



Standard Practice for Dealing With Outlying Observations¹

This standard is issued under the fixed designation E 178; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers outlying observations in samples and how to test the statistical significance of them. An outlying observation, or “outlier,” is one that appears to deviate markedly from other members of the sample in which it occurs. In this connection, the following two alternatives are of interest:

1.1.1 An outlying observation may be merely an extreme manifestation of the random variability inherent in the data. If this is true, the value should be retained and processed in the same manner as the other observations in the sample.

1.1.2 On the other hand, an outlying observation may be the result of gross deviation from prescribed experimental procedure or an error in calculating or recording the numerical value. In such cases, it may be desirable to institute an investigation to ascertain the reason for the aberrant value. The observation may even actually be rejected as a result of the investigation, though not necessarily so. At any rate, in subsequent data analysis the outlier or outliers will be recognized as probably being from a different population than that of the other sample values.

1.2 It is our purpose here to provide statistical rules that will lead the experimenter almost unerringly to look for causes of outliers when they really exist, and hence to decide whether alternative 1.1.1 above, is not the more plausible hypothesis to accept, as compared to alternative 1.1.2, in order that the most appropriate action in further data analysis may be taken. The procedures covered herein apply primarily to the simplest kind of experimental data, that is, replicate measurements of some property of a given material, or observations in a supposedly single random sample. Nevertheless, the tests suggested do cover a wide enough range of cases in practice to have broad utility.

2. Referenced Documents

2.1 ASTM Standards:

E 456 Terminology Relating to Quality and Statistics²

¹ This practice is under the jurisdiction of ASTM Committee E11 on Statistical Methods and is the direct responsibility of Subcommittee E11.30 on Data Analysis.

Current edition approved May 10, 2002. Published July 2002. Originally published as E 178 – 61 T. Last previous edition E 178 – 00.

² *Annual Book of ASTM Standards*, Vol 14.02.

3. Terminology

3.1 *Definitions:* The terminology defined in Terminology E 456 applies to this standard unless modified herein.

3.1.1 *outlier*—see **outlying observation**.

3.1.2 *outlying observation, n*—an observation that appears to deviate markedly in value from other members of the sample in which it appears.

4. Significance and Use

4.1 When the experimenter is clearly aware that a gross deviation from prescribed experimental procedure has taken place, the resultant observation should be discarded, whether or not it agrees with the rest of the data and without recourse to statistical tests for outliers. If a reliable correction procedure, for example, for temperature, is available, the observation may sometimes be corrected and retained.

4.2 In many cases evidence for deviation from prescribed procedure will consist primarily of the discordant value itself. In such cases it is advisable to adopt a cautious attitude. Use of one of the criteria discussed below will sometimes permit a clear-cut decision to be made. In doubtful cases the experimenter’s judgment will have considerable influence. When the experimenter cannot identify abnormal conditions, he should at least report the discordant values and indicate to what extent they have been used in the analysis of the data.

4.3 Thus, for purposes of orientation relative to the over-all problem of experimentation, our position on the matter of screening samples for outlying observations is precisely the following:

4.3.1 *Physical Reason Known or Discovered for Outlier(s):*

4.3.1.1 Reject observation(s).

4.3.1.2 Correct observation(s) on physical grounds.

4.3.1.3 Reject it (them) and possibly take additional observation(s).

4.3.2 *Physical Reason Unknown—Use Statistical Test:*

4.3.2.1 Reject observation(s).

4.3.2.2 Correct observation(s) statistically.

4.3.2.3 Reject it (them) and possibly take additional observation(s).

4.3.2.4 Employ truncated-sample theory for censored observations.