frequency measured at the generator terminals may be used instead of shaft speed to correct gas turbine performance since the shaft speed is directly coupled to the line frequency. The chosen method shall meet the uncertainty requirement in this Code.

4-9 HUMIDITY MEASUREMENT

The moisture content of inlet air shall be measured directly with a hygrometer or indirectly by measuring the adiabatic wet-bulb temperature. The measurement location shall be upstream of any inlet air-conditioning device and preferably in close proximity to the dry-bulb temperature measurement. The measurement location shall be shielded from direct sunlight.

(23) 4-9.1 Direct Measurement

Direct measurement of humidity is required if freezing conditions are present during the test. The most common type of direct humidity measurement is a capacitive-type hygrometer. Appropriate calibration standards for field calibration or recent factory calibration certification shall be available to ensure compliance with the measurement uncertainty requirement. Be aware that uncertainty levels for a capacitive-type device often increase at extreme low and extreme high humidity levels.

4-9.2 Indirect Measurement via Wet-Bulb Temperature

Indirect measurement of humidity does not require special calibration standards (other than what is needed for the temperature-sensing element). Indirect measurement can be used whenever conditions are above freezing. Wet-bulb temperature is measured by snugly covering the temperature-sensing element with a wetted cotton sock. Distilled water shall be used as a wetting agent. Air velocity across the sensing element shall be kept between 800 ft/min and 1,200 ft/min (4 m/s and 6 m/s) to ensure continuous evaporation of the distilled water. If the existing air velocity at the measurement location is insufficient by being less than 800 ft/min (4 m/s), the air can be forced across the sensing element using a fan.

Wet-bulb temperature can be inferred by a properly designed, mechanically aspirated psychrometer. The mechanically aspirated psychrometer should incorporate the following features:

(a) The sensing element is shielded from direct sunlight and any other surface that is at a temperature other than the dry-bulb temperature. If the measurement is to be made in direct sunlight, the sensor shall be enclosed by a double-wall shield that permits the air to be drawn across the sensor and between the walls.

(b) The sensing element is suspended in the airstream and is not in contact with the shield walls.

(c) The sensing element is snugly covered by a clean cotton wick that is kept wetted from a reservoir of distilled water. The length of the wick shall be sufficient to minimize the sensing element stem conduction effects and to ensure it is properly wetted.

(d) The air velocity across the sensing element is maintained constant in the range of 800 ft/min to 1,200 ft/min (4 m/s to 6 m/s).

(e) Air is drawn across the sensing element in such a manner that it is not heated by the fan motor or other sources of heat. The psychrometer should be located at least 4.9 ft (1.5 m) above ground level and should not be located within 4.9 ft (1.5 m) of vegetation or surface water.

4-10 HEAT LOSSES (23)

Gas turbine heat losses are all system losses that cross the test boundary. Gas turbine heat losses have a very small influence on the final calculated exhaust energy or flow, and therefore are often calculated from data provided by the manufacturer rather than measured directly. Manufacturers may identify and categorize heat losses differently, but heat losses can generally be placed into four major categories: generator losses, gearbox losses, fixed losses, and variable losses.

Where the measurement of heat loss from lubricant coolers and other sources is required, the accuracy of temperature and flow measurement shall be such that determination of heat rejection may be accomplished with an uncertainty not greater than 10%. Where the actual measurement of heat loss is deemed unnecessary or impractical, the means of determining heat loss shall be determined by agreement among the parties to the test.

4-10.1 Generator Losses

Generator losses typically include exciter and collector losses, which are a function of generator output and power factor, and windage losses, which are a function of the generator cooling medium temperature. It is not practical to measure these losses directly during a test; therefore, they must be determined from curves provided by the generator manufacturer. Generator losses are typically on the order of 1% to 2% of the gross electrical output.

4-10.2 Gearbox Losses

Gearbox losses shall be determined for applications that require load gears for speed reduction between the turbine rotor and the generator rotor. Gearbox losses are typically determined from data provided by the gearbox manufacturer. Gearbox losses can vary greatly, but are typically on the order of 1% to 2% of shaft output.