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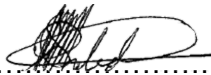





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1. INTRODUCTION

The quality of field installation of control and instrumentation equipment forms a vital part in the life cycle costing of the plant and in effective and efficient maintenance regimes.

1.1 INTENDED AUDIENCE

1.1.1 Generation

C&I Maintenance

1.1.2 Engineering

C&I Engineering

1.1.3 Projects

C&I Contractors

1.2 ADDITIONAL MATERIAL

1.2.1 RELATED PROCESSES

All field equipment installation shall firstly comply with 240-56355754 Field Instrument Installation Standard, and then all requirements of this standard.

1.3 DEVIATIONS

Deviation from this standard is subject to written approval by Eskom. Special or unique applications not covered by this standard must be presented with recommendations to Eskom.

2. SUPPORTING CLAUSES

2.1 SCOPE

2.1.1 Purpose

The Standard covers the minimum requirements for the installation of temperature instrumentation.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 NORMATIVE/INFORMATIVE REFERENCES

2.2.1 Normative

None.

2.2.2 Informative

None.

2.3 DISCLOSURE CLASSIFICATION

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

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2.4 ABBREVIATIONS

| Abbreviation | Description |
|--------------|--------------------------------------------|
| ASTM | American Society for Testing and Materials |
| C&I | Control and Instrumentation |
| EN | European Standard |
| IEC | International Electrotechnical Commission |
| IP | Ingress Protection |
| ISA | Industry Standard Architecture |
| RTD | Electrical Resistance Thermometers |
| SANS | South African National Standard |

2.5 ROLES AND RESPONSIBILITIES

- The Lead Design Engineer shall be responsible to ensure that this standard is implemented on new projects.
- The Design Review Team checks compliance to this standard during the various stages of review as part of the project lifecycle model (PLCM).

2.6 PROCESS FOR MONITORING

This document will be reviewed as per the next review date or earlier if warranted.

2.7 RELATED/SUPPORTING DOCUMENTS

None.

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3. INSTALLATION STANDARD

3.1 RELATED/SUPPORTING DOCUMENTS

Where specific references are made to specifications this shall imply the latest revision of that specification.

- IEC 61515: Mineral insulated thermocouple cables and thermocouples.
- IEC 60751: Industrial Platinum Resistance Thermometer Sensors.
- ASTM E230: Standard specification and temperature-electromotive force (EMF) tables for standardised thermocouples.
- 240-56239129: High Pressure Pipe Work for Fossil Fired Power Stations Standard.
- SANS 10108:2005: The Classification of Hazardous Locations and the Selection of Apparatus for Use in such Locations.
- SANS 60529:2001: Degrees of protection provided by enclosures (IP Code).

3.2 INSTALLATION REQUIREMENTS

3.2.1 Temperature Sensing

Bi-metallic, 130mm diameter, adjustable angle dial thermometers shall be installed for local indication.

Temperature switches shall not be used.

Thermocouples are the preferred means of temperature measurements for centralised control and indication, for multipoint indication or recording. Resistance thermometers may be installed in selected cases:

- Where accuracy of measurement is required greater than obtainable with a thermocouple, a resistance thermometer shall be installed.
- Resistance thermometers shall not be installed where high frequent vibration is present, e.g. in high velocity steam or gas streams.
- Where narrow range duty is required i.e. less than 100oC range a resistance thermometer shall be installed.
- Thermocouples and resistance thermometers pocket assemblies shall be provided with terminal heads certified for the appropriate area classification and afford environmental protection to IP65.
- The distance between the end of the thermocouple pocket and the head shall be such that no bending of the thermocouple shall occur. Where longer lengths are required additional sheathed supports for the head shall be installed.
- All thermocouples shall be 6mm in diameter. All exceptions shall be approved by Eskom.
- Head caps shall be screw on and secured with a chain to the head body.
- Terminal heads shall contain terminal blocks made of insulating material and used to support and join termination of conductors.
- Terminal head shall be a housing that encloses the terminal block and shall be provided with threaded openings for attachment to a protection tube and for attachment of a conduit.
- Protection tube shall be used to protect the sensor from damaging environmental effects. Ceramic materials, such as mullite, high purity alumina shall be used in high temperature applications. High purity alumina tubes are required with platinum thermocouples above 1200°C because mullite contains impurities that can contaminate platinum at these temperatures.

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- Temperature detecting elements shall be installed in thermocouple pockets and direct exposure of temperature-sensing devices to the process is not allowed. Spring loading shall be used to ensure good contact between all temperature detecting elements and the bottom of their thermocouple pocket.

3.2.2 Are there any requirements for calibration and maintenance activities?

Test thermocouples requires to be inspected and calibrated on a regular interval. The calibration period to be determined by the drift data from the calibration records.

3.2.3 Thermocouple Pocket

All thermocouple pockets shall comply with Eskom Specification 240-56239129: High Pressure Pipe Work for Fossil Fired Power Stations Standard.

Thermocouple pockets shall either be welded into to process lines or screwed into the process line.

A thermocouple pocket's process thread shall be 1/2" BSPT (tapered) and instrument thread shall be 1/2" BSPF (parallel) with suitable breakable seals as shown in Figure 1 that follows.

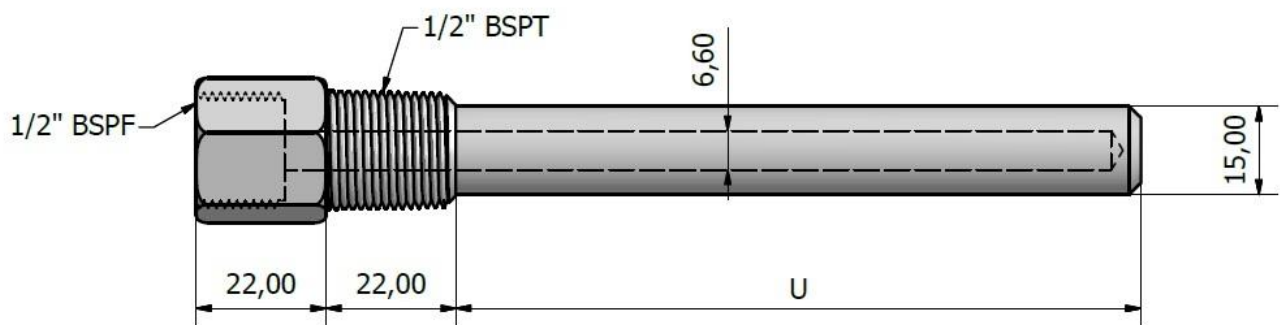


Figure 1: Typical Screw into the Process Line Thermocouple Pocket.

The materials selected for thermocouple pockets must be suitable for the temperature and corrosion environments in which they are applied.

The preferred temperature nozzle orientation shall be vertical (top) on horizontal lines and horizontal (side) on vertical lines.

Thermocouple pockets installed in lines through which fluid flows at high velocities shall be suitable for the stresses resulting from stream velocity conditions. The wake frequency shall not exceed 66 percent of the thermocouple pocket's natural frequency.

3.2.4 Thermocouples

Thermocouples shall be:

Chromel-Alumel (Type K) for temperatures between -70°C and +1300°C.

Platinum / 10% Rhodium Platinum (Type S) for temperatures in excess of 1300°C.

Use of any other thermocouple type shall be subject to Eskom approval.

Thermocouples shall be mineral insulated according to IEC 61515, sheathed to 6mm with hot junction insulated from the sheath. Metal-sheathed thermocouples provide longer life and improved long-term accuracy.

Thermocouple head terminals shall be marked with positive and negative symbols.

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The correct type of compensating wire for the particular thermocouple must be used to connect the thermocouple to the instrument.

To minimize temperature lag, the thermocouple must be in direct contact with bottom of the thermocouple pocket.

A special application of thermocouples is in the measurement of temperature of the skin or tube-metal surface of furnace tubes and shall be subject to Eskom review. Such installations require careful attention to ensure that the thermocouple is properly attached to the tube and is shielded from furnace radiation.

Where the thermocouple extension wire needs to be joined, care should be taken to ensure that it is compliant with the requirements for the joining of extension wire i.e the two junctions to be at the same temperature etc.

3.2.5 Thermocouple and Extension Wire Colour Coding

Thermocouples and extension wires shall be colour coded according to the **ASTM E230** standard, as this is the standard colours used in Eskom. See Appendix A.

ANSI MC 96.1 was used as colour standard but has since been superseded by ASTM E230 with no impact on the existing colour codes used in Eskom.

3.2.6 Electrical Resistance Thermometers (RTD)

Resistance thermometer elements shall comply with IEC 60751 and have a resistance of 100Ω at 0°C , with a fundamental interval of 38.5Ω . They shall be of the grade of accuracy appropriate to the application.

Resistance thermometers shall be sheathed in a 316 stainless steel tube, 6mm outside diameters.

To compensate for changes in ambient temperature, resistance thermometers shall be connected to measuring or transmitting instruments by a three wire system, unless special accuracy applications dictate four wire.

3.2.7 Pyrometers

Purge facilities shall be provided for cooling and for keeping the optical lens clean from dust.

Pyrometer units shall be installed with due regard for accessibility and where required it shall be possible to swing the measurement unit 90 degrees from the line of sight to allow maintenance access.

The use of pyrometers with fibre optic links between the sighting head and the electronic converter should be considered as it will minimise or even remove the need for cooling.

Coated optical lenses that allows for dust shedding and anti-light scattering should also be considered.

The IP rating should be IP65 or alternatively it, it should be housed in such a way to exclude dust and moisture i.e. inside an IP65 enclosure box.

Maximum response time $t_{98} = t_{90} \leq 100$ ms. This implies that 90% of the final value will be reached in less than 100 ms. Systems faster than this should be time integrated to exclude spikes in the measurement as the basis of the original design was the maximum response time.

3.2.8 Transmitters

All transmitters shall be 4-20mA loop powered with HART protocol.

For all applications with Thermocouples or RTDs, the associated transmitters shall be remote mounted in Junction Boxes, with short lengths of compensating or triad cable. The output signal shall be linear with respect to temperature.

Head mounted temperature transmitters shall only be installed where it is not possible or practical to install remote mounted thermocouple/RTD amplifiers. Installations that use head mounted amplifiers can continue this practise bearing in mind that when the opportunity arise these should be replaced with the

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intended remote mounted amplifiers. The use of head mounted transmitters shall be subject to Eskom approval.

The transmitter failure output due to a transmitter fault condition must be determined specifically for each temperature measurement based on the risk associated for that plant area i.e. drive down scale or upscale.

3.2.9 Access Requirements

Temperature instruments shall be located to be accessible from grade, permanent platform or fixed ladders. Access should be within 2 metres of grade or permanent platform or 4 metres, provided access is available from a mobile platform or lift.

Where access from normal operational platforms is not practical, additional access facilities shall be provided.

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5. REVISIONS

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6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

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APPENDIX A

Colour coding of thermocouples and extension wires.

| | ASTM E230 Thermocouple wire | ASTM E230 Extension wire |
|---|-----------------------------------|--------------------------------|
| N | | |
| J | | |
| K | | |
| E | | |
| T | | |
| R | | |
| S | | |
| B | | |

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