GUIDELINE

ASHRAE Guideline 2-2010 (RA 2014)

Engineering Analysis of Experimental Data

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NOTE

Approved addenda, errata, or interpretations for this guideline can be downloaded free of charge from the ASHRAE Web site at www.ashrae.org/technology.

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(This foreword is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

FOREWORD

Originally published in 1986, Guideline 2 has been revised several times to keep up with changes to technology and users' needs with regard to collecting and analyzing data and reporting results in the most appropriate manner. Although this guideline addresses many of the ways in which statistics are used in HVAC&R applications, it should not be considered a comprehensive statistical text. An attempt has been made to provide sufficient background and references for the statistics used in this guideline.

This is a reaffirmation of Guideline 2-2010. This guideline was prepared under the auspices of ASHRAE. It may be used, in whole or in part, by an association or government agency with due credit to ASHRAE. Adherence is strictly on a voluntary basis and merely in the interest of obtaining uniform guidelines throughout the industry. This version of the reaffirmation includes minor editorial changes.

1. PURPOSE

The purpose of this document is to provide guidelines for planning, analyzing data, and reporting the uncertainty of experiments.

2. SCOPE

Appropriate terms are defined and statistically based procedures and formulae are recommended for evaluating experimental data related to HVAC&R. Numerous examples are provided to illustrate analysis of experimental data.

3. DEFINITIONS

***accuracy*:** the degree of conformity of an indicated value to an accepted standard value, or true value. The degree of inaccuracy is known as total measurement error and is the sum of bias error and precision error.

***bias, fixed, or systematic error*:** the difference between the true or actual value to be measured and the indicated value from the measuring system that persists and is usually due to the particular instrument or technique of measurement.

***confidence level*:** the probability that a stated interval will include the true value. In analyzing experimental data, a level of 95% is usually used.

confidence limits *(used for multisample data) and* ***uncertainty interval*** *(used for single-sample data):* that range of values that can be expected, given a stated probability, to include the true value. For example, a statement that the 95% confidence limit is 5 to 8 means that there is a 95% probability (19 chances out of 20) that the interval between 5 and 8 will contain the true value.

data: information obtained by experimental means, assumed to be in numerical form; recorded values of the variables; readings.

deviation: the difference between a single result and the mean of many results.

error: the difference between the true value of the quantity measured and an observed value. Since the true value is often not known, it is estimated by the mean. The difference between the mean and an observed value is often called its deviation.

experiment: a systematic approach for collecting information on a physical apparatus or system to determine the nature of its operation.

mean: the sum of measurement values divided by the number of measurements. It is considered the best approximation of the true value.

parent population: synonymous with population but emphasizing the relation to a sample.

population: any finite or infinite aggregation of items or individuals (inanimate or animate).

precision: the closeness of agreement among repeated measurements of the same characteristic by the same method under the same conditions.

propagation of uncertainty: the degree to which the uncertainties in the values of the parameters affect the uncertainty in the result.

random error (or precision error): a statistical error that is caused by chance and is not recurring. There are two types of random errors:

- *additive* errors that are independent of the magnitude of the observations
- *multiplicative* errors that are dependent on the magnitude of the observations

repeatability: the closeness of agreement among repeated measurements of the same characteristic under the same conditions by the same instrument.

replication: repetitions of measurements at the same conditions that are taken to estimate the uncertainty in the results.

reproducibility: the closeness of agreement among repeated measurements of the same characteristic under the same conditions by different instruments.

sample: a portion, subset, or limited number of items of a population; a set of values, experimentally obtained, that is representative of the parent population.

***standard deviation*:** the square root of the mean of the squares of the deviations.

uncertainty: a measure of the potential error in a measurement or experimental result that reflects the lack of confidence in the result to a specified level.

uncertainty range (or confidence interval): the band for the error in an estimate at a certain confidence level. The greater the acceptable confidence level (e.g., 95% rather than 50%), the wider the uncertainty range.

variance: the square of the standard deviation.

4. TYPES OF MEASUREMENTS

4.1 Types of Measurements. Measurements are categorized as either primary measurements or derived measurements.

4.1.1 Primary. A primary measurement is one that is obtained directly from the measurement sensor. This can be