

Electricity Specification 352

Issue 10 February 2022

Design of Distribution Substations and Transforming Points



Amendment Summary

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1 Introduction

This Electricity Specification provides information on various aspects of the approved designs for distribution substations and transforming points operated by Electricity North West Limited, hereinafter referred to as Electricity North West.

This document, together with Code of Practice 352, replaces Code of Practice 334.

Where a distribution substation or transforming point exists on the same site as a 132kV or primary substation, the provisions of Code of Practice 351 & 356 shall be taken into account.

All Independent Connection Providers (ICP) must comply with this policy wherever the asset is adopted by Electricity North West. Independent Distribution Network Operators (IDNO) substations shall also comply with this policy for the interface connection with Electricity North West.

2 Scope

The requirements stated in this document relate to 11 or 6.6kV to lower voltage distribution substations and transforming points for both single customer and general network connections.

The types of substation and transforming points covered are as follows:

- (a) Padmount substation.
- (b) Unit substation.
- (c) Compact substation.
- (d) Indoor substation. Brick or GRP
- (e) Compound substation.
- (f) Pole mounted transformer.

3 Definitions

The following abbreviations are used for Electricity North West documents.

EPD	Electricity Policy Document
CP	Code of Practice
ES	Electricity Specification
Substations & Transformers	The Electricity Safety, Quality and Continuity Regulations (ESQCR) define a substation as follows:

	<p><i>“substation” means any premises or enclosed part thereof which contain apparatus for either transforming or converting energy to or from high voltage (other than transforming or converting solely for the operation of switching devices or instruments) or for switching, controlling or regulating the energy at high voltage but does not include equipment mounted on a support to any overhead line;</i></p> <p>This ES distinguishes between ‘transformers’ and ‘substations’ based on the above definition. Compact and Pad Mounted Transformers, therefore, fall within this definition of “substation.”</p>
Substation	As defined in the Electricity Safety, Quality and Continuity Regulations 2002
Standard Indoor Substation	A Ground Mounted Transformer with individual 11/6.6kV Switchgear and LV Fuse Board all enclosed within a brick building.
Pad Mounted Substation	Ground Mounted Transformer with Integral 11/6.6kV ‘Off Load’ Isolation and 11/6.6kV and LV fuses, enclosed in one cabinet. The design is NOT enclosed by a fence, GRP or other housing.
Compact Substation	Ground Mounted Transformer with Integral 11/6.6kV ‘On Load’ Isolation and 11/6.6kV and LV fuses, enclosed in one cabinet. The design is NOT enclosed by a fence, GRP or other housing.
Unit Substation	A Ground Mounted Transformer with attached 11/6.6kV Switchgear and LV Fuse Board all enclosed within a GRP housing, building or perimeter fence.
Compound Substation	A Ground Mounted Transformer with individual 11/6.6kV Switchgear and LV Fuse Board all enclosed within a perimeter fence.
Primary Substation	33kV/11kV or 33kV/6.6kV substation with all the equipment enclosed within a building or perimeter fence.
Totem Pole Transformer	A pole mounted transformer that is supplied via an 11/6.6kV cable and not connected to any overhead conductors. (The support to a Totem Pole Transformer should be regarded in every respect as being a support to an overhead line.)
Engineer	The engineer or other representatives of the Company responsible for the installation, testing and commissioning of the equipment.
Company	Formally known as Electricity North West Limited.

NOTE: In the above Definitions, the term “LV Fuse Board” includes open type LV fuse boards, free standing LV fuse cabinets and transformer mounted LV fuse cabinets.

4 Regulatory and Other Reporting Requirements

The following Regulations and their enforcing Acts are applicable to substation and transformer installation design and Construction.

4.1 Main External Regulations, Acts of Parliament, etc

- Health and Safety at Work Etc Act, 1974
- Electricity at Work Regulations 1989
- Construction (Design and Management) Regulations 2015
- Electricity Act, 1989:
- Electricity Safety, Quality and Continuity Regulations, 2002
(See EPD101 for application in Electricity North West)

4.2 Local Authority Planning

- Town and Country Planning Act, 1990
- Town and Country Planning (General Permitted Development) Order, 2015
- RRFSSO – Regulatory Reform (Fire Safety) Order 2005

4.3 Relevant Regulations under the Following Acts

- Control of Pollution (Oil Storage) (England) Regulations 2001
- Environmental Act, 1995 (for matters relating to site contamination)
- Water Resources Act, 1991 (for matters relating to rivers, lakes etc)
- Water Industry Act, 1991 (for matters relating to discharges into sewers etc)

5 Requirements

5.1 Substation Siting

All ground mounted plant, both for Electricity North West and customer supplies, shall be situated indoors in either an approved Glass Reinforced Plastic (GRP) housing or free standing building.

If this cannot be achieved due to site or planning restrictions, the substation or transforming point may be located in part of a larger building or, in exceptional circumstances, as an outdoor installation. In both instances, the substation designer shall produce a justification.

Distribution substations or transforming points forming part of an otherwise occupied building are defined as:

- Substations forming part of a building accessible to the public, eg flats, shops, offices, or places of entertainment;

- Substations in industrial premises.

In these situations, every effort shall be made to secure space at ground level on the outside wall with access only from the outside. Reference shall also be made to [Section 11](#) (Fire Risk).

The substation shall be

- (a) Sited so that no other fences need be erected to determine site ownership.
- (b) Compatible with the local surrounding area.
- (c) Sited in such a way that will permit Electricity North West 24 hours, 7 days per week, unrestricted access, without having to obtain keys or codes to locking arrangements not owned wholly by Electricity North West.
- (d) Sited as near to the edge of the curtilage as practicable.
- (e) Sited in such a way that the doors, when open, do not protrude into the public highway, public footpaths, or other public areas.
- (f) Sited in such a way that it shall never be on top of or over any utility service.

When deciding on the location for a substation consideration shall be given to the risk of flooding based on site location within a known flood plain, historical data or the Environmental Agency Flood Maps. All new substations shall be checked against these sources to confirm the flooding risk. Where a proposed substation site is situated in a flood plain or has the potential to flood as per the Environment Agency's Flood Maps, the policy requirements of EPD355 shall be applied.

When deciding on the location for a substation a security risk assessment shall be completed in accordance with CP998. Additional security measures such as Centre for the Protection of National Infrastructure (CPNI) rated GRP enclosures, Security Doors, Copper Tape Pinning may be required.

5.2 Rural Areas

In low load density rural areas, pole mounted transformers may be used as may the Compact and Padmount type assemblies. These are all designed to be installed without the need of fences. Where a ground mounted substation or transforming point is required and where the risk of interference, damage to fences and the dumping of rubbish is assessed as low and no other option is available, then a unit type assembly surrounded by a fence (conforming to the appropriate Electricity North West standard drawing listed in [Appendix D](#)) may be used.

5.3 Substation and Transforming Point Plant

The plant used in the construction of a substation or transforming point shall be of a type approved by the Electricity North West Plant Policy Manager and shall comply with the appropriate Electricity North West Electricity Specifications. A list of Electricity North West approved plant is contained in EPD307.

The Engineer shall undertake certain plant preparation procedures and checks necessary to ensure satisfactory and compliant assembly. The plant assembly pre-commissioning requirements prior to installation for Electricity North West are set out in ES320.

5.4 General Arrangement Drawings

General Arrangement (GA) drawings are listed in [Appendix D](#). The listed drawing numbers do not contain the version number as they are continually updated. The latest versions are held in the electronic library along with a document containing a list of the current version numbers called ES352 Approved Drawing Numbers and are available on request from the Electricity North West Civil Policy Manager.

The requirements of the drawings and associated specifications shall be taken as a minimum standard and any derogation would require the approval of the Electricity North West Civil Policy Manager on an individual basis.

5.5 Recording of Plant and Site Information

It is the Engineer's responsibility to ensure that all equipment is recorded on the Ellipse work and asset management system prior to commissioning.

The Engineer shall undertake certain pre-commissioning procedures and checks necessary to ensure satisfactory and compliant connection. The pre-commissioning requirements for Electricity North West are set out in ES220.

6 Risk Assessments

Each site should be Risk Assessed in line with EPD 301, EPD 355, EPD 356 prior to being approved for use by Electricity North West.

7 External Works

The following paragraphs contain general information on the siting of distribution substations and transforming points.

7.1 Site

Every effort shall be made to minimise cost by:

- (a) Avoiding purchase of excessive ground area.
- (b) Letting or selling off unused area.
- (c) Selecting a surface treatment to minimise overall cost including maintenance (after due regard to covenants and drainage).
- (d) Avoiding vegetation. When covenants require such, slow growing, shallow rooted shrubs shall be selected in preference to grass, plants, or hedges that would require more frequent maintenance.
- (e) Positioning to minimise cable length.

The site area shall provide for the envisaged installed plant, shall provide access for the delivery and removal of the largest indivisible item of plant or an entire unit substation and access for the ultimate number and size of cables. Easements shall be negotiated at an early stage to cover the foreseeable requirements.

Electricity North West Estates & Wayleaves shall be consulted at the earliest possible stage regarding purchase or lease, or any easement or wayleave. Formal instructions shall be given to Estates & Wayleaves to legally acquire the site on the best possible terms. Plans showing the site area, rights of access and easements or wayleaves required (if any) shall accompany the formal instructions. The site legal processes shall be completed before any site work is commenced.

7.2 Roadways

Sites shall be chosen to avoid or at least to minimise the need for Electricity North West maintained roadways.

Driveways shall normally be used for cable access, plant delivery and maintenance vehicle access. No detailed design is offered since it is necessary to take into account local variations of ground and of covenants, but in general:

- (a) Cables shall preferably be laid down the centre to avoid disturbing ground that will be load bearing.
- (b) Wheel tracks shall be consolidated with well-rammed granular fill, e.g. DTP Type 1 or 2.
- (c) The surface shall be treated with an approved persistent weed killer (having due regard to the risk to adjacent property and Electricity North Wests' Environmental policy), blinded with ash or crushed stone and rolled to near level with due regard to surface water drainage.

7.3 Fencing

Fencing, where used, shall be provided to the greater of the minimum requirements to satisfy all the following conditions

- (a) The requirements of covenants or planning authorities.
- (b) The assessed risk of vandalism or child trespass risk (for definition of trespass risk, reference shall be made to Appendix A of EPD301).

The preferred fence shall be a galvanised steel palisade fence to BS 1722 General Purpose quality no less than 1.85m high. Fencing specification is detailed in [Appendix D](#) drawing number 900350-022. Where the planning authority insists on screening, the alternative of a full enclosure shall be considered. An outdoor substation with a screen fence shall have see-through gates facing the public view.

Where the fence is required to act only as boundary demarcation then a 1.35m high palisade fence can be used. For any other use approval shall be sought from the Electricity North West Civil Policy Manager.

Gates shall be sited in the optimum position for operational safety, eg opening outwards to provide emergency egress. A section of fence may be removed, if necessary, for the rare event of plant delivery. Open gates shall not obstruct public footpaths or emergency exits.

7.4 Drainage

Rainwater drainage from a substation roof shall be led to a local surface water drainage system or soakaway. The outdoor area of a substation shall be covered with limestone chippings and the levels shall take due regard of surface water drainage. No other provision shall be made except where necessary to avoid standing water or nuisance to adjoining property, or to comply with any covenants.

7.5 Plant Movement Provision

Substations shall have access so as to facilitate the future replacement of assets which in the case of a unit type substation involves the changing of a complete plant unit rather than carrying out dismantlement and re-erection on site. The minimum requirement would be for access by flatbed lorry with HIAB.

In situations where there are cable connections between the High Voltage switchgear, the transformer and LV fusegear, it shall be possible to change any item of plant without hazard and without disturbing any other major item of plant. It is acceptable to have to temporarily remove a transformer to change high voltage switchgear. It is important that the LV fusegear (with safety screening) can be retained in service to maintain parallel supplies while other work proceeds.

7.6 Surface Treatment

The site area shall be treated to minimise the lifetime cost including maintenance (see also [Sections 7.1](#) and [7.4](#)). This shall include the consideration of the use of chippings, flags or surface screed. The finished surface shall be at the correct level as it can be very difficult to open doors if chippings or tarmac are too high. The preferred surface treatment to be 75mm thick limestone chippings on heavy duty weed membrane such as GROUNDTEX. Subsurface to be treated with pre emergence weed killer in accordance with manufacturer's recommendation.

7.7 Unarmoured Cable

Unless indoors or within a substation fence, all unarmoured cables above ground shall be enclosed within dedicated steel trunking. If the cable is not of the type with an earthed metallic sheath, this trunking shall be of earthed metallic construction.

8 Substation Enclosures

8.1 General

This section provides details which shall be considered when designing a building for a specific site and is borne in mind during negotiations for a substation in a customer's premises.

Apart from providing a weatherproof housing, the building shall withstand an internal arc explosion (albeit with venting through the roof space) and contain an oil fire for a minimum time of one hour. The layout shall provide for easy and rapid escape from such an incident. See [Section 12](#).

The volume inside the enclosure shall be such that no additional measures are required to meet manufacturer's requirements for compliance with internal arc test performance (the minimum dimensions for venting space are available in manufacturers' literature and in [Appendix C](#)).

Where the enclosure for a distribution substation or transforming point is to be within an otherwise occupied building, every effort shall be made to secure substation accommodation at ground level on an outside wall with access only from outside. Where a suspended floor exists, special consideration shall be given to issues such as cable access and supports and the suitability of the floor construction to bear the weight of the installed plant. Reference shall also be made to [Section 11](#) (Fire Risk).

Where a new distribution substation or transforming point is to be installed within the site of a 132kV or primary substation, overall technical arrangements shall be agreed with the Electricity North West System Operations Manager before detailed designs are prepared.

On completion of cable work, cable trenches shall be filled with sand and Lytag Aggregate to form a flush finish to surrounding levels without any trip hazards.

8.2 GRP Housings

GRP housings shall comply with ES301 (a single colour anti-graffiti surface is preferred). See the GA drawings in [Appendix D](#) for details.

The switchgear shall be suitably placed to conform to the guidance for venting as detailed in [Appendix C](#).

To gain acceptance from Local Planning Authorities a brick, roughcast or stone effect with colouring to match surrounding buildings may be used.

A standard GRP housed distribution substation shall not normally be fitted with lighting and power. If an operator is expected to enter a substation (rather than stand in the doorway) to carry out normal operations (e.g. where a multi-panel switchboard is installed), lighting and power shall be fitted in accordance with ES397.

8.3 Buildings, other than GRP

8.3.1 General

Buildings (as opposed to GRP housings) shall be used as a means of enclosure for standard distribution substations, only in the following situations:

- (a) Where this is the only way to gain acceptance of a site.
- (b) To avoid noise complaints. For this purpose the walls need to have substantial mass, and conventional brick may be the most economic design. See [Section 14](#).
- (c) In exceptional vandal-risk areas.
- (d) Where the building is provided by the customer, landlord or developer.
- (e) Where there are overriding technical reasons for using an indoor type of high voltage switchgear.

8.3.2 Walls

Walls shall be constructed in accordance with the appropriate Electricity North West standard drawings, as listed in [Appendix D](#).

8.3.3 Roofs

An enclosure will only withstand an internal arc explosion if it has a very large venting area. Roofs shall therefore be of the restrained top hat design that will allow pressure relief in such a rare event. The major damage in known incidents has been due to heavy roofs and their beams crashing down.

Roofs shall be of a pitched lightweight construction with overhanging eaves to shed rainwater clear of the building and to deter trespass. The soffit of the roof shall be protected with an approved fire resistant material to give a one-hour fire resistance.

8.3.4 Doors

Doors shall be in accordance with ES326. Preferred doors are by PRIMA

In areas subject to higher security, additional measures may be required to satisfy CPNI standards as defined in CP998, Security of Substations.

8.3.5 Thermal Insulation

Where transformers are not situated within a chamber, thermal insulation or insulating construction materials shall be provided to ensure that the following maximum U values are not exceeded:

Walls 0.54W/m² °C

Roof 1.13W/m² °C.

8.3.6 Floors

Floors shall normally be of untreated concrete, finished smooth and level in accordance with the requirements of the Electrical plant specification.

8.3.7 Heating and Ventilation

It is necessary to avoid damage to transformers by limiting the maximum temperature. This requires ventilation provided by convection to remove the losses of an indoor transformer. Since any convection requires a temperature rise to provide the necessary drive, there is some reduction in transformer output; the aim shall be to minimise this temperature rise. See drawings in [Appendix A](#).

It is also necessary to prevent a temperature so low that lubricant viscosity in bearings and dashpots increases sufficiently to prevent correct operation. It is also necessary to avoid excessively low temperature for batteries, where fitted.

On occasions where primary style or retrofit switchgear is fitted the humidity levels must be maintained to meet the manufacturer's specification. If the rules in [8.3.7](#) are followed an indoor transformer will provide the necessary heat and will not require additional heating.

In all cases, excess chamber height shall be avoided - in the case of customer substations (such as those in converted mill engine rooms), it may be advisable to add a false ceiling whilst ensuring that the minimum volume requirements for internal arc performance are met (see [Appendix C](#)).

The rules for effective convective ventilation using an indoor transformer are illustrated in [Appendix A](#) and listed below:

- (a) Both inlet and outlet shall be provided on one wall only.
- (b) Outlet shall be as high as practicably possible.
- (c) Inlet shall be as low as possible (but allow kerb to limit ingress of windblown material or water).

- (d) The inlet air shall preferably be sited close to the transformer, but plant shall not be less than 0.6m from wall.
- (e) Inlet and outlet louvres for GRP enclosures and brick built substations shall be as detailed in the appropriate Electricity North West standard drawings, listed in [Appendix D](#).

Where there is no indoor transformer, some ventilation is necessary to prevent any build-up of inflammable gas and to remove any moisture which may percolate through roof, walls, or floor (see also Section 7.4 - Drainage). This ventilation shall comprise the minimum number of airbricks arranged on one wall only in pairs, one high, one low, and sited to avoid direct entry of air on to switchgear. Provision of one pair for each 15m² of floor space is adequate.

Heating shall be arranged as described in ES397. No heating shall be required with switchgear designed for outdoor use, other than internal heaters provided as part of the switchgear.

Where primary style switchgear is required to be used within a distribution substation for overriding technical reasons then the substation shall be temperature controlled. Heating and dehumidification shall be fitted along with the appropriate humidistats and thermostats. The amount of ventilation shall be kept to a minimum (since all heating provided is directly lost due to ventilating air).

8.3.8 Lighting and Power

The electrical installations within distribution substations shall be as detailed in ES397.

9 Oil Containment

9.1 Introduction

Electricity North West's practice on oil containment in distribution substations and transforming points is guided by the Control of Pollution (Oil Storage) Regulations 2001. April 2011, known as OSR England and the Environmental Pollution Act 1995.

OSR England confirms that oils used as heat transfer fluids in transformers are classed as being in use rather than stored and thus are exempt from the Regulations.

The Environmental Pollution Act 1995 states "*It is an offence to cause or knowingly permit the discharge of poisonous, noxious or polluting matter into relevant waters or into any underground strata*".

9.2 Principles of Oil Containment

However, having regard to the above and the company's environmental policy EPD 901, oil containment features shall NOT be incorporated into designs for distribution substations or transforming points.

9.3 Measures for Containment of Oil

No oil bunding containment shall be required.

A new substation or transforming point shall not be sited close to a watercourse unless adequate measures are taken that would allow sufficient time to deploy mopping up operations to prevent widespread oil pollution.

10 Accumulation of Inflammable Gas in Indoor Substations

10.1 General

Generally, there is no danger due to accumulation of gases in outdoor substations and ground-level indoor substation chambers that have adequate ventilation, and where the prevention measures given below are applied. Adequate ventilation shall be achieved by providing appropriate high and low ventilation openings (refer to [Appendix A](#)), such that there shall be not less than two air changes per hour.

Where there is a danger of gas accumulation occurring (e.g.: chambers without ventilation; de-humidifier controlled chambers; chambers with cable basements or tunnels forming part of substations and their approaches), "TEST FOR GAS" notices shall be displayed in prominent positions. It shall be the Designer's responsibility to determine the need and location of such notices.

10.2 Prevention of Accumulation

All cable ducts shall be sealed to prevent the ingress of gas. Preferred method is NOFIRNO supplied by CSD Sealants as specified in ES400D5.

Wherever possible, the area under and over the duct ends immediately outside the wall shall be filled with porous material to provide a ready escape for gas that follows cable runs. Paving or impervious surfaces shall be avoided in this locality. The porous backfill if correctly placed can also act as a "French drain" to avoid sub-surface water causing dampness within the substation. (A French drain is a ditch backfilled to surface level with broken stone, etc.)

10.3 Explosion Hazard

This hazard arises from gas ingress, gas developed from a compound filled cable box fault, gas developed from a fault under oil which is not cleared rapidly or, in the case of non-oil switchgear, an internal arc fault.

An explosion will be so rapid as to occur before escape is possible. Hence screening shall be provided (where possible) from the greatest hazards, to facilitate clear exits from operating positions (the greatest possibility of such faults is during switching), and to avoid injuries or obstructions which may prevent escape, due to building collapse.

The final precautions that shall be taken are to limit building collapse. The best method of achieving this is to provide a light construction roof which lifts to prevent pressure build up, which could cause the walls to blow out.

11 Fire Risk

All Sites are to have Fire Risk Assessment undertaken in accordance with EPD 357.

12 Access and Clearance

12.1 Avoidance of Hazard due to Exposed Live Conductors

This shall be achieved by using metal enclosed 11 or 6.6kV switchgear, shielded pattern LV fuseboards and shrouding over cable connections.

12.2 Escape from Faulted Equipment

The rules set out below shall be considered when designing new installations.

The route to the exit or sanctuary should be direct and away from major hazards. (A sanctuary is a separate chamber offering protection from fire and providing an alternative exit. This sanctuary or "Protected escape route" is particularly applicable to substations forming part of other buildings or sited below ground level.) The exit route shall be:

- (a) Preferably straight and level but at most with one obtuse bend and one-step that shall not exceed 250mm rise or fall.
- (b) Not less than 1m wide except that the minimum door width may be 700mm.
- (c) Short, not longer than 6m.
- (d) Provided with doors that open outwards from the hazard. (This applies to all doors.)
- (e) In a direction of decreasing hazard, ie it shall not pass plant of a higher hazard than that being operated upon.
- (f) Adequately lit.

The hazards in a distribution substation or transforming point in decreasing order of danger are:

- (a) 11 or 6.6kV cable boxes
- (b) 11 or 6.6kV switchgear
- (c) LV fuseboard
- (d) Remote Terminal Unit (RTU)
- (d) Transformer.

By careful arrangement, the operator can be screened from the transformer cable box by plant whenever operations are taking place.

Forward facing angled cable boxes shall never be used on Electricity North West's Network.

13 Security

13.1 Locking

Locking arrangements for Substation doors and gates shall be in accordance with the requirements of EPD603, ES309, ES301 (for GRP housings) and ES326 (for all other door types).

All substations where dual access is required shall be fitted with an appropriate dual locking arrangement.

13.2 Public Interference with Substations

Substations and transforming points which are unattended and accessible to the public may suffer from interference ranging from malicious intent to passing mischief.

The risk of interference to substations, transforming points, cable bridges or other electrical installations is classified in EPD301. The background risk classification shall be recorded on the system amendment forms.

It is necessary to take steps to discourage interference and minimise its effect. Although no site can ever be totally secure, a graduated approach to security shall be applied which matches the local circumstances and the site's history of interference. For example, total enclosure of a distribution plant or very careful attention to the detail of a security fence around exposed live equipment may be necessary. An increased frequency of inspection may also be necessary.

14 Noise

14.1 Introduction

Unless suitable precautions are taken when a transformer is to be located near dwellings, a noise complaint is likely to arise. The following sub-sections set out the parameters to be considered when planning the location of distribution type substations and transforming points. More detailed information on transformer noise is available in CP353.

14.2 General

Wherever possible, distribution substations and transforming points shall not be sited where they will be overlooked by windows of adjacent dwellings.

If the distance between the transformer and the nearest dwelling is less than the applicable limiting value given in [Table 14.2](#), the transformer shall be arranged to accept further noise reduction measures - to be fitted only if subsequent complaints are considered to be justified.

14.3 Transformer Noise Levels

Transformer noise levels vary to some extent between manufacturers' types; also between apparently similar transformers of the same make and rating. For planning purposes it is necessary to assume the maximum noise levels permitted by a particular transformer specification. In Electricity North West, the maximum permitted noise levels for distribution transformers are as stated in [Table 14.1](#) below.

Table 14.1 – Distribution Transformer Noise Levels

TRANSFORMER RATING	MAXIMUM PERMITTED TRANSFORMER NOISE LEVELS (SOUND POWER LEVELS)	LOW FLUX DENSITY (1.2 TESLA)* TRANSFORMERS
kVA	dB(A)	dB(A)
200	52	40
315	54	40
500	56	43
800	58	45
1000	59	46

*The noise levels given are for selected 1.1 Tesla low flux density transformers. Transformers with similarly low flux densities may not have similar low noise levels.

14.4 Noise Assessment

Noise is liable to provoke complaints whenever its level exceeds the existing background noise by a certain margin; or when it attains a certain absolute level. The method of noise assessment depends on comparing the specific noise, corrected to take account of its character, with the measured background noise level.

British Standard 4142 provides a method for predicting whether a noise is likely to give rise to a complaint based upon this concept. The background levels are to be measured using the method described in BS 4142. For general guidance, the figures for background levels used within Electricity North West are:

- (a) Rural (Residential) area = 30dB(A)
- (b) Sub-Urban area = 35dB(A)
- (c) Urban area = 40dB(A)

Care is required in applying these area definitions because, due to changing industrial or traffic activity patterns, an area which may be classed as "Urban" during working hours could have noise levels equivalent to "Rural" during weekends or overnight.

Complaints may be expected if the transformer noise level at the dwelling exceeds the measured background level by 5dB(A) or more. If the transformer noise level is more than 10dB(A) below the background levels, this may be taken as positive indication that complaints are unlikely.

14.5 Distances between Transformer and Nearest Dwelling

The above concept combined with the information given in [Table 14.1](#) and other published information has been used to establish the distance between a dwelling and a transformer at which complaints should not

arise. These distances are given in [Table 14.2](#) below. In establishing the distances due regard has been taken of the tonal character of transformer noise.

The [Table 14.2](#) is based on the background noise levels stated in [14.4](#) above. Lower actual background noise levels may lead to complaints for separations greater than those tabulated.

Table 14.2 – Limiting Distances between Transformer and Nearest Dwelling

TRANSFORMER RATING (KVA)	200 and 315	500	800	1000
LIMITING DISTANCE (M): RURAL/RESIDENTIAL LOCATION	11	14	17	19
LIMITING DISTANCE (M): SUB-URBAN LOCATION	7	9	10	12

NOTE:

- (a) Situations with background levels = 50dB(A) or more should not produce transformer noise complaints. For this reason there is no tabulation for urban locations.
- (b) All distances in the table above are taken from the transformer tank.
- (c) If the measured background noise is significantly lower than the guidance figures set out in [Section 14.4](#), advice shall be obtained from the Electricity North West Technical Support Unit or other acoustic specialist.

14.6 Transformer Noise Reduction

The background levels quoted earlier may be inappropriate in cases where unusually low background noise levels exist. These are likely to arise in isolated rural areas and some urban districts at night. In those cases where the distance between the dwelling and the transformer is less than the recommended distance, the use of a low flux density transformer could reduce the possibility of a complaint arising. No attempt should be made to use the low noise characteristics of low flux-density transformers to permanently alter the normal substation to domestic property spacing recommended in this Section. The use of these transformers shall be restricted to particular cases in consultation with the Electricity North West Plant Policy Manager.

Experience has shown that the effectiveness of many transformer enclosures is reduced by badly fitting lightweight doors and large ventilating apertures. In distribution substation buildings, noise emission will come principally from substation ventilators. Where noise complaints may arise due to noise emission from substation ventilators, space shall be left within the substation for fitting noise-reducing baffles. Details of suitable ventilator noise baffles are obtainable from the Electricity North West Plant Policy Manager. Where possible, doors shall be built into a side of the substation building not facing adjacent property.

The use of barrier walls or screens will generally not be of much benefit, since the length and effective height can seldom be sufficient to provide a useful degree of noise attenuation.

Because of their inherent mass, concrete, bricks and blocks provide effective sound insulation.

In situations where transformers are located adjacent to or adjoining buildings, vibrations may be transmitted to the buildings, which in some cases may give rise to audible effects long before the vibrations can be felt. Resilient mountings (anti-vibration pads) shall be provided for such transformers. To avoid cancelling the effect of the resilient mountings, rigid cable supports, etc, between the transformer and floor or walls shall be avoided. It should be noted that resilient mountings require special attention to loadings. Therefore, the Electricity North West Plant Policy Manager shall be consulted for information on suitable types.

15 Outdoor Plinths

15.1 General

Plinths shall be designed to support the ultimate weight that may be installed. Allowance shall be made for the excavation of cable trenches after the plinth has been loaded. This may need to include a support wall with its foundation below trench level.

Plinths shall be so positioned to allow for equipment overhangs, access for maintenance, painting, and for operation.

The GA drawings listed in [Appendix D](#) give details of standard plinths.

15.2 Plant Type Considerations

Freestanding ring main units can have cabling arrangements where the cables fall on three sides; so it is usual to excavate to trench depth and cast a full slab. However, there are exceptions. In particular, for the types where cables fall within the feet, it may be necessary to provide two piers or to cast in ducts in appropriate positions.

All cable-connected transformers up to 1000kVA can be supported on a rectangular plinth but the smaller sizes may require a slot for the 11 or 6.6kV cable.

Unit substations require a simple plinth to accommodate the ultimate size of transformer and transformer mounted switchgear. The dimensions shall be carefully chosen to ensure that any stability foot or outrigger is accommodated and that provision is made for the secure fastening of a housing.

For outdoor installations top entry cable boxes on transformers and switchgear should be avoided due to moisture ingress risks.

16 Circuit and Plant Identification

Clear and unambiguous naming and labelling is a major factor in reducing human errors in switching. A standard system is essential and the system described in CP615 shall be applied in all situations.

17 Notices and Nameplates

The signs Approved for use in Electricity North West are given in ES356.

There is a legal requirement to display the following approved signs in a position where the public may read them:

- (a) Appropriate notices warning of DANGER.
- (b) Telephone number (the telephone number to be displayed is a number, which can be contacted at any time of the day or night).
- (c) Substation name.
- (d) Company name.

The substation name shall be displayed in a size, style and colouring which aids reading from a distance of, say, 10m. The substation number shall be included on the nameplate as an aid to identification on maintenance inspection tours.

Ground mounted substation and transforming point nameplates, emergency telephone number and "DANGER OF DEATH - KEEP OUT" notices shall be as specified in ES356. These notices shall be fitted to the wall adjacent to the opening leaf of each access door. Where it is not possible to fit these signs on the wall they shall be fitted directly on each door.

To provide a check during switching, additional nameplate(s) shall be provided and be visible from the normal position(s) for the operation of HV switchgear.

A "Treatment for Electric Shock" notice shall not normally be provided. However, some substations and transforming points may be located at sites where different regulations apply, e.g. mines and quarries. Such special situations shall be equipped to satisfy any special requirements. It shall be the designer's responsibility to identify such situations and determine what notices are necessary.

Substations and transforming points with outdoor switchgear where the vandalism or trespass rating is other than LOW (for the definition of trespass risk, see EPD301) shall be provided with additional Approved notices on each face from which the enclosure may be approached. For substations within a building or GRP the Approved notices are only required at each point of access. These notices shall carry a pictorial warning and the legend "DANGER OF DEATH - KEEP OUT" and shall be affixed to the building using non-rusting screws. In addition, an Approved notice shall be attached to all live equipment, carrying a pictorial warning and the legend "DANGER OF DEATH - KEEP OFF".

Due to the government regulations on smoking it is a requirement to fit a no smoking sign inside all substation buildings. The approved sign is detailed in ES356.

A DNA marking sign shall be fitted to every substation. The approved sign is detailed in ES356.

Following commissioning the LV Board shall have the phase labels correctly applied to match the Phase Rotation of the Substation. The approved replacement labels as required are detailed in ES356.

The correct Standard Phase Rotation or Non-standard Phase Rotation Warning sign shall be fitted to the inside of the LV Cabinet/Pillar or as near to the LV Wall Mounted Board as possible to match the Phase Rotation of the substation. The approved signs are detailed in ES356.

18 Earthing

18.1 General

EPD333, "Earthing Design for High Voltage Substations and Equipment" is the primary source for earthing policy.

For security against unauthorised interference, modern LV pillars and cabinets provide a bonding point consisting of five studs within the cabinet or pillar to permit the "11 or 6.6kV Steelwork Earth" to be bonded to:

- (a) 11 or 6.6kV Switchgear.
- (b) Transformer.
- (c) 11 or 6.6kV earth electrodes.

In LV cabinets manufactured to Energy Networks Association (ENA) Technical Specification (TS) 37-2, a link will be provided with a label bearing the legend; "Disconnect when the overall resistance to earth is greater than 1ohm".

18.2 Typical Earthing Connections

Earthing connections are described in CP333.

Due to the changing nature of distribution systems and in particular the change to cables with a plastic outer sheath, there is a growing need to pay increased attention to substation earthing from the point of view of both public and personnel safety.

19 Preferred Plant, Interconnections and Industrial Services

19.1 Plant for Distribution Substations and Transforming Points

Reference shall be made to the following notes and to [Table 19.1](#):

- (a) The plant approved for use on the Electricity North West system is listed in EPD307. This approved plant meets the requirements of the appropriate Electricity Specification (ES313, ES314, ES315, ES319, ES321, ES322).
- (b) Only plant conforming with the above Electricity Specifications shall be installed in both indoor and outdoor substations and transforming points. If installing in indoor substations, consideration shall be given to the dimensions to allow for the venting of explosions caused by internal faults. (see [Appendix C](#))
- (c) Distribution transformer 11 or 6.6kV protection and LV distribution fuse-link ratings shall be determined by reference to CP331.
- (d) Ground mounted distribution transformers of below 315kVA rating are non-standard, with the exception of Padmount and compact substations. Their use and method of installation shall be agreed beforehand with the Electricity North West Plant Policy Manager.

- (e) Extensible 11 or 6.6kV switchgear shall be installed where its use can be justified on engineering and economic grounds. Additional approval of network design is required. See EPD282.
- (f) All new distribution substations and transforming points with capacity in the range 315kVA to 1000kVA shall use unit type transformers with the exception of the Compact types.
- (g) For use on unit transformers, fuse-cabinets with up to 7-ways are available to special order.
- (h) Where a facility exists, all items of HV plant shall be bolted to the plinth.

Table 19.1 – Standard Plant Installations for Indoor and Outdoor Ground Mounted Network Substations and Transforming Points

TRANSFORMER SIZE (3PH KVA)	11 OR 6.6 KV SWITCHGEAR (MINIMUM REQUIREMENT)	LV SWITCHGEAR
200/315 (Compact)	Non – extensible Transformer switch * with incoming circuit earth facility	Integral LV fusegear with shielded pattern 800A, 2 way
50/100/200 Padmount	Fused cable box	Integral LV fusegear with shielded pattern 800A, 1 way
315 (Compact)	Non-extensible RMU	Integral LV fusegear with shielded pattern 800A, 3 way
315	Transformer switch * or non-extensible RMU	Fuse cabinet with shielded pattern 800A, 3 way or 1600A, 5 way
500	Transformer switch * or non-extensible RMU	Fuse cabinet with shielded pattern 800A, 3 way or 1600A, 5 way
800	Transformer switch * or non-extensible RMU	Fuse cabinet with shielded pattern 1600A, 5 way
1000	Transformer switch * or non-extensible RMU	Fuse cabinet with shielded pattern 1600A, 5 way

* Fuse switch or equivalent circuit breaker. When not part of a switchboard, shall include incoming cable earth and test facility.

19.2 Distribution Transformer LV Cable Connections

For new installations of low voltage cable connections to transformers, refer to [Table 19.2](#).

Table 19.2 – Distribution Transformer LV Cable Connections

	TRANSFORMER RATINGS	
	300-500 kVA	750-1000 kVA
INDOOR SITUATIONS	4 x 400mm ² circular copper conductor, XLPE insulated cables with PVC oversheath in accordance with ES400C11.	7 x 400mm ² circular copper conductor, XLPE insulated cables with PVC oversheath in accordance with ES400C11.
OUTDOOR SITUATIONS	4 x 400 mm ² circular copper conductor, XLPE insulated cables with Aluminium armour in accordance with ES400C11.	7 x 400 mm ² circular copper conductor, XLPE insulated cables with Aluminium armour in accordance with ES400C11.

Cleats shall be provided initially for two cores per phase on all indoor transformer installations.

Clamp type connectors are approved for outdoor transformers (with flexible connectors), indoor transformers (cable bend to allow for expansion) and for fuseboards.

For earthing and protection arrangements for transformer cables see CP331, CP332 and CP333.

19.3 Plant for Industrial Customer Supplies

See ES215, ES216, ES217 and ES218 for application guidance.

19.4 Non-Standard Phasing

Plant shall not be modified in any way, in order to facilitate its connection to a network with non-standard phasing.

The LV board shall have the phase identification labels corrected to match the Phase Rotation of the Substation. The approved signs are detailed in ES356.

The correct Standard Phase Rotation or Non-standard Phase Rotation Warning sign shall be fitted to the inside of the LV Cabinet/Pillar or as near to the LV Wall Mounted Board as possible to match the Phase Rotation of the substation. The approved signs are detailed in ES356

However Litton Generator Connectors on LV Fuse Cabinets in certain circumstances may be swapped, subject to Approval by the Electricity North West Plant Policy Manager. The LV Cabinet and the Litton Connectors shall be labelled to inform operators that they have been swapped. Where the Litton Connectors are required to be modified this shall be done on site prior to installation to prevent the LV Board from inadvertently being used at the wrong location.

For any sites with non-standard phasing that have not been altered then the Litton Connectors shall be barriered off and labelled "Do Not Use Non-Standard Phasing".

The approved signs are detailed in ES356.

Where directly connected plant is used, this shall involve the crossing of connections of cables, which enter or leave the site.

Where crossed connections are made the phase colours of the system shall be shown in addition to those of the plant, and shall be labelled "System Phasing".

For examples of non-standard phasing arrangements see [Appendix B](#).

20 Pole Mounted Installations

20.1 Definition

A pole mounted installation is defined as any pole bearing an item of 11 or 6.6kV fusegear, 11 or 6.6kV switchgear, or 11 or 6.6kV/LV transformer - adjacent poles carrying any of the above are deemed to form part of the same installation.

Pole mounted surge diverters, LV fuses and LV switchgear may be part of an installation as defined above.

Refer to CP420-1 Chapter 08 for further information on pole mounted plant.

20.2 Fencing

No fencing is required but all live parts shall be above 4.3m (14ft).

20.3 Notices and Nameplates

Pole mounted installations shall be labelled in accordance with CP420-1 Chapter 09.

20.4 Switchgear Labels

Pole mounted air break switches shall be labelled with type and restriction – in accordance with site specific requirements advised by Electricity North West.

Reclosers and sectionalisers shall be labelled to indicate number of trips causing lockout. These labels shall be fitted in the workshop prior to installation.

20.5 Mounting of Plant

The arrangements for mounting of transformers, sectionalisers and reclosers, shall be as detailed in CP420-1.

21 Documents Referenced

DOCUMENTS REFERENCED	
External Regulations, Acts of Parliament, etc	
Health and Safety at Work Etc Act, 1974	
Electricity Act, 1989	
Town and Country Planning Act, 1990	
Town and Country Planning (General Permitted Development) Order, 2015	
Control of Pollution (Oil Storage) Regulations 2001	
Environmental Act, 1995	
Water Resources Act, 1991	
Water Industry Act, 1991	
Electricity at Work Regulations 1989	
Construction (Design and Management) Regulations 2015	
Regulatory Reform (Fire Safety) Order 2005	
External Reference Documents and Standards	
BS 4142	Method for rating Industrial Noise
BS EN 60947-1	Low-voltage switchgear and control gear Annex C, Degrees of protection of enclosed equipment

ENA TS 37-2	Low Voltage Distribution Switchgear
ENA TS 35-1	Distribution Transformers (from 16kVA to 2000kVA)
Electricity North West Documents	
Distribution Safety Rules	
<u>Electricity Policy Documents:</u>	
EPD101	Application of the Electricity Safety, Quality and Continuity Regulations 2002
EPD279	Distribution System Design - General Requirements
EPD282	Distribution System Design - 11/6.6kV Network
EPD283	Distribution System Design - 400/230V Network
EPD301	Inspection and Maintenance of Electrical Plant
EPD307	Approved Plant for use on Electricity North West Networks
EPD333	Supply System Earthing
EPD355	Substation Flood Protection
EPD357	Fire Risk Assessments of operational Sites.
EPD603	Substation Locking
<u>Codes of Practice:</u>	
CP331	Protection of LV U/G & O/H Distributors, Distribution Transformers and HV O/H networks by fuses

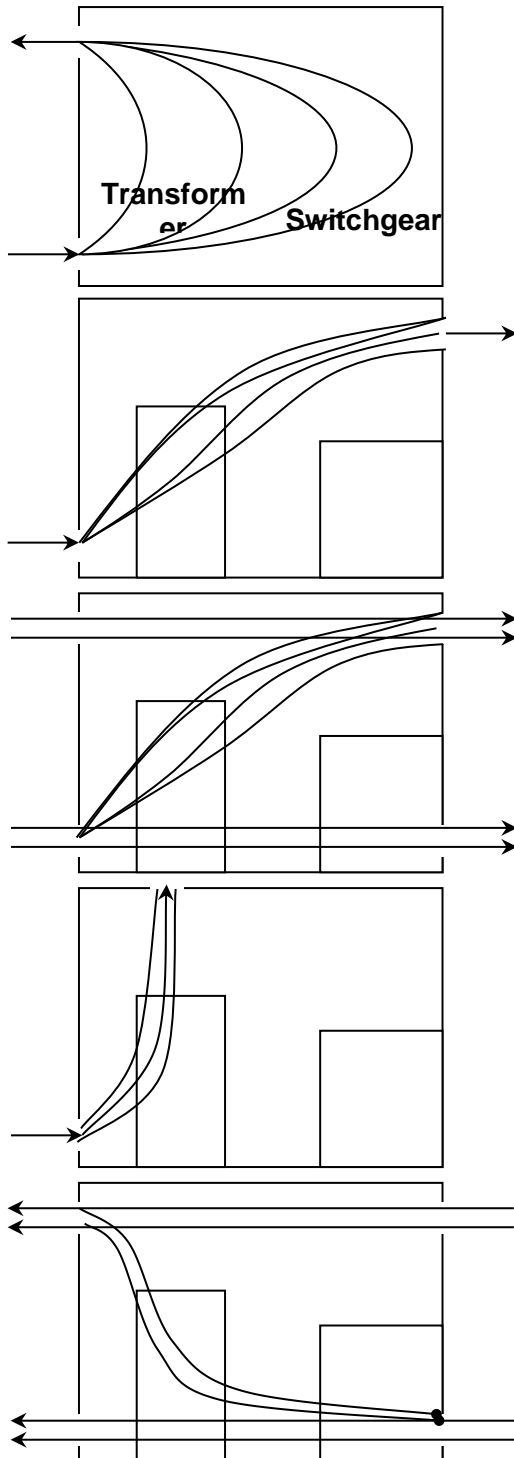
CP332	LV Service Supplies and Application of Protective Multiple Earthing
CP333	Earthing Design for 11/6.6kV Distribution Substations and Equipment
CP352	Design of Distribution Substations and Transforming Points for Asset Replacement
CP353	Transformer Noise
CP420-1	Policy & Practice for Wood Pole Overhead Lines
CP615	Substation, Circuit and Plant Nomenclature
<u>Electricity Specifications</u>	
ES215	Design Specification for Third Party provided New Connections of up to 1500kVA Capacity
ES216	Design Specification for Third Party provided New 11/6.6kV Connections of up to 9MVA (6.6kV) or 15MVA (11kV) Capacity
ES217	Design Specification for Third Party provided 33kV Connection up to 90MVA
ES218	Design Specification for Third Party provided New Connections from either Bulk Supply Transformers with a capacity up to 120MVA (33kV) or from the 132kV network with a capacity up to 240MVA
ES220	Pre-commissioning Requirements for ICPs requiring New Assets to be connected to the 11/6.6kV Network
ES301	GRP Distribution Substation Housings
ES309	Locks for Substations and Associated Plant

ES313	11 & 6.6 kV Switchgear
ES314	12 & 7.2 kV 20 kA Switchgear
ES315	11 & 6.6 kV Pole Mounted Auto-Reclosers
ES319	LV Distribution Switchboards
ES321	Pole Mounted Transformers up to 12 kV
ES322	Ground Mounted Transformers up to 12 kV
ES326	Substation Security Doors
ES356	Notices and Nameplates
ES397	Electrical Installations within Distribution Substations
ES400C11	Low Voltage Mains Cables
ES400D5	Duct Seal

22 Keywords

Design; Earthing; Housing; Lighting; Plant; Substation; Switchgear; Transformer.

Appendix A – Examples of Substation Convection Due to Ventilation Positioning



Preferred case:

Note: the cold blast cooling of the transformer; switchgear insulation is in warmed air; wind pressure on inlet and outlet is approximately balanced.

Undesirable:

Switchgear can be in relatively unswept cold zone; wind pressure can reduce, balance out or reverse convective air flow.

Undesirable:

Through wind may reduce convective circulation by blanketing part of the outlet area; switchgear is likely to be in cold air.

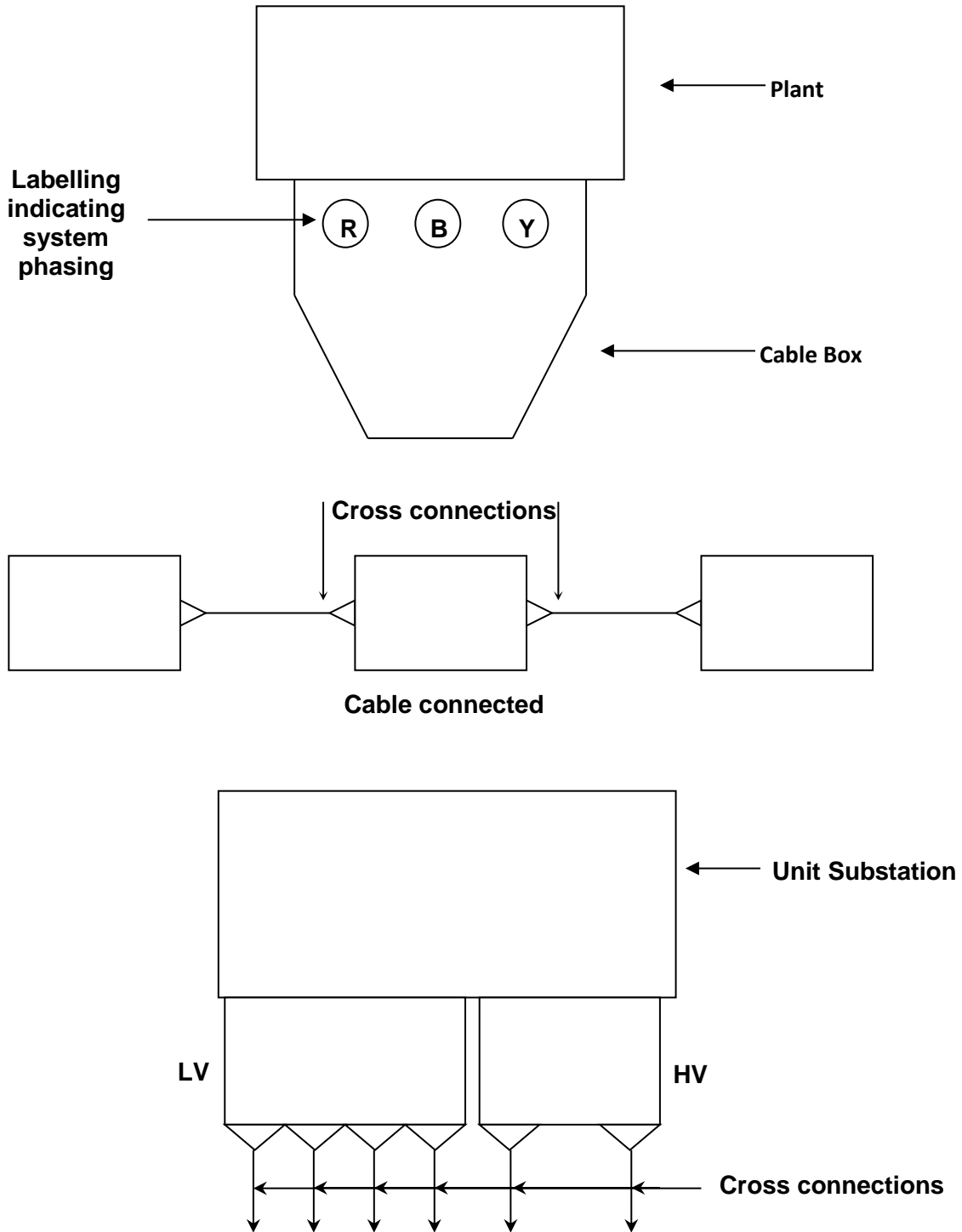
Undesirable:

Switchgear is in stale, cold air; It is not widely realized that a smaller mass of air may be circulated (albeit at higher velocity) and the transformer temperature may be higher than that of the preferred method; water and snow proofing is difficult;

Undesirable:

Blast cooling of transformer is lost; convective efficiency is lost; switchgear is in cold air.

Appendix B – Examples of Non-Standard Phasing



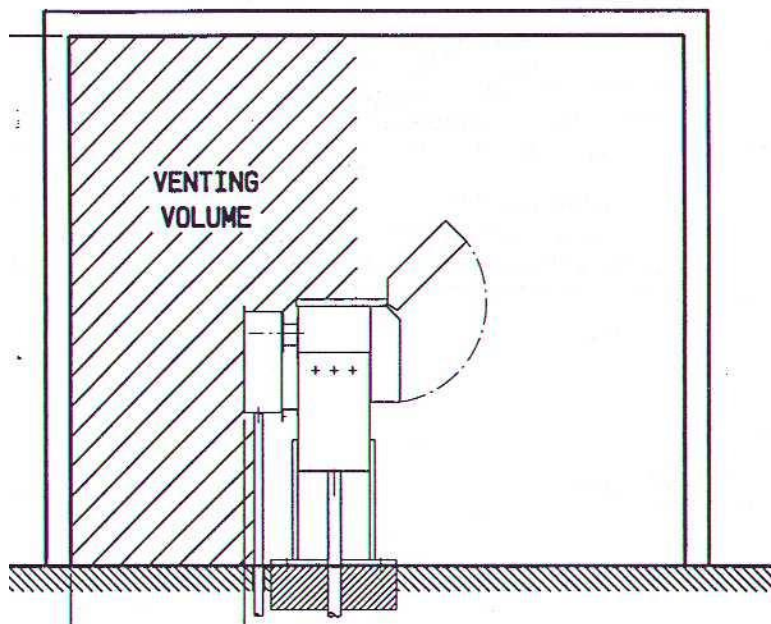
Appendix C – Internal Arc Requirements – Guidance on Venting of Switchgear

C1 Designer’s Responsibilities

When considering the installation of any switchgear and associated venting there are various measurements, which must be known. The decision on whether or not venting is required depends on the fault level at the substation and the volume of free air space in the substation. It is essential that in all cases the fault level and the free air space is included in the design documentation.

Free air space for Venting - The free air space is the space behind the switchgear over the full height and width of the substation from the forward edge of the venting orifice, excluding volume taken up by any other equipment (Fig. C1). In addition to the volume requirements, the HV switch/switchboard and any transformers shall be at least 600mm from the nearest wall. If the unit is directly connected to a transformer, the transformer shall be at least 600mm from the back wall.

Figure C1 – Illustration of Components of Free Air Space



In addition, designers shall consider any prospective change in fault level due to proposed/planned work at primary substations and known generation schemes, and detail the assessed effect in the documentation.

The designer shall also check that the fault rating recorded in the Master Asset Management System (MAMS) agrees with that stated on the switchgear nameplate. If not, MAMS shall be updated with the correct value.

The following guidelines gives indication on how individual makes of switchgear should be treated with regards to venting.

C2 Merlin Gerin (Schneider)

In order to achieve the requirements for internal arc the following guidelines shall be followed when installing Merlin Gerin (Schneider) switchgear

For the entire Ringmaster Range

For the design fault level the substation building or housing shall be constructed such that the space behind and above unit is greater than or equal to 15m³.

C3 Lucy Switchgear

Lucy switchgear does not require special volume arrangements the test was completed in a standard ENA TS 41-36 substation.

C4 All Other Switchgear

The designer of schemes proposing to use other equipment not covered above shall discuss the internal arc tests carried out with the manufacturer. Information on tests, standards, etc. and drawings of test arrangement shall be presented to Electricity North West Plant Policy Manager for consideration.

Appendix D – Drawing List

ENWL DRAWING NO.	DRAWING TITLE
900350-001 rev 1	Plinth for Schneider CN2, RN2c & RN6c Ringmaster Units
900350-002 rev 4	Construction Details for Schneider GRP Unit Substation
900350-003 rev 1	Foundation for Lucy Sabre VRN2A Switchgear in GRP Housing
900350-004 rev 1	GRP Housing Foundation for T3GF3 & T4GF3
900350-005 rev 1	Construction details for standard G.R.P housing for O/D service cubicle (>60kVa)
900350-006 rev 1	Plinth for Free Standing Lucy Sabre VRN2A
900350-007 rev 1	Plinth for Schneider Compact Substation
900350-008 rev 1	Plinth for Schneider Standard Mini Substation
900350-009 rev 1	Plinth for Schneider Maxi Substation
900350-010 rev 1	Plinth for Schneider Shielded Feeder Pillar 7 Way 1600A
900350-011 rev 1	Foundation for Schneider Shielded Feeder Pillar 5 Way 1600A
900350-012 rev 1	Foundation for Schneider Shielded Feeder Pillar 3 Way 800A
900350-013 rev 1	Typical Ring Beam Foundation for GRP Housings
900350-014 rev 1	Plinth for Schneider Extensible Switchgear in GRP Housing (Cable Trench Central)
900350-015 rev 1	Plinth for Free Standing Cable Connected 315 / 1000kVA Transformer
900350-016 rev 1	Plinth for Schneider RMU & Metering Unit
900350-017 rev 1	Plinth for FRMU
900350-018 rev 1	Plinth for FRMU Mk2 with Mounted Transformer
900350-019 rev 1	Plinth for Ringmaster Extensible Switchgear
900350-020 rev 0	Hasp & Staple Locking Arrangement
900350-021 rev 0	Plinth for Transportable Unit Substation
900350-022 rev 3	Palisade Fence 1850mm High
900350-023 rev 1	Palisade Fence 1350mm High
900350-024 rev 0	Modular Fence 1850mm & 1350mm High
900350-025 rev 4	Timber Fence 1850mm & 1350mm High
900350-026 rev 0	Typical Brick Housing for External Substation Sheet 1 of 2
900350-027 rev 0	Typical Brick Housing for External Substation Sheet 2 of 2
900350-028 rev 1	Construction Details for Unit Substation
900350-029 rev 0	Construction Details for Standard Indoor Brick Substation
900350-030 rev 0	Construction Details for Standard GRP Substation
900350-031 rev 3	Construction Details for Standard Wall Louvre
900350-032 rev 0	Plinth for Extensible Ringmaster RE2c Compact RMU Coupled to a CE2 Extensible Circuit Breaker
900350-033 rev 1	Anti-Vandal and Non-Standard Modular Substation Gate Details
900350-034 rev 2	Feather-edged Panel Fencing to Concrete Posts
900350-035 rev 1	Plinth 100kVA 11kV 433V 3 Phase Pad-Mounted Ancillary Transformer
900350-036 rev 1	Plinth for 50kVA 11kV 250V 3 Single Phase Auxiliary Transformer