFS-48** has been placed at its work location, the incoming and outgoing connections are made on the MV feeder cubicle, together with the LV incoming lines.

Check that the MV voltage of the transformer is in accordance with the installation project. This is indicated on the transformer characteristics plate and in the test protocol.

### 5. MAINTENANCE

#### 5.1. CLEANING

Once **PFS-48** Transformer Substation has been installed, clean the entry cover groove.

Repeat this cleaning operation when dirt accumulates in the personnel access cover which may affect the watertightness of the Transformer Substation cover.

Clean **PFS-48** horizontal ventilation grilles regularly.

[^5]: Please consult the corresponding IG Ormazabal General Instructions document for the commissioning and operation of the various MV and LV functional units of the Transformer Substation.
6. ADDITIONAL INFORMATION

6.1. DIMENSIONAL PLANS

6.1.1. PFS-48-H

Figure 6.1: PFS-48-H plans

Sizes in millimetres
6.1.2. PFS-48-V

Figure 6.2: PFS-48-V Plans

Sizes in millimetres
6.2. INSTALLATION PLANS

6.2.1. PFS-48-H

**IMPORTANT!**
To prevent possible cave-ins into the pit, it must be filled in up to the cable incoming/outgoing level, as soon as possible.

1. As a requirement for the installation, the resistance of the Transformer Substation support ground must be greater than 1 kg/cm².

2. The base of the pit, must be covered with a reinforced concrete slab at least 200 mm thick, on which be an even layer of sand between 30 and 50 mm thick must be laid.

3. Four ends of the reinforcing mesh shall be left protruding from the concrete slab to connect to the earth bus.

4. Install the enclosure slightly above level 0.

5. For installations on sloping ground or with power lines, please consult Ormazabal’s Technical - Commercial Department.
6.2.2. PFS-48-V

1. As a requirement for the installation, the resistance of the Transformer Substation support ground must be greater than 1 kg/cm².

2. The base of the pit, must be covered with a reinforced concrete slab at least 200 mm thick, on which be an even layer of sand between 30 and 50 mm thick must be laid.

3. Four ends of the reinforcing mesh shall be left protruding from the concrete slab to connect to the earth bus.

4. Install the enclosure slightly above level 0.

5. For installations on sloping ground or with power lines, please consult Ormazabal’s Technical - Commercial Department.

**IMPORTANT!**
To prevent possible cave-ins into the pit, it must be filled in up to the cable incoming/outgoing level, as soon as possible.

Figure 6.4: PFS-48-V installation plans

Sizes in millimetres

A: Natural wall slope depending on the terrain

River sand
Concrete
8 mm 10x10 mesh

50
200

MV and LV cables
LV and Earth cables

MV Cables

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