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IEEE Std 844.4™-2019/CSA C293.4:19

IEEE/CSA Standard for Impedance Heating of Pipelines and Equipment—Application Guide for Design, Installation, Testing, Commissioning, and Maintenance

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IEEE/CSA Standard for Impedance Heating of Pipelines and Equipment—Application Guide for Design, Installation, Testing, Commissioning, and Maintenance

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Approved 8 February 2019

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Abstract: An application guide for the design, installation, testing, commissioning, and maintenance of impedance heating systems for pipelines and equipment intended for use in general industrial applications is provided in this standard. This standard provides requirements when utilizing impedance heating systems in ordinary as well as hazardous areas having explosive atmospheres.

Keywords: heating systems, IEEE 844.4™, CSA C293.4, process heating, condensation prevention, freeze protection and temperature maintenance, re-melting solidified fluids, impedance heating, thermal insulation

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IEEE Introduction

This introduction is not part of IEEE Std 844.4-2019/CSA C293.4:19, IEEE/CSA Standard for Impedance Heating of Pipelines and Equipment—Application Guide for Design, Installation, Testing, Commissioning, and Maintenance.

Impedance heating systems have been used for a number of years in the industry. They were recognized for the first time in the 1981 issue of the National Electrical Code®, NFPA 70.[1]

Impedance heating of pipelines and equipment in petrochemical as well as other industries is a portion of total heating requirements.

This standard is a companion document to IEEE Std 844.3™/CSA C22.2 No. 293.3, IEEE/CSA Standard for Impedance Heating of Pipelines and Equipment—General, Testing, Marking, and Documentation Requirements.

Since impedance heating systems are interrelated with electric power, control, and alarm systems, other standards (some of which are listed in Clause 2) should be referred to when using this standard. This standard is not intended to supersede any current standards or recommended practices, and sound engineering judgment should always be used when applying this or any other standard.

This standard correlates industry practices; it is not intended to be a design guide or an exhaustive procedure manual. The annexes that are included in this standard are informative.

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CSA Preface

This is the first edition of IEEE Std 844.4™/CSA C293.4, IEEE/CSA Standard for Impedance Heating of Pipelines and Equipment—Application Guide for Design, Installation, Testing, Commissioning, and Maintenance, which is a harmonized standard jointly developed by IEEE and CSA Group. The IEEE requirements for impedance heating were previously published in IEEE Std 844.

This standard is one of five projects to break up the original IEEE Std 844 into separate requirements and application guidelines. This standard was developed under the Partner Standards Development Organization cooperation agreement between IEEE and CSA Group and was submitted to a parallel enquiry vote by both organizations.

Impedance heating systems have been used for a number of years in the industry. They were recognized for the first time in the 1981 edition of the National Electrical Code®, NFPA 70. Impedance heating of pipelines and equipment in petrochemical as well as other industries is a growing portion of total heating requirements.

This standard should be used in conjunction with IEEE Std 844.3™/CSA C22.2 No. 293.3, IEEE/CSA Standard for Impedance Heating of Pipelines and Equipment—General, Testing, Marking, and Documentation Requirements.

Since impedance heating systems are interrelated with electric power, control, and alarm systems, other standards (some of which are listed in Clause 2) should be referred to when using this standard.

This standard is not intended to supersede any current standards or recommended practices, and sound engineering judgment should always be used when applying this or any other standard. This standard correlates industry practices; it is not intended to be a design guide or an exhaustive procedure manual. The annexes that are included in this standard are informative.

This standard was reviewed for use in Canada by the CSA Integrated Committee on Trace Heating, under the jurisdiction of the CSA Technical Committee on Wiring Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee.

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Contents

1. Overview 16
1.1 General 16
1.2 Scope 16
1.3 Purpose 17
1.4 Terminology 17

2. Normative references 17

3. Definitions 18

4. Design 18
4.1 Impedance heating principle of operation 18
4.2 Utilization 19
4.3 Applications 20
4.4 Selection criteria 23
4.5 Design guidelines and considerations 23
4.6 Thermal insulation 28
4.7 Power system 32
4.8 Control and monitoring 34

5. Installation considerations and guidelines 39
5.1 Receiving and storage 39
5.2 Conformance to standards 39
5.3 Installation monitoring 39
5.4 Preparatory work 39
5.5 Equipment location 39
5.6 Piping system 39
5.7 Installation of the power connection and insulated impedance conductor 40
5.8 Installation of thermal insulation 41
5.9 Warning signs/labels 42
5.10 Installation of control and monitoring equipment 42
5.11 Installation of power distribution and control cabling 42
5.12 Document retention 42

6. Field testing, start-up, and commissioning 42
6.1 General 42
6.2 Grounding 42
6.3 Connections 43
6.4 Transformer voltage tests 43
6.5 Secondary current testing 43
6.6 Electrical equipment testing and pre-commissioning 43
6.7 System start-up, commissioning, and test documentation 44
6.8 System operation 44

7. Maintenance and repairs 44
7.1 General 44
7.2 Preventive maintenance 45
7.3 Thermal insulation system maintenance 45
7.4 Heater fault location and troubleshooting 46
7.5 Repair 47

Annex A (informative) Bibliography 48

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Annex B (informative) Pipe heat loss considerations 50
B.1 Heat loss formula and calculations 50

Annex C (informative) Heat-up and cool-down considerations 55
C.1 Heat-up 55
C.2 Cool-down 56

Annex D (informative) Method to determine equivalent thicknesses of insulating cements 58

Annex E (informative) Design input parameters—Example 59

Annex F (informative) Installation record—Example 60

Annex G (informative) System commissioning record—Example 61

Annex H (informative) System preventive maintenance record—Example 62

Annex I (informative) Insulated impedance conductor types covered by this standard 63

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IEEE/CSA Standard for Impedance Heating of Pipelines and Equipment—Application Guide for Design, Installation, Testing, Commissioning, and Maintenance

1. Overview

1.1 General

This standard is divided into seven clauses. Clause 1 provides the scope and purpose. Clause 2 lists references to other standards that are useful in applying this standard. Clause 3 references definitions that are found in IEEE Std 844.3/CSA C22.2 No.293.3. Clause 4 establishes the design guidelines for impedance heating. Clause 5 provides installation considerations and guidelines. Clause 6 covers field testing, start-up, commissioning, and operation of impedance heating systems. Clause 7 provides maintenance and repair guidelines.

This standard also contains annexes. Annex A provides bibliographical references. Annex B provides pipe heat loss calculation methods. Annex C provides heat-up and cool-down calculation methods. Annex D provides a method to determine equivalent thicknesses of insulating cements. Annex E provides an example of design input parameters for an impedance heating design. Annex F presents an example of a record for installation requirements. Annex G shows an example of a form that can be used to document the commissioning of the system. Annex H presents an example of a preventive maintenance record. Annex I shows the insulated impedance conductor types covered in this standard.

1.2 Scope

This standard provides for the application of impedance heating systems for steel or steel alloy pipe and equipment. It provides recommendations for design, installation, maintenance, and repair of these systems in general industry applications.

This standard applies to impedance heating systems intended to be installed in ordinary and hazardous locations with explosive atmospheres. The hazardous locations include the following:

— In Canada: Zone 2; Zone 22; or Class I, Division 2; Class II, Division 2; Class III, Division 2 as described in CSA C22.1; and

— In the USA: Class I, Zone 2; Zone 22; or Class I, Division 2; Class II, Division 2; Class III, Division 2 as described in the NEC.

This standard, when used with other recognized codes and standards, is intended to cover impedance heating systems in their entirety, including system design, specification, installation, operation, testing, commissioning, and maintenance. This document also addresses the following associated systems that are important to the performance of impedance heating systems:

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a) Thermal insulation systems;

b) Electric power supply systems;

c) Electric grounding systems; and

d) Control and monitoring systems.

1.3 Purpose

This standard is intended to aid the user in specifying, installing, operating, testing during commissioning, and maintaining impedance heating systems that:

a) Maintain design temperature;

b) Provide electrical, thermal, and mechanical durability and reliability; and

c) Reduce hazards to the user and the surroundings.

Design information, selection parameters, and data in this standard are not intended to provide a complete design primer for impedance heating systems. The information presented provides guidelines for the following:

— Selecting the optimum impedance heating system design;

— Establishing design criteria and constraints for the heated pipeline or equipment to help ensure system compatibility;

— Preparing specifications to obtain quotations for impedance heating systems; and

— Developing information on installation, operation, testing, commissioning, and maintenance of the impedance heating system.

1.4 Terminology

In this standard, “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; “should” is used to express a recommendation or that which is advised but not required; and “may” is used to express an option or that which is permissible within the limits of the standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

2. Normative references

The following referenced documents are indispensable for the application of this standard (i.e., they shall be understood and used, so each referenced document is cited in the text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

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ASME B31 Pressure Piping series of standards.[1]

IEEE Std 844.3™-2019/CSA C22.2 No. 293.3:19, IEEE/CSA Standard for Impedance Heating of Pipelines and Equipment—General, Testing, Marking, and Documentation Requirements.[2, 3]

3. Definitions

For the purposes of this standard, the definitions given in IEEE Std 844.3/CSA C22.2 No. 293.3 shall apply.

The *IEEE Standards Dictionary Online* should be consulted for terms not defined in IEEE Std 844.3/CSA C22.2 No. 293.3.[4]

4. Design

4.1 Impedance heating principle of operation

Impedance heating systems introduce low-voltage ac to a section of the pipeline to be heated and return the current through an insulated impedance conductor. The wall of the current-carrying pipeline becomes the heating element. The insulated impedance conductor that completes the circuit, when it is laid parallel and adjacent to the pipeline, creates a proximity effect. The skin effect phenomena and hysteresis enhance heating for ferromagnetic materials.

[1] ASME publications are available from The American Society of Mechanical Engineers (https://www.asme.org).
[2] IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (http://standards.ieee.org/).
[3] CSA Group publications are available from CSA Group (Standards Sales), 178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3 (https://store.csagroup.org/).
[4] *IEEE Standards Dictionary Online* is available at: http://www.ieee.org/portal/innovate/products/standard/standards_dictionary.html.

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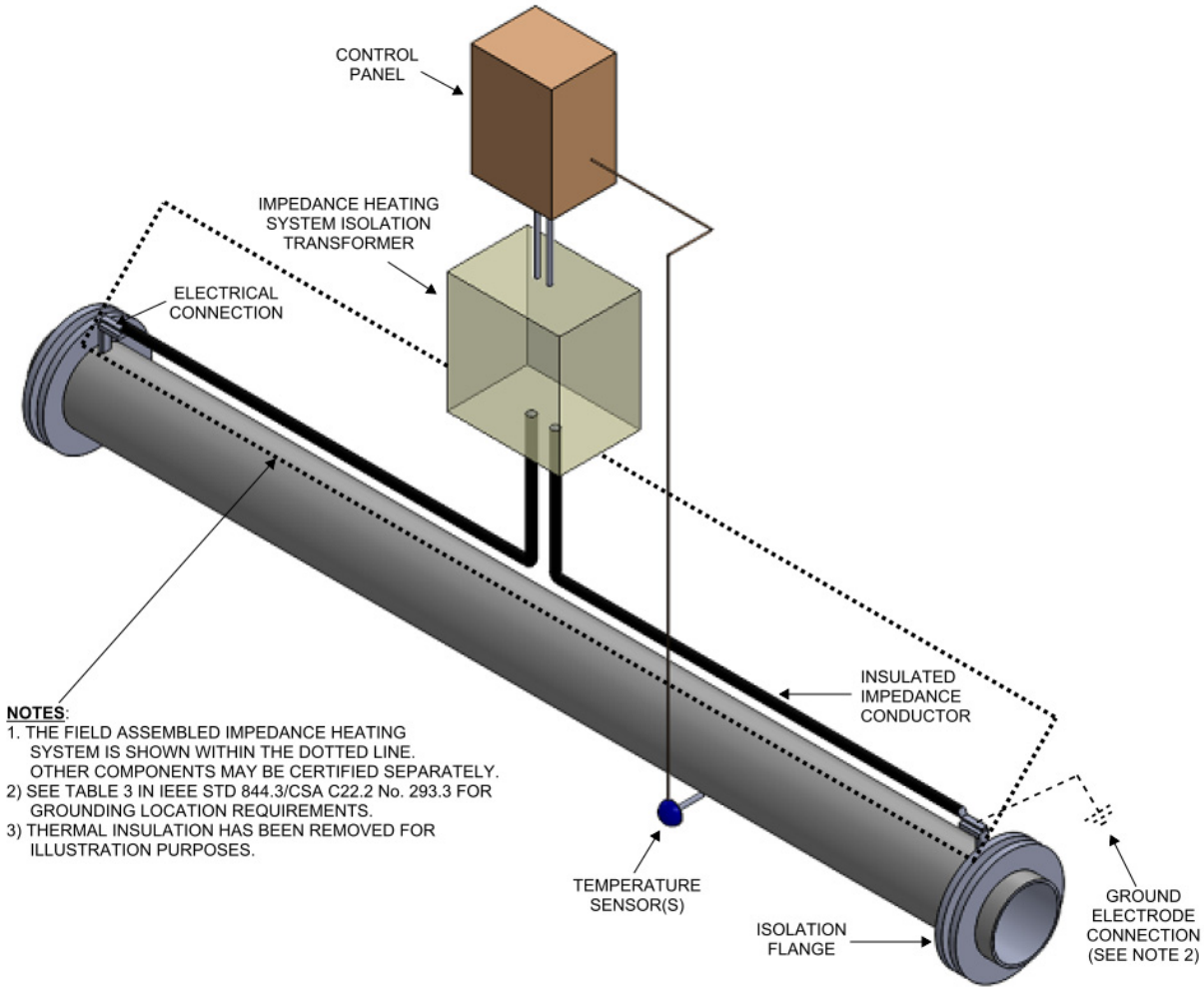

Figure 1—Impedance heating system

The workpiece shall be electrically conductive steel or an alloy of steel, either magnetic or nonmagnetic. It may be long (hundreds of meters) or very short (one or two meters). To maintain a consistent workpiece temperature, the diameter, wall thickness, and metallurgy of the workpiece shall be the same within each circuit. Applications of impedance heating systems are best suited for installation on welded workpiece construction. Weld procedures should be in compliance with the appropriate ASME B31 series standard, or an equivalent standard. The workpiece may be indoors or outdoors, horizontal or vertical.

4.2 Utilization

4.2.1 General

The utilization of impedance heating systems covered in this standard can be divided into the five categories described in 4.2.2.1 through 4.2.2.5.

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