



Designation: E 1407 – 97

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Guide for Materials Database Management¹

This standard is issued under the fixed designation E 1407; 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 The purpose of this guide is to provide internationally acceptable guidelines for builders, maintainers, and distributors of computerized materials properties databases in any form, including PC disks, compact disks, or online systems.

1.2 The scope of this guide includes recommendations and guidelines on the following aspects of the production, supply and management of sources of machine-readable material-property data.

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1.3 This guide provides certain basic tenets of database management operating philosophy. They are intended to ensure the development, maintenance, and distribution of machine-readable material property databases that are easily accessed and utilized, and are responsive to users' needs and expectations with respect to quality, reliability, and degree of documentation.

1.4 In developing this guide, the recommendations of a variety of international groups and services have been consolidated and, in some cases, amplified^{2,3}.

2. Referenced Documents

2.1 ASTM Standards:

E 380 Practice for Use of the International System of Units (SI) the Modernized Metric System⁴

E 399 Test Method for Plane-Strain Fracture Toughness of Metallic Materials⁵

E 1313 Guide for Recommended Formats for Data Records Used in Computerization of Mechanical Test Data for Metals⁶

E 1338 Guide for the Identification of Metals and Alloys in Computerized Material Property Databases⁶

3. Terminology

3.1 A useful glossary of terms is included in CODATA Bulletin No. 69.³

4. Significance and Use

4.1 The guidelines and procedures described, herein, are intended to be of value to both builders and distributors of databases covering all aspects of materials and material properties. They are intended to provide help to newcomers to this discipline as well as to experienced organizations who may seek to enhance the breadth and strength of their services.

4.2 The guidelines and procedures described, herein, are applicable to all types of materials databases, regardless of the medium used to disseminate them, such as personal computer diskettes, CD-ROM disks, magnetic tapes, local area networks, or telecommunications.

4.3 Materials databases described, herein, refer to a combination of data files covering some specific subject area and computer software used for search and retrieval, all of which are organized such that once installed, users may execute the program via a set of instructions and commands and have the results displayed at a terminal. No additional programming by the user is necessary.

4.4 Assessments of strength or weakness in several of the aspects of database building and distribution covered by this guide are relatively subjective, and it is impossible to state specific practices to be universally applied. Even in such cases, some general guidelines are of value.

4.5 The requirements and guidelines for quality, reliability and documentation of numeric/factual material property databases are expected to evolve as this relatively new field develops.

5. Management of Operations

5.1 *Qualifications of Personnel*—It is essential to have experienced and knowledgeable personnel involved in the process of locating, assembling, evaluating and inputting data, as well as in the operation of a well-supported data source. While this aspect is among those to which largely

¹ This guide is under the jurisdiction of ASTM Committee E-49 on Computerization of Material Property Data and is the direct responsibility of Subcommittee E49.05 on Data and Database Quality.

Current edition approved April 10, 1997. Published March 1998. Originally published as E 1407 – 91. Last previous edition E 1407 – 91.

² "The Operation of Materials Property Data Systems in the EC," A Code of Practice for Use in the Materials Data Base Demonstrator Programme (MDP). Prepared by CEC group MPD (MAT-01)-OS-3, Summer 1987. Available from M. Jean-Pierre Durand, The Commission of the European Committee DG XIII, Magatex, 34, rue de Marve, 92410 Ville d'Auray, France.

³ Guidelines for Materials Database Management, Hemisphere Press, New York, November 1988.

⁴ Annual Book of ASTM Standards, Vol 14.02.

⁵ Annual Book of ASTM Standards, Vol 03.01.

⁶ Annual Book of ASTM Standards, Vol 14.01.

subjective judgments must be employed in lieu of more stringent specifications, it is necessary that at least two areas of knowledge and experience be represented: (1) the technical/scientific knowledge encompassed in the database, and (2) the building, maintenance and operation of an electronic (machine-readable) database.

5.1.1 It is inappropriate to specify limiting measures of the knowledge and experience required, and it is recognized that not every staff member can have extensive background in both areas noted above. However, it is clear that at least one engineer/scientist working on any specific database should be knowledgeable in the technical field(s) involved and at least one staff member should have some database management training or experience, or both.

5.2 *Standard Procedures and Practices*—A reliable database builder, and maintainer and supplier, or both, should have a regular set of procedures that are, in effect, standards for the respective operations, ensuring a consistent quality to those operations. Further, the standards and practices should be such that they ensure the maintenance of high quality and reliability, both of the content of the database and of the service to the user of that database.

5.2.1 Procedures for collecting and for assessing quality and reliability should be consistent, unbiased, and carried out on bases which the user will understand and accept as reasonable and reliable (see 7.2).

5.2.2 Terminology, including nomenclature, abbreviations, symbols, units, and acronyms should be clearly defined and presented. It should reasonably conform to industry standards and expectations, and be used in a consistent manner.

5.2.3 Interfaces should be developed carefully and consistently to ensure user understanding and high standards of readability and clarity.

5.2.4 Attention should be given to ensuring that unreasonable precision is not suggested by extra, apparently significant figures resulting from unit conversions and other transformations of the data, or display programs.

5.2.5 For online systems, telecommunication links and the associated access and logon procedures should be based upon current industry standards, and should be consistently and easily carried out (see 7.4).

5.3 *Auditing Quality Assurance Programs*—The practices employed for assurance of quality regarding operation (5.2) and consistency and quality of data (6.2) should be auditable. Sufficient records should be kept documenting what, when, and by whom checks and corrective actions are taken so that it is possible for a person not directly involved in the process to ascertain that well-defined quality assurance practices are being utilized on a regular basis.

6. Data and Data Management

6.1 *Type or Statistical Significance of Numeric Values*—There should be unambiguous descriptors of the type of numeric values given in a database, that is, whether they are individual test results, averages of several values, statistically derived values or values specified as minimum by some certification organization. When they are statistically derived, the specific statistical definition should be cited.

6.2 *Completeness of Data*—Consistent attention should be given to the completeness of the documentation of

numeric data so that the utility and reliability of the data to the user are maximized. In general, it is appropriate to utilize standard data formats to ensure that there is sufficient and consistent background information on the material itself, the test methods, and the properties themselves. These elements of information, though secondary in many respects to the specific performance data required by any given user, are essential to comparisons of data from various sources. See Guides E 1313 and E 1338 for more specific guidance on these points.

6.2.1 *Material Descriptions*—Complete descriptions of the materials for which detailed performance properties are given should also be included in the database. While the specifics will vary depending upon the application area, there is generally some minimum essential set of facts required to ensure adequate comparability but for the broadest applicability, additional detail may be highly desirable. In general, factors such as product form, size, and condition must be considered when attempting to compare data from different sources and must be retained in a useful database.

6.2.2 *Test Methods*—It is essential to provide test method descriptors, notably standard test method references where applicable, plus such information as specimen type, size, and direction (orientation), and loading rate. Such information is even more important when dealing with data developed with non-standard methods. The availability of test method documentation enables users to judge the comparability of data generated by different laboratories. Factors used in the reduction and analysis of data, such as percent offset for yield strength measurements and gage length for elongation measurement in tensile tests, are also important for comparisons of data from different countries.

6.2.2.1 In the event that key variables such as temperature are known but not stated explicitly in a database as originally produced (for example, all data are for *room temperature*), consideration should be given to their addition before the database is widely distributed.

6.2.3 *Test Conditions*—Independent variables such as temperature, humidity, environment, and exposure times should always be specified, even though they may not have been varied within the specific set of data being compiled; any or all may differ when one dataset is compared with another.

6.2.4 *Test Results*—All elements of the individual test results should be included in any database which is to be a source of *raw* test data (that is, the original individual test results as contrasted to calculated average or statistically derived values).

6.2.5 *Validity Criteria*—Some test results and calculated properties have specific criteria associated with them which provide essential information as to whether or not they were correctly generated or derived. In all such cases, the validity criteria and the original data upon which the judgment of whether or not the criteria were met should be included in the database whenever possible. For example, the reporting of plane-strain fracture toughness data requires at minimum a descriptor indicating whether or not the requirements of Test Method E 399 are met, and preferably would contain the specific results of the measurements required to deal with those requirements.

6.3 *Consistency and Quality of Data*—Specific practices