Contents

Scope

This Instruction covers the use of Laboratory Condition stations used in FRL experiments.

Instrument Description

GENERAL

A Laboratory Condition station is used to measure the ambient temperature, barometric pressure and relative humidity inside the laboratory. The Laboratory Conditions stations consist of a power supply, an Ethernet based data acquisition module, and a probe which measures the ambient conditions. Laboratory Conditions stations measure the temperature, pressure and relative humidity using capacitive digital sensors. The sensors have surface mounted circuitry which reacts to changes in the environment and outputs a digital signal which is read by the data acquisition module and stored via the secure FireTOSS results database. Laboratory Conditions stations must be calibrated according to manufacturer specifications.

Uncertainty and Accuracy

Three different uncertainties are associated with laboratory conditions stations. Each type of measurement has its own independent uncertainty. Information about the errors and accuracy of each measurement is provided by Omega, the manufacturer of the Laboratory Condition station hardware [1].

It can be assumed that the errors have a rectangular probability distribution, in which case the standard uncertainty is computed by the following equation [2]:

$$u(x) = \frac{e}{\sqrt{3}} \quad (1.1)$$

where:

$u(x)$ = Standard uncertainty
e = Error/accuracy of the measurement

Where more than one type or uncertainty is present for a measurement, the values can be combined in quadrature to achieve a combined uncertainty, using the following equation [2-4]:

$$u_C(\mathrm{X}) = \sqrt{\sum \mathrm{u}(\mathrm{x_i})^2} \quad (1.2)$$

where:

$u_c(X)$ = Combined standard uncertainty
$u(x_i)$ = Standard uncertainty component

TEMPERATURE

Omega lists the accuracy of the temperature measurement as ±1°C, the repeatability as ±0.1°C, and the resolution as ±0.1°C. Using Equation 1.1, these errors yield a standard uncertainty of 0.58, 0.06, and 0.06, respectively. These values are combined in quadrature to calculate the combined standard uncertainty of the temperature measurement. The result is a combined standard uncertainty of 0.59°C.

$$u_C(\mathrm{T}) = \sqrt{0.58^2 + 0.06^2 + 0.06^2} = 0.59°C \quad (1.3)$$

RELATIVE HUMIDITY

Omega lists the following values for the error of the relative humidity measurement:

- Accuracy: ±2% for 10-90% RH
  ±3% for 0-10% and 90-100% RH
- Linearity: ±3%
- Hysteresis: ±1%
- Repeatability: ±0.1%
- Resolution: 0.03%

It is assumed that under normal operating conditions the relative humidity inside the testing area will fall between 10-90% RH, and thus the value of ±2% is used.

Using Equation 1.1, these errors yield a standard uncertainty of 1.15, 1.73, 0.58, 0.06, and 0.02, respectively. These values are combined in quadrature to calculate the combined standard uncertainty of the relative humidity measurement. The result is a combined standard uncertainty of 2.16%

$$u_C(\mathrm{RH}) = \sqrt{1.15^2 + 1.73^2 + 0.58^2 + 0.06^2\ 0.02^2} = 2.16\% \tag{1.4}$$

PRESSURE

Omega lists the accuracy of the pressure measurement as ±200 Pa and the resolution as 10 Pa. Using Equation 1.1, these errors yield a standard uncertainty of 115.47 and 5.77, respectively. These values are combined in quadrature to calculate the combined standard uncertainty of the pressure measurement. The result is a combined standard uncertainty of 116 Pa.

Operating Instructions

REQUIREMENTS

1. The assigned operator shall be qualified in accordance with laboratory proficiency requirements.
2. If data acquisition is used, the data acquisition equipment shall be calibrated and be marked with the calibration status in accordance with FRL calibration procedures.
3. The measuring probe shall be clean and free of debris.

PROCEDURE

The following is the general procedure that shall be followed for lab conditions stations.

1. Set up
   1.1 The calibration marking on the laboratory conditions station shall be checked to confirm that the instrument is calibrated.
   1.2 If data acquisition is used, the laboratory conditions station shall be connected to the laboratory Ethernet network.
2. Pre-Test
   2.1 Verify that the laboratory conditions station is free of debris or any obstacle that would prevent an accurate measurement of the surrounding conditions.
3. Test
   3.1 The measurements of the laboratory conditions station shall be monitored.
4. Post-Test
   4.1 The laboratory condition station shall remain powered and connected to the Ethernet network.

Laboratory Conditions Documentation Requirements

The FireTOSS input parameters for laboratory conditions are listed below in Table 1.

Table 1 – Lab Conditions Data Acquisition Input Parameters

Parameter	Required	Input Method
description	True	User Input From List
Bar Code	True	Automatic
Time out of service (s)	False	User Input
Out of service reason	False	User Input
Temperature Data (C)	False	Automatic
Temp Initial value	False	Automatic
Pressure data (Pa)	False	Automatic
Pressure Initial value	False	Automatic
Relative Humidity Data (fraction)	False	Automatic
Relative Humidity Initial value	False	Automatic

References

1. "iBTHX User's Guide," Omega, Stamford, CT, 2008.
2. Guthrie, W. & Liu, H., "Hands-on Workshop on Estimating and Reporting Measurement Uncertainty," National Institute of Standards and Technology, Presentation given to CPSC, 2007.
3. Taylor, B. N., & Kuyatt, C. E., "NIST Technical Note 1297: Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results," National Institute of Standards and Technology, Gaithersburg, MD, 1993.
4. Bryant, A.R., Ohlemiller, T.J., Johnsson, E.L, Hamins, A., Grove, B.S., Guthrie, W.F., Maranghides, A., Mulholland, G.W., "Special Publication 1007," National Institute of Standards and Technology, Gaithersburg, MD, 2003.