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National Grid

National Grid
Technical
Specification

**Temperature Monitoring
Systems for Power Cables**

NGTS 3.5.5
Issue 6
September 2002

CONTENTS	Page
Foreword	1
1 Scope	1
2 References	1
3 Definitions	2
4 General Requirements	2
5 Performance Requirements	5
6 Type Test Requirements	6
7 Routine Test Requirements	8
8 Sample Test Requirements	8
9 Site Test Requirements	8
Appendix A	9
Appendix B	11

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TEMPERATURE MONITORING SYSTEMS FOR POWER CABLES

FOREWORD

This specification forms part of a suite of documents which define National Grid requirements for new plant. The Level 2 Specification for cable, NGTS 2.5, covers major requirements and there is a series of Level 3 Specifications covering various specific requirements.

1 SCOPE

This document is a Level 3 Specification giving the requirements for distributed temperature monitoring systems for power cables.

2 REFERENCES

- | | |
|---------------|--|
| BSEN 187000 | Generic Specification for Optical Fibre Cables. |
| IEC 60050 | International Electrotechnical Vocabulary. |
| IEC 60304 | Standard Colours for Insulation for Low-Frequency Cables and Wires. |
| IEC 60529 | Degrees of Protection Provided by Enclosures (IP Code) |
| IEC 60794-1 | Optical Fibre Cable. |
| IEC 60870-2-1 | Telecontrol Equipment and Systems – Power Supply and Electromagnetic Compatibility. |
| IEC 60874-1 | Connectors for Optical Fibres and Cables |
| I-ETS 300 227 | ITU-T Recommendation G 652 Type Single-Mode Optical Fibre. |
| NGTS 1 | Ratings and General Requirements for Plant, Equipment, Apparatus and Services for the National Grid System and Direct Connections to it. |
| NGTS 2.5 | 132 kV, 275 kV and 400 kV Single Core Cable. |
| NGTS 2.7 | Specification for Substation Control Systems. |
| NGTS 3.5.4 | Sheath Bonding and Earthing for Insulated Sheath Cable Systems. |
| NGTS 3.5.7 | Installation Requirements for Power and Auxiliary Cables. |
| NGTS 3.8.7 | Non Metallic Underground Optical Fibre Cable |
| NGTS 3.8.8 | Fibre Optic Joint Boxes. |
| NGTS 3.8.23 | Fibre Optic Joint Closures for End Links. |
| NGTS 3.12.3 | Substation LVAC Supplies. |
| NGTS 3.12.4 | 48 V and 110 V DC Supplies. |
| NGTS 3.24.15 | Electronic Equipment. |

3 DEFINITIONS

- 3.1 The terms used in this document are as defined in NGTS 2.5.

4 GENERAL REQUIREMENTS

- 4.1 Cable operating temperatures can be applied to the calculation of real-time thermal ratings. Although cable temperatures can be obtained from thermocouples or other point sensors, it is not always possible to identify the cable hot spots. This specification is for a fibre-optic distributed temperature monitoring system. Alternatives meeting the functional and performance requirements will also be considered.

Environmental Conditions

Fibre-Optic Cable or Tube With Blown Fibre

- 4.2 The fibre-optic cable or tube with blown fibre shall be capable of operating over the temperature range -10°C to 70°C.
- 4.3 Under transmission system fault conditions the surface of the power cable may achieve an operating temperature above 70°C for short periods. To ensure design compatibility the supplier of the fibre-optic cable or tube with blown fibre shall state the maximum temperature which the fibre-optic cable or tube with blown fibre can survive for 1 h without sustaining any permanent damage.

Distributed Temperature Sensing

- 4.4 The supplier of the distributed temperature sensing (DTS) equipment shall ensure that the combination of the equipment and the fibre-optic cable are able to achieve the system performance criteria specified in Section 5.
- 4.5 The DTS equipment will normally be located indoors in a substation environment and where this is the case it shall conform to the requirements of NGTS 3.24.15.
- 4.6 The DTS equipment shall operate satisfactorily over the range of conditions defined in NGTS 1 Table 1 Class 2.

Optical Fibres

- 4.7 The type of optical fibre installed shall be 50/125 µm multimode fibre.
- 4.8 The optical fibre coating shall be mechanically removable for connection purposes.
- 4.9 The coating and/or buffer of each fibre shall be colour coded for identification purposes. The colours used shall be as specified in IEC 60304.

Cable Construction

- 4.10 There shall be a minimum of two fibres per fibre-optic cable or tube.
- 4.11 The fibre-optic cable or tube shall have a nominal diameter no greater than 8 mm. The cable design shall provide maximum resistance to water-induced degradation of the optical fibres and this shall include filling the interstices of the cable core with water-excluding compound.

Oversheath

- 4.12 The oversheath shall have a high resistance to moisture penetration and shall provide robust mechanical protection equivalent to or better than that provided by High Density Polyethylene (HDPE).

- 4.13** Where a cable is to be installed in an environment where special precautions are required to reduce fire emissions and where the oversheath material is not fire retardant an additional coating shall be applied to minimise the risk of fire propagation.

Metallic Components

- 4.14** In the event that metallic components are used in the construction or installation of the fibre-optic cable:
- (a) The supplier shall take all necessary precautions to prevent any possibility of accidental contact with any metallic components which may be subject to a standing voltage in excess of 10 V.
 - (b) Where metallic components are subject to potentially dangerous induced voltages, it is the responsibility of the supplier to agree with National Grid either Insulated Working or Earthed Working practices to cover situations where it is necessary for personnel to come into contact with the components.
 - (c) The supplier shall ensure that the temperature measured by the DTS system is not raised by more than 0.5°C under normal operating conditions as a result of the metallic components being present.
 - (d) The supplier shall ensure the cable will not be damaged by fault currents in adjacent equipment. NGTS 1 Table 5 details the appropriate range of short circuit current ratings for system voltages of 132 kV and above.
 - (e) Where a conducting material is included in the fibre-optic cable or tube construction this component shall be solidly bonded to earth and have continuity.

Cable Identification

- 4.15** The protective oversheath shall be identified longitudinally with the words "National Grid Optical Cable" and the manufacturer's identification at intervals not greater than 1 m along the side of the cable.
- 4.16** The markings shall remain legible following installation and throughout the required working life of the power cables which is nominally 40 y.

Optical Fibre Jointing

- 4.17** The optical fibres shall be capable of being joined by the fusion splicing technique.

DTS Equipment

Data Logger Facilities

- 4.18** The cable temperature shall be stored on a data logger consisting of a main fixed data storage device with a removable storage device for backup.

Informative: Typically the fixed data storage device will be a hard disc drive and the removable storage device will be a floppy disc drive or CD writer.

- 4.19** The data logger shall have the facility for direct connection by a portable personal computer for local control and interrogation. It may also be required that the data be viewed and controlled locally via a fixed colour screen monitor this will be agreed at the time of contract. The logger shall be capable of:
- (a) Storing three months of hourly cable temperature measurements taken at 2 m intervals along the route.
 - (b) Plotting a graph of the cable temperature profile for any given set of readings.
 - (c) Being remotely accessed for control and interrogation via telephone network.
 - (d) Being remotely programmed to provide cable temperature warning alarms.

Data Logger Interfaces

- 4.20** In addition to any interfaces to meet the requirements for the data logger facilities the data logger shall be provided with a:

- (a) Substation Control System alarm interface.
- (b) Substation Control System analogue interface.

Remote Temperature and Alarm

- 4.21** Cable temperature warning alarms and temperature analogue readings shall be supplied to the Substation Control System. Alarm inputs to the Substation Control System shall be via separate clean contacts rated at 0.2 A, 48 V d.c. The requirements for National Grid Substation Control System are specified in NGTS 2.7.

Power Supplies

- 4.22** Unless otherwise agreed supplies for cable temperature monitoring equipment should be derived from a secure supply.

Informative: Substations will normally have the following power supplies available for use:

- (a) 48 V and 110 V d.c. – specified in NGTS 3.12.4
- (b) 230 V 50 Hz a.c.

Installation

- 4.23** The fibre-optic cable shall be compatible with the installation conditions used for the power cables.

Informative: The most common installation methods are given below and the detailed installation requirements for power cables are specified in NGTS 3.5.7 and NGTS 3.5.12:

- (a) Buried below ground in a cement-bound-sand (CBS) backfill.
- (b) In air outdoors, indoors or in tunnels.
- (c) In ducts with a bentonite filler.
- (d) In concrete troughing which may be filled with a CBS backfill or be unfilled.

Configuration

- 4.24** The fibres shall be connected to form loops by joining the fibres together at the remote end in the DTS equipment.
- 4.25** The number of splices in the fibre-optic sensing cable shall be minimised.

Informative: The routing of the fibres shall be normally optimised to provide for reconfiguration following the failure of any fibre.

Fibre-Optic Cable or Tube Attachment

- 4.26** Where the power cables are in horizontal flat formation the fibre-optic cable or tube shall be attached to the centre cable of each three-phase group on the oversheath at the uppermost position. The fibre-optic cable or tube shall be taped in the upper most position for cable in air. The fibre-optic cable or tube shall be attached to the power cable in such a manner that it is in contact with the power cable surface, or the crests on the surface of a cable with a corrugated sheath. The maximum gap between the fibre-optic cable or tube and the power cable surface shall be 1 mm after installation.
- 4.27** At joint positions and where the power cables are laid in other than horizontal flat formation the temperature monitoring positions shall be agreed with National Grid.