NPS/006/002 – Technical Specification for Distribution Substation Enclosures

1. Purpose

The purpose of this document is to detail the requirements of Northern Powergrid (the Company) in relation to the products detailed within this document.

This document supersedes the following documents, all copies of which should be destroyed;

Document Reference	Document Title	Version	Published Date
NPS/006/002	Technical Specification for Distribution Substation Enclosures	7.0	Jan 2015

2. Scope

This document includes the functional design and performance requirements for housings to enclose electrical plant and switchgear installed in substations that form part of the Northern Powergrid 11kV and 20kV distribution networks and should be read in conjunction with MNT/006 – Policy for Operational Inspections and IMP/009 – Policy for the Enclosure of Ground Mounted Distribution Substations. NSP/007/020 – Guidance on Substation Design: Transformer Noise. Substation designs for metered generation connections are not included within this document. If required, a bespoke design will be issued by Northern Powergrid.

The following appendices form part of this technical specification:

- Appendix 1: Drawings.
- Appendix 2: Self Certification Conformance Declaration

2.1. Table of Contents

1. Purpose 1

2. Scope 1

2.1. Table of Contents 2

3. Technical Requirements 3

3.1. Basic Requirements 3

3.2. Design Requirements 3

3.3. Construction Elements 8

3.4. Acoustic Requirements 10

4. References 13

4.1. External Documentation 13

4.2. Internal Documentation 14

4.3. Amendments from Previous Version 14

5. Definitions 14

6. Authority for Issue 15

6.1. CDS Assurance 15

6.2. Author 15

6.3. Technical Assurance 15

6.4. Authorisation 15

Appendix 1 – Drawings 16

Appendix 2 – Self Certification Conformance Declaration 19

Appendix 2 – Continued 20

3. Technical Requirements

3.1. Basic Requirements

Enclosures shall be categorised as:

- Standard security enclosures.
- Enhanced security enclosures.
- High security enclosures.

The enclosure shall withstand and provide protection to the contents from the effects of the UK temperate climate (including coastal situations). It shall also provide resistance to unauthorised entry and fire (see sections 3.2.7 and 3.2.5 respectively). In addition to these requirements, when specifically identified it shall also provide acoustic attenuation & mitigation measures (See section 3.4).

The enclosure must allow the installation, operation and maintenance of the plant and switchgear that is contained within and the use of portable fault location equipment and facilities for remote control of the plant and switchgear.

Enclosures shall be in accordance with the Company requirements as specified in the drawings presented within Appendix 1.

3.2. Design Requirements

3.2.1. Environment and Loadings

The enclosures and elements thereof shall be designed and constructed to resist dead and live load deflections and thermal movements and to be suitable for use under the following environmental conditions and loadings:

- Wind loading in accordance with BS EN 1991-1-1 NA applying basic wind speed up to 23 m/s.

Due allowances shall be made for the effect of any resulting internal pressure rises when the complete housing is exposed to these wind speeds.

- Snow loading up to 0.8kN/m2
- Distributed loading of 1.0kN/m2
- Thermal properties: Minimum U Value of 1.6W/m2/°C
- Solar gain of 1,000W/m2

3.2.2. Nominal Asset Life

The design and manufacture of the enclosure shall provide for a minimum operational life span of a minimum of 20 years before replacement of major components.

The Manufacturer shall provide details of the recommended / reasonable expected operational life span of each element and of the complete housing, with supporting evidence.

3.2.3. Ventilation

Natural ventilation shall be calculated and provided to: dissipate heat created from a 1000kVA transformer on full load of 15kW, plus solar gain from roof surface of 1,000W/m2 and to prevent condensation. Ventilation may be incorporated into the doors or walls and the roof soffit. Ventilation units shall be robust, vandal and corrosion resistant, steel welded construction with mesh backing to

prevent vermin intrusion. They must not provide hand or footholds. See drawing C969426. When required, ventilation shall be suitably acoustically attenuated, be congruent and sympathetic with the surrounding environment. Use of rotating vents that could attract negative attention and exacerbate customer complaints is not encouraged but if considered essential to provide adequate ventilation, their use would have be agreed with Northern Powergrid at the design stage, prior to being built. Vents, louvers, ducts etc. shall not present sharp edges or corners, either inside or outside the enclosure. In order to ensure that ventilation and associated noise is directed away from nearby residents, the ability to reconfigure or adjust the direction of flow is required.

As a guide the total net ventilation area is to be divided approximately equally between high and low level across the room.

3.2.4. Pressure Relief

All freestanding distribution 'Standard' category enclosures shall be equipped with explosion relief roofs (see section 3.3.1). Explosion relief roofs are not required to be installed on 'Enhanced' and 'High' category freestanding distribution enclosures.

'Standard' category prefabricated enclosures shall be subjected to a type test in which the effects of an internal arc within a sealed chamber inside the enclosure are demonstrated. This may be achieved by either a short circuit or by a synthetic fuel /air explosion. The method detailed within Building Research Establishment (BRE) report 1997 TCR 20/97 is approved. In all cases the proposed method of test shall be submitted for approval prior to any tests being completed. The amount of arc energy produced will depend on amongst other things, the system voltages and associated .fault levels. The fault level at 11kV will be in the order of 250MVA (13.1kA) for 1 second and the fault level at 20kV will be in the order of 350MVA (10.1kA) for 1 second. All tests shall be carried out at an accredited test station.

The criteria for the test shall include:

- Doors shall remain closed and latched.
- No projection of flame.
- No breakage or fracture to the enclosure.
- If pressure relief is achieved by lifting roof then the roof shall be tethered and shall return to the original position without manual help.
- Deflection of any flame external to the enclosure shall be deflected away from persons directly adjacent to any external surface of the enclosure.
- All tests shall be recorded on high speed video in accordance with BRE report 1997 TRC 20/97.

Where an enclosure has previously been tested as detailed above then appropriate type test data may be submitted for consideration.

Where modifications are made to any enclosure that has been subjected to type testing, such enclosures shall be subjected to repeat testing unless written prior agreement to the contrary has been issued by the Policy and Standards Manager.

Test evidence shall be provided to demonstrate that after any movement of the roof due to normal climatic conditions (gusts of wind), or third party interference, the roof returns to its normal position and the pressure relief provision, IP rating and intruder resistance are not compromised.

Prefabricated enclosures of bespoke design and size must comply in principle to BRE report 1997 TRC 20/97.

3.2.5. Fire Resistance

Fire resistance shall be categorised as:

- **Standard security enclosures** - Half hour fire rating. The enclosure should be designed and tested to Class 2 of BS476 - 22 with a half hour fire rating (retention of stability and integrity).
- **Enhanced security enclosures** - Half hour fire rating. The enclosure should be designed and tested to Class 2 of BS476 - 22 with a half hour fire rating (retention of stability and integrity).
- **High security enclosures** - Half hour fire rating. The enclosure should be designed and tested to Class 2 of BS476 - 22 with a half hour fire rating (retention of stability and integrity).

Manufacturers may put forward any proposals they feel will enhance this minimum requirement without being detrimental to the durability or structural performance of the enclosure.

3.2.6. Surface Finish / Appearance

The preferred standard external finish of prefabricated enclosures is for walls to have a simulated red brick finish (colour reference Ral 10-B-27 to BS 4800) and roof and doors to have a smooth grey finish (colour reference Ral 18-B-25 to BS 4800). However, some enclosures will require a simulated brick/stone, bespoke clad effect, or smooth finish in a colour to match the local environment.

The internal surfaces shall be a light colour (preferably white) to maximise light levels to improve internal visibility. The surface should also have an anti-condensation coating with an incorporated fungicide.

All surface finishes shall be applied in such a manner so as to ensure that the colour is maintained for the design life of the enclosure. The finished enclosure shall be free from projecting fibres.

Conventional masonry enclosures shall match the local environment and meet Local Authority planning requirements.

A 480mm wide x 220mm flat area is required above every access doorway to allow substation name plate and property labels to be attached.

3.2.7. Degrees of Protection

Degrees of protection shall be categorised as:

- **Standard security enclosure** - The design and manufacture of the enclosure shall be such that it is sufficiently robust to resist drilling, sawing and vandal intrusion and shall preferably have a Security Rating Classification in accordance with Loss Prevention Certification Board LPS 1175. Doors shall be fitted with a high security anti-tamper lock cloaking device, in accordance with drawing C993355. This is an additional shield against lock tampering but is not part of the overall security rating.
- **Enhanced security enclosure** - The enclosure shall have been tested and certified to Security Rating Classification 1 of Loss Prevention Certification Board LPS 1175. Doors shall be fitted with a high security anti-tamper lock cloaking device, in accordance with drawing C993355. This is an additional shield against lock tampering but is not part of the overall security rating.
- **High security enclosure** - The enclosure shall have been tested and certified to Security Rating Classification 2 of Loss Prevention Certification Board LPS 1175. Doors shall be fitted with a high security anti-tamper lock cloaking device, in accordance with drawing C993355. This is an additional shield against lock tampering but is not part of the overall security rating.

Please note:- In situations where the level of vandalism/trespass/theft is assessed as exceptionally high combined with the associated safety risk to the public and staff, then the application of security

measures or enclosure construction designed to Security Rating Classification 3 of Loss Prevention Certification Board LPS 1175 shall be considered.

All enclosures, regardless of LPS certification; shall be tested and certified to confirm that they meet the following criteria and have successfully passed appropriate testing:

For the protection against ingress of solid foreign objects of 12.5mm diameter or above and against the ingress of spraying water; complete enclosures shall provide an IP rating of IP23 in accordance with BS EN 60529.

A single sample of complete enclosures shall be tested in accordance with BS EN 60068-2-75, with the following criteria below. Clause references in brackets refer to BS EN 60068-2-75:

a) Impact energy (4.1.2) shall be 20J for standard security enclosures and shall be 50 Joules for enhanced and high security enclosures.

b) Number of impacts (4.1.3) shall be:

- At least twelve impacts to every facet and door (see item g below).
- Six impacts to every: locking point, vent (excluding soffit vents less than 100mm wide), generator cable entry point and visible hinge.

c) Type(s) of test apparatus to be used (4.2.1):

- Tests on the roof facets shall be done with a vertical hammer.
- Tests on the locking points shall be downward impacts at 45 degrees to the vertical and applied with a spring hammer, or as agreed with the Company.
- All other tests shall be done with a pendulum hammer.

d) Method of mounting (4.2.2): The enclosure shall be secured, using the manufacturer's recommended standard fixing arrangement for that housing, and on completion of the tests shall not have moved more than 6mm as a result of the tests.

e) Preconditioning (4.3): Is not required.

f) Initial measurements (4.4): Are not required.

g) Attitude and impact locations (4.5.2):

- Impact locations on the facets and doors shall be chosen to test the weakest point of the facet; but as default shall include TWO impacts in each of the following locations:
  - The mid-point of every join in the facet material (e.g. plywood sheet joins).
  - Two diagonally opposite corners, 150mm in from each facet edge.
  - The mid-point of two adjacent sides, 300mm in from each facet edge.
  - The centre of the facet.
  - Impacts on the locking points shall be applied equally along the top of the locking points.

h) Securing of bases, covers and similar components (4.5.3) see item d) above.

i) Operating mode and functional monitoring (4.5.4) is not required.

j) Acceptance and rejection criteria (4.5.4 and 4.7): the housing shall have passed the test if:

- Any impact shall not have penetrated into the facet more than 10mm.
- The facet shall not have more than 6mm of extra flex/movement at any point on any edge/joint.
- 'Daylight' shall not be visible through any gaps created by the impact testing.
- Any resulting cracks in the outer surface of the facet shall be less than 1mm wide and 50mm long.
- The facet shall not have delaminated to any significant extent.

k) Conditions for recovery (4.6) are not applicable.

l) Final measurements (4.7):

- The following shall be measured, photographed and recorded: Impact penetration, facet edge flex/movement, cracks in the outer surface of the facet, and visibility of daylight through any gaps.
- The IP rating testing shall be carried out on the same sample enclosure used for the impact testing and shall be carried out after the impact testing, as recommended in Appendix B of BS EN 60068-1.

3.2.8. Application of Locking Arrangements

The Northern Powergrid master / sub master cylinder and pad locks fitted at operational buildings on gates or doors shall meet the requirements of NPS/006/003 – Technical Specification for Locks for use on Operational Sites and Apparatus.

They will have an attack resistance grading to match the stated LPS of the enclosure as detailed in section 3.2.7 of this document. The cylinder will achieve the attack resistance grading required in BS EN 1303 with the pad locks meeting the required security requirements of BS EN 12320.

3.2.9. Summary of Key Design Variances

The following table identifies the key variances for each of the enclosure security standards as defined in section 3.2.7.

	Security Standard		
	Standard	**Enhanced**	**High**
Loss Prevention Certification Board LPS 1175 (Security Rating Classification)	Optional	1	2
Pressure Relief (BRE Report 1997 TCR 20.97)	250MVA (13.1kA) for 1 second	Optional	Optional
Fire Resistance (Class 2 of BS476-22)	30 mins	30 mins	30 mins

3.3. Construction Elements

Where the enclosure is manufactured from steel then the unit shall be fully galvanised to BS EN ISO 1461.

Regardless of the enclosure material; external fasteners shall be high tensile coach bolts with smooth domed or smooth faced countersunk head to minimise tampering opportunities.

3.3.1. Roofs

Roofs shall be manufactured in one composite piece and shall be profiled with a 2 way 5 degree fall to each side of the unit to prevent drainage of water over the doors. When planning requirements have detailed that alternative tile effect roofs are required these shall be profiled with a 22.5 degree 4 way pitch and to incorporate an edge detail to prevent drainage of water over the doors.

To minimise the opportunity for climbing and roof access; high security enclosures shall have 22.5 degree 4 way pitched roofs.

Materials shall not be susceptible to rusting, rotting, shrinking, warping, etc.

When manufactured from steel then the unit shall be fully galvanised to BS EN ISO 1461.

Roofs are to be designed to support a distributed loading of 1kN/m2 (snow loading).

The roof shall support an additional static load of 200kg applied over a 500mm x 500mm area (to represent three youths standing close together).

The roof shall support a dynamic loading of 140kg over a 500mm x 300mm area, dropped from a height of 100mm, repeated twelve times (to represent two youths jumping on the roof).

Roofs on free-standing standard enclosures shall be equipped with an explosion relief facility which must have automatic return. The explosion relief device should be designed with facilities to prevent unauthorised access, roof lift during transportation and must be such that neither winds of 50mph, nor gusts of 90mph, approaching the enclosure from any direction shall affect the roof positioning; i.e. the roof shall not lift or become misaligned as a result of these wind conditions. As stated in section 3.2.4, roofs on the Enhanced and High security enclosures shall NOT be equipped with explosion relief facility and shall be permanently fixed.

Roofs shall incorporate integral lifting features to facilitate safe craning of the complete unit into position and possible future removal of the complete unit/roof for maintenance and/or replacement of the electrical plant contained therein. The Supplier shall supply details of the fixing down methods and lifting arrangements before delivery.

Alternative construction methods and design will be considered provided the Manufacturer can provide sufficient evidence that the alternative will achieve equal strength and enhance the requirements.

3.3.2. Doors

Enclosures shall be equipped with lockable, outward opening doors with lock/finger opening facilities.

Materials to be used shall not be susceptible to rusting, rotting, shrinking, warping, etc. When manufactured from steel then the unit shall be fully galvanised to BS EN ISO 1461.

The minimum door dimensions shall be 2000mm high by 750mm wide. Where openings are greater than 1m wide, double doors shall be fitted.

Doors shall be capable of being removed and replaced by the use of conventional tools without ''wet working'' i.e. without the need for resins, glues, etc.

Doors shall open outwards to an angle of 90° to 110°, with automatic engagement device(s) to secure the door in this open position. The operator shall be required to physically release the device to allow the door to close.

If a more robust engagement device is required for exposed areas with high wind speeds then enclosures shall be supplied equipped with the enhanced device as standard. The device must be fitted with a drop cord or bar to allow easy release.

The left hand door (viewed externally) shall be the captive door, being held in a closed position by spring loaded shoot bolts top and bottom. Bolting of the door shall be designed for one-man operation.

The right hand door (viewed externally) shall have a dead lock mechanism capable of being operated with a free issue cylinder provided by the Company and shall meet the requirements of NPS/006/003 and attack resistance detailed in section 3.2.7 of this document. The external face of the cylinder shall be protected by a Lock Cloaking device that should be secured with a free issue padlock provided by the Company (see drawing C993355).

Doors shall be equipped with anti-jemmy meeting covers and stainless steel door hinges with incorporated dog bolts.

When conventional louvers or MS punched type ventilation is to be installed in the doors the design must be a robust anti-jemmy type and have internal fixings (see section 3.2.3).

The Supplier shall supply details of the fixing down methods and lifting arrangements before delivery.

The option for Bi-fold doors is required for situations such as: restricted substation access or presenting an obstruction to passing pedestrians when in the open position. A Bi-fold door arrangement must still comply with the required Security Rating Classification in accordance with section 3.2.7.

Alternative construction methods and design will be considered provided the Manufacturer can provide sufficient evidence that the alternative will achieve equal strength and enhance the requirements.

3.3.3. Walls

Enclosure walls shall be vertical and at least 2.40m high. Materials to be used shall not be susceptible to rusting, rotting, shrinking, warping, etc. Walls shall be capable of withstanding all loads in accordance with BS EN 1991 1-4 Eurocode 1: Actions on structures — Part 1-4: General actions — Wind actions.

For prefabricated enclosures the fixing down method shall be specified and provided by the manufacturer.

New distribution substations forming part of a new development may be of a brick/masonry construction to match that development. The structure shall be of a double skin cavity design constructed to BS 6399. The structure shall be fully cured before any plant, cables and associated equipment is installed.

This type of structure may be classified as ‘Enhanced’ providing that all associated fixtures and fittings are compliant with LPS 1175 Class 1 as referenced in section 3.2.7.

3.3.4. Features

The enclosure shall be provided with a portable generator cable access point ‘cat flap’ to allow the installation of temporary generator cables. The 215mm x 215mm aperture shall be positioned to the left of the doors, 300mm above the finished floor level. This should be held closed by a shoot bolt lockable with a padlock on the inside of the unit.

Northern Powergrid signage is to be located externally, centrally above the door and internally, centrally 1.2m up from floor on the first opening door. A flat area of 480mm wide x 220mm high is required to place the signage and fixed using anti-clutch screws.

The enclosure shall have a 1000mm wide x 400mm high x 12mm thick fibre notice board fitted internally to allow light weight equipment, locks and notices to be placed. Location of the board shall be on the front right hand side 1800mm to the top elevation. The supplier shall state the maximum weight(s) that this arrangement can support and shall provide calculations to justify this declaration. Where necessary, heavy auxiliary and/or ancillary equipment that is not by design floor mounted shall be installed using free standing and rigid "Unistrut" type frameworks or similar that is secured to the floor rather than fixing or suspending such heavy equipment on the walls.

The supplier shall provide details of available locations and methods of attachment to allow the retrofitting of equipment; e.g. metering units, RTUs (remote/radio tele-control units), battery chargers, light fittings etc. The supplier shall state the maximum weight(s) that these arrangements can support and shall provide calculations to justify this declaration.

The supplier shall locate the enclosure in the rebate on the edge of the concrete base and must internally grout with sand and cement to prevent a tripping hazard.

3.3.5. Electrical Installation

When specified, enclosures shall be supplied with the electrical wiring and fittings fully installed. The electrical installation requirements for the various types of enclosure are as indicated on the relevant drawings.

All installation work shall be to the latest edition of the IET Wiring Regulations, BS 7671.

All wiring shall be installed in surface fixed round PVC conduit manufactured and installed in accordance with BS 4607-1 and BS EN 61386-1.

Light switches shall be weather proof to IP55 in accordance with BS EN 60529.

13A switched socket outlets and 13A fused spur outlets shall be PVC fittings.

When specified 240W 1200mm wall mounted thermostatically controlled tubular heaters shall be provided and mounted horizontally at low level. Sufficient heaters will be required to maintain an internal temperature of +5°C, at an external temperature of -5°C.

When specified, a 4way PVC distribution board shall be IP30 to BS EN 60439-3 and shall be installed with a double-pole 100A 30mA RCD isolator. Suitably rated HRC cartridge fuses shall be installed for all circuits. Spare fuse ways shall be blanked off.

The electrical installation shall be fully tested by the manufacturer prior to delivery in accordance with the current edition of the IET Wiring Regulations BS 7671, for TNCS and TNS, UK nominal supply voltage, 50Hz single-phase supply or any subsequent edition requirements.

3.4. Acoustic Requirements

3.4.1. Basic Overview

Northern Powergrid own and operate assets associated with electrical distribution including; overhead lines, underground cables and substations. These assets can often be sited in relative close proximity to residential properties which can sometimes lead to complaints of nuisance noise.

It is most often the electrical transformers which are the cause of the nuisance due to their inherent constant production of sound. Electrical transformers are a "static" piece of equipment with the exception of automatic tap-changing equipment. Vibration is produced by the transformer core laminations. Generally agreed to be caused by a phenomenon known as magnetostriction, which is a change in core dimensions caused in turn by magnetisation, the resulting noise and vibration waveforms produce harmonics of 100Hz, namely 200, 300, 400Hz etc. and these "signature frequencies" are those to which particular attention is paid as part of the noise survey.

However, each site must be assessed individually and consideration given to the unique environmental and operational factors and whether an enclosure of standard size as specified in this document would be adequate or if a bespoke enclosure is required. If a bespoke unit is required, the required physical measurements, any specific design considerations and relevant drawings will be supplied to the service provider who would be manufacturing the enclosure.

In certain cases it may be necessary to have panels within the enclosure that are removable to allow access to specific areas and items of apparatus. In these cases, the panels must be able to be removed without complete dis-assembly of the enclosure and the remaining structure must be self- supporting. Such removable panels will be specified by and agreed with the Northern Powergrid representative in advance of the enclosure being requested.

3.4.2. Technical Requirements

All acoustic filler material shall be inert, non-hygroscopic, vermin proof and rot proof, shall not support bacteriological growth and have a suitable sound absorption coefficient to achieve the required attenuation of noise and have fire ratings that meet the requirements of section 3.2.9 of this document

To ensure the insertion loss provided by the completed built structure will guarantee compliance with BS 4142, sound survey report findings and recommendations as well as World Health Organisation guidelines for community noise and other specified documents, the calculated predicted Sound Reduction Index for this construction will be shown in dB over a wide range relevant 1/3 octave frequencies and by a value of reduction in dB, (A) weighted at 100Hz

In general, and unless otherwise stated, the enclosure shall be designed and built to achieve an attenuation in sound (insertion loss) of between 15dB & 20dB at 100Hz provided by the complete enclosure or provide attenuation levels to comply with the requirements of the recommendations of an acoustic report that has been done prior to these works to assess levels of required attenuation.

3.4.3. Consideration of Standing Wave Build Up in Enclosures

The efficacy of the acoustic enclosure can be to some extent nullified if certain critical distances are not observed due to the build-up of standing sound waves within the structure.

The design of transformer enclosures shall consider the effect of these standing sound waves. The distance between large flat faces of the transformer tank (sides and top and not the cooling fins) and the acoustically reflective surface of the enclosure walls or lining, floor and roof, opposite walls or acoustically reflective surfaces is critical as a build of these standing waves can nullify, to some extent, the attenuating effects of acoustic enclosures.

The distance should be such that the half wave tones of 100Hz and 200Hz are avoided to prevent the setting up of standing waves. These dimensions are 1.68m and 0.84m, +/- 0.08m respectively and any multiple of these values. The 100Hz wave is the major contributor of noise and its associated dimension of 1.68m and its multiples should always be avoided. The 200Hz wave makes a much smaller contribution to the total noise and the dimension of 0.84m and multiples should be avoided wherever possible. Guidance on these figures is available in (BEBS T2 (1966 revised 1977) Chapter XIII).

Dimensions within which standing waves can be produced 100Hz Wave		Dimensions within which standing waves can be produced 200Hz Wave	
Multiple of wavelength	Distance in which standing waves can be generated (m)	Multiple of wavelength	Distance in which standing waves can be generated (m)
0.5	1.60 – 1.78	0.5	0.76 – 0.92
1	3.28 – 3.44	1	1.60 – 1.78
1.5	4.96 – 5.12	1.5	2.44 – 2.60
2	6.64 – 6.80	2	3.28 – 3.44
2.5	8.32 – 8.48	2.5	4.12 – 4.28
3	10.0 – 10.16	3	4.96 – 5.12
		3.5	5.80 – 5.96
		4	6.64 – 6.80
		4.5	7.48 – 7.64
		5	8.32 – 8.48
		5.5	9.16 – 9.32
		6	10.00 – 10.16

Note: 0.84m +/-0.08m gives a range of 0.76m-0.92m to be avoided; this is the 0.5 multiple of the 200Hz wavelength. Doubling this distance gives a range of 1.6m to 1.76m to be avoided (i.e. (0.84x2) +/-0.08m) which is the full wavelength at 200Hz and 0.5 wavelength at 100Hz.

As it is necessary to have access around the transformer and enough room to remove the lid for operational and maintenance reasons anyway, the access routes and clearances should be considered with the above in mind.

The finished installed structure must reduce the noise levels to within the limits prescribed by BS4142 over the whole spectrum of 1/3 octave frequencies.

4. References

4.1. External Documentation

Reference	Title
BRE Global Limited, Loss Prevention Certification Board, LPS 1175	Requirements and testing procedures for the LPCB approval and listing of intruder resistant building components, strong points, security enclosures and free-standing barriers
BS 4142:2014	Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas
BS 4607-1:1984	Non-Metallic Conduit Fittings for Electrical Installations – Part 1: Specification for Fittings and Components of Insulating Material
BS 476 - 21:1987	Fire Tests on Building Materials and Structures Part 21: Methods for Determination of the Fire Resistance of Load bearing Elements of Construction
BS 476 - 22: 1987	Fire Tests on Building Materials and Structures Part 22 Methods for Determination of the Fire Resistance of Load bearing Elements of Construction
BS 4800: 2011	Paint Colours for Building Purposes
BS 4800:2011	Schedule of paint colours for building purposes
BS 7671: 2018	IET Wiring Regulations
BS EN 1303: 2015	Building hardware. Cylinders for locks. Requirements and test methods
BS EN 12320: 2012	Building hardware – padlocks and padlock fittings
BS EN 1991 1-4:2005	Eurocode 1: Actions on structures — Part 1-4: General actions — Wind actions
BS EN 1991-1-1 NA:2002	UK National Annex to Euro code 1: Actions on structures — Part 1-1: General actions — Densities, self-weight, imposed loads for buildings
BS EN 50086-1	Conduits for Electrical Installations Part 1: Specification of General Requirements
BS EN 60068-1:2014	Environmental Testing Part 1: General and Guidance
BS EN 60068-2-75: 2014	Environmental testing Part 2: Tests Test Eh. Hammer tests
BS EN 60439-3: 1991	Specification for Low-voltage switchgear and control gear assemblies — Part 3: Particular requirements for low-voltage switchgear and control gear assemblies intended to be installed in places where unskilled persons have access to their use
BS EN 60529: 1992	Degrees of protection provided by enclosures (IP Code)
BS EN 61386-1: 2008	Conduits for Electrical Installations – Specification Part 1: General Requirements
BS EN ISO 1461: 2009	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods
Building Research Establishment report TRC 20/97	Test results and report by the Building Research Establishment for the effects of an internal arc within a sealed chamber
Energy Networks Association BEBS T2 1966 (Revision 1 1977) Section 13	Specification for Transformers and Reactors Section 13, Noise and Vibration
World Health Organisation (WHO)	Guidelines for Community Noise April 1999 Night Noise Guidelines for Europe 2009

4.2. Internal Documentation

Reference	Title
IMP/009	Policy for the Enclosure of Ground Mounted Distribution Substations
MNT/006	Policy for Site Inspections of Ground Mounted Substations
NPS/006/003	Technical Specification for Operational Locks
NSP/007/020	Guidance on Substation Design: Transformer Noise

4.3. Amendments from Previous Version

There are no material changes in this version. All references have been updated.

5. Definitions

Term	Definition
n/a	

6. Authority for Issue

6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		Date
Liz Beat	Governance Administrator	07/01/2021

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

Review Period - This document should be reviewed within the following time period;

Standard CDS review of 3 years?	Non Standard Review Period & Reason	
No	Period: 5 years	Reason: To align with purchasing cycles
Should this document be displayed on the Northern Powergrid external website?		Yes
		Date
Paul Buttery	Building and Civil Manager	12/01/2021

6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

		Date
Joseph Helm	Senior Policy & Standards Engineer	07/01/2021

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Greg Farrell	Head of System Engineering	15/01/2021

Appendix 1 – Drawings

General Arrangement Drawings	Northern Powergrid Drawing No.
315 – 800 KVA UDE Masonry Enclosure (Restricted Site)	C1004506
315 – 800 KVA Prefabricated Enclosure (Restricted Site)	C1004507
1000 KVA UDE Masonry (Restricted Site)	C1004508
1000 KVA UDE Prefabricated Enclosure (Restricted Site)	C1004509
315 - 800 KVA Extensible UDE Masonry Enclosure (Restricted Site)	C1004510
315 – 800 KVA Extensible UDE Prefabricated Enclosure (Restricted Site)	C1004511
315 – 500 KVA UDE Masonry Enclosure standard layout	C993889
315 – 500 KVA UDE Prefabricated Enclosure standard layout	C993890
800 – 1000 KVA UDE Masonry Enclosure standard layout drawing	C993891
800 – 1000 KVA UDE Prefabricated Enclosure standard layout	C993892
315 – 500 KVA Extensible UDE Masonry Enclosure standard layout	C993893
315 – 500 KVA Extensible UDE Prefabricated Enclosure standard layout	C993894
800 – 1000 KVA Extensible UDE Masonry Enclosure standard layout	C993895
800 – 1000 KVA Extensible UDE Prefabricated Enclosure standard layout	C993896
20kV Distribution Substation Masonry Enclosure standard layout	C993897
20kV Distribution Substation UDE Prefabricated Enclosure standard layout	C993898
315 – 1000KVA slide-in UDE Masonry Enclosure	C993899
315 – 1000 KVA slide-in Extensible UDE Masonry Enclosure	C993901
11KV Extensible HV panel with metering annexe masonry enclosure	C993903
11KV Extensible HV panel with metering annexe prefabricated enclosure	C993904
20KV Extensible HV panel with metering annexe masonry enclosure	C993905
20KV Extensible HV panel with metering annexe prefabricated enclosure	C993906
11kV RMMU with optional extensible switch masonry enclosure	C993907
11kV RMMU with optional extensible switch prefabricated enclosure	C993908
20KV RMU cable connected 1600KVA TX and 2500A ACB	C993909
11KV RMU cable connected 1600KVA TX and 2500A ACB	C993910
Working Drawings	**Northern Powergrid Drawing No.**
315 – 800 KVA UDE Masonry Enclosure (Restricted Site)	C1004500
315 – 800 KVA Prefabricated Enclosure (Restricted Site)	C1004501
1000 KVA UDE Masonry (Restricted Site)	C1004502
1000 KVA UDE Prefabricated Enclosure (Restricted Site)	C1004503
315 - 800 KVA Extensible UDE Masonry Enclosure (Restricted Site)	C1004504
315 – 800 KVA Extensible UDE Prefabricated Enclosure (Restricted Site)	C1004505
315 – 500 KVA UDE Masonry Enclosure standard layout	C991542
315 – 500 KVA UDE Prefabricated Enclosure standard layout	C991442
800 – 1000 KVA UDE Masonry Enclosure standard layout drawing	C991543
800 – 1000 KVA UDE Prefabricated Enclosure standard layout	C991443
315 – 500 KVA Extensible UDE Masonry Enclosure standard layout	C991544
315 – 500 KVA Extensible UDE Prefabricated Enclosure standard layout	C991545
800 – 1000 KVA Extensible UDE Masonry Enclosure standard layout	C991546
800 – 1000 KVA Extensible UDE Prefabricated Enclosure standard layout	C991547

20kV Distribution Substation Masonry Enclosure standard layout	C991548
20kV Distribution Substation UDE Prefabricated Enclosure standard layout	C991549
315 – 1000KVA slide-in UDE Masonry Enclosure	C993717
315 – 1000 KVA slide-in Extensible UDE Masonry Enclosure	C993719
11KV Extensible HV panel with metering annexe masonry enclosure	C993721
11KV Extensible HV panel with metering annexe prefabricated enclosure	C993722
20KV Extensible HV panel with metering annexe masonry enclosure	C993723
20KV Extensible HV panel with metering annexe prefabricated enclosure	C993724
11kV RMMU with optional extensible switch masonry enclosure	C993725
11kV RMMU with optional extensible switch prefabricated enclosure	C993726
20KV RMU cable connected 1600KVA TX and 2500A ACB	C993727
11KV RMU cable connected 1600KVA TX and 2500A ACB	C993728
315 – 1000 KVA UDE outdoor compound	C992655
11kv RMU Plinth	C992656
11kV Transformer Plinth	C992657
LV Cabinet Plinth	C992658
20 kV RMU Plinth	C992659
Companion Drawings	**Northern Powergrid Drawing No.**
Steel Hi Security Standard UDE doors	C969422
Steel Hi Security doors typical detail	C969423
Hardwood doors typical details	C969424
Hardwood Standard UDE doors	C969425
Steel Door Louvre	C969426
Steel Wall Louvre	C969427
Steel punched Door Louvre	C993352
Steel punched Wall Louvre	C993353
Steel / GRP Roof	C969428
Hi-Security Enclosure	C969429
Generator Cable Access	C969998
Standard Lock Cloaking Device	C992314
Hi Security Lock Cloaking Device	C993354
Lock Cloaking Device photos	C993355
Dual locking arrangement and hasp and staples	C993356
Hardwood door and furniture photos	C978467
Steel Hi Security door and furniture photos	C978644
Timber gates and fencing	C978465
Steel palisade gates and fencing - Distribution S/S and boundaries.	C978466
Steel palisade Security fencing - Primary S/S.	C993468
Steel palisade Security double gates - Primary S/S.	C993469
Steel palisade Security single gates - Primary S/S.	C993470
Hanging details of single and double gates – Primary S/S	C993471
Earth Point Connection	C978643
Street Lighting Control Box Hi-Security Cover	C993357
Asphalt Roof covering replacement	C993358
Northern Powergrid UK signage – full list with reference and photos	C993359

Signage for anti-climbing barriers and anti-vandal paint	C993360
Asbestos Inspection Management Systems (signage and report)	C993467

Appendix 2 – Self Certification Conformance Declaration

Distribution Substation Enclosures shall comply with the latest issues of the relevant national and international standards. Additionally this technical specification is intended to amplify and/or clarify requirements relating to these Standards.

This self-declaration sheet identifies the clauses of the aforementioned standards relevant to Distribution Substation Enclosures for use on the Northern Powergrid distribution network. The manufacturer shall declare conformance or otherwise, clause by clause, using the following levels of conformance declaration codes.

Conformance declaration codes
N/A = Clause is not applicable/ appropriate to the product
Cs1 = The product conforms fully with the requirements of this clause
Cs2 = The product conforms partially with the requirements of this clause
Cs3 = The product does not conform to the requirements of this clause
Cs4 = The product does not currently conform to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to conform.

Instructions for completion

- When Cs1 code is entered no remark is necessary
- When any other code is entered the reason for non-conformance shall be entered

Northern Powergrid's Product Specification and Reference: (e.g. Type A to NPS/006/002)

Manufacturer:

Manufacturer's Product Reference:

Name:

Signature:

Date:

NOTE: One sheet shall be completed for each item or variant submitted.

Appendix 2 – Continued

Technical Specification NPS/006/002

Clause	Requirement	Conformance Code	Confirm compliance *Briefly describe how it complies, or doesn't comply AND give details of the tests or other method(s) that were used to verify compliance*
3.1a	Standard security enclosure category Enclosures to be in accordance with drawings listed in Appendix 1 State what materials are used in the major elements; E.g. GRP walls, roof & doors		
3.1b	Enhanced security enclosure category Enclosures to be in accordance with drawings listed in Appendix 1 State what materials are used in the major elements; E.g. GRP walls, roof & doors		
3.1c	High security enclosure category Enclosures to be in accordance with drawings listed in Appendix 1 State what materials are used in the major elements; E.g. GRP walls, roof & doors		
3.2.1	Wind loading 23m/s Snow loading 0.8kN/m2 Distributed loading 1.0kN/m2 U value 1.6W/ m2/°C Solar gain 1,000W/m2		
3.2.2	Minimum of 20 year design life		
3.2.3	Ventilation Dissipate heat created from 1000KVA transformer on full load of 15kW + solar gain of roof surface at 1,000W/m2		

Clause	Requirement	Conformance Code	Confirm compliance *Briefly describe how it complies, or doesn't comply AND give details of the tests or other method(s) that were used to verify compliance*
	State how ventilation requirement is achieved		
3.2.4	Pressure Relief – per BRE report TCR 20/97 250MVA for 1 second and all pass criteria met. For Standard security enclosures only.		
3.2.5a	Declare fire resistance for standard security enclosure – Class 2 to BS476 - 22 Minimum of 30 minutes rating.		
3.2.5b	Declare fire resistance for enhanced security enclosure – Class 2 to BS476 - 22 Minimum of 30 minutes rating.		
3.2.5c	Declare fire resistance for high security enclosure – Class 2 to BS 476 - 21 Minimum of 30 minutes rating.		
3.2.6	Surface Finish types: Brick/stone, bespoke clad effect or smooth finish to match environment. Non fade for design lifetime Smooth surface above door for property label. All internal surfaces to be light colour to maximise light levels to improve internal visibility. The internal surface should have an anti-condensation coating incorporated with a fungicide.		
3.2.7a	Declare LPCB SR 1175 classification for the Standard security enclosure. Where Northern Powergrid has an optional LPCB security rating requirement.		
3.2.7b	Declare LPCB SR 1175 classification for the Enhanced security enclosure. Where Northern Powergrid has a LPCB security rating classification of 1.		
3.2.7c	Declare LPCB SR 1175 classification for the High security		

Clause	Requirement	Conformance Code	Confirm compliance *Briefly describe how it complies, or doesn't comply AND give details of the tests or other method(s) that were used to verify compliance*
	enclosure. Where Northern Powergrid has a LPCB security rating classification of 2.		
3.2.7d	Entered in the British Research Establishments (BRE) Red book Live for LPCB enclosures.		
3.2.7e	Declare Degrees of Protection: IP33 before and after impact tests Tested to BS EN 60068-2-75 a) Impact energy 20J or 50J b) Number of impacts shall be: Twelve impacts to every facet and door Six impacts to other specified points. c) Test apparatus d) The housing shall not move >6mm. g) Attitude and impact locations as specified h) Securing of bases, covers and similar j) Pass criteria all met Not penetrated more than 10mm <6mm added flex/movement at edges/joints Daylight not visible through new gaps Cracks on outer surface <1mm x 50mm l) Final measurements and records		
3.2.8	List suppliers preferred cylinder, dead lock and padlock types. They should have an attack resistance graded to match the LPCB security rating for each level of enclosure.		
3.3	Where the enclosure is manufactured from steel then the unit shall be fully galvanised to BS EN ISO 1461		
3.3	External fasteners shall be high tensile coach bolts with smooth domed or smooth faced countersunk head to minimise tampering opportunities		

Clause	Requirement	Conformance Code	Confirm compliance *Briefly describe how it complies, or doesn't comply AND give details of the tests or other method(s) that were used to verify compliance*
3.3.1	Roof: 2 way 5° or 4 way 22.5° - state characteristics: Explosion relief, (standard security enclosure only) Integral lifting feature(s) Support distributed load 1.0kN/m2 Support 3 stationery youths (200kg) Support 2 jumping youths (140kg)		
3.3.2	Doors: Minimum 2,000mm high and 750mm wide Open outwards to 90° to 110° Automatic engagement device with drop cord or bar to allow easy release. Left hand door; spring loaded bolts top & bottom Right hand door lock to be fitted with the cylinder and dead lock case. Internal, bolted security bar over dead lock body, to give added protection from punching through. External lock protected by cloaking device. Anti-jemmy meeting covers. Stainless door hinges with dog bolts. Robust steel welded louvers fitted with vermin gauge. Bi-fold door option available.		
3.3.3	Walls – 2.4m high		
3.3.4	Features: 215mm x 215mm generator lead 'cat flap' pad locked internally. 1,000mm x 400mm x 12mm notice board Maximum weight calculations and fixing procedure for possible surfaced fixed equipment/ fittings.		

Clause	Requirement	Conformance Code	Confirm compliance *Briefly describe how it complies, or doesn't comply AND give details of the tests or other method(s) that were used to verify compliance*
	Internally grout at base level.		
3.4.2a	The insertion loss provided by the completed built structure will guarantee compliance with BS 4142, Meets World Health Organisation guidelines for community noise and other specified documents. The anticipated Sound Reduction Index for this construction will be shown in dB over a wide range 1/3 octave frequencies and by a value of reduction in dB, (A) weighted at 100Hz		
3.4.2b	The enclosure shall be designed and built to achieve attenuation in sound (insertion loss) of between 15dB & 20dB at 100Hz provided by the complete enclosure or provide attenuation levels to comply with the requirements of the recommendations of an acoustic report that has been done prior to these works to assess levels of required attenuation.		
3.4.2 (c)	The efficacy of the acoustic enclosure can be to some extent nullified if certain critical distances are not observed due to the build-up of standing sound waves within the structure. The design of transformer enclosures shall consider the effect of these standing sound waves. The distance between large flat faces of the transformer tank (sides and top and not the cooling fins) and the acoustically reflective surface of the enclosure walls or lining, floor and roof, opposite walls or acoustically reflective surfaces is critical as a build of these standing waves can nullify, to some extent, the attenuating effects of acoustic enclosures.		