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Electricity Specification 400G3

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Compressed Gas Supply and Control Systems for Underground Gas-Filled Cables

Amendment Summary

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1 Introduction

This specification covers the technical requirements and standards for the design, construction and installation of compressed gas supply and control systems for underground gas-filled cables.

All existing pressure systems shall be replaced by systems that meet the requirements of the Pressure System Safety Regulations 2000 (PSSR).

2 Scope

This specification covers all gas-filled cable systems and their associated control systems owned and operated by Electricity North West Limited (Electricity North West).

3 Definitions

Definitions are as per British Compressed Gases Association (BCGA) Codes of Practice 4 and 39, and as follows:

BCGA	British Compressed Gases Association.
Pressures	Pressures quoted are gauge pressures unless stated otherwise.
PSSR	Pressure System Safety Regulations 2000.
Transition joint	A joint which has been specifically designed to connect together two different types of cable. In the case of a joint designed to connect a gas-filled cable to a solid cable, the requirement to maintain gas-pressure on the gas-filled side will have been taken into account.
SCADA	Supervisory Control and Data Acquisition.

4 Background

Certain older cables operating at 33kV use pressurised nitrogen as an insulating medium. The nitrogen needs to be pressurised to maintain a high enough density of gas to suppress ionisation which would otherwise occur at this voltage. Additionally, the gas must be dry and uncontaminated. It is extremely important to keep moisture out of cables.

These existing cables can be of the order of many km in length. There is a mixture of general arrangements of gas control/termination systems in substations and street pillars. The complexity of the systems depends on the circuit length, the number of circuits and mixture of cables. If a gas leak occurs, there must be sufficient

provision designed into the supply system to enable gas pressure to be maintained until the leak can be repaired.

Additionally, many of these cables are under built-up areas or adjacent to roads. Safety distances and security of equipment (for example, pumping equipment) will need careful consideration.

Future development of all gas-filled cable systems also needs to be considered. In future, when any failures occur in these cables, the policy is to replace the failed length of cable with solid cable, which would necessitate a transition joint at either end. This would effectively split up the gas-filled cable into segments, each of which would need to be supplied with pressurised, dry nitrogen gas.

5 Technical Requirements

5.1 General Requirements

The following general requirements shall be met.

- Tenderers shall be members of the British Compressed Gases Association (BCGA).
- All systems to this specification shall be designed, constructed and installed to BCGA Codes of Practice 4 and 39.
- In addition to these technical requirements, all designs shall take account of the background information (refer to Section 4).
- All materials, processes and documentation (records, Written Scheme of Examination, etc) shall comply with BCGA Codes of Practice 4 and 39. (Only nitrogen gas approved materials shall be used.)
- All equipment installations shall be rated meet the specifications required for the new 300 bar cylinders.
- The equipment and inspection regime shall be designed to avoid the requirement of a weekly inspection.
- Preferably, systems shall be designed for ease-of-replacement/ease-of-modification, for example, accessible, modular type designs.

5.2 Safety Requirements

5.2.1 General

Safety shall be a primary consideration in any design. Members of the Public, Electricity North West Staff and Property shall be protected against the failure of any system (including failure of primary protection systems, such as pressure relief valves). Examples of such protection are as follows:

- Risk assessments shall be carried out at every location as part of the design process. This process shall include guidance from the BCGA codes of practice listed in Section 6. The risk assessments shall be used to establish safety clearances, ventilation requirements, alarms and blast mitigation measures, etc.

- The risk of asphyxiation shall be designed out wherever possible. This can be achieved by providing adequate ventilation (to be based on a stated maximum storage capacity). All systems shall be vented to atmosphere outside the substation.
- There shall be an oxygen depletion alarm at the location of each supply system and manifold in any enclosed space or pit where a gas leak could cause an asphyxiation risk, for example, in a substation.
- The risk of explosion due to rapid heating or failure of pressure relief valves, shall be mitigated by, for example, the provision of blast walls or ensuring compressed nitrogen cylinders will not be stored near heat sources or potential heat sources.
- All systems shall meet the requirements of the Health and Safety Executive Approved Code of Practice L122 (Second Edition, 2014).

5.2.2 Safety Distances

Safety distances shall meet the requirements of BCGA Code of Practice 4.

Safety distances shall be minimised. For example, manifold and supply system shall be kept together, wherever possible.

5.2.3 Compressed Nitrogen Cylinders

The following points shall be accounted for in all installations housing compressed nitrogen cylinders:

- Cylinders containing compressed nitrogen shall be stored upright.
- Cylinders containing compressed nitrogen shall be stored in well-ventilated areas.
- Cylinders containing compressed nitrogen shall be stored at temperatures below 50ºC.
- There shall be adequate access to areas housing compressed nitrogen cylinders, such that they can be transported in and out without rolling or sliding, and the likelihood of the cylinders being dropped is minimised.

In addition, the storage areas shall comply with BCGA Code of Practice 44.

5.3 Specific Technical Requirements

5.3.1 Nitrogen Requirements

Nitrogen shall be:

- Generally, as specified in BCGA Code of Practice 4.
- Purity Grade 4.8 (that is 99.998% pure). Refer to Appendix A for more details of the gas specification.

5.3.2 Pressure Requirements

Operating pressures of gas-filled cables are as follows:

- Maximum cable pressure = 1517kN/m^2 (220psi).

- Maximum operating pressure = 1379kN/m^2 (200psi).
- Nominal normal operating pressure = 1103kN/m^2 (160psi).
- Minimum normal operating pressure = 965kN/m^2 (140psi).
- Minimum operating pressure > 862kN/m^2 (125psi). If the cable pressure drops to 862kN/m^2 (125psi), the circuit needs to be switched out (normally via telecontrol). Note that switching out at 862kN/m^2 (125psi) is NOT an automatic process.

Operation between 862kN/m^2 (125psi) and 965kN/m^2 (140psi) is not considered to be "normal operation". It is only acceptable for a relatively short time and in special circumstance, for example, maintaining operation of the cable until a leak can be located and repaired.

5.3.3 Supply, Control, Monitoring and Regulation

All supply, control, monitoring and regulation installations shall comply with BCGA Codes of Practice 4 and 39.

New installations shall be connected directly to the cable feed pipes via the pipework and joints specified in Section 5.3.5.

These installations will need to incorporate Electricity North West wiring and monitoring equipment (for example telecontrol wiring and existing transducers).

Manifolds shall be designed to enable additional cylinders to be connected, either at the manifold or in the form of temporary cylinder bundles. (This may be necessary to maintain sufficient gas pressure in cables when managing gas leaks.) The as-installed information for each location shall include a method for the safe connection of additional cylinders.

Manifolds in substations shall be fitted with suitable pressure relief devices that are safely vented out of the substation and into a safe area.

Gas cylinders shall be fitted with gauges that read up to 34,474kN/m^2 (5000psi).

5.3.4 Street Pillars

Street pillars are generally single cylinder charging points, and require a regulator and pressure relief valve.

5.3.5 Replacement Pipework, Joints and Gauges – LP System

Pipework and joints will be needed to connect new installations (Sections 5.3.3 and 5.3.4) into existing cable feed pipes. These low pressure pipes and joints are to be connected between the low pressure output of regulators and existing cable feed pipes.

Pipework shall be made of copper or stainless steel and shall match the specification of the existing cable feed pipes to which they are connected. Pipework size shall be selected to minimise the pressure drop.

The minimum number of mechanical joints shall be used. Mechanical joints shall match the pipework to which they are connected.

Pipework (including joints) shall be rated to 23.5 bar.

Pressure gauges for measuring cable pressure shall read up to 1724kN/m^2 (250psi).

5.3.6 Identification of Items to aid Future Maintenance

Each gas cylinder shall be indelibly marked with an identification number in such a position that there is no likelihood of the number being defaced during handling or transportation.

All equipment locations (street pillars, etc) shall be numbered to match Ellipse.

5.3.7 Remote Control, Monitoring and Alarms

The control and monitoring system shall interface with the Electricity North West SCADA system to provide pressure alarms, etc.

Pressure transducers shall be fitted on the high pressure side and low pressure side, so that cylinder pressure and cable supply feed pressures can be monitored and alarms raised.

The supplier shall liaise closely with Electricity North West on the precise requirements in each case to ensure smooth integration of appropriate devices and systems.

5.3.8 Provision of Information

As constructed Information shall be provided in paper and electronic form. All drawings or diagrams shall be in Adobe illustrator format. This information shall include the extent of the system under the written scheme and not-written scheme.

The Written Scheme of Examination shall contain sufficient detail to be undertaken by a suitably qualified third party.

Sufficient information shall be supplied to enable Electricity North West to operate and maintain the system safely.

5.4 Testing and Commissioning

Prior to use, all systems shall be tested and commissioned in accordance with BCGA Code of Practice 4.

A proposal for testing and commissioning shall be included in the Tender.

6 Documents Referenced

DOCUMENTS REFERENCED	
The Pressure Systems Safety Regulations 2000	

Health and Safety Executive Approved Code of Practice L122 (Second Edition, 2014)	Safety of Pressure Systems
BCGA Code of Practice 4, Revision 4 : 2012	Industrial Gas Cylinder Manifolds and Gas Distribution Pipework xcluding Acetylene)
BCGA Code of Practice 39, Revision 2: 2017	In-Service Requirements of Pressure Equipment (Gas Storage and Gas Distribution Systems)
BCGA Code of Practice 44, 2016	The Storage of Gas Cylinders

7 Keywords

Gas; Pressure

Appendix A – Specification for Commercial Grade Nitrogen

A1 General

The purity of nitrogen used in gas-filled cable systems shall meet or exceed the specification below.

A2 Specification

- Nitrogen: 99.9% approximately (on dry gas).
- Oxygen: 0.05%.
- Carbon dioxide: Up to 20 volumes per million (vpm).
- Carbon monoxide: Nil.
- Other carbonaceous compounds: less than 5vpm.
- Hydrogen: 20vpm approximately.
- Neon: 600vpm approximately.
- Argon: less than 50vpm.
- Helium: 160vpm approximately.

The water vapour content of the gas at NTP drawn from a full cylinder shall not exceed 0.20g/m^3, or if the cylinder is exhausted down to 3100kN/m^2, 0.6g/m^3.