

Changes shown by

SCOPE

- 1.1 This practice covers the design and selection of temperature instruments and sensors.
- 1.2 Temperature measurement requirements for specific process and equipment items such as rotating equipment, fired heaters, motors, and storage tanks are covered by the equipment-specific practices.
- 1.3 **An asterisk (*)** indicates that either a decision by the Owner's Engineer or Purchaser is required, that **additional information** is to be furnished by the Owner's Engineer, or that information for Owner's Engineer approval is to be supplied by the vendor or Purchaser.

SUMMARY OF ADDITIONAL REQUIREMENTS

- 2.1 **Table 1** lists the practices and standards which shall be used with this practice.
- * 2.2 **Table 2** lists additional practices and standards which shall be used with this practice, as specified by the Purchaser.

TABLE 1

PRACTICES			
IP 3-6-1	Piping for Instruments	IP 15-10-1	Field Wiring of Thermocouples and Instruments
IP 3-16-1	Flanged Joints, Gaskets, and Boltings	IP 15-1-1	Instrumentation for Fired Heaters
IP 15-6-1	Electronic and Pneumatic Instruments	IP 20-1-1	Inspection of Equipment and Materials
IP 15-6-2	Environmental Protection for Electronic Devices		
STANDARDS			
API Standard		ASTM Standards	
RP551	Process Measurement Instrumentation	A249	Welded Austenitic Steel Boiler, Superheater, Heat Exchanger, and Condenser Tubes
ASME Standards		A268	Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service
B1.20.1	Pipe Threads General Purpose	A276	Stainless and Heat-Resisting Steel Bars and Shapes
B16.5	Pipe Flanges and Flanged Fittings	A479	Stainless and Heat-Resisting Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
ANSI Standards			
PTC 19.3	Performance Test Code - Temperature Measurement		

TABLE 2

PRACTICES			
IP 3-18-1	Piping Fabrication, Shop or Field	IP 15-7-2	Protective Systems
IP 3-19-1	Piping Erection and Testing	IP 15-12-1	Instrument Wire and Cable
IP 15-1-3	Instrumentation for Storage Tanks and Vessels	IP 18-7-1	Welding Procedures
IP 15-2-2	Digital Variable Indicating System		
STANDARDS			
API Standard		ANSI / NEMA Standard	
2543	Measuring the Temperature of Petroleum and Petroleum Products	250	Enclosures for Electrical Equipment (1000 volts maximum)
ASTM Standards		IEC Standards	
E230	Standard Temperature - Electromotive Force (EMF) Tables for Standardized Thermocouples	529	Specification for Degrees of Protection Provided by Enclosures (IP Code)
E235	Thermocouples, Sheathed Type K, for Nuclear or Other High Reliability Applications	584	Thermocouples. Part 1: Reference Tables. Part 2: Tolerances. Part 3: Extension and Compensating Cables. Tolerances and Identification System
E1137	Standard Specification for Industrial Platinum Resistance Thermometers	751	Industrial Platinum Resistance Thermometer Sensors

IP 15-2-1		Temperature Instruments	
Page 2 of 7			
Rev. 2	June 2000		

(This practice is appropriate for attachment to Inquiry or Purchase Document)

BASIC DESIGN

- M,S 3.1 **Thermowells** are required for all temperature measuring devices used in **flammable, toxic, or otherwise hazardous, pressurized or vacuum** systems. Thermowells are not required for temperature measurement of equipment such as reactor shell skin, machinery bearings, or motor windings where there is no risk to personnel from the process fluid during removal of the measuring element, or where radial thermocouples are used. Where a thermowell is not used, a **permanent label** shall be affixed to the primary element, indicating that there is no thermowell.
- I,C * 3.2 For general temperature measurement and control, **thermocouples** shall be the preferred choice for the primary sensing elements. Alternatively, **resistance temperature devices** may be used, subject to the approval of the Owner's Engineer.
- R 3.3 For **temperature control loops** where the sensor element is a thermocouple, a dual thermocouple in a single thermowell shall be used with the spare element not connected to the control system.
- R 3.4 A **single thermocouple** shall not be connected to more than one device. A single thermocouple signal needed at more than one receiver device shall first be converted to a standard current or voltage signal.
- R,M * 3.5 The use of **filled system or bimetallic temperature switches** require approval by the Owner's Engineer. Other temperature measuring elements may be used subject to the approval of the Owner's Engineer.

THERMOCOUPLES

- R 4.1 **Thermocouples for general service** shall be **mineral-insulated metal-sheathed** with the following construction:
- a. **Minimum wire size** shall be **20 AWG** (0.5 mm²).
 - * b. The choice of **grounded or ungrounded thermocouple hot junction** shall be specified by the Owner's Engineer.
 - c. **Sheath** shall be 1/4 in. (6 mm) OD, Type 316 stainless steel.
- M 4.2 **Thermocouple head** (or conduit fitting) shall be as follows:
- * a. Enclosure shall be **weatherproof** to NEMA Type 4 or IP 65 construction and shall meet the electrical area classification.
 - b. **Body and cover material** shall be cast iron or aluminum.
 - c. **Cover** shall be **threaded and gasketed**, with retaining chain to body.
- O,R * 4.3 **For the temperature range 0 to 2000°F** (-20 to 1090°C), thermocouple material shall be **chromel-alumel (Type K per API RP 551)** unless other types of material (such as Type J) are required to connect to existing equipment. **Thermocouple extension wire** connected to Type K thermocouples shall be **Type KX**. Use of any other type of thermocouple or extension wire material requires the approval of the Owner's Engineer.
- O * 4.4 **For the temperature range -300 to 200°F** (-195 to 95°C), thermocouple material shall be **copper-constantan (Type T)**. **Thermocouple extension wire** connected to Type T thermocouples shall be **Type TX**. Use of Type T thermocouples requires the approval of the Owner's Engineer.
- I 4.5 **Tube metal thermocouples for fired heaters and boilers** shall be in accordance with [Figure 1](#) and with the following construction:
- a. Thermocouple material shall be **Type K**.
 - b. A **retaining clip** and **expansion loop** shall be provided to allow for movement of tubes and walls when hot without putting strain on the thermocouple hot junction weld.
 - c. **Material selection and installation/welding procedures** shall be in accordance with [Figure 1](#) and vendor requirements.
 - d. **Terminal heads** shall project at least 6 in. (150 mm) from heater or boiler furnace walls.
- The design and installation of tube metal thermocouples, or the proposed use of any alternative design, requires the approval of the Owner's Engineer.
- S 4.6 Design of **multi-point thermocouple assemblies** shall require approval of the Owner's Engineer. Design features to be considered include:
- a. A **secondary seal** to ensure safe containment of the process if the primary well fails
 - b. A mechanism to **prevent the loss of secondary seal from pressurizing the junction box assembly**.
- O 4.7 For furnace bridge wall temperature measurement, thermocouple installations shall include shielding from flame radiation.

RESISTANCE TEMPERATURE DEVICES

- I,C * 5.1 When approved, **Resistance Temperature Devices (RTDs)** shall be the industrial **100 ohm platinum, three or four wire type**. They shall conform to ASTM E1137 or IEC 751. Accuracy requirements shall be specified by the Owner's Engineer. Use of any other type of RTD (such as copper type on existing tank gauging systems) requires the approval of the Owner's Engineer.

OTHER TEMPERATURE MEASURING ELEMENTS

- I,C * 6.1 When approved, **filled system type primary elements** shall meet the following requirements:
- a. **Maximum bulb temperature** shall not exceed **600°F (315°C)** unless approved by the Owner's Engineer.
 - b. The **filled system thermal element bulb** and **capillary tube** shall be **all-welded stainless steel**. The capillary shall be protected from mechanical damage by stainless steel spiral wound armour and supports. The maximum distance between supports shall be 18 in. (450 mm).
 - c. **Capillary length** shall not exceed **10 ft (3 m)**.
 - d. A **minimum of 50% overrange protection** shall be provided for all filled system devices.
 - e. **Compensation** for variations in ambient temperature and barometric pressure shall be provided.

TRANSMITTERS

TRANSMITTERS

- O 7.1 **Transmitters shall have the narrowest available span** which covers the anticipated temperatures during startup, normal operations, and process upset conditions. Where possible, the range shall be selected so that normal temperature will be in the middle third of the range.
- I,S * 7.2 **Transmitters shall have a selectable upscale or downscale burnout (open circuit) feature without transient spikes on burnout.**
- For protective systems, sensing element open circuit protection shall be in accordance with **IP 15-7-2**. For non-protective control functions, sensing element open circuit protection shall operate to drive the controller output to the final control element failure position. The Owner's Engineer shall specify the direction of open circuit detection in all other applications.

TEMPERATURE INDICATING GAUGES

- O * 8.1 **Local temperature indicating gauges** shall be **adjustable angle bi-metallic** or **filled system thermometers**, with rigid stems. **Minimum dial size** shall be 4 in. (100 mm), **minimum stem length** shall be 9 in. (225 mm).

THERMOWELLS

- O,C 9.1 For pipe-mounted thermowells, immersion length (measured from inside wall of pipe) shall be selected such that the tip falls in the middle third of the pipe diameter and does not exceed 10 in. (250 mm) unless the maximum velocity rating of the thermowell requires a shorter length. Vendor standard lengths shall be used to the maximum extent possible.
- S,R 9.2 **Thermowell insertion length** shall not be greater than the length corresponding to the **maximum velocity rating** of the thermowell given by **Figure 2**. Thermowell insertion length is the distance between the free end of the well up to but not including the external threads or means of attachment to the flange or pipe. To reduce the complexity of presenting this information, the ratings are given based upon thermowells constructed to this practice and operating temperatures of 1000°F (540°C). Slightly higher velocity is possible at lower temperatures. The values given represent safe values for water, steam, air, or gas. Maximum velocity ratings of thermowells operating at conditions other than 1000°F (540°C) or of thermowells made of materials other than Type 304 or Type 316 stainless steel shall be determined from ASME PTC 19.3 (Performance Test Code on Temperature Measurement).