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Electric surface heating —

**Part 3: Code of practice for the
installation, testing and maintenance of
electric surface heating systems**

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- Committee for Electrical Equipment for use in Flammable Atmosphere (BEAMA)
- Electricity Supply Industry in England and Wales
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- Engineering Equipment and Materials Users' Association
- Glass Manufacturers' Federation
- Health and Safety Executive
- Induction and Dielectric Heating Manufacturers' Association
- Institution of Electrical Engineers
- Lighting Industry Federation Ltd.
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Foreword

This Part of BS 6351 has been prepared under the direction of the Power Electrical Engineering Standards Committee.

BS 6351 consists of the following Parts:

- *Part 1: Specification for electric surface heating devices;*
- *Part 2: Guide to the design of electric surface heating systems;*
- *Part 3: Code of practice for the installation, testing and maintenance of electric surface heating systems.*

This Part should be read in conjunction with Parts 1 and 2 of BS 6351 and with the instructions and recommendations of the system designers and of the manufacturers of the equipment being installed.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations¹⁾. In particular, attention is drawn to the following:

Health and Safety at Work etc. Act 1974

Factories Act 1961

Electricity (Factories Act) Special Regulations 1908 and 1944

Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972

IEE Regulations for Electrical Installations

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

¹⁾ The designer, installer and user should make themselves aware of any legal or local regulations applying to the works or site.

0 Introduction

Electric surface heating (ESH) systems are designed to match the requirements of the process and plant. The ESH system comprises a number of components that are integrated on site and it is therefore necessary to ensure that the plant parameters used in the design are still valid when the ESH system is installed and that the components are installed correctly. Appropriate testing and maintenance are also essential to ensure satisfactory performance and safety.

1 Scope

This code of practice makes recommendations on installation procedures for ESH systems. It also covers the related topics of repair methods and inspection, maintenance and testing. Recommendations are made additionally on wiring systems and the installation of thermal insulation. It does not cover devices that operate by induction heating, immersion heating, skin-effect heating or direct pipeline heating, nor those intended for stress relieving.

Recommendations are given for use both in non-hazardous areas and in those hazardous areas (other than marine applications, mining applications or explosives processing and manufacture) classified as Zone 1 or Zone 2 in accordance with BS 5345. The scope of this code does not include areas classified as Zone 0 nor the heating of parts of vessels, etc. when they may have an internal Zone 0 classification.

NOTE The titles of the publications referred to in this code are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 6351, the definitions given in BS 6351-1 apply.

3 Preparatory work

3.1 Personnel. All persons involved in the installation, testing and maintenance of electric surface heating systems should be suitably trained in any special techniques required, as well as in general electrical work. All work should be monitored by trained supervisors.

3.2 Pre-installation checks. Before starting installation work, the check list given in Table 1 should be used to determine whether the design matches the installation conditions.

It is essential that the work follow the design scheme, but no item listed should be allowed to pass unchecked.

3.3 Surface preparation. The surface to which the ESH device is to be fitted should be free from rust, grease, oil, etc. and any sharp protrusions such as weld spatter, cement splashes, etc. should be removed. All surfaces should be smooth and clean as far as is possible. Care should be taken to ensure that any coating or finish applied to the workpiece is suitable for the duty.

4 Installation of ESH devices

4.1 Recommendations for all types of ESH system

4.1.1 General. The aspects of installation procedure described in 4.1.2 to 4.1.11 are common to all types of ESH system and should be observed unless otherwise specified by the designer.

Recommendations for individual types of ESH device are given in 4.2 to 4.5.

4.1.2 Appropriateness of device. The details given on the label attached to the ESH device should be checked for compliance with the system documentation.

4.1.3 Terminations

4.1.3.1 General. It is essential that all types of surface heating equipment are terminated correctly. Manufacturer's specific instructions should be followed together with the general procedures described in 4.1.3.2 to 4.1.3.7.

4.1.3.2 Cold leads. Cold leads should be fitted or modified on site only in strict accordance with the manufacturer's recommendations. Any such work carried out on ESH devices used in hazardous areas will invalidate the certificate unless carried out strictly in accordance with specific instructions incorporated in the certificate schedule; the manufacturer of the ESH device should be consulted.

Where cold leads have been jointed to metal-sheathed heating cables by means of soldering or brazing, neither the heating cables nor the cold lead should be bent within 150 mm of the joint. Each cable should be fixed at a distance of 150 mm from the joint to prevent this.

NOTE In some instances it is not desirable to have a cold lead anchored to the heated surface because of the risk of exceeding the maximum recommended temperature for the cold lead.

Table 1 — Pre-installation checks

Items to be checked	Remarks
1. Is the pipework fully erected and tested and all temporary supports removed?	Any welding or pressure testing after the installation of an ESH device could damage the device
2. Is the surface to which the ESH device is to be applied normal steel?	If the surface is of polished stainless steel, very thin-walled pipe or plastic of any kind, then special precautions may be necessary
3. Do the items to be heated correspond in size, length, position, etc. with the design?	It is sometimes difficult to be sure that the correct pipe is being heated. BS 1710 could be of assistance, as could any other line numbering system
4. Has an inner cladding been specified to be installed before the application of the ESH device?	This may be used to provide an earth path and/or to aid heat distribution
5. Has an inner cladding been specified to be installed after the application of the ESH device?	This may be used to prevent lagging from surrounding the ESH device and so increasing its temperature
6. Can flow of product under normal or abnormal conditions reach temperatures greater than those that the ESH device can withstand?	This would normally be covered in the design stage; however, further discussion with staff at the plant may show that incorrect or out-of-date information has been used
7. Are the ESH system designer's working drawings or designs and the manufacturer's installation instructions available?	No change should be contemplated without reference to the ESH system designer, as careful calculations are necessary to ensure safe operation
8. Can pipe or surface expand and contract so as to cause stress on any part of the heating installation?	In this case precautions are necessary to avoid damage
9. Can sensors of temperature controllers be affected by outside influences?	An adjacent heating circuit could affect the sensor
10. Is the ESH device to be spiralled or snaked on to the pipework, according to the design?	
11. Are cold leads suitable for contact with the heated surface?	If the cold lead is to be buried under the lagging, it has to be able to withstand the temperature
12. Is pipework hung from a pipe rack?	In this case special precautions are required to ensure the weatherproofing of the lagging at points of suspension.
13. Does pipework have its full complement of supports?	The addition of intermediate supports at a later stage could damage the heating system
14. Are sample lines/bleed lines, etc. on plant but not on drawings?	These could obstruct or prevent the fitting of the ESH device and reference to the ESH system designer may be necessary
15. Are other parameters used in the design of the equipment as specified by the design documentation?	
16. Are the ESH devices, controllers, junction boxes, switches, cable, cable glands, etc., suitable for the hazardous area classification (if any) and the environmental conditions and are they protected as necessary against corrosion and the ingress of liquids and particulate matter?	

After site-fitting of cold leads, checks should be made to ensure that the joints have not affected continuity or insulation resistance, that joints are waterproof (where applicable) and that the earth connection across the joint is valid. Joints between cold leads and heating conductors should always be firmly anchored to the heated surface such that the hot cable cannot leave the surface to be heated. Cold leads should always emerge from the thermal insulation (where applied) in such a way that the resultant hole in the lagging cannot admit water or other contaminants. Excess lengths of cold leads may be distributed under the thermal insulation where construction and the manufacturer's instructions permit.

A check should be made to ensure that the cold leads can accommodate any movement of pipework resulting from expansion, contraction or vibration.

4.1.3.3 Junction boxes. ESH devices should be connected into junction boxes having a suitable degree or type of protection. Junction boxes should be located as closely as possible to the cold-lead exit point so that the length of cold lead vulnerable to mechanical damage will be a minimum. To achieve this, junction boxes, etc. can be mounted on the workpiece [see Figure 1(a)], provided that a thermal barrier is inserted between junction box and heated surface if indicated by the designer.

For outdoor applications, all junction boxes should be water and dust resistant and be mounted as shown in Figure 1(b). Lids should not be left open during the period of erection.

4.1.3.4 Cable entries and glands. ESH devices should be provided with seals and/or glands appropriate to the degree or type of protection. With threaded entries into the junction box, glands should be fully screwed into the box and compression applied to the cold leads or heating cable/tape to provide a complete seal. Unused entries should be blanked off with suitable plugs.

If unthreaded entries are used, the entry size should provide just sufficient clearance for the threaded section of the gland with the gland backnut tightened against a compressible sealing washer to seal the gland to the enclosure.

NOTE Requirements for dealing with unused entries in hazardous areas are given in BS 5501, BS 4683 and BS 5345.

4.1.3.5 Conductor terminations. Cold leads should be terminated in a safe and neat manner in the junction box or associated equipment. Terminals should be of sufficient size and rating to accept the conductors, which may be solid or stranded wires or foils. Care should be taken in stripping back insulation to avoid damaging the conductors.

Compression-type connectors or ferrules should be of the correct size and of an approved type for the conductor concerned. Compression tools should be of the ratchet type specific to the fittings used and be in good condition.

Cable ends that are not finally terminated immediately after cutting should be sealed to prevent ingress of moisture and should be protected from damage pending completion of the termination.

4.1.3.6 Earthing. Where an earth lead is fitted to an ESH device it should always be connected to an established earth terminal. (See CP 1013.)

In the case of braided and metal-sheathed cables and tapes, it may be necessary to earth at more than one point. Manufacturer's instructions should be observed. In a hazardous area, reference should be made to 22.6 of BS 5345-1:1976.

4.1.3.7 Jointing and splicing. Jointing and splicing may be done on site only in strict accordance with the manufacturer's recommendations. Any such work carried out on ESH devices used in hazardous areas will invalidate the certificate unless carried out strictly in accordance with specific instructions incorporated in the certificate schedule: the manufacturer of the ESH device should be consulted.

4.1.4 Electrical testing

4.1.4.1 General. ESH devices should be tested before installation for conductor continuity, unit resistance and, on units provided with a metallic covering, insulation resistance as described in 4.1.4.2 to 4.1.4.5.

4.1.4.2 Insulation resistance. The insulation resistance should be measured under normal dry conditions and before connection of the device to the associated wiring and control equipment by means of a d.c. voltage within the range 80 V to 500 V.

The insulation resistance should be not less than 0.1 MΩ km.

4.1.4.3 Unit resistance. The unit resistance of the device should be within the declared tolerance except for ESH devices with self-limiting characteristics.

NOTE For self-limiting ESH devices the resistance can vary considerably without affecting the operation of the device. A tolerance, related to the ambient temperature, for the circuit resistance of self-limiting ESH devices should be stated by the designer to allow a site material quality control check to be made.

4.1.4.4 Repetition of testing procedures. Tests should be repeated after installation of the ESH devices and again after the application of thermal insulation including any protection applied by surface treatment or the fixing of cladding. If a metal surface is to be in contact with the ESH devices after installation, insulation resistance tests should be made as described for units with a metallic covering.

4.1.4.5 Test report. All test results obtained in 4.1.4.1, 4.1.4.2, 4.1.4.3 and 4.1.4.4 should be recorded in the system documentation for future reference.

4.1.5 Thermal contact. Where an ESH device is designed to be in contact with the surface to be heated, it should be installed to provide as intimate a contact as is reasonably practicable, avoiding air gaps that may create hot spots and avoiding encapsulation by thermal insulation. Where such contact is not possible, the designer should specify appropriate measures to provide a suitable heat sink, e.g. metal bridge pieces across obstructions or application of thermally conducting materials.

4.1.6 Laying. ESH devices should not be folded, twisted or allowed to cross, overlap or touch, as this could create hot spots.

NOTE This precaution may not be necessary with devices having self-limiting characteristics if it has been allowed by the design.

4.1.7 Fixing. ESH devices should be affixed to the workpiece by a means approved by the manufacturer such that the possibility of damage is minimized. Fixing materials should be suitable for the temperature and environmental conditions.

4.1.8 Protection from leaks. Where ESH devices cross possible sources of liquid leaks, for example flanges, they should be positioned to minimize contact with the leaking medium.

4.1.9 Modifications. ESH devices should not be modified on site other than by agreement with the designer.

4.1.10 Damage prevention. Precautions should be taken with all ESH devices to prevent damage prior to the application of thermal insulation. The installer should liaise with the lagging contractor (where applicable) to ensure that thermal insulation is applied as soon as possible after installation of the ESH devices. Where lagging is not provided, the ESH devices should be protected to avoid the possibility of mechanical damage and hazard to personnel.

4.1.11 Labelling. On completion of the installation, all labels should be firmly fixed to the appropriate items of apparatus and contain the correct information in accordance with clause 11.

Particular care is necessary in this respect in the case of site-fabricated ESH devices.

Labels should be fixed on the cold leads of devices at all power supply points and to both sides of any series connection points.

All junction boxes, controls, isolators, etc. should be clearly marked indicating to which circuits they relate.

Where thermal insulation is to be applied by others, warning labels should be given to the client/lagging contractor for application in prominent positions over the thermal insulation/cladding. Any identification labels required should also be handed into safe keeping with clear instructions for fixing.

4.2 Heating tapes and heating tape units

4.2.1 General. In addition to the general points in 4.1, the points given in 4.2.2 to 4.2.9 should be observed when installing heating tapes or heating tape units.

4.2.2 Spiral application

NOTE 1 Where tapes are intended for spiral application to the pipework, the approximate pitch of the spiral will have been specified at the design stage.

NOTE 2 The relationship between spiral pitch and the ratio of nett tape length to nett pipe length is given in Appendix B of BS 6351-2:1983.

Spiral pitch markings should be made on the pipework before applying the tape in a uniform spiral, starting at the power supply point and maintaining slight tension in the tape as it is applied. If at the end of the section to be heated, excess or insufficient tape exists, the spiral pitch should be lengthened or shortened to retain a uniform spiral whilst maintaining good contact between pipe and tape and remaining in general accordance with the design documentation. In no circumstances should the spacing be less than the minimum declared by the manufacturer.

4.2.3 Straight tracing. Where tapes are intended for straight tracing on horizontal pipework, they should be applied as shown in Figure 2, Figure 3 and Figure 4. On vertical pipework the tapes should be spaced equally around the pipe.

NOTE Excess tape at the end of a section to be heated may be re-apportioned in agreement with the designer by spiralling or snaking.

4.2.4 Fixing. The heating tape should be fixed to the pipework at intervals not exceeding 2 000 mm for spiral application and 300 mm for straight traced application. Additional fixings should be applied at bends, flanges and other obstructions to maintain contact with the workpiece.