



# Standard Practice for Statistical Analysis of Linear or Linearized Stress-Life ( $S$ - $M$ ) and Strain-Life ( $\epsilon$ - $N$ ) Fatigue Data<sup>1</sup>

This standard is issued under the fixed designation E739; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers only  $S$ - $N$  and  $\epsilon$ - $N$  relationships that may be reasonably approximated by a straight line (on appropriate coordinates) for a specific interval of stress or strain. It presents elementary procedures that presently reflect good practice in modeling and analysis. However, because the actual  $S$ - $N$  or  $\epsilon$ - $N$  relationship is approximated by a straight line only within a specific interval of stress or strain, and because the actual fatigue life distribution is unknown, it is *not recommended* that (a) the  $S$ - $N$  or  $\epsilon$ - $N$  curve be extrapolated outside the interval of testing, or (b) the fatigue life at a specific stress or strain amplitude be estimated below approximately the fifth percentile ( $P \approx 0.05$ ). As alternative fatigue models and statistical analyses are continually being developed, later revisions of this practice may subsequently present analyses that permit more complete interpretation of  $S$ - $N$  and  $\epsilon$ - $N$  data.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

E206 Definitions of Terms Relating to Fatigue Testing and the Statistical Analysis of Fatigue Data; Replaced by E 1150 (Withdrawn 1988)<sup>3</sup>

E468 Practice for Presentation of Constant Amplitude Fatigue Test Results for Metallic Materials

E513 Definitions of Terms Relating to Constant-Amplitude, Low-Cycle Fatigue Testing; Replaced by E 1150 (Withdrawn 1988)<sup>3</sup>

E606/E606M Test Method for Strain-Controlled Fatigue Testing

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee E08 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.04 on Structural Applications.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

## 3. Terminology

3.1 The terms used in this practice shall be used as defined in Definitions E206 and E513. In addition, the following terminology is used:

3.1.1 *dependent variable*—the fatigue life  $N$  (or the logarithm of the fatigue life).

3.1.1.1 *Discussion*—Log ( $N$ ) is denoted  $Y$  in this practice.

3.1.2 *independent variable*—the selected and controlled variable (namely, stress or strain). It is denoted  $X$  in this practice when plotted on appropriate coordinates.

3.1.3 *log-normal distribution*—the distribution of  $N$  when log ( $N$ ) is normally distributed. (Accordingly, it is convenient to analyze log ( $N$ ) using methods based on the normal distribution.)

3.1.4 *replicate (repeat) tests*—nominally identical tests on different randomly selected test specimens conducted at the same nominal value of the independent variable  $X$ . Such replicate or repeat tests should be conducted independently; for example, each replicate test should involve a separate set of the test machine and its settings.

3.1.5 *run out*—no failure at a specified number of load cycles (Practice E468).

3.1.5.1 *Discussion*—The analyses illustrated in this practice do not apply when the data include either run-outs (or suspended tests). Moreover, the straight-line approximation of the  $S$ - $N$  or  $\epsilon$ - $N$  relationship may not be appropriate at long lives when run-outs are likely.

3.1.5.2 *Discussion*—For purposes of statistical analysis, a run-out may be viewed as a test specimen that has either been removed from the test or is still running at the time of the data analysis.

## 4. Significance and Use

4.1 Materials scientists and engineers are making increased use of statistical analyses in interpreting  $S$ - $N$  and  $\epsilon$ - $N$  fatigue data. Statistical analysis applies when the given data can be reasonably assumed to be a random sample of (or representation of) some specific defined population or universe of material of interest (under specific test conditions), and it is desired either to characterize the material or to predict the performance of future random samples of the material (under similar test conditions), or both.