The total temperature of the gas stream is required and if the average velocity in the area of temperature measurement exceeds 100 ft/sec (30.5 m/s), then it is suggested that the individual temperature reading be adjusted for velocity effect.

(U.S. Customary Units)

\[ T_i = T + \frac{V^2}{2(g_c C_p)} = T + T_v \]

where

- \(C_p\) = the specific heat, Btu/lbm °F
- \(g_c\) = the conversion constant as defined in Section 2,
  \(32.1741 \text{ lbm ft/lbf sec}^2\)
- \(J\) = the mechanical equivalent of heat, \(778.1692623 \text{ ft lbf/Btu}\)
- \(T\) = the measured temperature, °F
- \(T_i\) = the total temperature, °F
- \(T_v\) = the dynamic temperature, °F
- \(V\) = the gas velocity (ft/sec)

(SI Units)

\[ T_i = T + \frac{V^2}{2(C_p)} = T + T_v \]

where

- \(C_p\) = the specific heat, kJ/kg °C
- \(J\) = the mechanical equivalent of heat, \(1 \text{ kJ/m}^2/\text{kg}°\text{C} \text{s}^2\)
- \(T\) = the measured temperature, °C
- \(T_i\) = the total temperature, °C
- \(T_v\) = the dynamic temperature, °C
- \(V\) = the gas velocity, m/s

Exhaust gas combustion products flowing into and through a duct are subject to spatial variations such as nonuniform velocity, varying flow angle, temperature, and composition. This is especially true at the inlet of a duct or near a flow disturbance, such as a bend, tee, fan, vane, damper, or transition. Spatial variation effects, if not addressed by the measurement approach, are considered errors of method and contributors to the systematic uncertainty in the measurement system. Generally, the temperature uncertainty can be reduced either by sampling more points in a plane perpendicular to the flow or by using more sophisticated calculation methods such as flow/velocity weighting and flow angle compensation.

The measurement plane should be located away from bends, constrictions, or expansions of the duct. Temperature measurements shall be read individually and not be grouped together to produce a single output. As such, the number and location of temperature measurement devices and flow velocity measurements should be determined such that the overall systematic uncertainty of the average exhaust gas temperature measurement devices is minimized as much as practically possible.

It is recommended that the exhaust gas temperature be measured at the test boundary; however, there may be cases where the measurement upstream or downstream may be more practical and result in a measurement of lower uncertainty such as selecting to measure temperature inside the duct at the interface plane between the gas turbine and HRSG or the gas turbine exhaust stack because of better mixing to attain a more representative bulk temperature measurement. If measurements are made at locations other than the test boundary, the location selected shall be such that no heat addition or loss occurs between the test boundary and the selected measurement location.

4-3.3.3 Fuel Temperature. Fuel temperatures of fuel supply and, if applicable for liquid fuel, of fuel return lines, shall be measured at representative locations close to the corresponding flowmeters. Two different measurement locations may be required, one for fuel flow measurement, and one for the sensible heat at the test boundary.

Refer to ASME PTC 19.5 for guidance as to the proper location for these temperature measurements.

4-3.3.4 Extraction/Injection Fluid Temperature. Extraction/injection fluid temperature measurements (such as water, steam, nitrogen, air) shall be provided to determine the heat content of the fluid.

4-3.4 Calibration of Temperature Instruments

This Code recommends that instrumentation used in the measurement of temperature have a suitable calibration history (three or four sets of calibration data). The calibration history should include the temperature level the device experienced between calibrations. A device that is stable after being used at low temperatures may not be stable at higher temperatures. Hence, the calibration history of the device should be evaluated to demonstrate the required stability of the parameter.

During the calibration of any thermocouple, the reference junction shall be held constant preferably at the ice point with an electronic reference junction, isothermal reference junction or in an ice bath. The calibration shall be made by an acceptable method, with the standard being traceable to a recognized international or national standards laboratory such as the National Institute of Standards and Technology. The calibration shall be conducted over the temperature range in which the instrument is used.

The calibration of temperature measurement devices is accomplished by inserting the candidate temperature measurement device into a calibration medium along with a traceable reference standard. The calibration medium type is selected based upon the required calibration range and commonly consists of a block calibrator, fluidized sand bath, or circulating bath. The temperature of the calibration medium is then set to the calibration temperature setpoint. The temperature of the