

Electrical resistance trace heating systems for industrial and commercial applications -

**Part 2: Application guide for system design, installation and maintenance
(IEC/TS 62395-2:2008)**

Systèmes de traçage par résistance
électrique pour applications industrielles et
commerciales -
Partie 2: Guide d'application pour la
conception, l'installation et la maintenance
du système
(CEI/TS 62395-2:2008)

Elektrische Begleitheizungen (Trace-
Widerstandsheizungen) für industrielle
und gewerbliche Zwecke -
Teil 2: Anwendungsleitfaden für
Systementwurf, Installation und Wartung
(IEC/TS 62395-2:2008)

This Technical Specification was approved by CENELEC on 2010-10-25.

CENELEC members are required to announce the existence of this TS in the same way as for an EN and to make the TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

This Technical Specification consists of the text of the Technical Specification IEC/TS 62395-2:2008 prepared by IEC TC 27, Industrial electroheating.

It was circulated for voting in accordance with the Internal Regulations, Part 2, Subclause 11.3.3.3 and was accepted as a CENELEC Technical Specification on 2010-10-25.

The following date was fixed:

- latest date by which the existence of the CLC/TS
has to be announced at national level (doa) 2011-04-25

Annex ZA has been added by CENELEC.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-841	-	International Electrotechnical Vocabulary (IEV) - Part 841: Industrial electroheat	-	-
IEC 60519-1	-	Safety in electroheat installations - Part 1: General requirements	EN 60519-1	-
IEC 62395-1	2006	Electrical resistance trace heating systems for industrial and commercial applications - Part 1: General and testing requirements	EN 62395-1	2006

CONTENTS

FOREWORD.....	7
INTRODUCTION.....	9
1 Scope and object.....	10
2 Normative references	11
3 Terms and definitions	11
4 Surface heating of vessels and piping systems.....	11
4.1 Application description	11
4.1.1 General	11
4.1.2 Environmental conditions.....	11
4.1.3 Trace heating systems considerations	12
4.2 Design information – General	12
4.2.1 General	12
4.2.2 Electrical system design	12
4.2.3 Control and monitoring	12
4.2.4 Trace heating system design	13
4.2.5 Design information documentation.....	14
4.3 Thermal system design.....	14
4.3.1 General	14
4.3.2 Design conditions	14
4.3.3 Thermal insulation	15
4.3.4 Heat loss determination	20
4.3.5 Design safety factor.....	21
4.3.6 Heat-up considerations.....	21
4.3.7 Selection of trace heater.....	22
4.3.8 Design calculations	25
4.3.9 Theoretical sheath temperature calculations – Metallic pipe applications	25
4.3.10 Theoretical sheath temperature calculations – Non-metallic pipe applications	26
4.3.11 Design documentation	27
4.3.12 Start-up at low ambient temperatures	28
4.3.13 Long trace heater circuits	28
4.3.14 Chimney effect	28
4.4 Electrical design.....	29
4.5 Control and monitoring system design	29
4.5.1 General	29
4.5.2 Mechanical controllers.....	29
4.5.3 Electronic controllers	30
4.5.4 Application suitability.....	30
4.5.5 Location of controllers	31
4.5.6 Location of sensors	31
4.5.7 Alarm considerations	32
4.5.8 Integrated control	33
4.5.9 Flow pattern analysis.....	33
4.5.10 Dead-leg control technique.....	35
4.6 Special design considerations	35
4.6.1 General	35

4.6.2	Freeze protection systems.....	35
4.6.3	Sprinkler systems, fire suppression	36
4.6.4	Hot water services/tempered water	36
4.6.5	Specialty lines	37
4.7	Installation	39
4.7.1	General	39
4.7.2	Personnel aspects	39
4.7.3	Preparatory work	40
4.7.4	Preliminary installation of trace heating circuits	40
4.7.5	Insulation resistance test.....	40
4.7.6	Installation of trace heater systems	41
4.7.7	Installation of control and monitoring equipment	43
4.7.8	Necessary modifications	44
4.7.9	Installation of the thermal insulation system	44
4.7.10	Installation of electrical power	46
4.7.11	Commissioning	46
4.8	Maintenance.....	47
4.8.1	General	47
4.8.2	Training of maintenance personnel	47
4.8.3	Frequency of inspection.....	48
4.8.4	Maintenance program documentation	48
4.8.5	Visual evaluation	48
4.8.6	Electrical evaluation	48
4.8.7	Review of the electrical protection system	49
4.9	Repair	49
4.9.1	General	49
4.9.2	Fault location.....	49
4.9.3	Practicability of repair to electric trace heaters	49
4.9.4	Repair techniques for electrical trace heaters	50
5	Roof and gutter de-icing	50
5.1	Application description	50
5.2	Design information – General	51
5.3	Thermal design	52
5.4	Electrical design.....	52
5.5	Control and monitoring system design	52
5.6	Special design considerations	53
5.7	Installation	53
5.7.1	General	53
5.7.2	Trace heaters and component mounting	53
5.8	Maintenance.....	56
5.9	Repair	56
6	Rail heating	57
6.1	Application description	57
6.1.1	Point heating	57
6.1.2	Contact/live rail heating	57
6.1.3	Track heating	57
6.1.4	Catenary/pantograph shoe heating	57
6.2	Design information	58
6.2.1	General	58

6.2.2	Weather data.....	58
6.2.3	Surface description.....	58
6.2.4	System design.....	58
6.2.5	Performance level classification.....	58
6.3	Thermal design	58
6.3.1	General	58
6.3.2	Typical heating load	59
6.4	Electrical design.....	59
6.5	Control and monitoring system design	59
6.6	Special design considerations	60
6.6.1	Electrical considerations.....	60
6.6.2	Finite element analysis	60
6.7	Installation	60
6.8	Maintenance.....	63
6.9	Repair	63
7	Snow melting.....	63
7.1	Application description	63
7.2	Design information	64
7.2.1	General	64
7.2.2	Weather data.....	64
7.2.3	Construction details of workpiece	64
7.2.4	Electrical considerations.....	64
7.2.5	System performance level	64
7.2.6	Trace heater layout and component mounting	65
7.3	Thermal design – Power output (heat load) determination	69
7.4	Electrical design.....	69
7.5	Control and monitoring system design	69
7.6	Special design considerations	69
7.7	Installation	70
7.8	Maintenance.....	70
7.9	Repair	71
8	Floor warming	71
8.1	Application description	71
8.2	Design information	71
8.2.1	General	71
8.2.2	Environmental data.....	71
8.2.3	Construction details of workpiece	71
8.2.4	Electrical considerations.....	71
8.2.5	Trace heater layout and component mounting	72
8.3	Thermal design – Heat load determination.....	73
8.4	Electrical design.....	74
8.5	Control and monitoring system design	74
8.6	Special design consideration	74
8.7	Installation	74
8.8	Maintenance.....	75
8.9	Repair	75
9	Frost heave prevention	75
9.1	Application description	75
9.2	Design information	76

9.2.1	General	76
9.2.2	Construction details of the floor	76
9.2.3	Electrical considerations	76
9.3	Heat load determination	76
9.3.1	General	76
9.3.2	Trace heater layout and component mounting	77
9.4	Electrical design	78
9.5	Control and monitoring system design	78
9.5.1	Control options	78
9.5.2	Monitoring	78
9.6	Special design considerations	78
9.7	Installation	79
9.8	Maintenance	79
9.9	Repair	79
10	Underground thermal energy storage systems	79
10.1	Application description	79
10.2	Design information	79
10.2.1	General	79
10.2.2	Environmental data	80
10.2.3	Construction details of building	80
10.2.4	Electrical considerations	80
10.2.5	Trace heater layout and component mounting	80
10.3	Thermal design – Heat-loss determination	81
10.4	Electrical design	81
10.5	Control and monitoring system design	82
10.6	Special design considerations when trace heaters are located in sand layer	82
10.7	Installation	82
10.7.1	General	82
10.7.2	Installation in sand	82
10.7.3	Installation in concrete	82
10.8	Maintenance	83
10.9	Repair	83
Annex A (informative)	Pre-installation checks	84
Annex B (informative)	Trace heater commissioning record	85
Annex C (informative)	Maintenance schedule and log record	86
Bibliography		87
Figure 1	– Thermal insulation – Weather-barrier installation	17
Figure 2	– Typical temperature profile	19
Figure 3	– Equilibrium conditions for workpiece maintenance	24
Figure 4	– Equilibrium conditions for upper limit evaluation	24
Figure 5	– Heated tank example	34
Figure 6	– Bypass example	35
Figure 7	– Double containment system	38
Figure 8	– Gravity flow piping systems	39
Figure 9	– Ice dam formation	51
Figure 10	– Downspout to underground drain	52

Figure 11 – Roof and gutter trace heater arrangement.....	54
Figure 12 – Gutter detail	54
Figure 13 – Typical roof mounting methods.....	55
Figure 14 – Drain detail for flat roof	56
Figure 15 – Typical positioning of point trace heater on stock rail and switch rail	61
Figure 16 – Typical positioning of trace heater on swing nose crossing.....	61
Figure 17 – Typical clamp lock trace heater	62
Figure 18 – Typical positioning of trace heater on steel and aluminium clad contact rails	62
Figure 19 – Typical positioning of trace heater in pantograph shoe	63
Figure 20 – Snow melting trace heater embedded in concrete	66
Figure 21 – Snow melting trace heater located in conduit	67
Figure 22 – Expansion joint detail	68
Figure 23 – Snow melting junction box location.....	68
Figure 24 – Typical floor warming trace heater mounting	73
Figure 25 – Typical floor heating power requirements	74
Figure 26 – Typical frost heave prevention substructure	76
Figure 27 – Frost heave prevention power requirements.....	77
Figure 28 – Typical underground thermal energy storage system installation	81
Table 1 – Application types.....	13
Table 2 – Recommendations for monitoring and control – Type II and III control	31
Table 3 – Recommendations for hot water services and tempered water temperatures	37
Table 4 – Possible trace heating load requirements	59
Table 5 – Typical snow melting heat loads.....	65

INTRODUCTION

IEC 62395-1 provides the essential requirements and testing appropriate to electrical resistance trace heating equipment used in industrial and commercial applications. While some of this work already exists in national or international standards, this standard has collated much of this existing work and added considerably to it.

IEC/TS 62395-2 provides detailed recommendations for the system design, installation, maintenance and repair of electrical resistance trace heating systems in industrial and commercial applications which can include piping, vessels, roofs and concrete slab heating applications.

It is the objective of IEC 62395 that, when in normal use, electrical trace heating systems should operate safely under their defined conditions of use, by

- a) employing heaters of the appropriate construction so as to meet the test criteria and requirements detailed in IEC 62395-1. The construction should include a metallic sheath, braid, screen or equivalent electrically conductive covering;
- b) operating at safe temperatures when designed, installed, and maintained in accordance with IEC/TS 62395-2;
- c) having at least the minimum levels of overcurrent and ground fault protection requirements in IEC 62395-1 (2006) (4.3).

ELECTRICAL RESISTANCE TRACE HEATING SYSTEMS FOR INDUSTRIAL AND COMMERCIAL APPLICATIONS –

Part 2: Application guide for system design, installation and maintenance

1 Scope and object

This part of IEC 62395 provides detailed recommendations for the system design, installation, maintenance and repair of electrical resistance trace heating systems in industrial and commercial applications. This technical specification does not include or provide for any applications in potentially explosive atmospheres.

This specification pertains to trace heating systems that may comprise either factory constructed or field (work-site) assembled units, and which may be series heater cables, parallel heater cables, heater pads or heater panels that have been assembled and/or terminated in accordance with the manufacturer's instructions for connection to voltage supplies up to and including 450 V/750 V.

This Technical specification does not cover induction, impedance or skin effect heating.

Trace heating systems can be grouped into different types of installations. These are characterized by different requirements for testing and are usually certified for a specific type of installation or application. Typical applications for the different types of installation are as follows:

- a) Installations of trace heating on pipes, vessels and associated equipment. Applications include:
 - freeze protection and temperature maintenance;
 - hot water lines;
 - oil and chemical lines;
 - sprinkler systems.
- b) Outdoor exposed area installations of trace heating. Applications include:
 - roof de-icing;
 - gutter and downspout de-icing;
 - catch basins and drains;
 - rail heating.
- c) Installation with embedded trace heating. Applications include:
 - snow melting;
 - floor warming;
 - frost heave prevention;
 - underground thermal energy storage systems;
 - door frames.
- d) Installations with trace heating inside conduit or piping. Applications include:
 - snow melting – in conduit;
 - floor warming – in conduit;
 - frost heave prevention – in conduit;

- underground thermal energy storage systems – in conduit;
- internal trace heating of potable water lines;
- enclosed drains and culverts.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-841, *International Electrotechnical Vocabulary – Part 841: Industrial electroheat*

IEC 60519-1, *Safety in electroheat installations – Part 1: General requirements*

IEC 62395-1:2006, *Electrical resistance trace heating systems for industrial and commercial applications – Part 1: General and testing requirements*

3 Terms and definitions

For the purposes of this document, the referenced terms and definitions are given in IEC 60519-1, IEC 62395-1 and IEC 60050-841.

4 Surface heating of vessels and piping systems

4.1 Application description

4.1.1 General

Piping and vessels are often provided with surface-mounted trace heating systems to maintain water above freezing-point and to maintain process fluids and gases at given temperature levels. The trace heaters compensate for heat losses to the environment that are reduced but not eliminated by thermal insulation.

4.1.2 Environmental conditions

Attention should be directed to the surrounding environmental conditions, especially for systems that are exposed to sunlight (ultraviolet exposure), coastal atmospheres (corrosive salt spray and high humidity), and chemical atmospheres such as oil refineries and chemical plants.

Equipment subject to ultraviolet exposure may degrade due to surface oxidation, which can possibly lead to surface embrittlement and cracking. Corrosive atmospheres can affect the same exposed surfaces and can accelerate degradation of surfaces that are also susceptible to ultraviolet exposure. Chemical exposure can affect all equipment, whether covered by thermal insulation or not.

The trace heating equipment for piping and vessels is often protected from corrosion and ultraviolet exposure to some degree by the thermal insulation. However, these systems can have components that are exposed to the environment such as electrical connection components and weather barrier around the thermal insulation. The selection of trace heating equipment shall include a review of the suitability of equipment to the expected environmental conditions.