

IEEE Recommended Practice for the Design and Installation of Electric Pipe Heating Control and Alarm Systems for Power Generating Stations

**(Supplement to ANSI/IEEE Std 622-1979, IEEE
Recommended Practice for the Design and Installation
of Electric Pipe Heating Systems for Nuclear Power
Generating Stations)**

Sponsor
**The Power Generating Committee
of the
IEEE Power Engineering Society**

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USA

Foreword

(This Foreword is not a part of IEEE Std 622A-1984, IEEE Recommended Practice for the Design and Installation of Electric Pipe Heating Control and Alarm Systems for Power Generating Stations.)

In June, 1976, the Working Group on Electric Heat Tracing Systems of the Station Design Subcommittee was formed and charged with producing a recommended practice for electric pipe heating systems. As a result of the working-group formation, ANSI/IEEE Std 622-1979, IEEE Recommended Practice for the Design and Installation of Electric Pipe Heating Systems for Nuclear Power Generating Stations was published.

The ANSI/IEEE Std 622-1979 is a much needed coverage of the general design and installation aspects of electric pipe heating systems. It covers such topics as heater design, power systems design, temperature control and alarm considerations along with receiving of materials, installation of materials, recordkeeping, and inspections.

At the time of publication of the ANSI/IEEE Std 622-1979 the Electric Heat Tracing Working Group received numerous inquiries as to the possibility of a standard more specific in the area of design and installation of electric pipe heating control and alarm systems. The Station Design Subcommittee and ultimately the Power Generation Committee endorsed the idea and charged the working group with producing such a standard. This standard, IEEE Std 622A-1984, is a result of the desire to address the electric pipe heating control and alarm questions that exist in the power generation industry today, including nuclear and fossil generating stations.

Anyone wishing to utilize the recommendations of this standard should first review, in detail, the general recommendations of ANSI/IEEE Std 622-1979, for only then will they have a complete understanding of electric pipe heating system criteria.

IEEE Std 622A-1984 covers topics such as types of control components available, freeze protection control, process control and critical process control criteria, design of control systems, type of alarm systems available, design of alarm systems, calibration and testing of controls and alarms, and installation methods.

Since electric pipe heating control and alarm systems can be part of numerous systems in a power generating station, other IEEE standards should be referred to when using this recommended practice. The recommendations here are not intended to supersede any current IEEE standards or practices and sound engineering judgement should always be used when applying this recommended practice.

This recommended practice correlates industry practices; it is not intended to be an exhaustive compilation of rigid procedure manual. This recommended practice was prepared by the Working Group on Electric Heat Tracing Systems, Station Design Subcommittee of the Power Generation Committee.

Suggestions for improvement of this recommended practice will be welcome. They should be sent to the

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At the time this recommended practice was approved, the members of the working group were:

D. E. Roberts, *Chair*

G. P. Alexander
K. W. Brown
D. O. Brown

J. J. Dennehy
J. W. Miller
C. L. Sandberg

R. Schilling
R. S. Schoellkopf

At the time this recommended practice was approved, the members of the Power Generation Committee were:

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1. Scope and Purpose

1.1 Scope

IEEE Std 622A-1984 provides recommended practices for designing and installing electric pipe heating control and alarm systems as applied to mechanical piping systems that require heat. The recommendations include selection of control and alarm systems, accuracy considerations, local control usage, centralized control usage, qualification criteria of controls and alarms, and calibration and testing of controls and alarms.

1.2 Purpose

The purpose of this recommended practice is to provide recommendations that will ensure design consistency and reliable operation of electric pipe heating control and alarm systems which in turn will ensure that piping systems' fluids will be available for use not only during station operation but also during normal shutdown.

2. References

[1] ANSI MC96.1-1975, Temperature Measurement Thermocouple.¹

¹ANSI publications are available from the Sales Department, American National Standard Institute, 1430 Broadway, New York, NY 10018.

[2] ANSI/ASME N45.2.2-1978, Packaging, Shipping, Receiving, Storage, and Handling of Items for Nuclear Power Plant (During the Construction Phase).

[3] ANSI/EIA RS-309-1965 (R1981), General Specifications for Thermistors.

[4] ANSI/IEEE Std 100-1977, IEEE Standard Dictionary of Electrical and Electronic Terms.

[5] ANSI/IEEE Std 622-1979, IEEE Recommended Practice for the Design and Installation of Electric Pipe Heating Systems for Nuclear Power Generating Stations.

[6] ANSI/NEMA ICS6-1978, Enclosure for Industrial Control and Systems.

[7] ANSI/NFPA 70-1984, National Electrical Code.²

3. Definitions

For definitions of terms and phrases used in this recommended practice, reference should be made to ANSI/IEEE Std 100-1977 [4]³ and specifically ANSI/IEEE Std 522-1979 [5].

Definitions specifically applicable to this recommended practice are defined here (in some cases the terms or phrases are used interchangeably and more than one term or phrase is defined because of industry practice):

alarm, alarm signal: A signal for attracting attention to some abnormal condition. Alarms associated with electric pipe heating systems can signal high temperature, low temperature, loss of heater circuit voltage, etc.

calibration error: In operation, the departure under specified conditions, of actual performance from performance indicated by scales, dials, or other markings on the device.

centralized control/alarm: A common (central) point where multiple control, alarm, or both signals or functions are brought together. With respect to electric pipe heating systems, centralized control/alarm stations usually consist of cabinets or panels where remote control, alarm, or both signals are brought together for a common output signal to the generating unit control room.

components: Items from which a system is assembled; for example, resistors, capacitors, wires, connectors, tubes, switches, etc.

controller: A device that regulates the state of a system by comparing a signal from a sensor located in the system with a predetermined value and adjusting its output to achieve the predetermined value. Controllers, as used in electric pipe heating systems, regulate temperatures on the system and can be referred to as temperature controllers or thermostats. Controller sensors can be mechanical (bulb, bimetallic) or electrical (thermocouple, RTD, thermistor).

critical freeze protection: The use of electric pipe heating systems to prevent the temperature of fluids from dropping below the freezing point of the fluid in important or *critical* outdoor (usually) piping systems at nuclear generating stations. An example of a critical freeze protection system is the heating for the nuclear service water system.

critical process control: The use of electric pipe heating systems to increase or maintain, or both, the temperature of fluids (or processes.) in important or *critical* mechanical piping systems including pipes, pumps, valves, tanks, instrumentation, etc., in nuclear power generating stations. An example of an important or critical mechanical piping system is the safety injection system.

dead band differential: The difference in degrees between the OFF and the ON stage of temperature controllers.

²NFPA documents are available from the Sales department of the National Fire Protection Association, Batterymarch Park, Quincy, Mass 02269. In the US, this document is available from the Sales department of American National Standards Institute, 1430 Broadway, New York, NY 10018.

³The numbers in brackets correspond to the references listed in Section 2 of this standard.

essential freeze protection: The use of electric pipe heating systems to prevent the temperature of fluids from dropping below the freezing point of the fluid in desirably available or *essential* outdoor (usually) piping systems at fossil fueled generating stations. An example of an essential freeze protection system is the heating for the feedwater system.

essential process control: The use of electric pipe heating systems to increase or maintain, or both, the temperature of fluids (*or processes*) in desirably available or essential mechanical piping Systems including pipes, pumps, valves, tanks, instrumentation, etc, in fossil fueled generation stations. An example of an essential process control system is the heating for the fuel oil system.

freeze protection: The use of electric pipe heating systems to prevent the temperature of fluids from dropping below the freezing point of the fluid. Freeze protection is usually associated with piping, pumps, valves, tanks, instrumentation, etc, such as water lines, that are located outdoors or in unheated buildings.

local control/alarm: The locations where control, alarm, or both signal or function take place. With respect to electric pipe heating systems, these are usually mounted in close proximity to the individual heating circuits that they operate.

modules: Any assembly of interconnected components which constitutes an identifiable device, instrument, or piece of equipment which can be disconnected, removed as a unit and replaced with a spare, and has definable performance characteristics which permit it to be tested as a unit. A module can be card or other subassembly.

monitoring: To check the operation and performance of an equipment or system by sampling the results of the operation. Monitoring with respect to electric pipe heating systems usually consists of checking system temperatures or operation of the heater circuits, voltage, current, etc.

process control: The use of electric pipe heating systems to increase or maintain, or both, the temperature of fluids (*or processes*) in mechanical piping systems including pipes, pumps, valves, tanks, instrumentation, etc, in power generating stations.

range: The capability span of an instrument, the region between the lower and upper limits of a measured or generated function. With respect to electric pipe heating systems, range is usually defined as the difference between the lowest available set point and the highest available set point.

repeatability: The closeness of agreement among a number of consecutive measurements of the output for the same value of the input under the same operating conditions approaching from the same direction. With respect to electric pipe heating systems, repeatability is usually associated with temperature controllers and is the difference in degrees for repeated operation at a specific temperature setting.

resettability: The restoring of a mechanism, electrical circuit, or device to the prescribed state. Resettability is usually associated with temperature controllers and is the difference in degrees when returning to original temperature setting.

sensitivity: The ratio of the magnitude of a device response to the magnitude of the quantity measured. In electric pipe heating systems sensitivity is usually associated with temperature controls and alarms and addresses their response function.

sensor, sensing element: The first system element that responds quantitatively to the measure and performs the initial measurement operation. Sensors, as used in electric pipe heating systems, respond to the temperature of the system and may be directly connected to controllers, alarms, or both. Sensors can be mechanical (bulb, bimetallic) or electrical (thermocouple, RTD, thermistor).

set point: A fixed or constant (for relatively long time periods) command. With respect to electric pipe heating systems, set points are usually associated with temperature controllers or alarms and are the position of the dials, taps, levels, scales, etc, so as to secure the desired operating characteristics.

4. Selection of Control Systems

There are numerous types of mechanical and electronic controls available that are suitable for electric pipe heating applications. Proper selection of controls should take into account their features and functions, and they should be

examined with regard for suitability of functional application and physical environment. In a broader sense, controls should be viewed in terms of compatibility to a total system concept. Sample block diagrams representing system concepts are shown in Figs 1 and 2.

4.1 Types of Control Components Available

4.1.1 Mechanical Control Components

4.1.1.1 Fluid Filled Bulb and Capillary

Bulb and capillary type thermostats are the most commonly used mechanical controllers for electric pipe heating applications. Attention to many factors is required to properly select such a thermostat.

Enclosures must be suitable for the environment; otherwise damage to the thermostat will occur. Some areas may require more than one type of equipment rating, such as *NEC Classified* and *weathertight*, and in such instances, the enclosure should be rated to meet all conditions.

Sensor bulb and capillary material should also be suitable for the environment. Copper, chrome-plated copper, and stainless-steel bulbs and capillaries are commonly available. Stainless steel will generally survive better under conditions of mechanical abuse or harsh chemical exposure; however, some manufacturers have units available with chemically resistant coatings. Flexible armored capillaries are recommended.

Switch configuration and load switching capacity are critical. In some thermostats, switches are gravity sensitive and the mounting position can affect set-point accuracy. Sealed, snap-action switches provide greater reliability and are more suitable for generating station applications. Switches capable of a minimum of 100 000 cycles are recommended.

The greatest ease of setting accuracy is obtained from thermostats with smaller divisions on the dial and greater rotation per degree of set-point change, assuming constant differentials. It is desirable to select a range where the expected set point will be near the center of the scale. Most manufacturers offer both Centigrade and Fahrenheit calibrated units, and some dials have both. Units that have accessibility to dials without exposing live electrical connections ensure more operator safety.

Ambient temperature fluctuations can introduce error in thermostat calibration because a relatively large volume of fluid is contained in the bellows assembly which is exposed to ambient air. Volume change in the sensor can be offset by volume change in the bellows which deviates with ambient temperature. Better quality thermostats have built-in ambient temperature compensation mechanisms to minimize the influence of ambient temperature fluctuations. Additionally, some thermostats offer overtravel protection to prevent overexpansion of the bellows from damaging the electrical switch. Thermostats have a maximum temperature exposure that must be observed to prevent damage to the unit. The limit will vary depending on the unit's range.