



C2/115

**Homologation procedure for prefabricated enclosures of HV/LV
cabinets without HV switchgear but with a HV/LV transformer
and a LV switchboard
according to the technical prescription C2/112**

Part 3.3

Technical specification for homologation

(edition 1 - 05.2025)

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1 Object and scope

This technical specification defines the functional and technical characteristics that **concrete prefabricated** enclosures, containing only a HV/LV transformer and a LV switchgear connected to an electric high voltage substation (C2/115-1) or high voltage cabinet (C2/115-2), must meet to be homologated by Synergrid and included on the C2/115-0 list with homologated prefabricated enclosures.

The document is only applicable to non-walk-in enclosures (where service areas are located outside the enclosures).

Enclosures made of other materials than concrete are not in the scope of this document.

2 Reference documents

2.1 General provisions

The latest edition of the regulations, standards and technical specifications in paragraphs 2.2 and 2.3 below (non-exhaustive list), including any addenda, are intended as reference documents and will apply provided that they do not contradict the criteria set out in this specification. In the event of a contradiction, application of the part of the corresponding standard is superseded by the requirements of this specification (the rest of the standard remains fully applicable however).

2.2 Rules and regulations

Reference	Title
RGIE-AREI	Royal Decree of 28/10/2024 establishing the Book 1 on low voltage electrical installations and very low voltage, Book 2 on high voltage electrical installations and Book 3 on facilities for the transport and distribution of electrical energy, including all annexes.
Belgian Law of 4 August 1996	Well-being at Work Code
RGPT-ARAB-CODEX	(Règlement Général pour la Protection du Travail Algemeen Reglement voor de Arbeidsbescherming)
Code of Economic Law	Book IX: "Product and service safety"
Synergrid technical prescription C2/112 and its annexes	Technical prescriptions regarding connection to the high-voltage distribution network
Synergrid technical specifications C2/113-1/2/3/4/6/7	Procedure for the classification and homologation of HV switchgear
CR (EU) 2019/1783	Commission Regulation (EU) 2019/1783 of 1 October 2019 amending Regulation (EU) No 548/2014 on implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to small, medium and large power transformers

2.3 Standards

Where they exist and are set out, NBN, CENELEC, IEC and ISO standards apply.

If other test methods are used, the manufacturer must demonstrate their equivalence with the corresponding methods under the NBN, CENELEC, IEC and ISO standards.

2.3.1 Standards for electrical equipment used in electrical enclosures

Reference	Title
NBN EN 60364-4-41	Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock
NBN EN 61936-1	Power installations exceeding 1 kV a.c. - Part 1: Common rules
NBN EN 50110-1	Operation of electrical installations Part 1: General requirements
NBN EN 50110-2	Operation of electrical installations Part 2: National appendices
NBN EN 50588	Medium power transformers 50 Hz, with highest voltage for equipment not exceeding 36 kV Part 1: General requirements
NBN EN 60076-1	Power transformers – part 1: General
NBN EN 60076-7	Power transformers – part 7: Mineral oil immersed transformers
NBN EN 62271-202	High-voltage switchgear and controlgear – Part 202: High-voltage/low-voltage prefabricated substation
NBN EN 60050	International Electrotechnical Vocabulary

NBN/EN 61439-1	Low voltage switches and distribution boards
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2.3.2 Construction standards

Reference	Title
NBN EN 206 2014 +A1 2016	Concrete: Specification, performance, production and conformity
NBN B 15-001	Addendum to NBN EN 206 2014+A12016 – Cement – specifications, performance, production and conformity
NBN EN 13369	Common rules for precast concrete products
NBN EN 1990 and NBN ENV 1991	Eurocode 0 – Basis of structural design
NBN EN 1991 and NBN ENV 1991	Eurocode 1 - Actions on structures
NBN EN 1992 and NBN ENV 1992	Eurocode 2 - Design of concrete structures

2.3.3 Miscellaneous standards

Reference	Title
NBN EN 60529	Degrees of protection provided by enclosures (Code IP)
NBN EN 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
NBN EN ISO 12944-6	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Laboratory performance test methods
NBN EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods
NBN EN ISO 9001	Quality management systems. Requirements
NBN EN ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories

3 Definitions

3.1 General definition

All terms used in this specification are defined in NBN EN 60050 "International Electrotechnical Vocabulary"

3.2 Terminology used in this specification

Terms	Definitions
Enclosure	Part of a prefabricated housing or cabinet providing protection against external influences on the housing or the cabinet and a specified degree of protection for operators and the general public with respect to approach to, or contact with, live parts and against contact with moving parts.
Non-walk-in enclosure	A non-walk-in enclosure is an enclosure where the operator is not able to enter .
LV	Low Voltage
DSO	Distribution System Operator
DSU	Distribution System User
HV	High Voltage, i.e. High Voltage category 1 according to AREI/RGIE
LV Switchboard	Low Voltage Switchboard Energy distribution installation feeding a LV network

4 Normal and special service conditions

The enclosure must be designed and constructed in such a way that the service conditions inside shall correspond to the normal service conditions for an HV/LV transformer according to NBN/EN 60076-1 and indoor LV switchboard according to NBN/EN 61439-1.

- Min. temperature inside the enclosure : -5°C
- Measures must be taken to limit the influence of solar radiation on the indoor ambient temperature.
- The average relative humidity must not exceed 95% over a 24-hour period and 90% over a one-month period.

The enclosure shall be designed to withstand the normal service conditions for outdoor equipment according to NBN/EN 60076-1 and the NBN/EN 61439-1 as follows:

- Outdoor ambient air temperature must remain between -25°C and $+40^{\circ}\text{C}$, with a maximum average of $+35^{\circ}\text{C}$ covering a 24-hour period (taking into account rapid temperature variations).
- Solar radiation: maximum 1000 W/m^2 .
- No exposure to excessive vibrations, shocks or tilting.
- Maximum altitude: 1000 m.
- Ambient air is not significantly polluted by dust, smoke and/or corrosive gases, vapours or salt and would be considered as having site pollution severity class (SPS) "very light" according to IEC TS 60815-1:2008.

5 Rated characteristics

5.1 General rated characteristics

The justification of the building's resistance to various loads must be established in compliance with the aforementioned standards.

If, under the conditions described in chapter 4, condensation may occur, the enclosure must be designed in such a way as to prevent or reduce it as much as possible. Where condensation is unavoidable, its elimination must be guaranteed.

The structural safety, serviceability and durability of the entire construction must be guaranteed by compliance with standards NBN EN 206, NBN B 15-001, NBN EN 13369 and the Structural Eurocodes: the NBN series EN(V) 1990 to 1992.

In addition, for short-term stresses such as those mentioned above, it is also permissible to consider an increased factor of 1.3 in strength for reinforced concrete.

5.2 Degree of protection of enclosures

The degree of protection of the enclosure shall be in accordance with section 6.14 of NBN EN 62271-202 and C2/112. Therefore, the enclosure must be perfectly dry and waterproof and must remain so subsequently. The minimum degree of protection of the enclosure shall be IP23D in accordance with NBN EN 60529.

5.3 Protection of the prefabricated substation against mechanical stress

The protection against mechanical stress shall be in accordance with Eurocode 1 and C2/112. Additionally, section 6.101 of NBN EN 62271-202 applies. In addition to the actions defined in the Eurocodes, the building is designed to withstand the following specific occurrences:

- Roof load: minimal overload of 250 daN/m² on the roof (flat roof version to be taken into account for the calculation).
- Climatic loads as defined in Eurocode 1:
 - Minimum wind speed to be taken into account $v_b = 34$ m/s following NBN EN 62271-1
 - Minimum characteristic snow load to be taken into account $s_k = 1$ kN/m².
- Ice layer: maximum 20 mm.
- Ice density is 920 kg/m³.
- External mechanical impacts with an energy of 20 J corresponding to a degree of protection IK10 in accordance with NBN EN 62262.

5.4 Rated maximum power and class of enclosure

5.4.1 Rated maximum power of the prefabricated enclosure

There is no rated maximum power of the enclosure according to section 5.101.1 of NBN EN 62271-202.

The minimum load factor of the transformer to take in consideration is 70%.

Nevertheless, the manufacturer shall declare the maximum allowed power and losses of the transformer (as defined in NBN EN 60076-1, NBN EN 60076-7 or the CR (EU) 2019/1783) for which the enclosure is designed and check it according to subchapter 6.7 and 8.1.

5.4.2 Rated class of enclosure

There is no rated class of the enclosure according to NBN EN 62271-202.

Nevertheless, the enclosure class is mandatory and shall be checked according to subchapter 6.7 and 8.1.

5.5 Internal arc withstand

Not applicable due to the absence of HV switchgear.

6 Design and construction

6.1 General requirements

The degree of protection of the enclosure shall comply with subchapters 5.2 and 5.3

The external walls of the enclosure shall meet the requirements of subchapters 6.13 and 6.14

Rated class shall comply with subchapter 6.7

6.2 Fire behaviour

The prefabricated substation shall comply with the requirements regarding fire behaviour of NBN EN 62271-202 section 6.104.2, as well as the AREI/RGIE law.

The materials listed as non-flammable are:

- concrete,
- metal (steel, aluminium, etc.),
- plaster,
- glass fibre or rockwool.

The use of synthetic or other materials, (enclosure excluded) is subject to agreement and if allowed must comply with NBN EN 62271-202 section 6.104.2.3. The necessary test reports shall be added to the technical file of the prefabricated substation.

Please note that the provisions of the Royal Decree of 07/07/94 set out the basic standards for fire and explosion prevention and indicate the RF values of doors, openings and walls. This is the responsibility of the manufacturer. Precast concrete elements must comply with Eurocodes 1 and 2.

6.3 Thermal isolation and condensation

The thermal inertia and day-night thermal stability of the enclosure must avoid excessive humidity levels in the enclosure, as set out in chapter 4. In order to achieve these properties, some types of thin-walled constructions with poor thermal characteristics may require a combination of additional means such as thermal insulation, adequate ventilation, targeted heating and thermal regulation.

In addition, all precautions must be taken to prevent condensation and the ingress of water, snow or animals, particularly at the seals or connections between the various parts of the enclosure (cellar, walls, panels, ceiling, roof, etc.) and at cable embeddings (HV, LV and earthing cables).

6.4 Building materials

The building materials must have the required mechanical and electrical characteristics and their durability must be guaranteed, as mentioned in the legal provisions and standards in force.

Building materials must comply with the requirements of the standards mentioned in the section *Reference documents*. The application of alternative or equivalent standards can only be accepted if the manufacturer proves its equivalence, and with the explicit approval of Synergrid.

The building must be maintenance-free.

6.5 Concrete composition and treatment

6.5.1 General provisions

The walls, ceiling, possible floor slab, foundation slab and cellar must be made of reinforced concrete. All concrete surfaces must be smooth.

Tolerance for dimensions:

- ± 10 mm on the lengths, widths and connections of the construction's various concrete elements.
- ± 5 mm on wall, floor and ceiling thickness, ...
- ± 3 mm on the arrangement of the flush-mounted parts and holes.

Tolerance for the appearance of the different sides (walls) of the structure (both inside and outside the enclosure):

- Flatness: 5 mm tolerance with regard to the 2 m rule and 2 mm tolerance with regard to the 200 mm rule on flat surfaces.
- Texture:
 - The use of chamfered edges in the concrete moulds is optional. However, all edges and corners (including those of functional openings) must have a smooth finish and show no defects (i.e. gravel nest).
 - The surface area of a gravel nest is limited to 50 mm²/dm².
 - The presence of “sand streaks” is not acceptable.
 - The presence of “lime streaks” is not acceptable.
 - Hairline cracks must be limited in thickness to 0,1 mm.
 - A detachment of the top layer of the concrete walls is not acceptable.
 - Visible markings from spacers, reinforcement, rust, etc... are not acceptable.

Repairs on any enclosure surface are allowed provided that the surface is as flat as the adjacent non-repaired concrete.

6.5.2 Reinforcement

Reinforcement is carried out using reinforcements made of welded steel bars and/or mesh and/or reinforced fibres. Technical data sheets, certificates of conformity and certificate of origin must be provided.

Reinforcement of steels must be approved and identified (steels and reinforcements by markings and mesh by labels). Reinforced or prestressed concrete steels must comply with the properties defined in NBN EN 1992-1-1.

The electrical resistivity of the topcoat must be sufficient to meet the requirements for insulation resistance (see 6.14.2) of the building's outer walls and functional openings in relation to the earthing circuit.

When using reinforcing fibres, the dispersion of the needles constituting the reinforcement must be such that the homogeneity of the concrete is ensured.

The fittings must be designed to withstand the actions described in the section *Construction requirements*, without permanent damage to the enclosure.

Functional openings and related elements (covers, doors, ...) shall not make galvanic contact with the building's reinforcement in any place in case of an enclosure in a non-global earthing system.

6.5.3 Concrete composition

A concrete composition must be considered for optimal durability and protection against corrosion.

This can lead to a higher compressive strength of the concrete than that required for the design of the structure (NBN EN 1992-1-1).

The enclosure's duration of use shall be at least 50 years.

The minimum criteria required are:

- Resistance class: C30/37.
- Exposure class: EE3 XF1 in accordance with NBN EN 206 (Frost, contact with rain exterior walls exposed to rain, ...).
- Embedding (also applicable to holes and indentations in walls and floor slabs):
 - Pre-stressing steels for concrete exposed to external agents: 35 mm.
 - Pre-stressing passive fittings for concrete exposed to external agents: 25 mm.
 - Main concrete reinforcing bars and mesh not exposed to external agents: 25 mm.
 - Ancillary concrete reinforcing bars and anchors not exposed to external agents: 20 mm.

The above embedding conditions refer to Annex A of NBN EN 13369 (environmental condition E, high aggressiveness).

The consistency classes and grain size must be justified by the supplier according to the manufacturing conditions and must contribute to the achievement of the durability requirements.

6.6 Internal arc withstand - Overpressure effects

Not applicable due to absence of switchgear.

6.7 Rated class of the enclosure

The rated class of the enclosure shall be computed as required in subchapter 8.1

The rated class of the enclosure shall be determined depending on:

- The maximal power and losses of the transformer for which the enclosure is designed;
- The minimal rated class of the enclosure according to Annex D of NBN EN 62271-202:
 - Oil/winding maximum temperature rise: 60-65 K O/W
 - Average yearly ambient temperature: 10°C
 - Load factor of the transformer: 1

The enclosure class for the prefabricated substation is required to be 10 K or lower.

6.8 Functional openings

6.8.1 Doors

Doors are part of the enclosure and shall comply with the requirements as stated in NBN EN 62271-202, section 6.104.4 and in sub-chapter 6.13 and 6.14 of this document.

When closed, they shall provide the degree of protection as specified in sub-chapter 5.2 and 5.3 of this document.

The set door/frame shall be insensitive to the efforts to which the enclosure shall be submitted during its transportation (neither dis-adjustment, nor deformation).

The dimensions and relative arrangement of the doors shall allow easy operation and maintenance of the equipment inside the enclosure. Easy access to all interfaces of the installed equipment shall be guaranteed.

As doors potentially constitute a cold surface with very low thermal inertia, the risk of condensation on their internal surfaces must be taken into account (water drainage to be provided).

Doors shall always open to the outside and be equipped with a device able to maintain them in two open positions namely at an angle of at least 90° and at an angle of at least 160°.

On the outside they shall be fitted with a fixed handle and opened by means of a key lock.

Doors shall have closures with a minimum of two points.

Doors shall be designed so that no water infiltration is possible inside the enclosure with the door closed.

It must be possible to replace each door by a removable panel. In this case, the panel can be handled by two people which means that it has a maximum weight of 50kg in total.

6.8.2 Ventilation openings

Ventilation openings are part of the enclosure and shall comply with the requirements of NBN EN 62271-202 section 6.104.5 and in sub-chapter 6.13 and 6.14 of this document.

They shall also provide the degrees of protection as specified in sub-chapter 5.2 and 5.3 of this document.

Every enclosure is equipped with at least two ventilation openings according to the following instructions:

- One lower ventilation opening, placed at a lower level either in a wall or in the door, operating as an inlet of fresh air.
- One upper ventilation opening placed as high as possible in a wall, operating as extraction point of the warm air out of the substation.
- Both ventilations can be mounted in different walls or the same wall.
- Both ventilation openings shall be placed in the immediate vicinity of the location of the transformer , as to maximize the airflow over the transformer.

The size of the ventilation openings must meet the requirements for the heat dissipation of the substation linked to the maximum power of the transformer for which the substation is designed, in accordance with the requirements of subchapter 5.4 and 6.7 and verified by computation note in subchapter 8.1.

6.8.3 cable entries

The choice of the brand and type of cable entries used for the HV and LV cables will in most cases be made by the DSO and DSU.

Therefore, for the homologation of his enclosure, the manufacturer will only have to indicate for each wall the location, size, maximum number and the position of the cable entries for the HV and LV cables.

Regarding the position of the cable entries, the following requirements shall be taken into account:

- The distance between the HV cable entries and the transformer shall take into account the necessary space to respect the maximum bending radius of the HV cable. Typically the maximum cross section of the HV cable is 95 mm² with a bending radius of 480 mm.
- The distance between the LV cable entries and the LV switch board shall take into account the necessary space to respect the maximum bending radius of the LV cable (typically a 240 mm² Alu cable is used which has a bending radius of 665 mm. An indicative standard position for the HV and LV cable entries shall be included in the homologation file.

The manufacturer of the concrete enclosure is responsible for the incorporation of the cast part of the cable entries into the casted concrete enclosure. The adhesion of the concrete to the cable entry as to make the setup fully waterproof is the responsibility of the manufacturer.

The manufacturer of the enclosure shall also provide a waterproof entry of both ends of the earth loop inside the substation. Both ends shall be separated when entering the substation and shall be isolated from each other and from the surrounding concrete. The manufacturer shall include in his homologation application file which method/system he uses to achieve this.

6.8.4 Entry for cables of electric emergency generator/metering vehicle:

The enclosure shall be fitted with a cable entry to connect an emergency generator.

The cable entry for the emergency generator is part of the enclosure and shall comply with the requirements of sub-chapter 6.13 and 6.14 of this document.

In closed position, it shall provide the degrees of protection as specified in sub-chapter 5.2 and 5.3 of this document.

The free opening of the cable entry for the connection of an emergency generator shall have a minimum dimension of 200mm x 200mm and be either a square or a circle with an equivalent surface.

It shall only be opened from the inside.

It shall include no element that could damage the external insulation of the cables.

6.9 Volume of the enclosure

The volume of the enclosure must be designed to contain the maximum number of elements that the manufacturer wishes to be able to homologate its enclosure for, such as:

- Size of the area designated for the LV switchboard
- Power and size of transformer
- Possible LV measurement equipment
- Possible public lighting equipment

In any case, the enclosure must also take into account:

- The external footprint of the above-ground part (excluding any roof overhang) is limited to width x depth $\leq 2.25 \text{ m} \times 1.25 \text{ m}$
- The external height (above ground) is limited to 2 m.

6.10 Cellar

The cellar of the enclosure is considered to be its part below ground level.

It must be completely waterproof. Its watertightness, when required, must be guaranteed for at least 10 years by the supplier in the technical homologation file.

In case the cellar is made separately from the volume of the enclosure above ground level, the sealing between both parts must be guaranteed, and dispositions are made to prevent water ingress in the cellar.

The manufacturer describes the means used to guarantee the tightness of the cellar and to avoid infiltration or penetration of outside water (tight materials used, origin and possible path followed by the water, type and nature of barriers set-up to interrupt this path).

The size of the cellar shall be designed to contain the maximum number of elements that the manufacturer wishes to be able to homologate its enclosure for, such as:

- Cable entries and their position.
- Oil leak collector shall be provided and placed following section 6.102 of NBN EN 62271-202 and following AREI/RGIE 4.3.3.7 paragraph b of book 2 or book 3.

The oil leak collector shall always remain free and available in the event of an oil leak. No water infiltration is permitted in the oil collector. In order to guarantee the sealing of the tank, it should preferably consist of a single part; if this tank is composed of joined elements, the seals must be water- and oil-tight. No cables are permitted to pass through this tank or its walls.

There is no prescribed minimum depth for the cellar. However, the cellar is designed to allow for cables to pass through while respecting their bending radius.

The wall with the cable entries can be inclined to respect the bending radius of the cables.

6.11 Floor slab

- The floor slab (if present) is designed to withstand the maximum mobile load and the internal arc overpressure for which the manufacturer wants to homologate its enclosure. In most cases the load to be taken into consideration will be the weight of the biggest transformer for which the manufacturer wants to homologate its enclosure. The slab may lift-up in case of an internal arc but shall mandatorily fall back into its normal position without damage to the floor slab itself or the equipment.
- The floor is plain, slip-resistant, and free of any barrier or irregularity that could make an operator stumble and fall. The metallic rails anchored in the slab for fixation of the equipment may not exceed the level of the floor slab.

6.11.1 Floor slab's functional openings and characteristics

The number and the size of the floor slab functional openings is directly linked to the equipment which has to be installed in the enclosure:

- Opening for the LV cables under LV switchboard as well as for public lightning when applicable
- Opening(s) by the transformer for the HV cables.
- Opening under the transformer (not mandatory) for the collection of oil in case of an oil leak of the transformer.
- A guiding slope to the opening under/behind the transformer for the collection of the oil in case of an oil leak.
- Opening for Telecom cables when applicable
- Opening for the earthing conductor

6.12 Roof

The roof shall be completely waterproof. Its watertightness must be guaranteed for at least 10 years by the supplier in the technical homologation file.

The roof is preferably monobloc (in one piece).

It shall be able to withstand an overload of 250 daN/m².

The roof can be free or attached to the walls.

The roof shall be designed to avoid cracking/breaking even when it is lifted. The roof shall be independent (separate part) and removable from the walls. Instructions for disassembly, removal and re-assembly shall be provided in the technical homologation file. It shall be easy to remove. The lifting system shall be a standard and compliant system available on the market.

The roof shall have an overhang (not exceeding 100 mm) and be equipped with a drip course (a "drip breaker" device) to interrupt the flow of water and to prevent it from flowing along the walls.

The roof shall always be flat and shall have an inclination of at least 2 cm/m (2%). This inclination must be visible on the drawing.

6.13 Resistance to ageing and corrosion

6.13.1 Enclosure

Since the enclosure is usually intended to be installed outdoors, it is subjected to the environmental/climatic conditions listed in chapter 4. The enclosure shall therefore withstand climatic deterioration during its lifetime and comply with the requirements regarding corrosion of NBN EN 62271-202 section 6.104.3. The expected lifetime of an enclosure shall be at least 50 years.

6.13.2 Functional openings

The functional openings (doors, ventilation and cable ducts) and their frames shall be realized in solid, non-alterable, corrosion resistant material. They shall be protected against corrosion by a system suitable for climatic conditions corresponding to (for steel) or equivalent with (for other materials) the C4 High code in accordance with NBN EN ISO 12944-2 during their lifetime. They shall not require maintenance, except for rotating or movable parts – in case maintenance is necessary for those parts, the minimum time interval between two maintenance sessions will be at least ten years.

This system shall be designed so that deteriorations can be fixed without the application of special measures. It shall also permit the application and the adherence of a paint coating (powder coating when applicable) of any RAL type.

The manufacturer shall describe the process (including preliminary treatments) and the different types of products used (compliant with the RoHS directive)-

For functional steel openings:

- These shall be hot-dip galvanised and powder coated. in accordance with NBN EN ISO 1461.

For functional aluminium openings:

- Aluminium elements shall be painted or anodised.
- If applicable, anodizing shall be realized in accordance with Qualanod's (Quality Label for Anodic Oxide Coatings on Wrought Aluminium for Architectural Purposes) comparable specifications.
- Where applicable, the application of a paint coating shall be in accordance with the comparable Qualicoat specifications (Quality Label for Coating on Metal for Architectural Applications).

Other corrosion protection solutions may be submitted to Synergrid for approval. Where applicable, their equivalence shall be demonstrated.

6.13.3 Door and door frame:

Whichever the protection method, a painted version shall be proposed.

An unpainted version can also be proposed as an alternative (except in the case of hot-dip galvanised steel).

6.13.4 Frame, rails, screws and other fastening elements.

Any frames, rails, screws and other fasteners shall be protected against corrosion by a system suitable for climatic conditions corresponding to code C4 High in accordance with NBN EN ISO 12944-2.

Steel parts are anodised and powder coated in accordance with the NBN EN ISO 1461.:

Aluminium elements shall be painted or anodised. The requirements are the same as those mentioned above for functional openings.

Other corrosion protection solutions may be submitted to Synergrid for approval. Where applicable, their equivalence must be demonstrated.

6.14 Earthing and equipotential connections

6.14.1 General provisions

The earthing equipment must be in accordance with chapter 14 of the C2/112, the NBN EN 62271-202 section 6.3 and with the AREI/RGIE book 2 – sections 4.2.3.2 & 5.4 or book 3 – sections 4.2.5.2 & 5.5.

In case of a non-global earthing system the conductive elements that can be reached from outside the enclosure such as door(s), ventilation openings, cable entry for electric emergency generator /measuring vehicle are excluded from the interconnected earthing and shall be insulated from the concrete enclosure.

An indication of the position of the general earthing disconnecter shall be indicated on the drawing(s) (see 6.16).

6.14.2 Insulation level of the external walls of the enclosure in a non-global earthing system

In the event of an electrical fault, the contact voltage for a person outside the enclosure touching its walls (including functional openings) may not exceed the values prescribed in the relevant section of the AREI/RGIE.

For this reason, the enclosure's outer coating (including the finishing coatings) shall be insulated from the earthing circuit. 'Outer enclosure' is defined as follows:

- the walls (including their buried part).
- the functional openings and their covers.
- the roof.

The level of insulation required between the outer surface of this enclosure and the earthing circuit for non-global earthing is: no disruptive discharges at 3000 VAC for 1 minute.

In addition,

- The walls (including the buried part below the ground level), ceiling and roof of the buildings must be made of materials that have a sufficient electrical insulation capacity.
- Non-insulating material, especially metallic materials, are not permitted except for the closing of functional openings (which cannot be connected to the earthing circuit).

6.15 Nameplates

In accordance with section 6.11 of NBN EN 62271-202, each prefabricated substation shall be provided with a durable and clearly legible nameplate, which shall contain at least the following information:

- Manufacturer's name or trade-mark;
- Type designation;
- Max. power rating and max weight of the transformer;
- Serial number of the enclosure;
- Reference of C2/115 homologation (homologation number);
- Year and month of manufacturing.
- Space for a optional code (e.g.QR-code).

The nameplate shall be placed close to the door, inside the enclosure and shall remain legible for the whole lifetime of the enclosure.

An (design) example of this nameplate is given for approval in the homologation procedure.

6.16 Drawing and arrangement of enclosure

Drawings with the arrangement of the equipment inside the enclosure, indicating the provided space (dimensions) of the following equipment:

- the max size of the transformer,
- space for feeders for the LV switchboard,
- space for the metering panel
- space allowing the possibility to place a remote-control cabinet/smart grid equipment
- space for possible LV measurement equipment
- Space for possible public lighting equipment
- The min required dimensions of the escape path and of the free service areas around every equipment depending on the type of enclosure (walk-in / non-walk-in) should be indicated.

Drawings with the arrangement and dimension of each cover, openings (included cable entries) shall be also submitted.

Drawings with outside and inside dimensions and position of each element which has been described in this specification.

All drawings must be submitted in pdf-format, and also be available on request in dwg-format.

7 Type test reports

7.1 General provisions

In order to perform the homologation assessment of the prefabricated enclosure:

- For § 7.2 to § 7.4: only test reports from an accredited laboratory following ISO 17025 are taken into consideration.
- For § 7.5: only test report from an independent laboratory designated by the manufacturer and accepted by Synergrid are taken into consideration.

7.2 Corrosion resistance for the enclosure's metallic elements (and their frames)

The manufacturer proves in his technical file that he takes sufficient measures to prevent ageing and corrosion. To this end, he provides Synergrid with the following documents:

- Qualicoat certification of the manufacturer responsible for the supply of metal or aluminium components of the cabin.
- Qualanod certification of the manufacturer responsible for the supply of metal or aluminium components of the cabin.
- Attestation/statement from the manufacturer responsible for the delivery of the steel parts that this galvanisation is done in accordance with NBN EN ISO 1461.
- Attestation/statement demonstrating conformity with the RoHS directive.

The manufacturer must provide a description of the process (including preliminary treatments). The manufacturer specifies the different types of products used in accordance with the RoHS directive (leaded or chrome-plated components are prohibited).

7.3 Verification of degree of protection (IP-x-code)

The verification of the degree of protection of the prefabricated substation is done in accordance with NBN EN 62271-202 section 7.7.

The protection level IP 23D shall be verified and proved for all ventilation openings.

7.4 Mechanical impact test (IK-code)

A mechanical impact test according to NBN EN 62271-202 section 7.101.3 shall be performed on all external places of the enclosure (doors, covers, ventilation, hinges,...) to verify the IK10 degree of protection.

The test must be performed on at least the following parts of the enclosure:

- Door(s)
- Ventilation openings
- Hinges of the doors
- Entry for cables of electric emergency generator/metering vehicle

In order to pass the test, the criteria as mentioned in NBN EN 62271-202 shall be met. Superficial deterioration/damage is allowed under the conditions as described in the standard.

7.5 Verification of insulation resistance of the building's exterior walls and functional openings for use in a non-global earthing system

An insulation test shall be performed in order to assess compliancy with subchapter 6.14.2.

Details of the test procedure and test report can be found in subchapter 9.2.

8 Computed simulation - calculation notes

Calculation notes shall be introduced in order to obtain product homologation.

They shall be carried out according to the latest edition of the specifications and reference standards in this specification by an architect or engineering bureau specialized in stability, static and/or dynamic loads computations.

8.1 Computed simulation related to the temperature class

The rated class of the enclosure shall be verified according to the test procedure described in NBN EN 62271-202.

Computing conditions:

- The enclosure shall be equipped with a transformer corresponding to the rated maximum power of the prefabricated substation as defined in section 5.4.1
- All other losses (LV panel, cable connections,...) are simulated at the location of the LV panel.
- To simulate the power losses of the LV panel, cable connections, etc.... a heat source must be used. The thermal power of the heat source shall depend on the rated maximum power of the transformer that can be placed inside the prefabricated substation. The table below shows the corresponding thermal power of the heat source in relation to transformer power rating:
 - Max. 200 kVA: 150 W
 - Max. 400 kVA: 350 W

The result of the calculation will be used as the thermal power rating for the heat source. The calculation of the thermal power is added to the calculation note.

- The calculation will take into account the heat dissipation through ventilation and through transmission heat losses through walls, ceiling and floor.
- Solar irradiation of the roof or walls must not be taken into account.
- The calculation will be performed with a load factor of the transformer equal to 1 as defined in subchapter 6.7.
- The ambient temperature (outside) is fixed at 10°C as defined in subchapter 6.7. Additionally the calculation must be performed with an ambient temperature of 30°C.

The calculation note must clearly state the following information:

- The construction parameters of the enclosure (length, width, height and internal volume), thickness of the floor, ceiling and walls and their respective thermal conductivity (W/mK).
- The construction parameters of the door (length, width, height and thickness) and its thermal conductivity (W/mK).
- The construction parameters of the ventilation openings (width and height) and their aerodynamic resistance. And this for both the lower and higher ventilation openings.
- The height difference (centre to centre) of the ventilation openings.
- The rated maximum power, the heat losses (load and no load losses) and load factor of the transformer.
- Maximum power of the additional heat source of the transformer.
- The total internal heat developed in the prefabricated enclosure (transformer losses and heat source).
- Distribution in percentages of the heat dissipation between the ventilation and the transmission heat losses.
- The expected temperature rise inside the substation in regards to the outside ambient temperature (K or °C).
- The calculation note must also clearly state if the rated class of the enclosure (10K) has been achieved or not.

In case the calculation note indicates that the 10K class is not achieved for the enclosure for a load factor of 1 for the transformer, then the calculation note must indicate the maximal loading factor of the transformer such that the 10K class is achieved.

Additionally the manufacturer must state which modifications to the heat dissipation are necessary in order for the transformer to have a loading factor of 1 while still guaranteeing the 10K class for the enclosure. The manufacturer must provide the necessary calculation notes to validate this. In case the manufacturer suggests using bigger ventilation openings, the manufacturers must also provide the necessary calculation notes as mentioned in subchapter 8.2.

8.2 Calculation notes – mechanical and pressure resistance of the enclosure

The entire construction (walls, cellar, roof, or a floor slab if present, etc.) must be able to withstand the maximum stresses as defined in subchapter 5.3.

At least the following calculations notes according to the Eurocode must be present:

- Verification of the wind pressure withstand strength of the prefabricated substation
- Verification of the roof loads withstand strength of the prefabricated substation
- Verification of the snow loads withstand strength of the prefabricated substation
- Verification of the floor loads withstand strength of the prefabricated substation

9 Annexes

9.1 **Annex A: conformity assessment guide (checklist)**

See [conformity assessment guide C2/115-3 xlsx file](#).

The technical file shall be composed of the following documents:

A. **The C2/115-3 xlsx checklist**, completely filled in:

1. Sheet 1: Manufacturer's declaration about the correctness of all the provided information in the technical file.
2. Sheet 2: list of prefabricated enclosures. The information filled in here will be copied into the list C2/115-0 in case a homologation is obtained.
3. Sheet 3: technical file checklist, based on this technical prescription. If the characteristics are different for an enclosure or a series of enclosures listed in sheet 2, the manufacturer shall make as many copies of sheet 3 within the same xlsx-checklist as necessary.
4. Sheet 4: Numbered list of proofs of conformity.

B. **The necessary accompanying documents**, as listed and numbered in sheet 4 of the checklist:

certificates / test reports, plans, technical datasheets, certificates of origin, ... The filename of each document must start with the reference number given by the manufacturer in sheet 4 of the xlsx checklist.

Where the checklist indicates that the necessary proof of conformity is a declaration, completion of the requested information is considered to be a declaration on honor by the manufacturer, and confirmed by the information provided on the first sheet of the checklist. No separate document stating a manufacturer's declaration is necessary.

A signed and dated pdf-file for publication purposes shall be provided by the manufacturer after approval of the technical file by Synergrid. This pdf-file shall contain sheet 1 and sheet 2 of the xlsx-checklist.

9.2 Annex B: Insulation tests of the building's exterior walls

This test is only needed for enclosures in a non-global earthing system.

9.2.1 Measuring electrode

The wet electrode consists of a 250 mm square metal plate and a wet and wrung-out hydrophilic paper or cloth approximately 270 mm square which is placed between the plate and the area to be tested, as stipulated in IEC 60364-6. The conductivity value of the water used to humidify the electrode cloth is comprised between 100 and 150 $\mu\text{S}/\text{cm}$ as defined in NBN EN 62271-304 for classes 3 and 4.

During the measurements, a force of approximately 250 N is applied to the contact surface between the electrode and the enclosure.

9.2.2 Test method

Resistance measurement

Measurements of insulation resistance and dielectric strength are made on a finished structure ready for shipment.

Concrete walls: Measurements are made between the measuring electrode (described above) and the general grounding strip, with all grounding connections completed (metal reinforcement of walls, equipment, etc.).

Functional openings: Measurements are made between each functional opening and the general grounding strip, with all grounding connections completed (metal reinforcement of walls, equipment, etc.).

Measurement locations:

Concrete walls: Measurements are made at the most unfavourable locations, i.e., those with the minimum isolation distances between the measuring electrode and the metal masses. At least one measurement is made on each wall. If the walls have different properties (e.g., coating, concrete thickness), measurements are made on least at 3 different locations on each touchable side.

Functional openings: Measurements are made on each functional opening. If the opening is made up of several parts (e.g., door and frame), a measurement is made on each part.

9.2.3 Criteria for successful completion of the type test

Insulation resistance

The insulation resistance measured after 1 minute must be at least 100 k Ω for a voltage applied to the walls or functional openings of at least 3000 VAC.

Dielectric strength

The dielectric strength test is passed if no disruptive discharge occurs during the application of 3000 VAC for 1 min for each test surface.