

**Electrical resistance trace heating systems for industrial and commercial applications -- Part 2: Application guide for system design, installation and maintenance**

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

See Eesti standard EVS-EN 62395-2:2013 sisaldab Euroopa standardi EN 62395-2:2013 inglisekeelset teksti.	This Estonian standard EVS-EN 62395-2:2013 consists of the English text of the European standard EN 62395-2:2013.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 06.12.2013.	Date of Availability of the European standard is 06.12.2013.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile [standardiosakond@evs.ee](mailto:standardiosakond@evs.ee).

ICS 25.180.10

### Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:  
Aru 10, 10317 Tallinn, Eesti; [www.evs.ee](http://www.evs.ee); telefon 605 5050; e-post [info@evs.ee](mailto:info@evs.ee)

### The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:  
Aru 10, 10317 Tallinn, Estonia; [www.evs.ee](http://www.evs.ee); phone 605 5050; e-mail [info@evs.ee](mailto:info@evs.ee)

**Electrical resistance trace heating systems for industrial  
and commercial applications -  
Part 2: Application guide for system design, installation and maintenance  
(IEC 62395-2:2013)**

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 62395-2:2013)

Elektrische Widerstands-Begleitheizungen  
für industrielle und gewerbliche Zwecke -  
Teil 2: Anwendungsleitfaden für  
Systementwurf, Installation und Wartung  
(IEC 62395-2:2013)

This European Standard was approved by CENELEC on 2013-10-14. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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

**CENELEC**

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

**CEN-CENELEC Management Centre: Avenue Marnix 17, B - 1000 Brussels**

## Foreword

The text of document 27/927/FDIS, future edition 1 of IEC 62395-2, prepared by IEC/TC 27 "Industrial electroheating and electromagnetic processing" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62395-2:2013.

The following dates are fixed:

- latest date by which the document has to be (dop) 2014-07-14  
implemented at national level by  
publication of an identical national  
standard or by endorsement
- latest date by which the national (dow) 2016-10-14  
standards conflicting with the  
document have to be withdrawn

This document supersedes CLC/TS 62395-2:2010.

EN 62395-2:2013 includes the following significant technical changes with respect to CLC/TS 62395-2:2010:

- this document has been changed from a Technical Specification to a European Standard;
- design considerations for trace heating on sprinkler systems have been expanded and a figure has been added to illustrate how to avoid undue shadowing of spray patterns from insulated sprigs close to sprinkler heads;
- specific details of design considerations for trace heating for emergency eyewash units and safety showers have been added.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

## Endorsement notice

The text of the International Standard IEC 62395-2:2013 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60079-30-1:2007	NOTE	Harmonized as EN 60079-30-1:2007 (not modified).
IEC 60079-30-2:2007	NOTE	Harmonized as EN 60079-30-2:2007 (not modified).
IEC 60335-2-83:2001	NOTE	Harmonized as EN 60335-2-83:2002 (not modified).
IEC 60335-2-83:2001/A1:2008	NOTE	Harmonized as EN 60335-2-83:2002/A1:2008 (not modified).
IEC 60335-2-96:2002	NOTE	Harmonized as EN 60335-2-96:2002 (not modified).
IEC 60335-2-96:2002/A1:2003	NOTE	Harmonized as EN 60335-2-96:2002/A1:2004 (not modified).
IEC 60335-2-96:2002/A2:2008	NOTE	Harmonized as EN 60335-2-96:2002/A2:2009 (not modified).

**Annex ZA**  
(normative)

**Normative references to international publications  
with their corresponding European publications**

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 60519-1	-	Safety in electroheating installations - Part 1: General requirements	EN 60519-1	-
IEC 62395-1	2013	Electrical resistance trace heating systems for industrial and commercial applications - Part 1: General and testing requirements	EN 62395-1	2013

## CONTENTS

FOREWORD.....	7
INTRODUCTION.....	9
1 Scope.....	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 .....	13
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 .....	19
4.3.5 Design safety factor.....	20
4.3.6 Heat-up considerations.....	20
4.3.7 Selection of trace heater.....	21
4.3.8 Design calculations.....	23
4.3.9 Theoretical sheath temperature calculations – Metallic pipe applications .....	24
4.3.10 Theoretical sheath temperature calculations – Non-metallic pipe applications .....	25
4.3.11 Design documentation .....	26
4.3.12 Start-up at low ambient temperatures .....	26
4.3.13 Long trace heater circuits .....	27
4.3.14 Chimney effect .....	27
4.4 Electrical design.....	27
4.5 Control and monitoring system design .....	27
4.5.1 General .....	27
4.5.2 Mechanical controllers .....	28
4.5.3 Electronic controllers .....	28
4.5.4 Application suitability.....	28
4.5.5 Location of controllers .....	29
4.5.6 Location of sensors .....	29
4.5.7 Alarm considerations .....	30
4.5.8 Integrated control .....	31
4.5.9 Flow pattern analysis.....	31
4.5.10 Dead-leg control technique .....	33
4.6 Special design considerations .....	33
4.6.1 General .....	33

4.6.2	Freeze protection systems.....	33
4.6.3	Sprinkler systems, fire suppression .....	33
4.6.4	Hot water services/tempered water .....	35
4.6.5	Safety shower design requirements .....	36
4.6.6	Specialty lines .....	36
4.7	Installation.....	38
4.7.1	General .....	38
4.7.2	Personnel aspects .....	38
4.7.3	Preparatory work .....	38
4.7.4	Preliminary installation of trace heating circuits .....	39
4.7.5	Insulation resistance test.....	39
4.7.6	Installation of trace heater systems .....	39
4.7.7	Installation of control and monitoring equipment .....	42
4.7.8	Necessary modifications.....	43
4.7.9	Installation of the thermal insulation system.....	43
4.7.10	Installation of electrical power .....	44
4.7.11	Commissioning .....	45
4.8	Maintenance.....	46
4.8.1	General .....	46
4.8.2	Training of maintenance personnel .....	46
4.8.3	Frequency of inspection.....	46
4.8.4	Maintenance program documentation .....	46
4.8.5	Visual evaluation .....	47
4.8.6	Electrical evaluation .....	47
4.8.7	Review of the electrical protection system .....	47
4.9	Repair .....	48
4.9.1	General .....	48
4.9.2	Fault location.....	48
4.9.3	Practicability of repair to electric trace heaters .....	48
4.9.4	Repair techniques for electrical trace heaters .....	49
5	Roof and gutter de-icing .....	49
5.1	Application description .....	49
5.2	Design information – General .....	50
5.3	Thermal design .....	51
5.4	Electrical design.....	51
5.5	Control and monitoring system design .....	51
5.6	Special design considerations .....	51
5.7	Installation.....	51
5.7.1	General .....	51
5.7.2	Trace heaters and component mounting .....	52
5.8	Maintenance.....	55
5.9	Repair .....	55
6	Rail heating .....	55
6.1	Application description .....	55
6.1.1	General .....	55
6.1.2	Switch point heating .....	56
6.1.3	Contact/live rail heating .....	56
6.1.4	Track heating .....	56
6.1.5	Catenary/pantograph shoe heating .....	56

6.2	Design information .....	57
6.2.1	General .....	57
6.2.2	Weather data .....	57
6.2.3	Rail system description .....	57
6.2.4	System design .....	57
6.3	Thermal design .....	57
6.3.1	Heating load determination .....	57
6.3.2	Typical heating load .....	58
6.4	Electrical design .....	58
6.5	Control and monitoring system design .....	58
6.6	Special design considerations .....	58
6.6.1	Electrical considerations .....	58
6.6.2	Finite element analysis .....	59
6.7	Installation .....	59
6.7.1	General .....	59
6.7.2	Point heating .....	60
6.7.3	Swing nose crossing .....	60
6.7.4	Clamp lock heating .....	61
6.7.5	Contact/live rail heating and track heating .....	61
6.7.6	Catenary/pantograph shoe heating .....	62
6.8	Maintenance .....	62
6.9	Repair .....	62
7	Snow melting .....	62
7.1	Application description .....	62
7.2	Design information .....	63
7.2.1	General .....	63
7.2.2	Weather data .....	63
7.2.3	Construction details of workpiece .....	63
7.2.4	Electrical considerations .....	63
7.2.5	System performance level .....	63
7.2.6	Trace heater layout and component mounting .....	64
7.3	Thermal design – Power output (heat load) determination .....	68
7.4	Electrical design .....	68
7.5	Control and monitoring system design .....	68
7.6	Special design considerations .....	68
7.7	Installation .....	69
7.8	Maintenance .....	69
7.9	Repair .....	70
8	Floor warming .....	70
8.1	Application description .....	70
8.2	Design information .....	70
8.2.1	General .....	70
8.2.2	Environmental data .....	70
8.2.3	Construction details of workpiece .....	70
8.2.4	Electrical considerations .....	70
8.2.5	Trace heater layout and component mounting .....	71
8.3	Thermal design – Heat load determination .....	72
8.4	Electrical design .....	73
8.5	Control and monitoring system design .....	73



8.6	Special design consideration .....	73
8.7	Installation.....	74
8.8	Maintenance.....	74
8.9	Repair .....	74
9	Frost heave prevention .....	74
9.1	Application description .....	74
9.2	Design information .....	75
9.2.1	General .....	75
9.2.2	Construction details of the floor .....	75
9.2.3	Electrical considerations .....	75
9.3	Heat load determination .....	75
9.3.1	General .....	75
9.3.2	Trace heater layout and component mounting.....	77
9.4	Electrical design.....	77
9.5	Control and monitoring system design .....	77
9.5.1	Control options .....	77
9.5.2	Monitoring .....	77
9.6	Special design considerations .....	77
9.7	Installation.....	78
9.8	Maintenance.....	78
9.9	Repair .....	78
10	Underground thermal energy storage systems .....	78
10.1	Application description .....	78
10.2	Design information .....	79
10.2.1	General .....	79
10.2.2	Environmental data.....	79
10.2.3	Construction details of building .....	79
10.2.4	Electrical considerations .....	79
10.2.5	Trace heater layout and component mounting.....	79
10.3	Thermal design – Heat-loss determination.....	80
10.4	Electrical design.....	80
10.5	Control and monitoring system design .....	81
10.6	Special design considerations when trace heaters are located in sand layer.....	81
10.7	Installation.....	81
10.7.1	General .....	81
10.7.2	Installation in sand .....	81
10.7.3	Installation in concrete.....	81
10.8	Maintenance.....	82
10.9	Repair .....	82
Annex A (informative)	Pre-installation checks .....	83
Annex B (informative)	Trace heater commissioning record .....	84
Annex C (informative)	Maintenance schedule and log record .....	85
Bibliography	.....	86
Figure 1	– Thermal insulation – Weather-barrier installation.....	17
Figure 2	– Typical temperature profile.....	18
Figure 3	– Equilibrium conditions for workpiece maintenance.....	22
Figure 4	– Equilibrium conditions for upper limit evaluation .....	23

Figure 5 – Heated tank example .....	32
Figure 6 – Bypass example .....	32
Figure 7 – Fire sprinkler sprig: tapered thermal insulation .....	35
Figure 8 – Double containment system .....	37
Figure 9 – Gravity flow piping systems .....	38
Figure 10 – Ice dam formation .....	50
Figure 11 – Downspout to underground drain .....	50
Figure 12 – Roof and gutter trace heater arrangement .....	52
Figure 13 – Gutter detail .....	53
Figure 14 – Typical roof mounting methods .....	54
Figure 15 – Drain detail for flat roof .....	55
Figure 16 – Typical positioning of point trace heater on stock rail and switch rail .....	60
Figure 17 – Typical positioning of trace heater on swing nose crossing .....	60
Figure 18 – Typical clamp lock trace heater .....	61
Figure 19 – Typical positioning of trace heater on steel and aluminium clad contact rails .....	61
Figure 20 – Typical positioning of trace heater in pantograph shoe .....	62
Figure 21 – Snow melting trace heater embedded in concrete .....	65
Figure 22 – Snow melting trace heater located in conduit .....	66
Figure 23 – Expansion joint detail .....	67
Figure 24 – Snow melting junction box location .....	67
Figure 25 – Typical floor warming trace heater mounting .....	72
Figure 26 – Typical floor heating power requirements .....	73
Figure 27 – Typical frost heave prevention substructure .....	75
Figure 28 – Frost heave prevention power requirements .....	76
Figure 29 – Typical underground thermal energy storage system installation .....	80
Table 1 – Application types .....	13
Table 2 – Recommendations for monitoring and control – Type II and III control .....	29
Table 3 – Recommendations for hot water services and tempered water temperatures .....	35
Table 4 – Typical snow melting heat loads .....	64

## 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 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 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 includes a metallic sheath, braid, screen or equivalent electrically conductive covering;
- b) operating at safe temperatures when designed, installed, and maintained in accordance with IEC 62395-2;
- c) having at least the minimum levels of overcurrent and earth-fault protection required in IEC 62395-1 and IEC 62395-2.

# **ELECTRICAL RESISTANCE TRACE HEATING SYSTEMS FOR INDUSTRIAL AND COMMERCIAL APPLICATIONS —**

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

### **1 Scope**

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 standard does not include or provide for any applications in potentially explosive atmospheres.

This standard pertains to trace heating systems that may comprise either factory fabricated or field-assembled (work-site) units, and which may be series or parallel trace heaters, or surface heaters (heater pads or heater panels) that have been assembled and/or terminated in accordance with the manufacturer's instructions.

The products covered by this standard are intended to be installed by persons who are suitably trained in the techniques required and that only trained personnel carry out especially critical work, such as the installation of connections and terminations. Installations are intended to be carried out under the supervision of a qualified person who has undergone supplementary training in electric trace heating systems.

This standard 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 of trace heating internal to 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 documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 62395-1:2013, *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 terms and definitions given in IEC 60519-1 and IEC 62395-1:2013 apply.

NOTE General definitions are given in the International Electrotechnical Vocabulary, IEC 60050. Terms relating to industrial electroheat are defined in IEC 60050-841.

## 4 Surface heating of vessels and piping systems

### 4.1 Application description

#### 4.1.1 General

Piping and vessels often utilise 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