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IEEE Std 844.2™-2017/CSA C293.2-17

IEEE/CSA Standard for Skin Effect Trace Heating of Pipelines, Vessels, Equipment, and Structures—Application Guide for Design, Installation, Testing, Commissioning, and Maintenance

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IEEE/CSA Standard for Skin Effect Trace Heating of Pipelines, Vessels, Equipment, and Structures—Application Guide for Design, Installation, Testing, Commissioning, and Maintenance

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

Keywords: condensation prevention, CSA C293.2, freeze protection and temperature maintenance, heating systems, IEEE 844.2™, long line, process heating, re-melting solidified fluids, skin effect trace heating, structure heating, thermal insulation

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IEEE Introduction

This introduction is not part of IEEE Std 844.2-2107/CSA C293.2-17, IEEE/CSA Standard for Skin Effect Trace Heating of Pipelines, Vessels, Equipment, and Structures—Application Guide for Design, Installation, Testing, Commissioning, and Maintenance.

Skin effect trace heating systems have been used for a number of years by industry. They were recognized for the first time in the 1981 issue of the National Electrical Code® (NEC®) ANSI/NFPA 70.[a]

Skin effect trace heating of pipelines, vessels, equipment, and structures in petrochemical as well as other industries is a growing portion of total heating requirements because of its advantages in heating long pipelines with temperature control.

This standard is a companion document to IEEE Std 844.1/CSA C22.2 No. 293.1, IEEE/CSA Standard for Skin Effect Trace Heating of Pipelines, Vessels, Equipment, and Structures—General, Testing, Marking, and Documentation Requirements.

Since skin effect trace 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 844.2™/CSA C293.2, Standard for Skin Effect Trace Heating of Pipelines, Vessels, Equipment, and Structures—Application Guide for Design, Installation, Testing, Commissioning, and Maintenance, which is a harmonized Standard jointly developed by IEEE and CSA Group.

Skin effect trace heating systems have been used for a number of years in the industry. Skin effect trace heating of pipelines, vessels, equipment, and structures in petrochemical as well as other industries is a growing portion of total heating requirements because of its advantages in heating long pipelines with temperature control.

This Standard should be used in conjunction with IEEE Std 844.1™/CSA C22.2 No. 293.1, Standard for Skin Effect Trace Heating of Pipelines, Vessels, Equipment, and Structures—General, Testing, Marking, and Documentation Requirements.

Since skin effect trace 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 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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   Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization and are available on the Current Standards Activities page at **standardsactivities.csa.ca**.
5) This Standard is subject to review five years from the date of publication. Suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to **inquiries@csagroup.org** and include "Proposal for change" in the subject line:
   a) Designation;
   b) Relevant clause, table, and/or figure number;
   c) Wording of the proposed change; and
   d) Rationale for the change.

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IEEE/CSA Standard for Skin Effect Trace Heating of Pipelines, Vessels, Equipment, and Structures—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 844.1/CSA C22.2 No. 293.1. Clause 4 establishes the design guidelines for skin effect trace heating. Clause 5 provides installation considerations and guidelines. Clause 6 covers field testing, start-up, commissioning, and operation of skin effect trace 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 considerations. Annex C provides vessel heat loss considerations. Annex D covers heat-up and cool-down considerations. Annex E provides a method to determine equivalent thicknesses of insulating cements. Annex F provides an example of design input parameters for a skin effect trace heating design. Annex G presents an example of a record for installation requirements. Annex H shows an example of a form that can be used to document the commissioning of the system. Annex I presents an example of a preventive maintenance record.

1.2 Scope

This standard provides for the application of skin effect trace heating systems for pipes, vessels, and structures. It provides recommendations for design, installation, maintenance, and repair of these systems in general industry for ordinary locations, as well as in hazardous areas with potentially explosive atmospheres.

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

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 skin effect trace 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 skin effect trace heating systems. The information presented provides guidelines for

— Selecting the optimum skin effect trace heating system design;

— Establishing design criteria and constraints for the heated pipeline, vessels, or structures to ensure system compatibility;

— Preparing specifications to obtain quotations for skin effect trace heating systems; and

— Developing information on installation, operation, testing, commissioning, and maintenance of the skin effect trace 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.

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2. Normative references

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

IEEE Std 844.1/CSA C22.2 No. 293.1, IEEE/CSA Standard for Skin Effect Trace Heating of Pipelines, Vessels, Equipment, and Structures—General, Testing, Marking, and Documentation Requirements.[1]

3. Definitions

For the purpose of this standard, the definitions given in IEEE Std 844.1/CSA C22.2 No. 293.1 apply.

The *IEEE Standards Dictionary Online* should be consulted for terms not defined in IEEE Std 844.1/CSA C22.2 No. 293.1.[2]

4. Design

4.1 Principle of operation

A skin effect trace heating system consists of a single insulated conductor run inside a ferromagnetic envelope. A source of ac power is connected between the skin effect insulated conductor and the ferromagnetic envelope at the power connection (i.e., the start of the skin effect trace heater). The far end of the skin effect conductor is connected to the ferromagnetic envelope at the end opposite from the power source. Current flows from the power source through the skin effect insulated conductor to the far end and returns through the inner skin of the ferromagnetic envelope. The basic skin effect trace heating system is illustrated in Figure 1.

[1]IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (http://standards.ieee.org/).
[2]*IEEE Standards Dictionary Online* is available at: http://dictionary.ieee.org.

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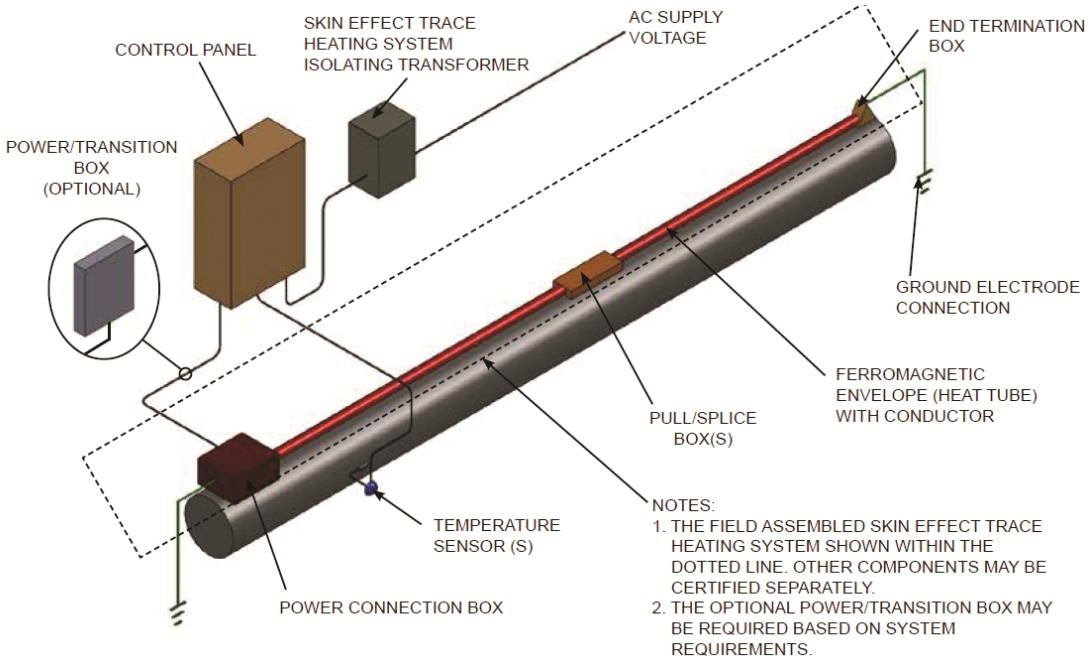


Figure 1 —Skin effect trace heating system

In skin effect trace heating, heat is generated in the ferromagnetic envelope wall by the return current. Additional heat is produced by the I^2R loss in the insulated conductor. The inductive interaction between the current in the skin effect insulated conductor and the return current in the ferromagnetic envelope, along with the ac skin effect in the ferromagnetic envelope, results in the current in the ferromagnetic envelope being concentrated in a thin layer at its inner surface.

A distinctive feature of the skin effect trace heating system is that there is no measureable voltage on the outer surface of the ferromagnetic envelope.

4.2 Utilization

4.2.1 General

The utilization of skin effect trace heating systems covered in this standard can be divided into the six categories described in 4.2.2.1 through 4.2.2.6.

4.2.2 Categories

4.2.2.1 Solidification prevention

Systems can be used to prevent the fluid in a line or a vessel from solidifying. These include water, aqueous solutions, crude oil, pitch, asphalt, metals, sulfur, and other chemicals. The heating system compensates for pipeline heat losses in order to maintain the temperature of the contents above the solidification point.

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