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Critical Surveys of Data Sources:

Mechanical Properties of Metals

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² Part of the Center for Radiation Research.

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⁴ Part of the Center for Building Technology.

Critical Surveys of Data Sources:

Mechanical Properties of Metals

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Foreword

The National Standard Reference Data System was established in 1963 for the purpose of promoting the critical evaluation and dissemination of numerical data of the physical sciences. The program is coordinated by the Office of Standard Reference Data of the National Bureau of Standards but involves the efforts of many groups in universities, government laboratories, and private industry. The primary aim of the program is to provide compilations of critically evaluated physical and chemical property data. These tables are published in the *Journal of Physical and Chemical Reference Data*, in the NSRDS-NBS series of the National Bureau of Standards, and through other appropriate channels.

The properties of commercial materials, and particularly their mechanical properties, have thus far received very limited coverage in the NSRDS program. However, many other groups select and compile data on the properties of such materials for various purposes using different criteria of selection. Thus, identifying the best data source for a given purpose requires something much more detailed than ordinary bibliographic guides.

This series is designed to provide such guides to data covering selected areas of materials and properties. This first survey covers mechanical properties of metals. Other properties of metals and various properties of other materials will be covered by succeeding surveys. In each case, we will seek guidance from specialists with emphasis on those involved in the production and use of important commercial materials. This assistance for the first survey was provided by a special task force organized by the Metal Properties Council listed below. The assistance of these individuals and the encouragement and support of the Technical Advisory Committee of the Metal Properties Council are gratefully acknowledged.

David R. Lide, Jr., Chief
Office of Standard Reference Data

Task force of the Metals Properties Council which reviewed the coverage and contents of this Survey:

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Gerald S. Hartman, Bethlehem Steel Corporation
William J. McGuire, Gulf Research and Development Company
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Abstract

This study was undertaken with the objective of providing a detailed critical survey of the existent sources of mechanical property data for commercially available metals and alloys. This survey was intended to assess the scope, assets, and deficiencies of about forty of the most prominent sources of such information. There were included: handbooks and technical compilations, information centers, foreign information sources, technical societies, and trade associations. The initial listing of sources to be examined was prepared by the authors with the advice and assistance of a subcommittee of the Metals Properties Council. The aim was to restrict the survey to sources which actually had compilations of mechanical property data in some form. Thus sources which offered only generalized guides to the literature, monographs, textbooks, or periodicals publishing original research or engineering articles were not to be included. Those sources from the original listing which were found upon detailed examination to fall into the latter categories are therefore treated in a separate appendix.

Key words: Commercial alloys; data sources; mechanical properties; metals.

Contents

Page

| | |
|---------------------------|-----|
| Foreword | iii |
| Introduction | vii |
| Source Descriptions | 1 |

Source No. HANDBOOKS AND TECHNICAL COMPILATIONS

| | |
|---|----|
| 1. Aerospace Structural Metals Handbook (The Mechanical Properties Data Center) | 2 |
| 2. Alloy Digest (Engineering Alloys Digest, Inc.) | 4 |
| 3. Aluminum Standards and Data (The Aluminum Association) | 6 |
| 4. Engineering Alloys 5th Edition (Woldman). (Van Nostrand Reinhold Company) | 8 |
| 5. Materials Selector (Reinhold Publishing Co., Inc.) | 9 |
| 6. Damage Tolerant Design Handbook MCIC-HB-01, 1st Edition (Air Force Materials Laboratory) | 11 |
| 7. Mechanical Properties of British Standard En Steels Vol. 1, 2, and 3 (Macmillan Co.) | 13 |
| 8. Metallic Materials—Specification Handbook 2nd Edition (E. and F. N. Spon, Ltd., London) | 14 |
| 9. Metals Handbook 8th Edition (ASM) | 16 |
| 10. Metals Reference Handbook 4th Edition (Smithells). (Butterworths, London) | 18 |
| 11. Military Handbook 5B—Metallic Materials and Elements for Flight Vehicle Structures (DoD and Federal Aviation Agency) | 19 |
| 12. Reactor Handbook, Volume 1, Materials 2nd Edition, 1960. (Interscience Publishers, Inc., New York) | 21 |
| 13. SAE Handbook, 1973 Edition | 22 |
| 14. Single Crystal Elastic Constants and Calculated Aggregate Properties: A Handbook 2nd Edition (M.I.T. Press) | 24 |
| 15. Structural Alloys Handbook 1st Edition (Mechanical Properties Data Center) | 25 |
| 16. Welding Handbook, Section Four, Metals and Their Weldability 6th Edition (American Welding Society) | 27 |
| 17. Wrought Copper and Copper Alloy Mill Products Cast Copper and Copper Alloy Products (Standard Handbooks, CDA) | 29 |
| 18. Monotonic and Cyclic Properties of Engineering Materials Handbook and Supplemental Literature (INCO) | 31 |
| 19. Huntington Alloys (Ford Motor Company) | 32 |
| 20. Materials Data Handbooks (Western Applied Research and Development, Inc.) | 34 |
| 21. Metal Progress Data Book 1973 Edition (ASM) | 35 |

INFORMATION CENTERS

| | |
|--|----|
| 22. NASA Network of University-Based Regional Dissemination Centers (RDC's) (NASA) | 38 |
| 23. Cryogenics Data Center (National Bureau of Standards, Boulder, Colorado) | 40 |
| 24. Copper Data Center (Battelle Memorial Institute) | 41 |
| 25. Mechanical Properties Data Center Traverse City, Michigan (Belfour-Stulen Inc.) | 42 |

| | Page |
|--|------|
| 26. National Research Institute for Metals (Japan) | 44 |
| 27. Data Items | |
| Engineering Sciences Data Unit (London, England) | 46 |
| 28. German Institute for Documentation (Düsseldorf, Germany) | 48 |
| 29. BSCC High Temperature Data | |
| Western Press, Westerhan, Kent, England (British) | 49 |
| 30. Iron and Steel Industry Profile (ISIP) | |
| Mechanical Properties and Materials Defects (British Iron and Steel Inst.) | 51 |

TECHNICAL SOCIETY DATA PUBLICATIONS

| | |
|--|----|
| 31. American National Standards Institute | 54 |
| 32. American Society of Mechanical Engineers | 55 |
| 33. American Society for Metals | 56 |
| 34. American Society for Testing and Materials | 57 |
| 16. American Welding Society | 27 |

TRADE ASSOCIATION DATA PUBLICATIONS

| | |
|---|----|
| 3. Aluminum Association | 6 |
| 17. Copper Development Association | 29 |
| 35. Steel Founders Society of America | 62 |
| 36. Lead Industries Association, Inc. | 64 |
| 37. Tin Research Institute | 65 |
| 38. Zinc Institute Inc. | 67 |
| 39. Underwriters' Laboratories, Inc. | 68 |

APPENDIX

| | |
|--|----|
| Aerospace Materials Information Center | 70 |
| American Petroleum Institute | 70 |
| Consultants Bureau | 70 |
| EMPIS Materials Information System (GE) | 71 |
| Magnesium Association | 73 |
| Metallurgical Documentation and Information System (SDIM) | 73 |
| Metal Properties Council | 73 |
| Metals and Ceramics Information Center (MCIC) | 73 |
| Research Materials Information Center | 74 |
| Smithsonian Science Information Exchange | 74 |
| Welding Research Council | 74 |
| Other Sources of Mechanical Property Information on Metals | 75 |
| Metals and Alloys Index | 76 |
| Properties Index | 77 |

Critical Surveys of Data Sources: **Mechanical Properties of Metals**

R. B. Gavert, R. L. Moore, and J. H. Westbrook

Introduction

Necessary first steps in the selection and compilation of reference data on any group of properties are to locate the best existing compilations and to evaluate these critically. Unfortunately in the case of mechanical properties, particularly those for commercial metals and alloys, no such compendium exists as is the case for thermodynamic properties with the JANAF Tables for example. Furthermore, despite the recent publication of two bibliographic aids on metals information^{1,2} as well as more general directories to information sources, e.g.³, there is no ready guidebook to sources of mechanical property information on metals that gives an adequate evaluation of the scope and validity of the individual sources.

The present survey was thus undertaken with the objective of providing a detailed critical survey of the existent compilations of mechanical property data for commercially available metals and alloys. This survey was intended to assess the scope, assets and deficiencies of about forty of the most prominent sources of such information. There were included: handbooks and technical compilations, information centers, foreign information sources, technical societies, and trade associations. The initial listing of sources to be examined was prepared by the authors with the advice and assistance of the National Bureau of Standards, Office of Standard Reference Data, and a subcommittee of the Metals Properties Council. The aim was to restrict the survey to sources which actually had compilations of mechanical property data in some form. Thus sources which offered only generalized guides to the literature, monographs, textbooks, or periodicals publishing original research or engineering articles were not to be included. Those sources from the original listing which were found upon detailed examination to fall into the latter categories are therefore treated in a separate appendix.

A survey of this type is never really complete or up-to-date. Descriptions of any given source need constant revision, new sources appear each year, and valuable—but obscure—sources are apt to be missed entirely. It is therefore hoped that readers and users of this survey will call all such errors and omissions to the attention of the authors.

The sources surveyed are arranged in a convenient, but arbitrary, grouping as set forth in the Table of Contents. Many sources could as well have been classified in two or more categories and some readers might find another listing more appropriate than that shown here. However, the listing is sufficiently short that locating a source of interest should pose no problem. Two indices have also been provided: a Metals and Alloys Index and a Properties Index. These indices are necessarily *not* all-inclusive. Only major categories of coverage from each individual source have been entered. Nonetheless, the indices should prove useful in combination in locating a source of information on any mechanical property of any particular metallic material.

Finally, a few words on the possible uses of this survey. It should facilitate the determination of: what significant properties are generally available on important materials; what reasonably finite group of materials might provide a minimally representative list of well-documented mechanical property data sets; what mechanical property determinations are most conspicuously lacking, and what existent compilations might afford the best base for building a Standard Reference Data set for mechanical properties.

¹ Wilcox, V. L., *Guide to Literature on Metals and Metallurgical Engineering*, ASEE, Washington, D.C. (1970) 32 pp.

² Hyslop, M. R., *A Brief Guide to Sources of Metals Information*, Information Resources Press, Washington, D.C. (1973) 180 pp.

³ Kruzas, A. T., *Encyclopedia of Information Systems and Services*, Academic Media, Orange, N.J. (1971) 1109 pp.

**Source
Descriptions
Handbooks and
Technical Compilations
(Sources 1-21)**

Source 1. Aerospace Structural Metals Handbook.

Publisher or Custodian: The Mechanical Properties Data Center, Belfour Stulen, Inc., 13919 West Bay Shore Drive, Traverse City, Michigan 49684.

Scope: Provides information on mechanical properties of over 200 metals and alloys of interest for high efficiency structural applications in the aerospace industry.

Properties Covered: Mechanical properties are presented at room temperature and at various other temperatures.

Room temperature properties include: Tension data and stress-strain diagrams, compression data and compression stress-strain diagrams, impact data, bending data, torsion and shear data, bearing data, stress concentration data, notch properties, fracture toughness, and combined properties data.

Elevated and low temperature properties include: Tension data and stress-strain diagrams, compression data and compression stress-strain diagrams, impact data, bending data, torsion and shear data, bearing data, stress concentration data, notch properties, fracture toughness, combined properties, creep and creep rupture properties, fatigue properties, elastic properties, Poisson's ratio data, modulus of elasticity data and modulus of rigidity data.

Included is a general discussion of properties and discussions on fracture toughness. There is a glossary of terms, list of abbreviations, and a cross index of alloys. There is a cross reference of Aerospace Materials Specifications (AMS) for materials presented. The data sheets are not to be used as materials specifications.

Sources of Data: Data are obtained primarily from metal alloy producers in the form of published and unpublished data sheets, Air Force and other Government agency technical reports and reports by information centers. Data are also acquired from professional society publications, aerospace companies, aircraft engine manufacturers and fabricators of components.

Size of the Data Bank: There are four volumes of printed looseleaf pages. All volumes are composed of a series of chapters each dealing with a specific metal or alloy. There are approximately 2800 pages in total. Data quantities vary from extensive—approximately 40 pages per alloy, to limited—less than 5 pages per alloy. Approximately half of the data are concerned with mechanical properties. The balance of the data concerns general properties, physical and chemical properties and fabrication information.

Data Storage and Search: Data are stored as printed looseleaf pages with the information shown in tables, graphs and diagrams. Data are primarily searched by alloy class identification as Ferrous, Nonferrous Light Metal Alloys, and Nonferrous Heat Resistant Alloys.

Volume one groups: Carbon and low alloy steels (FeC), Ultra high strength steels (FeUH), Austenitic stainless steels (FeA), Martensitic stainless steels (FeM).

Volume two groups: Age hardening steels (FeAH), Nickel chromium steels (FeNC), Aluminum alloys: cast (AlC), Aluminum alloys: wrought, heat treatable (AlWT), Aluminum alloys: wrought, not treatable (AlWN).

Volume three groups: Magnesium alloys: cast (MgC), Magnesium alloys: wrought, heat treatable (MgWT), Magnesium alloys: wrought, not heat treatable (MgWN), Titanium alloys (Ti), Titanium alloys: cast (TiC).

Volume four groups: Nickel base alloys (<5% Co) (Ni), Nickel base alloys (>5% Co) (NiCo), Cobalt base alloys (Co), Beryllium alloys (Be), Columbium (Niobium) Alloys (Cb), Molybdenum alloys (Mo), Tantalum alloys (Ta), Tungsten alloys (W), Vanadium alloys (V), Zirconium alloys (Zr).

Each alloy is located by key chemistry percentages. Additional designations and trade names are listed in the data sheets under Commercial Designations and Alternate Designations.

Selectivity of the Data: Input information from all sources is arranged in accordance with an established property code data classification for each alloy; example, Tension, Stress-strain diagram, Compression, etc. A panel of distinguished outside editors supported by staff specialists of the Materials Property Center review the input data and select typical properties for each classification.

Criteria used include:

- (a) comparison of similar data from different sources
- (b) the extent of scatter
- (c) volume of data
- (d) comparison with other properties

Specimen types and test methods are omitted if they are conventional. Listed properties are well referenced to their original documents. Statistical confidence is not presented.

Timeliness of the Data: The latest issue of the handbook is the 1972 publication which includes the 1971 supplement IV. Chapter revisions and additions are released quarterly in an annual printed supplement form. The references are mostly dated in the 1960's. A few references are given for time prior to the 1960's and a few for the late 1960's and early 1970's.

Availability: Distribution is unlimited. Copies are available from The Mechanical Properties Data Center, 13919 West Bay Shore Drive, Traverse City, Michigan 49684.

Cost of Access to Data: Subscription fee for the four volume handbook, plus revisions and additions is \$125 per year. There are no formal arrangements for telephone or letter inquiries.

General Comments: This is an excellent reference for use by a designer or materials engineer for the approximately 200 different materials presented. The data would not be satisfactory for a design review requiring high statistical reliability unless the reliability information was established in the originating reports.

Source 2. Alloy Digest.

Publisher or Custodian: Engineering Alloys Digest Incorporated, 356 North Mountain Avenue, Box 823, Upper Montclair, New Jersey 07043.

Scope: The *Alloy Digest* is a monthly compilation of data sheets on approximately 500 ferrous and nonferrous alloys, giving information on composition, properties, heat treatment, fabrication, corrosion resistance, specification equivalents, uses, and general characteristics of commercial alloys.

Properties Covered: Mechanical property data are primarily given at room temperature. The balance, approximately one-fifth, of the data sheets cover other data at elevated and low temperatures.

Data included are: tensile strength, tensile yield strength, compressive yield strength, elongation, reduction-of-area, hardness, bend ductility, hardenability, fatigue strength, endurance limit, creep properties, stress-rupture properties, impact properties, fracture data, heat treatment vs properties data, stress-corrosion behavior.

Sources of Data: Data are extracted from vendor data sheets and industry wide specifications.

Size of the Data Bank: There are over 1600 data sheets in the system in looseleaf binders. Approximately one-fourth of the data pertains to mechanical properties.

Data Storage and Search: The data are coded generally by chemical symbols, as follows:

| Code No. | Type or Class of Alloy | Approximate Number of Data Sheets |
|----------|-------------------------------------|-----------------------------------|
| Ag | Silver-base | 5 |
| Al | Aluminum-base | 196 |
| Au | Gold-base | 1 |
| Cb | Columbium-base | 17 |
| CI | Cast Iron | 35 |
| Co | Cobalt-base | 59 |
| Cr | Chromium-base | 2 |
| CS | Carbon Steels | 38 |
| Cu | Copper-base | 219 |
| Fe | Iron-base | 43 |
| Mg | Magnesium-base | 69 |
| Mn | Manganese-base | 2 |
| Mo | Molybdenum-base | 8 |
| Ni | Nickel-base | 157 |
| Pb | Lead-base | 6 |
| Pt | Platinum | 1 |
| Re | Rhenium | 1 |
| SA | Steel-Alloys (Alloy Steels) | 253 |
| Sn | Tin-base | 2 |
| SS | Stainless and Heat Resistant Steels | 239 |
| Ta | Tantalum | 1 |
| Ti | Titanium-base | 58 |
| TS | Tool Steels | 222 |
| W | Tungsten-base | 14 |
| Zn | Zinc-base | 12 |
| Zr | Zirconium-base | 5 |

There is a General Index which cross references trade names of the ferrous and nonferrous alloys to the Code Numbers, as an example:

| Trade Name | Code No. |
|------------------|----------|
| Armco PH 15-7 Mo | SS-75 |

Selectivity of the Data: Data are selected by the Editor of the *Alloy Digest* who is professionally trained. Reliability of the data varies with the quality of the vendor data sheets and specifications from the data are taken. There is no statistical treatment of the data by *Alloy Digest*.

Timeliness of the Data: Each Data Sheet is dated. The dates cover the period from the early 1950's to the 1970's. Most of the data comes from the 1960's. New sheets are issued monthly with the selections at the convenience of the editor.

Availability: The *Alloy Digest* is available to both domestic and foreign subscribers.

Cost of Access to Data: Subscription price is \$20.00 per year. A set of back issues may be purchased for \$135.00.

General Comments: The system is useful where it is inconvenient to send directly to vendors for data. Broad vendor claims are avoided in the *Alloy Digest* data sheets. Values used for design should be verified with other sources.

Source 3. Aluminum Standards & Data.

Publisher or Custodian: The Aluminum Association, 750 Third Avenue, New York, New York 10017

Scope: Provides mechanical properties on 41 wrought and 13 cast aluminum materials. These are the commercial aluminum and aluminum alloys used in United States.

Properties Covered: For Wrought Materials, typical values (not suitable for design purposes) are given for tensile strength and elongation at various temperatures; room temperature values for hardness, shear strength, fatigue properties, and modulus of elasticity (Young's modulus).

For Wrought Materials and Castings, maximum and minimum limits are given for tensile strength, yield strength, and elongation.

This publication also includes a cross index to the principal specification systems used in the United States, to Federal and Military specifications, and to similar foreign alloys.

Sources of Data: The Aluminum Association is an industry-wide organization representing over 70 companies which include all the primary producers of aluminum in United States, leading manufacturers of aluminum products and principal foundries and smelters.

Committees from the above companies have prepared and published standards and data (including mechanical properties) for all commercial aluminum and aluminum alloys. These committees meet at regular intervals to maintain the publications up-to-date.

Size of the Data Bank: Mechanical properties data for commercial aluminum and aluminum alloys are covered in this 200 page book. In addition to this publication, there are other documents which provide mechanical properties data for specific applications and fabrication procedures.

Data Storage and Search: Mechanical properties are listed in two sections.

The first section covers typical mechanical properties for commercial aluminum and aluminum alloys.

The second section covers mechanical properties limits (tensile strength and elongation) for commercial aluminum and aluminum alloys in the various wrought forms (i.e. sheet and plate, rod and bar, etc.) and cast forms (sand and permanent mold cast).

Selectivity of Data: Data are reviewed by a committee made up of technical people from the manufacturers of aluminum and aluminum alloys. The data are revised periodically to keep abreast of advances in production methods, to add data on new alloys and to delete those which become inactive.

Timeliness of Data: The present edition is dated 1972-73.

Availability: Distribution is unlimited. Copies may be obtained from The Aluminum Association.

Cost of Access to Data: The publication price is \$2.00; single copies free on letterhead request.

General Comments: This publication provides an excellent basis in preparing mechanical properties tables and The Aluminum Association should provide a direct access to the most knowledgeable people and data banks in this area. Other relevant publications available from The Aluminum Association include: Specifications for Aluminum Structures, and Engineering Data for Aluminum Structures.

While the individual companies representing The Aluminum Association have their own literature covering mechanical properties, they recommend the use of the data from The Aluminum Association in preference to that published by individual manufacturers. Where specific data are not covered, the companies also recommend that inquiry be made through The Aluminum Association as the above mentioned Committees could be working on such data; if not, the inquiry would be referred to the companies where such information might be available.

Source 4. Engineering Alloys.

5th Edition by Norman E. Woldman and Robert C. Gibbons.

Publisher or Custodian: Van Nostrand Reinhold Company, 450 West 33rd Street, New York, N.Y. 10001.

Scope: The reference book is a compilation of data and information on 36,000 proprietary commercial and technical alloys manufactured in the U.S.A. and in foreign countries, including North America, Europe, Australia, and Japan.

Properties Covered: Tensile strength, yield strength, percent elongation, percent reduction-of-area, and Brinell hardness, all primarily at room temperature.

Source of Data: Direct correspondence with the alloy manufacturer, supplemented by data obtained from commercial literature and technical publications.

Size of the Data Bank: The book has 1440 pages and is permanently bound. Approximately 50% of the book is devoted to mechanical properties.

Data Storage and Search: Each alloy is assigned a number. The user looks up the material alphabetically by its alloy name and is referred to the assigned number. The mechanical property data are found in the Alloy Data section under the associated number.

Example: (For Carpenter 10 Alloy)

Under C
in the
Alloy Data
Section I

Carpenter Stainless No. 10
M-32; 0.08 max C, 15-17 Cr,
17-19 Ni, bal Fe
Annealed: 75,000 TS; 35,000 YS; 55 EL, 72 RA; 145 Brin

In the example, M-32 is the manufacturer's assigned number. Section II presents an alphabetical list of manufacturers. Section III gives a numerical list of manufacturers. Section IV lists out-dated alloys. Section V lists association standards.

Selectivity of the Data: Values assigned for mechanical properties usually represent the most probable values that would be obtained under the given conditions. The authors have attempted to present the data impartially. They assume no responsibility for the accuracy or the reliability of the quoted values.

Timeliness of the Data: The present (5th) edition was published in 1973.

Availability: Distribution is unlimited through the Van Nostrand Reinhold Company.

Cost of Access to Data: The reference book sells at \$47.50 per copy.

General Comments: The 36,000 alloys listed appear complete but in many cases data are repetitions. Type 304 stainless steel, for example, would be listed as many times as there are vendors with different trade names. Searching the data knowing only the manufacturer is difficult, unless the alloy begins with the manufacturer's name. The reference is unique in that it covers more alloy variations than any other source. Mechanical properties presented need verification for design purposes. The property data presented are limited.

Source 5. Materials Selector.

Publisher or Custodian: Reinhold Publishing Company, Inc. A subsidiary of Litton Industries, Inc., 600 Summer Street, Stamford, Connecticut 06904.

Scope: Provides a materials reference guide to individuals who function in materials evaluation and selection, design, development, production, and management or wherever there is an involvement in the application and selection of metals, nonmetallics, forms and finishes.

Properties Covered: Mechanical properties at room temperature include: tensile strength, yield strength, compression strength, shear strength, transverse fiber strength, elongation, reduction-of-area, hardness, hardenability, modulus of elasticity in tension, fatigue strength, bearing strength, bearing load, burst strength. Impact strength and notch properties are covered at room temperature and lower temperatures.

Elevated temperature mechanical properties include: tensile strength, yield strength, elongation, hot hardness, stress-rupture strength, and creep properties.

Sources of Data: Data are provided primarily by metals producing companies. A permanent editorial staff of around thirteen people work on the selector. In addition there is a seven man Editorial Advisory Board which represents the metals industry.

Size of the Data Bank: The *Materials Selector* is approximately 500 pages in size. Only a portion of the book is devoted to metallic materials. There are approximately 50 pages of data on iron and steels and 65 pages for nonferrous metals.

Data Storage and Search: Data are stored in tabular form under the heading of mechanical properties. The data are searched by the following materials designations:

Iron and Steels—Gray Irons—Cast, Malleable Irons—Cast, Nodular or Ductile Irons—Cast, White and Alloy Irons—Cast, Iron-Base Superalloys—Cast & Wrought, Alloy Steels—Cast, Carbon Steels—Cast, Carbon Steels—Carburizing Grades, Carbon Steels—Hardening Grades, Free Cutting Carbon Steels—Wrought, High Strength Steels—Wrought, Low Alloy Steels—Wrought, Nitriding Steels—Wrought, Quenched and Tempered Alloy Steels, Age Hardenable Stainless Steels—Wrought & Cast, Austenitic Stainless Steels—Wrought, Specialty Stainless Steels—Wrought, Stainless Steels—Cast, Heat Resistant Alloys—Cast, Ultra-High Strength Steels—Wrought, Tool Steels—Wrought, Powder Metal Parts—Ferrous, Ferritic Stainless Steels—Wrought, Martensitic Stainless Steels—Wrought.

Nonferrous Metals—Aluminum and its Alloys—Wrought, Aluminum and its Alloys—Cast, Cobalt and its Alloys, Cobalt-Base Superalloys—Wrought, Cobalt-Base Superalloys—Cast, Columbium and its Alloys—Wrought, Copper and its Alloys—Wrought, Copper Alloys—Cast, Lead and its Alloys—Cast & Wrought, Magnesium Alloys—Wrought, Magnesium Alloys—Cast, Nickel and its Alloys—Wrought, Nickel and its Alloys—Cast & Wrought, Nickel-Base Superalloys—Cast & Wrought, Powder Metal Parts—Nonferrous, Precious Metals—Wrought, Tantalum, Tungsten, Rhenium, Molybdenum—Wrought, Tin and its Alloys—Cast & Wrought, Tin and its Alloys—Cast, Titanium and Titanium Alloys—Wrought, Rare Earths, Zinc Alloys—Wrought, Zinc Alloys—Cast, Zirconium and its Alloys—Wrought.

A Comparison of Materials section is included in the front of the handbook. Materials are ranked in order of tensile strength, yield strength, elongation, specific strength, modulus of elasticity in tension, specific thickness, and hardness.

Selectivity of the Data: The data represent average test values obtained from many different suppliers and secondary information sources. The values do not represent absolute minimum or maximum specified limits. Where a range is given, it may reflect either the test variations or variations in the composition, temper, heat treatment, form or other conditions. The data do not give a complete description of the materials and test conditions and should not be used directly for final designs.

Timeliness of the Data: The data averages represent up-to-date properties on commercially available materials. The *Materials Selector* is revised annually.

Availability: This reference manual is distributed annually to qualified individual recipients in the U.S., U.S. Possessions, and Canada employed in the Original Equipment Market who function in the materials area. Microfilmed past copies are available.

Cost of Access to the Data: Domestic subscriptions are \$18.00 per year. Foreign subscriptions are \$36.00 per year. Qualified individuals may receive three copies. Subscription also includes receiving monthly copies of "Materials Engineering" magazine.

General Comments: The *Materials Selector* is an excellent tool for selecting a material based on its mechanical properties. Use of the data for direct design is questionable unless supported by other data sources.

Source 6. Damage Tolerant Design Handbook.
MCIC-HB-01, 1st Edition.

Publisher or Custodian: Metals and Ceramics Information Center, Battelle, Columbus Laboratories, 505 King Avenue, Columbus, Ohio 43201.

Sponsored by: Air Force Materials Laboratory

Scope: Provides fracture and crack growth data for 19 Aluminum Alloys, 14 Alloy Steels, 7 Stainless Steels and 9 Titanium Alloys. The data assist designers in determining critical flaw sizes and fatigue lives in highly stressed structures. The Handbook aids materials engineers in selecting optimum alloys for highly stressed structures. The data are useful to nondestructive inspection specialists in estimating required sensitivity of nondestructive testing equipment.

Properties Covered:

- Plane-strain fracture toughness data (K_{Ic} values)
- Plane-stress and transitional fracture toughness data (K_c values)
- Threshold stress intensity factors in special environments (K_{Isc} values)
- Sustained-load, crack growth rates in special environments (da/dt versus K_I)
- Fatigue crack growth rates (da/dN versus ΔK)

Sources of Data: Cooperating sources of information include government agencies, metals producers, aircraft and engine manufacturers, universities, and private laboratories.

Size of the Data Book: The Handbook is a single volume looseleaf notebook containing 419 pages with 208 tables and 136 figures. Essentially all pages are related to mechanical fracture properties. The Handbook is intended to be updated with periodic supplements.

Data Storage and Search: Values K_{Ic} , K_c , and K_{Isc} are presented in tabular format. The da/dt and da/dN data are shown in graphical format. Alloys included in the first edition of the Handbook are:

Sections 4.0 through 8.0 in the looseleaf binder provide the direct data on Al alloys, alloy steels, stainless steels and titanium alloys as follows:

- Section 4.0 Plane-Strain Fracture Toughness Data (K_{Ic} data)
- Section 5.0 Plane-Stress and Transition Fracture Toughness Data (K_c data)
- Section 6.0 Threshold Stress Intensity Factors (K_{Isc} data)
- Section 7.0 Sustained-Load Crack Growth Rate (da/dt data)
- Section 8.0 Fatigue Crack Growth Rates (da/dN data)

| Aluminum Alloys | | | Alloy Steels | | Stainless Steels | Titanium Alloys | |
|-----------------|------|------|--------------|-----------|------------------|-------------------|---------------|
| 2014 | 2020 | 2021 | 4330V | AISI 4340 | PH13-8Mo | Ti-6Al-4V | Ti-6Al-6V-2Sn |
| 2024 | 2124 | 2219 | 300M | D6AC | PH14-8Mo | Ti-8Al-1V-1Mo | Ti-4Al-3Mo-1V |
| 2618 | 6061 | 7001 | Ni-Cr-Mo | HY140 | 15-5PH | Beta Ti (13-11-3) | |
| 7005 | 7007 | 7049 | 9Ni-4Co | 10Ni | 17-4PH | Beta 111 Ti | |
| 7050 | 7075 | 7079 | 12Ni-5Cr-3Mo | 18Ni(250) | Custom 455 | Beta C Ti | |
| X7080 | 7175 | 7178 | 18Ni(200) | 18Ni(350) | AFC77 | Transage 129 | |
| X7475 | | | 18Ni(300) | H-11 | AFC260 | IMI 679 | |

Data are searched by desired fracture and alloy designation. A special data search is also available. All data used in the Handbook have been indexed and stored in computerized programs. Inquiries to the computer for different format, additional data, and alloys may be directed to the Battelle Metals and Ceramics Information Center.

Selectivity of the Data: Input data comes from a wide variety of test programs and literature in the MCIC data bank. The designer must make his own analysis using the given data.

Timeliness of the Data: Majority of the data comes from the 1960's period with the remainder from the 1970's.

Availability: The Handbook is available from the National Technical Information Service (NTIS), Springfield, Virginia 22151.

Cost of Access to the Data: The Handbook cost is \$37.50 per copy. Foreign copies are \$40.00 each. Number AD 753774 should be specified in the purchase order.

General Comments: This is a good comprehensive reference source on fracture mechanics data. The data are of particular interest to aircraft and aerospace designers, materials engineers, and quality control specialists. The engineer must use his own judgment in using the given data.

Source 7. Mechanical Properties of British Standard En Steels.

Volumes 1, 2, and 3, by J. Woolman and R. A. Mottram.

Publisher or Custodian: The Macmillan Company, New York.

Scope: The *Mechanical Properties of British Standard En Steels* provides data on British Specification (B.S. .970) covering steels from En 1 through En 363. These are wrought materials for general engineering purposes.

Properties Covered: Properties include: proof stress, yield strength, tensile strength, elongation, reduction-of-area, hardness, Izod and Charpy impact tests, hardenability, torsion properties, fatigue properties, shear properties, creep and stress-rupture properties.

Source of Data: Data are compiled by J. Woolman and R. A. Mottram and advisory groups of the Steel User Section of the British Iron and Steel Research Association, now Corporate Laboratories of British Steel Corporation.

Size of the Data Bank: The data compilation includes around 1500 pages. Approximately 75 per cent of the material covers mechanical properties data.

Data Storage and Search: The data are stored in hard cover books in three volumes. Volume 1 includes the properties of steel compositions En 1 to En 20. Volume 2 includes En 21 to En 39. Volume 3 includes the steels En 40 to En 363. Data are presented in tables and graphs. Data are searched by En number grouping.

Selectivity of the Data: Data are gathered from the leading steelmakers in England. The material has been prepared and selected by experts in the field. The data are not statistically treated.

Timeliness of the Data: The *Mechanical Properties of British En Steels* volumes were issued sequentially with Volume 1 in 1964, Volume 2 in 1966, and Volume 3 in 1969. References cover the 1950's and 1960's periods.

Availability: The data are unlimited in distribution. The volumes are available from the publisher or from: The Iron and Steel Institute, 1 Charlton House Terrace, London SW1Y5DB, England.

Cost of Access to Data: The cost is £ 35 for all three volumes.

General Comments: The concentration of steel data in the *Mechanical Properties of British En Steels* is impressive. Cross reference information is given for similar foreign national steels. The lack of statistical treatment of the data makes it necessary for a designer to double check values with other data before using.

Source 8. Metallic Materials-Specification Handbook.
2nd Edition, Robert B. Ross, editor.

Publisher or Custodian: E. and F. N. Spon, Ltd., London.

Scope: Tabulates the composition and a few properties of a very wide variety of commercial metallic materials produced under a given specification or trade name. Because of the limited coverage of properties, this volume is more useful as an identification tool or cross index than as a properties reference.

Properties Covered: Diamond pyramid hardness, ultimate tensile strength, elongation and 0.1 percent proof strength are listed wherever these data were available. All data are given in metric units.

Each of the major groups of specifications is preceded by a short section covering the metal-lurgy, thermal treatment, weldability, methods of flaw detection, corrosion protection, machinability, and uses that apply generally to those materials as a group.

Sources of Data: Data listed were obtained directly from the manufacturer, his licensee or a trade or standards association. About 250 private firms and 15 national organizations contributed.

Size of the Data Bank: Data covering about 30,000 trade names, specifications or symbols for commercially available metals and alloys are included in an 833 page book. Full entries for all four properties are given for only about one-fifth of the listed alloys; partial entries appear for about another fifth; no properties whatsoever are given for more than half the listing.

Data Storage and Search: The data pages for various alloy groups are organized into sections according to the base metal, the more important bases having several sections. Thus, steels are covered in 30 sections; aluminum and its alloys in 16; copper and copper alloys in 13; nickel and nickel alloys in 8; irons, magnesium, and titanium based alloys, 4 sections each; and tin, molybdenum and zinc each have two sections. Alloy bases of lesser variety and volume-use such as beryllium, cadmium, lead, platinum, sodium, tantalum, zirconium, etc., are each covered in a single section.

Three appendices list: the names and addresses of companies or associations supplying the data, trade names and their sources, and tables of abbreviations and conversion factors.

Users of the book may start with the index to locate the ingredients and properties of an alloy bearing a given designation or may scan through a section, say medium-carbon silicon steels, to determine the specification and trade names of those alloys having desired properties.

Selectivity of the Data: Data are listed as supplied by the manufacturer or cognizant national association. No selectivity or reliability assessment has been made.

Timeliness: The first edition of this work was published in 1968. This, the 2nd edition bearing a 1972 date represents a 20% expansion in the number of listings. Errors have been corrected from the 1st edition and all properties converted to accepted metric units.

Availability. Distribution is unlimited. Available in the U.K. from the publisher and in the U.S. from Halsted Press, a Division of John Wiley and Sons, Inc., New York, New York.

Cost of Access to Data: The book sells in the U.S. for \$26.35.

General Comments: The primary utility of this book is as a guide to the identification of an unknown trade name, specification or symbol for a commercial alloy. The properties and grouping of alloy entries are suitable only for assistance in the compilation of a list of alternative materials for consideration. Under no circumstance could the tabulated properties be used for a final selection of material, design calculations or calibration or verification of tests.

Source 9. Metals Handbook, 8th Edition.

Publisher or Custodian: American Society for Metals, Metals Park, Ohio 44073.

Scope: Provides information on mechanical properties of over 800 metals and alloys of interest to a wide range of industries. The Handbook is presented with strong emphasis on the economics of materials selection and utilization.

Properties Covered: Approximately three-fourths of the mechanical properties covered are given at room temperature. Properties include: tensile strength, yield strength, elongation, reduction-of-area, hardness, Charpy and Izod impact data, compressive strength, torsional shear strength, modulus of elasticity, fatigue strength, bend ductility, fracture data, stress corrosion data, stress-strain diagrams. Summaries of heat treatment versus properties achieved are included.

Low temperature data presented are mostly related to fracture toughness. Data include: Charpy impact data, Izod impact data, notched data, fracture transition temperature data, hardness versus impact energy data, heat treatment versus impact properties data.

Sources of Data: Data are obtained from 300 to 1300 technical experts and up to 600 plants in the metalworking field. They are mostly members or associates of The American Society for Metals. The data for the most part come from direct experience and testing.

Size of Data Bank: There are eight volumes published to-date in the 8th edition of the Metals Handbook and others are in progress. Volume 1, the largest covering 1300 pages, contains most of the mechanical property information. The remaining volumes are from 300 to 700 pages in length and contain scattered mechanical property information. More specifically Volume 1 consists of 430 compilations of data on different metals and alloys. In addition there are 100 major articles, 1500 detailed "case method" examples, 6700 illustrations, 132 tables of recommended selections for 4400 combinations of service conditions, 2800 definitions and a 64 page index.

Data Storage and Search: Data are stored as tables, illustrations, and example problems in bound volume form. Data are searched through use of the table of contents and indices given in the front and back of each volume.

Volume 1: Properties and Selection. This volume presents classes of materials as follows:

| | |
|--|--------------------------------|
| Carbon and Low-Alloy Steels | Lead and Lead Alloys |
| Cast Irons | Magnesium and Magnesium Alloys |
| Stainless Steels and Heat-Resisting Alloys | Nickel and Nickel Alloys |
| Tool Materials | Tin and Tin Alloys |
| Magnetic, Electrical and Other Special-Purpose Materials | Titanium and Titanium Alloys |
| Aluminum and Aluminum Alloys | Zinc and Zinc Alloys |
| Copper and Copper Alloys | Precious Metals |
| | Pure Metals |

The data are presented to convey specific properties of the metals covered and to guide the reader in selecting a material for a particular application. There are also included: a section of metallurgical definitions, and special reference tables on physical properties, conversion factors, compositions, and sizes.

Volume 2: Heat Treating, Cleaning and Finishing

Volume 3: Machining

Volume 4: Forming

Volume 5: Forging and Casting

Volume 6: Welding and Brazing

Volume 7: Atlas of Microstructures

Volume 8: Metallography, Structure and Phase Diagrams

Selectivity of the Data: The data are presented without references to specific originating reports. Different committees of experts are responsible for each major topic in the various volumes. Each topic represents their combined experiences. Statistical treatment of the data is sometimes shown, as for example, graphs of normal distributions of the property.

Timeliness of the Data: Volume 1 of the 8th edition was issued in 1961. Previous to that time, the *Metals Handbook* was issued as a single volume (1948). Volume 2 was issued in 1964, Volume 3 in 1967, Volume 4 in 1969, Volume 5 in 1970, Volume 6 in 1971, Volume 7 in 1972 and Volume 8 in 1973. Two volumes on Fractography and Failure Analysis are under preparation and two more on Nondestructive Inspection and Mechanical Testing are being planned, with tentative annual issue dates beginning in 1974.

Availability: The *Metals Handbook* is available throughout the world.

Cost of Access to Data:

| | |
|-----------|---|
| Volume 1— | \$42.50 |
| Volume 2— | \$37.50 |
| Volume 3— | \$37.50 |
| Volume 4— | \$37.50 |
| Volume 5— | \$32.50 (in two volumes—5A, \$12.75; 5B, \$21.50) |
| Volume 6— | \$42.50 |
| Volume 7— | \$32.50 |
| Volume 8— | \$37.50 |

Outside the USA and Canada an added charge of \$5.00 is required per volume. Prices on first issues are lower to ASM members.

General Comments: Volume 1 is the most important reference for mechanical property data. The volume, however, emphasizes selection for properties and economy. The number of metals covered is small compared to the volume of material presented. Volumes 2 through 6 emphasize industrial metal processing operations rather than mechanical properties. Volume 7 deals only with metal microstructures. Identifications of sources of data are limited; there is only a listing of contributing authors for reference. The large size of these volumes and the focus on manufacturing details makes the *Metals Handbook* less of an engineering first reference for mechanical properties than the previous 1948 single volume edition. The *Metals Handbook* has enjoyed a reputation among metallurgists as being of reasonably good reliability.

Source 10. Metals Reference Book.
4th Edition, C. J. Smithells, editor.

Publisher or Custodian: Butterworths, London.

Scope: A concise summarization of physical, chemical and mechanical data on elemental metals and common alloys.

Properties Covered: Elastic properties, damping capacity, plastic and fracture properties at room, elevated and sub-normal temperatures, fatigue, creep and stress-rupture data.

Sources of Data: Data are taken from the original literature or from previous compilations of data. Reference is provided to either the primary or the secondary source.

Size of Data Bank: The present edition is published in three bound volumes of about 500 pages each.

Data Storage and Search: Data are presented very concisely in tables and graphs with minimal introductory text or footnote explanation. Data are organized by alloy group as follows: aluminum and its alloys, copper and its alloys, lead and its alloys, magnesium and its alloys, nickel and its alloys, titanium and its alloys, zinc and its alloys, steels, cast irons and cast steels, bearing alloys, and other industrially important metals. Alloys are designated by their nominal composition and with approximate British Standard and U.S. specification numbers.

Selectivity of the Data: The data are typical average values selected by the editor. Contradictory or discrepant data are sometimes presented in parallel without comment.

Timeliness: Since its inception, a new edition of Smithells has appeared every 5 to 6 years. Each has represented an expansion, rearrangement, correction and up-dating over its predecessors. The present 4th edition was published in 1967; a new edition should be forthcoming within a year or two.

Availability: Distribution is unlimited. Copies are available from the publisher, Butterworths, London or from Plenum Press in New York.

Cost of Access to the Data: The cost of the 3 volume handbook is \$92.50.

General Comments: A more concise, convenient and (in some respects) more complete tabulation of reference data on metals than the *ASM Metals Handbook*. The lack of criticality, the frequent use of secondary sources, and the absence of explanatory material limit its utility to rough comparisons, "ball-park" calculations, etc. The data are not suitable for design or calibration work.

Source 11. MIL-HDBK-5B Metallic Materials and Elements for Flight Vehicle Structures.

Dated 1 September 1971 with change notice 1, dated 1 July 1972.

Publisher or Custodian: Department of Defense and the Federal Aviation Administration. (Handbook preparation is managed by MIL-HDBK-5 Coordinating Activity, AFML-LAA, Wright-Patterson Air Force Base, Ohio)

Scope: Provides mechanical properties data for around 150 metallic materials and elements for military flight structures. Uniform data on materials used for some time and in considerable quantities are mainly presented. Emphasis is on light, high strength and heat-resistant metals.

Properties Covered: Stress-strain diagrams, Poisson's ratio, strain rate dependent properties, modulus of elasticity, modulus design curves, tensile proportional limit, tensile yield strength, ultimate tensile strength, ultimate compressive strength, modulus of rigidity, proportional limit in shear, yield strength in shear, ultimate strength in shear, yield and ultimate bearing strengths, creep properties, stress-rupture properties, minimum creep rate, fatigue properties, fracture data, mechanical and welded joint strengths, room, low and elevated temperature properties are treated.

Sources of Data: Information is obtained from materials producers, the airframe industry, reports on Government-sponsored research, the open literature, and by direct contact with research laboratories.

Size of the Data Bank: The handbook, including revisions is approximately 900 pages in length. Five percent of the book is devoted to formulas and definitions. The balance of the book presents mechanical property data in the form of charts, graphs and figures.

Data Storage and Search: Data are stored as pages in a paperback handbook. Smaller paperback supplements of similar format are issued as necessary. Metals data are searched under the following chapter headings.

Steel
Aluminum
Magnesium Alloys
Titanium

Heat-Resistant Alloys
Beryllium and Special Purpose Metals and Alloys

Selectivity of the Data: Primary Strength values are presented as minimum values in three data bases A, B, and S. The A Basis is presented where the value indicated is the value above which at least 99 percent of the population of values is expected to fall with a 95 percent confidence. The B Basis is presented where the value indicated is the value above which at least 90 percent of the population of values is expected to fall with a 95 percent confidence. The S Basis is presented as the specified minimum value of a Government or AMS specification without statistical assurance. Values other than Primary Strength values are to be regarded as average or typical values unless otherwise indicated. References are given at the end of the handbook sections.

Timeliness of the Data: The handbook is generally revised annually. References primarily cover the 1960's with the remainder covering the 1950's and 1970's.

Availability: Copies are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Cost of Access to Data: The handbook consists of two volumes at a total cost of \$9.60. Revisions cost between \$1.00 and \$1.50 per copy.

General Comments: This is a good conservative design data manual for the approximate 150 materials presented. Data are clearly presented in graphs and tables. Basic principles and definitions of mechanical properties are also clearly discussed.

Source 12. Reactor Handbook, Volume 1, Materials.
2nd Edition, edited by C. R. Tipton, Jr.

Publisher or Custodian: Interscience Publishers, Inc., New York.

Scope: Volume I of the *Reactor Handbook* contains information on the mechanical properties of metals used in nuclear applications. Over 900 metals, alloys, and metal compounds are covered.

Properties Covered: Most properties presented are for elevated temperature reactor service. Properties at various temperatures include: tensile, compressive and shear strength, yield strength, elongation, reduction-of-area, hardness, modulus of elasticity in tension and shear, Poisson's ratio, stress-rupture values, creep values, Charpy and Izod impact data, flexural strength, modulus of rupture, thermal shock and irradiation effects on mechanical properties.

Physical, metallographic, and chemical data make up the other parts of the handbook.

Sources of Data: Most of the data comes from unclassified United States Atomic Energy Commission reports. Other unclassified sources include: publications issued by other government agencies, private organizations, and British and Canadian publications. Individual contributors to the chapters represent nearly every major company or laboratory involved in atomic energy work.

Size of the Data Bank: The *Reactor Handbook* is composed of four volumes: Materials, Fuel Reprocessing, Engineering, Physics and Shielding. The Materials volume, which contains mechanical properties of metals, is 1207 pages in length. Approximately 35 percent of the book is devoted to mechanical properties of metals, alloys and metal compounds.

Data Storage and Search: The handbook is hard cover bound. Each volume is separately bound. Data are searched by using the Index and the Table of Contents. The contents are divided into the following major parts:

| Part | Base Metals Covered |
|--------------------------------------|--|
| A: General | Zr, Hf, Misc. |
| B: Fuel Materials | V, Th, Pu, Misc. |
| C: Cladding and Structural Materials | Al, C, Co, Cr, Stainless Steel, Mg, Mo, Nb, Ni, Ta, W, Ti, V, Zr, Misc. |
| D: Control Materials | Hf, B, Cd, Rare Earths, Ag |
| E: Moderator Materials | Graphite, Be, Misc. |
| F: Coolant Materials | Misc. |
| G: Shielding Materials | Misc. |

Selectivity of the Data: The data input has been taken from papers of very good technical quality and the data have been selected by experts in their field. Statistical confidence is not given.

Timeliness of the Data: The data in 2nd edition, 1960 represent the period from 1960 back to the atomic research done in the 1940's.

Availability: The Handbook is sold unrestricted as a standard publication of the Interscience Publishers Inc.

Cost of Access to the Data: The Handbook cost for Volume I is \$39.25.

General Comments: In spite of its publication date of 1960, this handbook contains remarkably good information in the selected area of Nuclear Materials. Updating is needed more to report new progress than to alter previous findings presented.

Source 13. SAE Handbook—1973 Edition.

Publisher or Custodian: Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.

Scope: Provides information on the mechanical properties of over 450 ferrous alloys and over 400 nonferrous alloys. The handbook deals primarily with automotive standards and recommended practices.

Properties Covered: Room temperature hardness, hardenability, yield strength, tensile strength, elongation, reduction-of-area, bend data, strain aging data, proof loads, torsional strength, torque data, stress-corrosion data, shear strength, modulus of elasticity, fatigue strength, impact strength, compression strength, crushing strength constant, elevated temperature rupture and creep data, hot hardness.

Other properties not strictly mechanical include machinability, case depth, weldability, and forgeability.

Sources of the Data: SAE has a General Materials Council with four committees directly or indirectly responsible for metallic materials. The Committee members come from the automotive and supporting industries. They provide the input information from data of their individual organizations. There are about 5000 members in SAE. A headquarters staff of around 50 people coordinates the activities.

Size of the Data Bank: *SAE Handbook* is over 1400 pages in length and is permanently bound. Approximately 5 percent of the handbook is devoted to mechanical properties of metallic materials.

Data Storage and Search: Data are stored primarily in a tabular format with a few graphs and diagrams. Data are searched by the subject index or by a numerical index of each information report which makes up the handbook. The Table of Contents lists information under Ferrous Metals and Nonferrous Metals, as follows:

Ferrous Metals

Numbering System, Chemical Compositions
General Data on Steels
Methods of Testing Steel
Steel Fasteners
Spring Wire and Springs
Ferrous Castings
Tool and Die Steels
Ferrous Materials
Ferrous and Nonferrous—General

Nonferrous Metals

Aluminum, Copper Alloys, Magnesium Alloys, Superalloys, Zinc Alloys, Nickel Alloys, Powder Metals, Solders and Finishes

Selectivity of the Data: Each committee is chosen to be competent and authoritative in its field. SAE membership is not a prerequisite for membership on Councils or Technical Committees. The councils strive for unanimous approval of all documents. The data are not given a formal statistical treatment. There are no references, only a listing of members for each technical committee.

Timeliness of the Data: The *SAE Handbook* is revised and issued annually. The latest in standards changes are presented. New and revised reports are presented monthly in *Automotive Engineering* magazine. Reports in the handbook are only annually current. The Handbook report changes are footnoted, as follows: New, Technical Revision, Reaffirmed without Change, and Editorial Change.

Availability: Distribution is unlimited. The handbook may be ordered from The Society of Automotive Engineers, Inc., Dept. 4, Two Pennsylvania Plaza, New York, New York 10001.

Cost of Access to Data: The handbook has a list price of \$40.00. SAE member price is \$9.75. Individual reports may be purchased at a cost of \$1.25 to \$4.00 each.

General Comments: This handbook reference is a good data source for materials common to automobiles. The amount of mechanical properties data is small, relative to the size of the handbook. Because of the numbering system and automotive components emphasis, data access is difficult. The mechanical property data, although poorly referenced, are generally reliable standard information.

Source 14. Single Crystal Elastic Constants and Calculated Aggregate Properties:
A Handbook. 2nd Edition, by Gene Simmons and Herbert Wang.

Publisher or Custodian: The M.I.T. Press, Cambridge, Massachusetts.

Scope: Provides advanced materials information on the elastic constants of single crystal elements and compounds at room and varied temperatures. Calculated crystal aggregate elastic constant data are also presented. Over 300 metals and compounds are included.

Properties Covered: Single crystal elastic constants include: Elastic Stiffness (C) and Elastic Compliance (S). Both have subscripts indicative of crystallographic direction. Crystal density and temperature data are included.

Crystal aggregate data include calculated bounds for: Young's Modulus (E), Shear Modulus (G), Poisson's Ratio (SIGMA), Bulk Modulus (K), Compressibility (BETA), Velocity of Shear Waves in an infinite medium (VS), Velocity of Compressional Waves in an infinite medium (VP). The elastic property bounds are calculated by Voight's Scheme (V), Reuss Scheme (R), The Hasin Bound (H), and The Shtrikman Bound (S). Density and temperature parameters are included.

Sources of Data: Single crystal data has been compiled from scattered research sources by a handful of prominent experts, such as Huntington, Hearman, Alexandrov, Ryzhova, and Simmons. These single crystal data are used to calculate aggregate crystal values of elastic constants. Many references cite work done in the Soviet Union.

Size of the Data Bank: The Handbook is 370 pages in length. Approximately 90 percent is tabulated data.

Data Storage and Search: The single crystal data and crystal aggregate data are grouped into sections related to the crystal structures: Cubic, Tetragonal 1, Tetragonal 2, Orthorhombic, Monoclinic, Hexagonal, Trigonal. Each crystal, compound, or aggregate is listed alphabetically in each section. A sample listing is:

| Name Code | Density | Ref | Temp(K) | 11 | Cubic 12 | 44 |
|-------------------|---------|-----|---------|----------|-------------|--------|
| | | | | | | |
| Aluminum 10051 | 2.7157 | 249 | 193.2 | C 1.778 | 0.6866 | 0.2922 |
| | | | | S 1.4880 | -0.5480 | 3.4220 |

Selectivity of the Data: The compilation is uncritical in the sense that data of low precision are included in the tables along with data of very high quality. The tables have multiple entries of data. The reader must choose the set of data he believes better for his particular application.

Timeliness of the Data: References come primarily from the 1960's and late 1950's.

Availability: Distribution is unlimited. Copies are available from the M.I.T. Press, Cambridge, Massachusetts.

Cost of Access to the Data: The Handbook costs \$15.00 per copy.

General Comments: The data on elastic constants are of more use to a mechanics of materials research engineer than to a design engineer. Use of the data requires judgment by the engineer as to which values are most reliable. The compilation of scattered data into a single book is a valuable asset to the field of mechanics of materials.

Source 15. Structural Alloys Handbook.
1st Edition, by T. D. Moore, Author/Editor.

Publisher or Custodian: Mechanical Properties Data Center, Belfour Stulen, Inc., 13919 West Bay Shore Drive, Traverse City, Michigan 49684.

Scope: Presents representative in-depth and up-to-date mechanical properties characterizations for the more common metals and alloys of importance in the construction, machine tool, heavy equipment, automotive and general manufacturing industries. Less than 300 alloys are presently included but expansion above 3000 chemically different structural alloys is feasible, using the MPDC data bank.

Properties Covered: Room temperature mechanical properties include: tensile, yield, elongation, reduction-of-area, notched tensile strength, joint tension, tensile fracture toughness, compressive strength, fastener shear, block shear, sheet shear, and joint shear, punch shear, bolt, pin or rivet bearing strength, pressure vessel burst strength, hardness, hardenability, notched and unnotched fatigue data, low cycle fatigue data, crack rate propagation data, impact (Charpy or Izod) strength, drop-weight impact data, bending fracture toughness data, stress-corrosion data, stress-strain curves, and true stress-strain data.

Elevated and low temperature properties include: tensile data, tensile creep, compression creep, stress-rupture properties, impact data, fracture toughness data, shear and bearing strength properties.

Included are data on corrosion, oxidation, hydrogen embrittlement, heat treatment, workability, machinability, and weldability. There are four appendices: (A) Symbols and Abbreviations, (B) Test Types, (C) The Well-Defined Test, (D) SI Conversion Factors and Tables.

Sources of Data: Data come from the data bank and library of the Mechanical Properties Data Center (MPDC), which is a Department of Defense materials information center. The data input consists of U.S. Government reports, producers' literature, and some foreign documents.

Size of the Data Bank: The MPDC data bank has over one million test results on approximately 5000 different metals and alloys. There are more than 40,000 technical documents used for data input. The *Structural Alloys Handbook*, 1st edition, has over 200 pages provided in a one volume looseleaf notebook. The Center (MPDC) intends to issue annual supplements which are based on the needs and recommendations of those who use the handbook. The book with small exceptions is devoted entirely to mechanical properties.

Data Storage and Search: Data are stored as printed looseleaf pages in a single volume notebook. Information is presented in the form of tables, graphs, and diagrams. A Selector Chart precedes each major section to enable the reader to compare the many alloys by their principal mechanical and physical properties. The major sections are as follows:

- Cast Iron-Ductile Iron, White and Alloy Cast Iron, Malleable Iron
- Cast Steel and Cast Stainless Steel-(No entries)
- Cast Al, Brass, Bronze, Cu and Mg-(No entries)
- High Strength, Low Alloy Steel-A242, A440, A441, A514, A517, A537, A572, A588
- Wrought Steel-1020 Steel, High Carbon Steel, 4140 Steel, 4340 Steel
- Wrought Stainless Steel-201, 202 Stainless Steel
- Wrought Aluminum-3003, 3004 Aluminum

The Selector Charts include more alloys than are presented in the individual sections. A search service is available for alloys not included in the book or for very specific test conditions.

Selectivity of the Data: Input data come from a wide variety of test programs and literature into the MPDC data bank. Data are defined to the same extent as was originally reported in each specific test program. Test definitions and test conditions are variable. There are no interpretive theories or statistical analyses. Inconsistent data have been eliminated as much as possible. The bulk of the data are not design values but rather test results. The designer must make his own analysis, using the given data. Reference and bibliography are given at the end of each section.

Timeliness of the Data: The 1st edition was issued March 1973. Supplements are issued twice a year. Data references show most of the information coming from the mid-1960's with lesser amounts coming from the late 1950's, early 1960's, and early 1970's.

Availability: Distribution of the handbook is unlimited. Copies are available from The Mechanical Properties Data Center, 13919 West Bay Shore Drive, Traverse City, Michigan 49684. A search service is available by telephone (616)947-4500, TWX 810-291-3360.

Cost of Access to the Data: The initial handbook and first year supplements cost \$75.00. Telephone information may be free or a fee will be quoted for detailed information.

General Comments: The *Structural Alloys Handbook* is an excellent concentrated source of mechanical property data. The data tabulations lack statistical documentation of the most probable value, the average value, the value for a 95 percent, 99 percent or other probabilities of confidence. The handbook is presently incomplete in coverage relative to the number of possible alloys mentioned in the Selector Charts. Data are easy to read.

Source 16. Welding Handbook, Section Four, Metals and Their Weldability.

6th Edition. Editors: C. Jackson, L. Griffing, S. D. Reynolds, Jr., S. Weiss, R. T. Telford, and I. G. Betz.

Publisher or Custodian: American Welding Society, 2501 N.W. 7th St., Miami, Florida 33125.

Scope: Section Four contains information on mechanical properties of base metals, fillers, and weldments for approximately 600 metals and alloys that are commercially weldable.

Properties Covered:

All weld metal, filler wire, and filler wire as-welded

Room temperature—tensile strength, yield strength, percent elongation, hardness, Charpy-V-notch impact properties, joint efficiencies, shear strength, fatigue strength, torque properties, structural beam welded properties, tear resistance, notch toughness, flexural strength.

Low and Elevated Temperature—rupture strength, impact transition temperature, creep properties.

Base Metal

Room temperature—tensile strength, yield strength, percent elongation, reduction-of-area, fatigue properties, elastic modulus, hardenability, Charpy-V-notch impact properties, bend properties, abrasion resistance, compressive strength, fracture toughness properties.

Low and Elevated Temperature—hardness, tensile strength, yield strength, percent elongation, percent reduction-of-area, impact properties, creep properties, drop-weight nil-ductility transition temperature.

Sources of the Data: Each of the fourteen chapters in *Welding Handbook, Section Four* is written by a separate chapter committee. Each chapter committee consisted of up to five experts from industry, universities and the government. Bibliographies are provided at the end of chapter referencing the data used. A Handbook Committee of six society members reviewed and edited all chapters submitted.

Size of the Data Bank: *Welding Handbook, Section Four* is 668 pages in length. Approximately one-third of the book covers mechanical properties of all weld metal, filler metal, filler metal as welded, and base metals.

Data Storage and Search: Data are stored mostly in tables and also in graphs, diagrams, and pictures in a permanently bound volume. The chapters include:

Iron, Wrought Iron, and Carbon Steels
Cast Irons and Cast Steels
Low-Alloy Steels
The 4 to 10% Chromium-Molybdenum Steels
and the Straight Chromium Stainless Steels
Austenitic Chromium-Nickel Stainless Steel
Austenitic Manganese Steel
Nickel and High-Nickel Alloys

Copper and Copper Alloys
Aluminum and Aluminum Alloys
Magnesium and Magnesium Alloys
Lead
Zinc
Titanium and Titanium Alloys
Other Metals

A subject index is provided at the end of Section Four of the *Welding Handbook*. There are four other sections in the entire *Welding Handbook*, including: Section One—Fundamentals of Welding, Section Two—Welding Processes: Gas, Arc and Resistance, Section Three—Welding, Cutting and Related Processes, Section Five—Applications of Welding. Very little mechanical property data are found in these other sections.

Selectivity of the Data: Committee authors present data from industry, university and government laboratories and plant operations in their assigned chapters. The authors are authoritative and competent in their welding specialties. The Committee authors and their supporting organizations are listed in the front of each chapter. The data are not given a statistical treatment. References are given in the back of each chapter. A large number of references come from the *Welding Journal Research Supplement*.

Timeliness of the Data: The *Welding Handbook*, sixth edition, is dated 1972. The fifth edition was dated five years earlier in 1967. Previous editions were revised on the average of once every seven years. References in the sixth edition come mostly from articles written in the 1960's with the remainder mostly from the 1950's.

Availability: Available from the American Welding Society; distribution is unlimited.

Cost of Access to Data: *Section Four* is sold at \$21.00 per copy. Member prices are \$4.00 lower and foreign prices are \$2.00 higher.

General Comments: The *Welding Handbook, Section Four* is one of very few sources available that provide the designer with weld properties. The book is intended for beginners and experts and does fairly well at it. The Handbook needs more fracture toughness data because of its growing importance.

Source 17. Standard Handbook; Wrought Copper and Copper Alloy Mill Products. Standard Handbook; Cast Copper and Copper Alloy Products.

Publisher or Custodian: Copper Development Association, 405 Lexington Ave., New York, N. Y. 10017.

Scope: Provides physical properties on over 300 commercial copper-based materials.

Properties Covered: The following mechanical properties are listed for each material:

Wrought Materials

Tensile strength
Yield strength
Elongation
Rockwell hardness
Shear strength
Fatigue strength
Modulus of elasticity (Tension)
Modulus of rigidity

Cast Materials

Tensile strength
Yield strength
Elongation
Hardness
Shear strength
Compressive strength
Impact strength
Proportional limit
Creep strength
Modulus of elasticity

Included is a cross index of the principal specification systems used in the United States for wrought and cast copper and copper alloys. These systems have used different codes to identify the same materials.

Sources of Data: Prepared by a committee of technical experts in the copper industry.

Size of Data Bank: All standard coppers and copper-based alloys are covered in these publications; there are 238 alloys covered in the handbook on wrought alloys and 93 alloys in the cast products handbook.

Data Storage and Search: The Standard Handbook; Wrought Copper and Copper Alloy Products is compiled in six, separately bound, parts:

Part 1-Tolerances
Part 2-Alloy Data
Part 3-Terminology

Part 4-Engineering Data
Part 5-Sources
Part 6-Specifications Cross Index

The Standard Handbook; Cast Copper and Copper Alloy Products is compiled in one bound book:

Part 7-Data/Specifications for cast materials

Mechanical properties data are listed in the following two parts of the Standards Handbooks:

Part 2-Alloy Data

Part 7-Data/Specifications for cast materials

Data are listed by CDA copper alloy numbers. For a cross reference to other material identification systems, refer to the following:

Part 6—Specifications cross reference for wrought materials

Part 7—Data/Specifications for cast materials

Selectivity of the Data: The data are based on years of experience in the production, specification and purchase of all copper products and are used by the mill product producers as applicable to commercial material.

Timeliness of the Data: The parts of the Standards Handbook which are of interest for mechanical data were issued at the following times:

Part 2—1973

Part 7—1970

These parts have been updated in the past approximately every four years.

Availability: Distribution is unlimited. Copies may be obtained from the Copper Development Association Inc.

Cost of Access to Data: No cost. It is a technical service to the customers of the copper and brass industry.

General Comments: These data were developed for CDA by a committee which represented nearly all of the producers in the copper and brass industry.

If contacted, CDA will make a search through Copper Data Center for any properties or values which are not presently covered by the "*Standards Handbooks*."

While literature of the individual companies in the copper industry is available, the companies recommend CDA Handbook data be used for general purposes since values presented by one manufacturer may vary slightly from the industry in general due to their particular manufacturing set-up or customer requirements.

Source 18. Monotonic and Cyclic Properties of Engineering Materials.

Publisher or Custodian: Metallurgy Department, Scientific Research Staff, Ford Motor Company.

Scope: Presents monotonic and cyclic properties for 21 steels, 7 aluminum alloys and 2 cast irons; in many cases these data are shown for different conditions of heat treatment.

Properties Covered:

Monotonic properties: Modulus of elasticity, yield strength, ultimate strength, reduction in area, true fracture strength, true fracture ductility, strain hardening exponent, strength coefficient, true toughness.

Cyclic properties: Yield strength, strain hardening exponent, strength coefficient, fatigue strength coefficient, fatigue ductility coefficient, fatigue strength exponent, fatigue ductility exponent, transition fatigue life.

Both monotonic and fatigue properties are given only for room temperature.

Data on chemistry, heat treatment, and microstructure accompany each data set.

Sources of Data: Data were obtained from six literature sources and from the unpublished laboratory tests of the Ford Motor Co.

Size of the Data Bank: The data are contained in one spiral-bound volume of about 150 pages. For each alloy in a given condition of heat treatment, there are usually two pages of data. For most alloys, data for only one condition of heat treatment are presented; for others, data for as many as six hardness levels or tempers may be shown.

Data Storage and Search: Data are presented in tabular form as standardized parameter values and also graphically as stress-strain and cyclic strain-cycles to failure curves. Pages are collected into sections for steels, cast irons, and aluminum alloys.

Selectivity of the Data: Property tabulations are average values obtained from a small number of samples. No attempt has been made to evaluate the data or to deal with material variability.

Timeliness of the Data: The current publication bears a June 1972 date. Referenced sources date from 1963 to 1971 but several of these are themselves secondary rather than primary sources.

Availability: The source is a private document prepared by and for Ford engineering people. It does not, however, contain proprietary information and, therefore, is presumably available to others on a professional courtesy basis.

Cost of Access to Data: See Availability.

General Comments: This is a laudable attempt to effect a compilation of mechanical property data in a standardized format useful to design, testing, and materials engineers. It suffers from a restricted scope, restriction to room temperature behavior and lack of statistical reliability.

A convenient appendix presents engineering drawings of each of 10 different specimen designs used in obtaining the data included in the report. Five literature citations lead to descriptions of testing techniques.

Source 19. Huntington Alloys, Handbook and Supplemental Literature.

Publisher or Custodian: Huntington Alloy Product Division, The International Nickel Company, Inc., Huntington, West Virginia 25720.

Scope: The Handbook covers the properties of thirty-one commercial nickel alloys with a cross reference to applicable ASTM, AMS, ASME, Military and Federal specifications.

Properties are covered in greater detail in supplemental literature, as follows:

| | |
|----------------------------|-------------------------------------|
| Nickel Alloys | INCONEL Alloy 706 |
| MONEL Nickel-Copper Alloys | INCONEL Alloy 718 |
| INCONEL Alloy 600 | INCONEL Alloy X-750 |
| INCONEL Alloy 601 | INCOLOY Nickel-Iron-Chromium Alloys |
| INCONEL Alloy 617 | INCOLOY Alloys 800,801,802 |
| INCONEL Alloy 625 | INCOLOY Alloy 825 |
| INCONEL Alloy 702 | |

Properties Covered: Handbook provides room temperature data such as:

| | |
|------------------|-----------------------|
| Tensile Strength | Density |
| Yield Strength | Modulus of Elasticity |
| Elongation | Poisson's Ratio |
| Hardness | |

Supplemental literature provides further data such as:

| | | |
|----------------------|---|--------------------------|
| Torsional Strength | } | At room temperature |
| Shear Strength | | |
| Bearing Strength | | |
| Compressive Strength | | |
| Impact Strength | | |
| Fatigue | | |
| Corrosion Fatigue | } | At elevated temperatures |
| Tensile Strength | | |
| Yield Strength | | |
| Elongation | | |
| Reduction-of-Area | } | At low temperatures |
| Tensile | | |
| Impact | | |
| Fatigue | | |
| Notch Fatigue | | |

Sources of Data: International Nickel Company's Huntington Division has the world's largest mill devoted exclusively to the manufacture of nickel alloys. They have extensive research facilities which have been the primary source of data on nickel alloys for the last fifty years.

Size of the Data Bank: There are twelve bulletins, as described in **Scope** paragraph, which provides approximately 290 pages of data. The mechanical properties listed are consistent for all alloys and are as listed under the **Properties Covered** paragraph. For further information and data not covered by the above bulletin a list of offices appears on the back of each bulletin which provides access to the data accumulated by the research facilities since 1921.

Data Storage and Search: Data on all commercial nickel alloys are covered in the Handbook bulletin. A paragraph on mechanical properties is listed with each alloy. The supplementary bulletins, which cover a specific alloy or alloys, each have a mechanical properties section of approximately 4 or 5 pages.

Selectivity of the Data: The data presented are based on INCO's experience as the primary producer of nickel alloys and with prior customer requests for information.

With few exceptions the values given are typical or average.

Timeliness of Data: The bulletins are revised as necessary to keep them up to date. The average time to last revision is less than three years.

Availability: Distribution is unlimited and is available from the Reader Service of the International Nickel Co., Huntington, West Virginia.

Cost of Access to Data: Bulletins are supplied at no cost.

General Comments: These publications are the basic source for mechanical properties of nickel alloys. They should be supplemented with additional data available through the publisher and through their contacts with the users of these materials.

Source 20. Materials Data Handbooks.

Publisher or Custodian: Western Applied Research and Development, Incorporated, 1403-07 Industrial Road, San Carlos, California 94070.

Scope: This is a series of handbooks, each covering a specific alloy, which provides information on mechanical properties for the following alloys: Aluminum alloys 2014, 2219, 5456, 6061, and 7075; Inconel alloy 718; Stainless Steel alloy A-286, Stainless Steel type 301; and Titanium 6Al-4V.

Properties Covered: Data are given for cryogenic, ambient and elevated temperature environments. The data are presented in two forms: design data and typical data. Properties include: tensile strength, yield strength, elongation, hardness, impact strength, fatigue strength, creep strength, modulus of elasticity, welded joint strength, Poisson's ratio, and modulus of rigidity.

Sources of Data: Data listed as design properties are based on procurement specifications, such as Military, Federal, AMS, and ASTM specifications.

Data listed as typical properties are based on such sources as *Aluminum Standards and Data*, *Alloy Digest*, and *Metals Handbook*.

Size of the Data Bank: A typical handbook is made up of 100 pages of which approximately 36 are devoted to mechanical properties.

Data Storage and Search: A typical handbook consists of 12 chapters with two chapters covering mechanical properties. Mechanical properties data are searched under the following chapter headings:

Static Mechanical Properties

- Specified properties
- Elastic properties and moduli
- Strength properties

Dynamic and Time Dependent Mechanical Properties

Selectivity of Data: The intent of these handbooks is to present a summary of the materials property information presently available.

Timeliness of Data:

Cost of Access to the Data:

| Materials Data Handbook | Date Published | Materials Data Handbook | Cost |
|-----------------------------|----------------|-----------------------------|----------|
| Aluminum alloy 2014 | -72 | Aluminum alloy 2014 | \$ |
| Aluminum alloy 2219 | 3-72 | Aluminum alloy 2219 | \$9.50 |
| Aluminum alloy 5456 | 6-72 | Aluminum alloy 5456 | \$7.25 |
| Aluminum alloy 6061 | 5-72 | Aluminum alloy 6061 | \$7.75 |
| Aluminum alloy 7075 | 4-72 | Aluminum alloy 7075 | \$9.25 |
| Inconel alloy 718 | 4-72 | Inconel alloy 718 | \$7.75 |
| Stainless steel alloy A-286 | 6-72 | Stainless steel alloy A-286 | \$7.50 |
| Stainless steel type 301 | 4-72 | Stainless steel type 301 | \$7.50 |
| Titanium 6Al-4V | 5-72 | Titanium 6Al-4V | \$8.25 |

Availability: Distribution is unlimited. Copies are available from National Technical Information Service, Springfield, Virginia 22151.

General Comments: These handbooks provide a very complete summary of the mechanical properties information available on each of the alloys covered.

Source 21. Metal Progress Data Book, 1973 Edition.

Publisher or Custodian: American Society for Metals, Metals Park, Ohio 44073.

Scope: Paperback notebook containing data sheets extracted from past issues of *Metals Progress* magazine. The section on Materials Selections has over 140 pages of mechanical properties data.

Properties Covered: Tensile strength, yield strength, elongation in 2 inches, hardness, reduction-in-area, fatigue properties, impact properties, creep properties, stress to rupture properties, abrasion resistance, deflection properties, modulus properties, and hardenability.

Sources of Data: In-field experts from the membership of ASM plus written works of industry, government, university and foreign sources.

Size of the Data Bank: The data book is 226 pages in length with over half devoted to mechanical properties data.

Data Storage and Search: The data are presented in three sections, (1) Materials Selection, (2) Process Engineering, (3) Fabrication Technology. There are only scattered amounts of data in sections 2 and 3. The data are presented in tables and charts under the various mechanical property headings. Some figures and graphs are also presented. Section 1 on Material Selection covers: irons and steels, nonferrous metals and alloys, superalloys, and special duty metals.

Selectivity of the Data: The material is selected by the editors of *Metals Progress* magazine. There is no statistical treatment of the data by the ASM. No references are given.

Timeliness of the Data: The data book is an annual publication.

Availability: Unlimited availability. Copies are obtained from the ASM, Metals Park, Ohio.

Cost of Access to Data: The data book is free with a \$25.00 membership to ASM. Advertising in the data book pays for most of the cost. A single purchase of the data book costs \$10.00.

General Comments: The goal of the publisher to keep the engineer up to date on materials and process technology and processor's know-how is reasonably well met. Lack of good references leaves the burden of validity on the user.

Information Centers
(Sources 22–25)

Source 22. National Aeronautics and Space Administration's Network of University-Based Regional Dissemination Centers (RDC's).

Publisher or Custodian: The National Aeronautics and Space Administration is the sponsor of the national network of University-based Regional Dissemination Centers (RDC's). The NASA Regional Dissemination Centers include:

| Area | RDC | Phone |
|-------------------------------|--|----------------------------|
| Midwest | Aerospace Research Applications Center (ARAC) Indiana University Foundation Bloomington, Indiana 47405 | (812)337-7970 |
| East | Knowledge Availability Systems Center (KASC) University of Pittsburgh, Pittsburgh, Pa. 15213 | (412)621-3500 Ext. 6352 |
| Southwest | Technology Application Center (TAC) University of New Mexico, Box 185, Albuquerque, New Mexico 87106 | (505)277-3118 |
| New England & Northeast | New England Research Application Center (NERAC) University of Connecticut Storrs, Connecticut 06268 | (203)429-6616 |
| Southeast | North Carolina Science & Technology Research Center (NCSTRC), P.O. Box 12235, Research Triangle Park, North Carolina 27709 | (919)549-8291 |
| West | Western Research Applications Center (WESRAC) University of Southern California Los Angeles, California 90007 | (213)746-6133 |

Scope: Each center has the mission to solicit and service fee-paying subscribers for services involving the selective provision of scientific, technical and other information from a miscellany of information sources. This mission includes the provision of available technical information on the mechanical properties of metals.

Properties Covered: Data can be searched on all key mechanical properties such as: tensile, compressive, bend, hardness, impact, fatigue, stress-rupture, creep, and fracture toughness properties. Lesser-used mechanical property data such as stress relaxation data can also be searched.

Sources of the Data Bank: NASA's data banks include data from: NASA, the Department of Defense, the Atomic Energy Commission and foreign sources. The Regional Dissemination Centers are depositories for the U.S. Government publications. In addition, the RDC's University libraries provide additional information from books and periodicals. Some examples of computerized information sources reported by an RDC (NERAC) include material from:

| | |
|--------------------------------|---|
| American Society for Metals | Institute for Scientific Information |
| Chemical Abstracts Condensates | Science Information Exchange |
| Chemical Titles | Tie-ins with all world-wide specialized |
| Engineering Titles | information centers |
| Engineering Index (Compendex) | |

The Regional Dissemination Centers can also search computer "softwear" such as tapes, cards, program listings, and machine-run instructions that come from the NASA COSMIC Center at the University of Georgia.

Size of the Data Bank: The NASA data bank includes 400,000 to 500,000 reports on 16,000 to 18,000 subjects. One RDC (NERAC) reports having its own library of 1,000,000 volumes, including 20,000 reference books and 7000 periodicals available. An estimate of 10 percent or less of the data is related to the mechanical properties of metals.

Data Storage and Search: Data are stored in hard copy form and computer tape form. Computerized search makes it possible to search as many as one million documents in an eight hour shift. A client subscriber may ask for a retrospective search on mechanical properties of metals which would include:

1. Pre-search analysis and search strategy set for obtaining specific mechanical property data by an assigned specialist.
2. Computerized or manual retrieval of the data and data compilation.
3. Delivery of the data in: evaluated print-out form, hard copy form, or microfiche form along with analysis where necessary.

In addition to the retrospective search, a selective dissemination service provides:

1. Development, updating and use of any specific mechanical property interest file by the assigned specialist for a regular period of time, such as a year.
2. Development of general interest files for a regular period of time.

Selectivity of the Data: The quality of data retrieved depends in part on the skill of the university-type search specialists in interrogating the data bank and in the selection and elimination procedures used in handling the data retrieved. The data bank has an entire spectrum of data quality from high to mediocre. Any statistical treatment of the data is only as dependable as was done in any original investigation.

Timeliness of the Data: The data come primarily from the 1960's as well as from earlier periods.

Availability: The open literature information is available on a world-wide basis. The system encourages use by small business organizations.

Cost of Access to Data: New clients may pay for searches as performed through a letter of intent or a blanket purchase order. The price of individual searches has varied between \$25.00 and \$900.00. Clients are encouraged to prepay an annual retainer for which they receive a ten percent discount. The minimum annual retainer is \$1000.00.

General Comments: The pricing system tends to discourage usage by designers who have to fight for the money before they can use the system. This is particularly a problem since the specific nature of the data feedback is unknown in terms of quality and quantity.

Source 23. Cryogenics Data Center, National Bureau of Standards.

Publisher or Custodian: Cryogenics Data Center, National Bureau of Standards, Boulder, Colorado 80301

Scope: They acquire and catalog for bibliographic purposes all literature and data of interest in cryogenics and evaluate and compile low-temperature data on properties of materials.

Properties Covered: The intent is to provide information on all properties including mechanical properties under low-temperature conditions.

Sources of Data: All literature and data of interest to cryogenics.

Size of Data Bank: There are 80,000 to 85,000 documents on file.

Data Storage and Search: Documents are correlated, evaluated, compiled, and stored in a computerized data system.

Selectivity of Data: Information and data from all sources are evaluated and compiled by a staff of experts.

Timeliness of Data: The latest information from world-wide technical literature and data is continually collected and screened for inclusion in the data bank.

Availability: The data is available to anyone on inquiry to the Data Center at Boulder.

Cost of Access to Data: The cost of time required for search. Average cost is approximately \$50.00 per search.

General Comments: This is an excellent source for mechanical properties under low-temperature conditions which are not available from other sources.

Source 24. Copper Data Center.

Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio 43201.

Sponsor: Copper Development Association Inc., 405 Lexington Ave., New York, N. Y. 10017.

Scope: Covers copper technology from the refining of metal through the end-use performance of parts, components and systems made from its mill products. Materials included: copper, copper alloys, iron and steel with copper as an alloying element, copper chemicals, and also materials which compete with copper.

Properties Covered: The intent is to provide information on all mechanical properties under all conditions of use.

Sources of Data: Primary emphasis is on current published and unpublished material from world sources. Published world literature dating back to 1959 is included in a computerized retrieval system.

Size of the Data Bank: The data bank now contains information and data based on pertinent published material from 107 sources.

There are over 5,000 terms and 20,000 interrelationships stored on computer tape.

Each document put in the system is given a serial number and this number is stored behind each term used to index it.

Data Storage and Search: Data are correlated and stored in a computerized Data Center and are immediately available through technical specialists at the Data Center.

Selectivity of Data: Information and data from both published and unpublished sources are collected and screened by specialists at Battelle. Each document selected for inclusion is sent for evaluation to one of 90 engineers and scientists who are the staff of experts that guides the program technically.

Timeliness of the Data: The latest information from world-wide technical data and information is continually collected and screened for inclusion.

Availability: The Copper Data Center serves the users of copper and copper alloys in two ways:

User-Oriented Data: Using the Data Center facilities, specialists prepare application data sheets, technical reports, and handbooks. A comprehensive, computer-coded field-of-interest register is maintained for prompt and accurate distribution of these publications. Requests for individual listing in this interest-register may be addressed to CDA in New York or to Copper Data Center at Battelle in Columbus.

Special Service: Engineers needing special information and data on the applications and performance of copper and copper alloys can contact CDA or Battelle for assistance. The same technical specialists working in the Data Center program who monitor and evaluate information on copper technology going into the center also research and respond to written or telephoned requests for assistance on specific topics. When required, computer searches are made. The requester gets the information or data as soon as possible and in usable form.

Cost of Access to Data: No charge. It is a technical service to the customers of the copper and brass industry.

General Comments: This is an excellent source for mechanical properties which are not readily available from other sources.

Source 25. Mechanical Properties Data Center, Belfour Stulen, Inc.,
13919 West Bay Shore Drive, Traverse City, Michigan 49684.

Publisher or Custodian: Same as above. This data center is sponsored by the Defense Supply Agency and monitored by the U.S. Army Materials and Mechanics Research Center.

Scope: This description covers the Search Service of their data bank which supplements their publications, *The Structural Alloys Handbook*, and *The Aerospace Structural Metals Handbook*. (q.v.) This service is primarily useful for alloys not included in the above handbooks and for tests in a specific mode or environment.

Properties Covered: Room temperature mechanical properties include: tensile, yield, elongation, reduction-of-area, notched tensile strength, joint tension, tensile fracture toughness, compressive strength, fastener shear, block shear, sheet shear, and joint shear, punch shear, bolt, pin or rivet bearing strength, pressure vessel burst strength, hardness, hardenability, notched and unnotched fatigue data, low cycle fatigue data, crack rate propagation data, impact (Charpy or Izod) strength, drop-weight impact data, bending fracture toughness data, stress-corrosion data, stress-strain curves, and true stress-strain data.

Elevated and low temperature properties include: tensile data, tensile creep, compression creep, stress-rupture properties, impact data, fracture toughness data, shear and bearing strength properties.

Included are data on corrosion, oxidation, hydrogen embrittlement, heat treatment, workability, machinability, weldability.

Source of Data: The data input are reports of U.S. Government sponsored research and development programs with a large amount of producers' literature and some foreign documents.

Size of the Data Bank: The MPDC data bank has over one million test results on approximately 5000 different metals and alloys. There are more than 40,000 technical documents used for data input.

Data Storage and Search: The over one million test results in the data bank are categorized into 25 different types of testing. Information can be requested on mechanical properties for all type alloys, test conditions and specimen configurations.

Selectivity of the Data: Input data comes from a metals properties library of more than 40,000 documents. Test definitions and test conditions are variable. There are no interpretive theories or statistical analysis. The bulk of the data are not design values but rather test results. The designer must make his own analysis, using the given data. The results may be requested as a reference list or an actual printout of the test results.

Timeliness of the Data: In addition to the existing data file and library, test data from new reports are coded and assimilated into the computer memory each month to constantly update the computer file.

Availability: Anyone can contact the MPDC and request information on mechanical properties.

Cost of Access to the Data: For a nominal fee the user can request results from all test programs pertaining to a specific alloy. If no data exist, there is no fee.

General Comments: This is an excellent source for mechanical properties which are not readily available from other sources.

**Foreign
Information Sources
(Sources 26–30)**

Source 26. National Research Institute for Metals (Japan).
NRIM Creep Data Sheets.

Publisher or Custodian: Creep Testing Division, National Research Institute for Metals, 2-3-12 Nakameguro, Meguro, Tokyo 153, Japan.

Scope: These data are from a systematic program of creep and rupture tests for defining more exactly the properties of high temperature materials in practical use.

Properties Covered: Tensile tests, creep and creep-rupture tests. Creep tests now in progress will run to 100,000 hours.

Source of Data: A new creep laboratory built by National Research Institute for Metals in 1967 and completed in 1968. They have 1100 single-specimen tensile creep-testing machines with 3500 testing points.

Size of Data Bank: Data have been or are being prepared on high-temperature materials, as follows:

| Material | Material Specification | | Similar ASTM Specification | Data Sheets published to 1972 |
|--------------------|------------------------|------------|----------------------------|-------------------------------|
| Steel Plate | JIS | SB48 | A515-70 | |
| Steel Plate | JIS | SBV 1B | A302-B | |
| Steel Plate | JIS | SPV 50 | — | |
| Steel Plate | ASTM | A387-C | A387-C | |
| Steel Plate | ASTM | A387-D | A387-D | |
| Steel Plate | JIS | SUS 32 HP | A240-316 | |
| Steel Tubes | JIS | STB42 | A210-A1 | |
| Steel Tubes | JIS | STBA 12 | A209-T1 | |
| Steel Tubes | ASTM | A213-T2 | A213-T2 | |
| Steel Tubes | JIS | STBA 22 | A213-T12 | x |
| Steel Tubes | JIS | STBA 23 | A213-T11 | x |
| Steel Tubes | JIS | STBA 24 | A213-T22 | x |
| Steel Tubes | JIS | STBA 25 | A213-T5 | |
| Steel Tubes | JIS | STBA 26 | A213-T9 | |
| Steel Tubes | JIS | SUS 27 HTB | A213 TP304H | x |
| Steel Tubes | JIS | SUS 29 HTB | A213 TP321H | x |
| Steel Tubes | JIS | SUS 32 HTB | A213 TP316H | x |
| Steel Tubes | JIS | SUS 43 HTB | A213 TP347H | x |
| Steel Forging Bars | ASTM | A470-8 | A470-8 | |
| Steel Forging Bars | JIS | SUS 50B | 276-403 | |
| Steel Forging Bars | ASTM | A565-616 | 565-616 | |
| Steel Forging Bars | JIS | SUS 32B | 276-316 | |
| Steel Castings | ASTM | 356-9 | 356-9 | |
| Steel Castings | ASTM | 357-HK40 | 357-HK40 | |

| Material | Material Specification | Similar ASTM Specification | Data Sheets published to 1972 |
|-----------------------|--|----------------------------|-------------------------------|
| Heat Resisting Alloys | | | |
| Iron Base | AMS 5732C | A 461-660 | |
| Iron Base | AMS 5734B | A 638-660 | |
| Iron Base | AMS 5737D | | |
| Iron Base | AMS 5770B | | |
| Iron Base | AMS 5376B | A 461-661 | |
| Iron Base | AMS 5768E | A 567-3 | |
| Iron Base | AMS 5769A | A 639-661 | |
| Iron Base | JIS NCF2P | B407 | |
| Iron Base | JIS NCF2TB | B409 | |
| Nickel Base | AMS 5384, 5751A | | |
| Nickel Base | (Inconel 700 trade name) | | |
| Nickel Base | AMS 5391 | A567-7V | |
| Cobalt Base | (X45 trade name) (25Cr-10Ni-7.5W-Fe-B) | | |

Data Storage and Search: All data are presented in tabular form for each material, as follows:

- Details of steel making process
- Results of chemical analysis
- Short time tensile properties
- Creep-rupture data

For creep-rupture, the time to rupture, as well as elongation and reduction of area are presented for each stress.

Selectivity of the Data: These data are from a systematic program of creep and rupture tests for defining more exactly the high temperature properties of materials.

Timeliness of the Data: This is a continuing program and Data Sheets will be published at creep test times of 10,000 hours, 30,000 hours and 100,000 hours.

Availability: Copies are available from the Creep Testing Division, National Research Institute for Metals, Japan.

Cost of Access to Data: Contact publisher for cost.

General Comments: This is a prime source for high temperature mechanical properties for the materials listed under **Size of the Data Bank**.

Source 27. Data Items.

The Engineering Sciences Data Unit (England).

Publisher or Custodian: Engineering Sciences Data Unit, Ltd., 251-259 Regent St., London W1R 7AD, ENGLAND

Scope: *Data Items* provide practical technical information in monograph form on working design information and physical data for design engineers. Certain of these Data Items provide organized data on mechanical properties of a few alloys (mostly aluminum and steel alloys), but most of the collection is not directly pertinent to the mechanical properties of metals and alloys. In general, the data provided on metals are more oriented to structure analysis and design than to properties.

Properties Covered: Fatigue and other mechanical data on some alloys of aluminum, steel, and titanium are covered, including the effects on fatigue of notches, screw threads, surface condition and treatment, microstructure, and impurities. Some illustrative Data Item titles are as follows: No. 71027, *Endurance of High Strength Steels* (in bending); No. 72015, *Endurance of Aluminum Alloy Structural Elements Subjected to Simulated Acoustic Loading*; No. Struct 00.02.01, *Standardised Stress-Strain Curves for Aluminum Alloys*; No. 68044, *Fatigue Strength of Cold-Rolled Titanium Alloy Screw Threads under Axial Loading*; and No. Struct 00.01.01, *Properties of Materials in Compression*.

Sources of Data: Data Items incorporate authoritative information, both published and unpublished, obtained from the pertinent literature (sources indicated in a bibliography in each Data Item) and from expert associates in industry, research, and teaching.

Size of the Data Bank: Most of the Data Items of interest for the mechanical properties of metals and alloys appear under the Aeronautical Series in the Fatigue (F) Sub-Series or, especially before 1965, in the Structures (S) Sub-Series. It is estimated that about 20 or so Data Items, typically of 7 to 20 pages each, cover the heart of mechanical property data on specific metals and alloys available from this collection. It is estimated that over 90 percent of the material contained in the 11 volumes of the F and S Sub-Series is not pertinent to mechanical properties of materials, but is oriented toward structural design in the analytical mechanics sense.

Data Storage and Search: Information in this source appears in monograph units called *Data Items* which are printed on rather heavy, durable paper, collected in binders, and organized into Series and Sub-Series. Data are searched by using a keyword index (rated fair by the reviewer) and by titles of Data Items under appropriate Sub-Series. (The Fatigue and the Structures Sub-Series under the Aeronautical Series appear to be the prime areas of search for mechanical properties of metals.)

Selectivity of the Data: ESDU engineers make a critical assessment of available data on a subject deemed of sufficiently broad interest to issue a Data Item. They resolve conflicts and concentrate the data into graphs, tables, and equations as appropriate. All stages of the work are carried out in association with an international technical committee (heavily British in the past), drawn from industry, research, and teaching and including typical users of the data to be published. The technical committee meets as often as 10 times a year to review in detail the work of the ESDU staff and to validate the outcome. The final data are presented in the form considered most useful to the design engineer with tolerances and limits of applicability included.

Timeliness of the Data: New Data Items are published as need is ascertained from industrial feedback (about 20-40 new Data Items per year), and Amendments are issued on existing Data Items for updating as additional information becomes available. In 1971, about 28 new Data Items and about 23 Amendments were issued. About one-third of the outstanding Data Items have been issued since 1965 with the earliest dated in 1943.

Availability: Distribution is unlimited. Copies of individual Data Items or of collected volumes are available from Engineering Data Sales, Ltd., 34 Haymarket, London SW1Y 4 HZ, England.

Cost of Access to Data: Individual Data Items can be ordered at a cost of from £3.00 to £61.00, depending on the cost classification of that Data Item. Discounts are available to Associates and to Educational Associates. One becomes an Associate by ordering one or more Sub-Series and agreeing to pay for Supplementary Issues as they are completed and distributed. The Fatigue Sub-Series of three volumes (now four volumes) was listed at £370.00 in August 1972. Associates are entitled to consult freely with the ESDU staff by telephone, correspondence, or in person concerning the use of the Data Items they hold, on the extension of the data, or on the availability of other data.

General Comments: The data are mostly product oriented. Fatigue information is useful for the limited number of alloys covered. The material information is incidental to the main purpose of providing technical information on structural configuration design. ESDU was originally established to serve the aviation industry. Its scope has been broader since 1965, but its data bank still shows its past aviation orientation.

Source 28. Werkstoffdatenbank Verein Deutscher Eisenhüttenleute (VDEh) (West Germany).

Publisher or Custodian: Verein Deutscher Eisenhüttenleute, Betriebsforschungsinstitut im VDEh, Sohnstrasse 65, Düsseldorf 4, West Germany.

Scope: Includes mechanical property data and related physical properties of German commercial steels and iron-based alloys.

Properties Covered: Yield point, flow stress, tensile strength, fracture elongation, reduction-in-area, notch impact strength, Brinell hardness, Vickers hardness, Rockwell hardness, creep strength, creep strain at fracture, reduction-in-area in creep, Young's modulus, bulk modulus, Poisson's ratio, and sound velocity. Property data are given for room temperature and frequently for high and low temperatures as well. Related, non-mechanical properties sometimes provided include: density, electrical resistivity, thermal conductivity, thermal diffusivity, thermal expansion coefficient, specific heat, and specific enthalpy.

Sources of Data: Data are obtained from the laboratories of the Betriebsforschungsinstitut or from the laboratories of the component companies supporting the VDEh. Records are coded to indicate source, specimen size and type etc.

Size of the Data Bank: About 200 steels are covered in the system incorporating about 5800 records. A record is defined as one data set comprising the properties for one composition produced by a given melting practice and with a certain heat treatment.

Data Storage and Search: All data are stored in a computer file which can either be interrogated for specific property information on a given steel or commanded to produce an x-y plot of the parameter dependence of a desired property, e.g., the temperature dependence of the yield point.

Where more than single points exist, the output selected may be in the form of the coefficients of a parametric equation, a frequency distribution plot, statistical mean with standard deviation, or a probability plot.

Selectivity of the Data: Data for input to the system are compiled by the source laboratories. This work is facilitated by a standardized questionnaire from which data are keypunched for entry into the data bank. These cards are checked for use of proper units, correct placement of entries on the card and accuracy of transcription but no technical evaluation is made. Scatter of values in the data thus includes variations in the test material itself (composition, heat treatment, etc.) and variations in the tests.

Timeliness of the Data: This data bank was begun about 1969 and additional input is continually being accumulated. It is not clear what means, if any, are used to expunge obsolete or incorrect data.

Availability: Access is restricted to the member firms of VDEh. The data bank is in the process of incorporation into a West German federal materials data bank. When this is operational, new rules of availability will undoubtedly prevail.

Cost of Access: See availability.

General Comments: The principal limitations are those of scope and selectivity. The outstanding feature is the full computerization, which conceptually lends itself to many useful forms of interrogation, display, and print-out.

Source 29. BSCC High Temperature Data (British).

Publisher or Custodian: Westerham Press, Westerham, Kent, England.

Scope: The *BSCC High Temperature Data* provides high temperature mechanical properties on six main groups of carbon steels, five groups of alloy steels, four groups of carbon steels, and ten groups of British Standard steels. BSCC stands for the British Steel Creep Committee.

Properties Covered: Properties include: long term creep rupture and elevated temperature tensile data. Tensile data include: lower yield stress, 0.2 percent proof stress, 1.0 percent proof stress, tensile strength, elongation, reduction-of-area.

Sources of Data: The *BSCC High Temperature Data* was compiled by the Corporate Laboratories of the British Steel Corporation. Data contributors include: the General Steels, Tubes, and Special Steels Divisions of the British Steel Corporation; Tube Investments, Ltd.; Brown Bayley Steels, Ltd.; Thos. Firth & John Brown Group; Electrical Research Association; and National Engineering Laboratory. Preparation was by the British Steelmakers Creep Committee which is the United Kingdom authority on elevated temperature property data.

Size of the Data Bank: The data are stored in hard cover book form. There are 735 pages. Over 90 percent of the book is comprised of numerical mechanical property data.

Data Storage and Search: The *BSCC High Temperature Data* book is divided into four parts:

1. Carbon and Carbon-Manganese Steels
 - Semi-Killed Carbon and Carbon-Manganese Steels
 - Silicon-Killed Carbon and Carbon Manganese-Steels
 - Silicon-Killed, Aluminum Treated, Carbon and Carbon-Manganese Steels
2. Alloy Steels
 - $\frac{1}{2}$ Chromium, $\frac{1}{2}$ Molybdenum, $\frac{1}{4}$ Vanadium Steels
 - 1 Chromium, $\frac{1}{2}$ Molybdenum Steels
 - $2\frac{1}{4}$ Chromium, 1 Molybdenum Steels
 - 9 Chromium, 1 Molybdenum Steels
 - 12 Chromium, Molybdenum, Vanadium Steels
3. Austenitic Steels
 - 18 Chromium, 8 Nickel Steels (Type 304)
 - 18 Chromium, 12 Nickel, Molybdenum Steels (Type 316)
 - 18 Chromium, 10 Nickel, Titanium Steels (Type 321)
 - 18 Chromium, 12 Nickel, Niobium Steels (Type 347)
4. Steels to British Standards
 - Semi-Killed, Niobium-Treated, Carbon and Carbon-Manganese Steels
 - Silicon-Killed, Niobium Treated, Carbon and Carbon-Manganese Steels
 - Molybdenum-Boron Steels (BS 1501-261)
 - Manganese, Chromium, Molybdenum, Vanadium; and Nickel, Chromium, Molybdenum Vanadium Steels (BS 1501-271 and BS 1501-281)
 - Nickel, Chromium, Molybdenum Vanadium Steels (BS 1501-282)

Tables for each part include details of test materials, tensile results, stress-rupture results. Graphs are presented under Tensile Graphs and Stress-Rupture Graphs.

Selectivity of the Data: The *BSCC High Temperature Data* book contains data taken from leading steelmakers in England, prepared and selected by experts in the field.

Timeliness of the Data: The data pool was started in 1950 and has been increased and improved every year since. The book is dated 1972.

Availability: The data are unlimited in distribution.
Correspondence for the book may be made with:

The Iron and Steel Institute
1 Charlton House Terrace
London SW1Y5DB
England

The book is also available directly from the Westerham Press, Westerham, Kent, England.

Cost of Access to Data: The *BSCC High Temperature Data* book costs £15 to nonmembers and £12 to members of the Iron and Steel Institute.

General Comments: The details of test materials given in the “BSCC High Temperature Data” are a good feature, usually not given with tabulated data. The graphical curves are presented conservatively bounding lower data points. There are more stress-rupture data than creep data reported.

Source 30. Iron and Steel Industry Profile (ISIP).

Mechanical Properties and Material Defects; Profile Group E.

Publisher or Custodian: The Iron and Steel Institute (British), Selective Dissemination of Information Service, 1 Charlton House Terrace, London SW1Y5DB, England.

Scope: The *Iron and Steel Industry Profile (ISIP) Profile Group E* sheets are a weekly publication concerning mechanical properties and materials defects of steels used throughout the world.

Properties Covered: The ISIP sheets provide a wide variety of mechanical properties data at room and elevated temperature in summary form taken from other publications.

Sources of Data: The ISIP profile sheets are compiled by the staff of the Iron and Steel Institute from a world-wide file of new publications.

Size of the Data Bank: The ISIP profile sheets consist of 1 or 2 pages issued each week. The sheets are completely devoted to mechanical properties. Only about 5 percent of the data is numerical.

Data Storage and Search: The ISIP profile sheets divide information under the following categories:

Testing of Materials Properties Found
Materials Defects

The first category contains the mechanical properties information of primary interest to a designer. The second category is of more interest to the research metallurgist.

Selectivity of Data: The ISIP profile sheet topics are selected from new literature in the field by technical people of the Iron and Steel Institute.

Timeliness of the Data: The ISIP profile sheets represent very current data, one or two years old.

Availability: The data are unlimited in distribution.

Correspondence for the ISIP sheets may be addressed to: The Iron and Steel Institute, London, England.

Cost of Access to Data: The ISIP profile sheets are available on a subscription fee basis on request.

General Comments: The ISIP profile sheets are too abbreviated to be good data sources alone without going to original documents.

**Technical Society
Data Publications
(Sources 31–34)**

Source 31. American National Standards.

Publisher or Custodian: American National Standards Institute, 1430 Broadway, New York, New York 10018.

Scope: Provides information on mechanical properties for approximately 420 commercial metals and alloys.

Properties Covered: ANSI standards for metals and alloys are all ASTM specifications. They usually define the chemical composition and those mechanical properties that are necessary to control the quality of the product. For a more detailed description refer to the write-up on ASTM.

Sources of Data: ANSI does not prepare or develop property data for materials. These data were prepared by ASTM.

Size of the Data Bank: There are approximately 420 standards for metals and alloys.

Data Storage and Search: Each standard is published as a separate document and is listed in the ANSI 1973 catalog under one of the following sections:

- G Ferrous materials and metallurgy
- H Nonferrous materials and metallurgy

Selectivity of Data: Since these data are prepared by ASTM, please refer to the write-up on Source 34 for this information.

Timeliness of the Data: Same as above.

Availability: Distribution is unlimited. Copies are available from American National Standards Institute.

Cost of Access to Data: The applicable standards are all priced at \$1.50 per single copy.

General Comments: These specifications are a duplicate of ASTM specifications but at present do not include all of the ASTM specifications in this area.

Source 32. ASME Handbook: Metals Engineering-Properties.

Publisher or Custodian: The American Society of Mechanical Engineers.

Scope: Provides information on mechanical properties for 345 ferrous materials in the following categories:

| | |
|------------|--------------------------|
| Iron | Wrought Steel, Stainless |
| Cast Iron | ASTM Steels |
| Cast Steel | AISI Steels |

Also for 216 nonferrous materials, as follows:

| | |
|----------|-----------|
| Copper | Lead |
| Aluminum | Tin |
| Zinc | Magnesium |

Properties Covered: The basic format includes: tensile strength, yield strength, hardness, endurance limit, and modulus of elasticity. For ferrous materials, impact strength and creep are also included.

Source of Data: The compilation of this material was done at Battelle Memorial Institute.

Size of the Data Bank: The book has 433 pages and is permanently bound. The entire book is devoted to chemical and mechanical properties.

Data Storage and Search: All metals included are indexed under Contents in the front of the book. Metals of a kind are grouped together. An ascending numerical sequence of designation (the commercial industry designation) is followed. All data for each metal are reproduced under the designation for that metal.

Selectivity of Data: The values used are actual test values for a single specimen or average values obtained in production practice.

Timeliness: This book was issued in 1954 and covers the commercial metals of that time.

Availability: Distribution is unlimited through: ASME Order Department, United Engineering Center, 345 East 47th Street, New York, New York 10017.

Cost of Access to Data: The Handbook sells for \$17.50 per copy.

General Comments: The book should be updated but ASME has no present plans to do so. The constant change in the field of engineering materials results in old items that are no longer significant, and new active items that are missing. Also, the industry designations for Copper and Copper-Base Alloys and for Aluminum and Aluminum-Base Alloys have completely changed from the designation systems used at the time of publication of this book.

Source 33. Publications of the American Society for Metals.

Publisher or Custodian: American Society for Metals, Metals Park, Ohio 44073.

Scope: The American Society for Metals is an 38,000 member organization with six major promotional goals in the field of metals and engineering materials: (1) Communications, (2) Meetings, (3) Education, (4) Unity of field, i.e., interdisciplinary field of metals, (5) Interrelationship among Engineers, Scientists, and Technologists, (6) Professional responsibility and public understanding. The organization allocates 62 percent of its resources to technical periodical and reference publications, 14 percent to scientific and engineering conferences and exhibits, 9 percent to metals information, 8 percent to education with the balance going to membership and general services. Mechanical properties are presented at random in all of the above activities.

Properties Covered: Nearly every mechanical property known has been randomly reported in the various activities of the ASM. (See also *Metals Handbook* and *Metal Progress Data Book*).

Sources of Data: In-field experts from the membership plus associates from all over the world prepare the various publications and services. A small permanent ASM staff of less than 100 people coordinate the activities.

Size of the Data Bank: Indeterminate Separate groups of ASM involve: metal information, education, conferences, publications.

Data Storage and Search: Random storage and search for mechanical properties is the general mode for all the ASM books, conferences, journals, and magazines. The Information Retrieval Service of the ASM is the easiest way to get at the data for a fee.

Selectivity of the Data: Input data are selected by the editors of The American Society for Metals and by member-selected special panels of experts. There is no consistent attempt to specially present mechanical property data over processing and fabrication data, heat treatment data, welding data, forging data, machining data, finishing data or theoretical technical information. There is no statistical treatment of the data unless individual authors choose to do so.

Timeliness of the Data: Abstract information dates back to January 1967. Magazines, journals, conferences, and courses are highly current representing work now being done or done within the past two years approximately.

Availability: Publications and conferences are open to the technical people of the entire world. Most of the ASM activities are within North America. The ASM in Metals Park, Ohio should be consulted for specific publications.

Cost of Access to Data: Cost vary, consult ASM, Metals Park, Ohio.

General Comments: Mechanical properties are not easily extracted from the large coverage of metals information by the ASM. The *Metals Progress Data Book* is the most concentrated source of mechanical property information other than the *Metals Handbook*. For a serious search of specific mechanical properties, the Information Retrieval Service of ASM should be consulted.

Source 34. ASTM Annual Book of Standards and the associated data services of the American Society for Testing and Materials.

Publisher or Custodian: American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103.

Scope: Provides information on mechanical properties for approximately 1100 metals and alloys in the *ASTM Annual Book of Standards* and in its special technical publications.

Properties Covered: In the *ASTM Annual Book of Standards*, mechanical properties are specified only where they are necessary to control the quality of the product. Occasionally, supplemental information is provided with expanded mechanical properties requirements. There are also appendices and footnotes to the specification standards which provide added mechanical property information. Tensile properties are almost always the key controlling mechanical properties in the specification standards. Various other mechanical properties that sometimes supplement the tensile data or may appear separately are:

Bend test data, hardness data, notched and unnotched impact test data, fracture transition temperature data, hydraulic and ring expansion test data, proof test data, strain gage data, microstructure and inclusion data, creep, creep-rupture and stress-rupture data, bearing strength properties, elastic properties, radiation hardening data, compression data, drop-weight test data, fatigue data, and stress relaxation data.

In addition to the *ASTM Annual Book of Standards*, there are other data services of ASTM, including: *ASTM Journal of Testing and Evaluation*, *ASTM Standardization News*, *Special Technical Publications*, and *Data Series*, some of which are directly involved with mechanical properties.

Sources of Data: Data originate with the members of ASTM, including consumers, producers and a general interest group composed of engineers, scientists, educators, testing experts, and research workers. Specification standards are adopted for publication only when approved by a series of votes by the membership. ASTM technical papers are edited by special committees made up of members and staff of the ASTM. Data obtained by the Metal Properties Council are frequently presented in these technical papers.

Size of the Data Bank: There are 47 bound parts in the *ASTM Annual Book of Standards*. Each part is 500 to 1000 pages in length. There are over 33,000 total pages and over 5000 standards. Twelve of the parts or about one-fourth of the total number of standards are devoted to metallic materials. The quantity of mechanical properties in the twelve parts is limited. Typically data for a single specification are given with two mechanical property parameters such as yield strength and tensile strength, or hardness and bend angle. By contrast, the ASTM data services include considerable mechanical property data in special technical publications. As examples, publication STP370 covers *Structure and Properties of Ultrahigh Strength Steels*, presenting 150 pages of mechanical property data. STP459 covers *Fatigue at High Temperatures*. Each year, ASTM lists around forty publications of STP's in the *ASTM PUBLICATIONS* booklet.

Data Storage and Search: Data for the *ASTM Annual Book of Standards* are stored as printed pages in annual bound parts. Data are searched using a Subject Index for situations where specification number is unknown or a Numeric List when the specification number is known. The following Parts include mechanical property as well as other information on metals and alloys:

- Part 1 Steel Piping, Tubing, and Fittings
- Part 2 Ferrous Castings; Ferroalloys
- Part 3 Steel Plate, Sheet, Strip, and Wire; Metallic Coated Products
- Part 4 Structural Steel; Concrete Reinforcing Steel; Pressure Vessel Plate; Steel Rails, Wheels, and Tires
- Part 5 Steel Bars, Chain, and Springs; Bearing Steel; Steel Forgings
- Part 6 Copper and Copper Alloys
- Part 7 Die-Cast Metals; Light Metals and Alloys
- Part 8 Nonferrous Metals-Nickel, Lead, and Tin Alloys, Precious Metals, Primary Metals; Reactive Metals
- Part 9 Electrodeposited Metallic Coatings; Metal Powders, Sintered P/M Structural Parts
- Part 10 Metals-Mechanical, Fracture, and Corrosion Testing; Fatigue; Erosion; Effect of Temperature
- Part 11 Metallography; Nondestructive Tests
- Part 44 Magnetic Properties; Metallic Materials for Thermostats and for Electrical Resistance, Heating, and Contacts; Temperature Measurement
- Part 45 Nuclear Standards

To assist in promoting the knowledge of materials of engineering, ASTM issues a five year *Index to ASTM Technical Papers and Reports*. The index provides detailed author and subject listings to all proceedings, *Materials Research and Standards* reports, and special technical publications issued in the five year time span.

Selectivity of the Data: Proposed standards are drawn up by ASTM members who contribute the input technical data on mechanical property requirements. The Society then follows a three step procedure:

- (1) Technically qualified committees and members of ASTM study proposed standards extensively, debate on their acceptability, and vote on adoption of the standards.
- (2) Before standards are formally adopted, the principal persons concerned—consumers, producers, and general interests—agree on the necessary requirements.
- (3) As the need arises, requirements for standards are revised.

The ASTM Committee on Papers and Publications has jurisdiction in all matters relating to publications such as: papers from technical symposia, reports by ASTM technical committees, special books and compilations of data developed in special Society groups with many organizations cooperating. Some criteria used in judging the publications are:

- (1) Whether or not subject matter promotes the knowledge of the properties of materials.
- (2) Whether or not contents are of an advertising value.
- (3) Whether or not subject matter is of a speculative nature.
- (4) Whether or not subject matter is new.
- (5) Literary form, ethical and legal considerations.

Timeliness of the Data: The Annual Book of ASTM Standards has on the average 30 percent of each part revised or presented new each year. They are issued annually as new bound books. Each standard has the year of last revision or approval suffixed to its numeric designation. There is a five year revision or reapproval requirement for published standards to remain in the system. The specifications in the *ASTM Annual Book of Standards* nearly all fall within the 1964 to 1972 time span. For other ASTM papers and publications, a lead time of approximately two years lies between the originating date and the final publication date.

Availability: Distribution is unlimited. Copies are available from ASTM. ASTM PUBLICATIONS booklet is free.

Cost of Access to Data: Separate standards for the *ASTM Annual Book of Standards* are priced at \$1.50 each. Special quantity prices are also available. Papers and publications generally are priced from under \$10.00 up to around \$50.00 each. No search function is provided by the publisher or custodian.

General Comments: The amount of mechanical property data that can be extracted from the *ASTM Annual Book of Standards* is small and requires a lot of searching. The data that are given, however, are key requirement data, useful to a designer who wants a practical idea of his safety margins. The properties given are minimum or maximum values and not mean values. Values are generally on the safe side of the normal data distribution even though no formal statistical distributions may have been calculated by the input authors. Many of the other ASTM papers and publications which cover the mechanical property field are excellent in data content, particularly in areas such as fracture analysis and stress-corrosion. In contrast to the *ASTM Annual Book of Standards*, the papers and special publications are presented opportunistically as information becomes available and there is no procedure to update, correct or revise past publications. Much of the data output from the work of the Metal Properties Council appears in one or another of the ASTM publications.

**Trade Association
Data Publications
(Sources 35–39)**

Source 35. Engineering Data File; Steel Castings Handbook.

Publisher or Custodian: Steel Founders Society of America, Westview Towers, 21010 Center Ridge Road, Rocky River, Ohio 44116.

Scope: Tabulates the composition and properties of a wide variety of steel castings at room and various temperatures.

Properties Covered:

Engineering Data File—Minimum mechanical properties as follows: tensile strength, yield strength, elongation, reduction-of-area, bend, impact strength and hardness.

Steel Castings Handbook—Provides handbook information on impact strength, fatigue strength, low temperature impact strength and high temperature creep properties as well as properties from the *Engineering Data File*.

Sources of Data:

Engineering Data File—Data listed are based on the specification requirements of ASTM, SAE, AAR (Association of American Railroads), ABS (American Bureau of Shipping), Lloyds, Federal and Military.

Steel Castings Handbook—Data listed are based on all available literature on the subjects covered, as well as unpublished information made available through research by the Steel Founders' Society and qualified individuals and companies within the steel casting industry.

Size of Data Bank:

Engineering Data File consists of 13 sections, three of which contain mechanical properties data.

Steel Castings Handbook consists of 952 pages of which approximately 200 are devoted to mechanical properties.

Data Storage and Search:

Engineering Data File has presented mechanical properties in three sections; Specifications, General Properties, and Heat-Resistant and Corrosion-Resistant Cast High Alloys.

Steel Castings Handbook mechanical properties data are covered in 5 of the 27 chapters. They are identified as chapters covering mechanical properties or are included in chapters covering properties of various classes of steel castings.

Selectivity of Data:

The *Engineering Data File* was prepared by the Specifications Committee of the Steel Founders' Society.

The *Steel Castings Handbook* has been in existence for 30 years and is updated at regular intervals. The last revision was made in 1970 by the Handbook Committee, which had representatives from 16 of the steel casting companies and represented 2 years of effort.

Timeliness of the Data: The data sheets in the *Engineering Data File* are more up to date than the *Steel Castings Handbook*, and cover each grade in greater detail.

| | |
|-------------------------|-------------------------|
| Engineering Data File | Revised January 1, 1971 |
| Steel Castings Handbook | Revised 1970 |

Availability: Distribution is unlimited from the Steel Founders' Society.

Cost of Access to Data:

| | |
|-------------------------|---------|
| Engineering Data File | \$ 3.00 |
| Steel Castings Handbook | \$10.00 |

General Comments:

These publications have listed mechanical properties for the commercial steel alloy castings.

The Steel Founders' Society is representative of this industry and has committees which develop and maintain up-to-date data in this area.

Source 36. Publication, *Lead*.

Publisher or Custodian: Lead Industries Association, Inc., 292 Madison Avenue, New York, New York 10017.

Scope: Presents monotonic and cyclic mechanical properties for the commercial grades of lead.

Properties Covered:

Monotonic properties: Tensile strength, elongation, hardness and creep.

Cyclic properties: Resistance to bending and fatigue.

Sources of Data: Data were obtained from LIA's own files and experience, close industry contact and research.

Size of the Data Bank: Approximately $\frac{1}{2}$ page of data.

Date Storage and Search: Data are presented in tabular form as typical values. In addition the Association maintains an extensive library of publications with data pertaining to lead. Access to this information may be obtained by inquiry to their Technical Service Department.

Selectivity of Data: The values given are typical or average and were based on data furnished by the corporate members of the Lead Industries Association.

Timeliness of the Data: The current publication bears a 1972 date.

Availability: Distribution is unlimited. Copies may be obtained from the Lead Industries Association, Incorporated.

Cost of Access to Data: The publication is available free in reasonable quantities.

General Comments: Lead has low strength and application is usually based on other characteristics than mechanical properties. For this reason there are limited data published by the Lead Industries Association on mechanical properties while they have many publications with data for specific types of application.

Source 37. Properties of Tin; Properties of Tin Alloys.

Publisher or Custodian: Tin Research Institute, Inc., 483 West Sixth Avenue, Columbus Ohio 43201.

Scope:

Properties of Tin—Data generally refer to tin of 99.99 percent purity.

Properties of Tin Alloys—Provides data on 35 different alloy systems.

Properties Covered:

Properties of Tin

Modulus of Elasticity

Modulus of Rigidity

Poisson's Ratio

Limit of Proportionality

Compressibility

Tensile Properties

Shear Strength

Fatigue Strength

Creep

Damping Capacity

Hardness

Properties of Tin Alloys—Hardness and tensile properties are considered to be of most importance and are covered for all alloys. Other properties are covered where the information was available in published literature or from work carried out at the Tin Institute.

Sources of Data:

Properties of Tin—This information was originally compiled by E. S. Hedges and C. E. Homer and the Tin Research Institute continues to collect and study new data.

Properties of Tin Alloys—The information is based largely on published literature and hitherto unpublished work carried out for the Tin Research Institute.

Size of the Data Bank:

Properties of Tin—9 pages

Properties of Tin Alloys—43 pages

Date Storage and Search:

Properties of Tin—Mechanical properties are indexed in the front of the publication.

Properties of Tin Alloys—The Table of Contents in the front of the publication indexes the various systems and lists the properties covered for each of the alloy systems.

Selectivity of the Data: The values given for mechanical properties are based on the recommendations of authoritative committees or other selecting bodies. Appropriate references are given for the source of data for each property.

Timeliness of Data: The data were originally compiled for *Properties of Tin* in 1934, revised in 1954, and reprinted in 1965. *Properties of Tin Alloys* was compiled in 1947, and reprinted in 1965. The Tin Institute has continued to collect and study new data and to update these publications as necessary.

Availability: Distribution is unlimited. Copies may be obtained from the Tin Research Institute.

Cost of Access to Data: No cost. This is a technical service to the customers and users of tin and tin alloys.

General Comments: This is the main source of mechanical properties data for tin and tin alloys in United States. They maintain a staff of technical people and welcome inquiries.

Source 38. Publications of the Zinc Institute, Inc.

Publisher or Custodian: Zinc Institute, Inc., 292 Madison Avenue, New York, New York 10017.

Scope: Does not present mechanical properties for wrought zinc materials. Typical mechanical properties for zinc casting materials are covered.

Properties Covered:

Monotonic properties: tensile strength, yield strength, shear strength, elongation, impact strength, creep stress, hardness, and Young's modulus.

Cyclic properties: fatigue endurance.

Sources of Data: Data were obtained from the Zinc Institute's own files and experience, close industry contact and research.

Size of the Data Bank: Approximately $\frac{1}{2}$ page of data.

Data Storage and Search: Data are presented in tabular form by properties or by alloy as typical values. In addition the Institute maintains an extensive library with data pertaining to zinc which may be obtained by inquiry.

Selectivity of the Data: Values given are typical or average. The data were collected by members of the Zinc Institute, Inc.

Timeliness of the Data: The current publications bear a 1972 date.

Availability: Distribution is unlimited. Copies may be obtained from the Zinc Institute, Inc.

Cost of the Data: The publications are available free in reasonable quantities.

General Comments: Wrought zinc properties such as tensile strength and elongation have little significance. When employed for structural purposes, creep data developed from service tests are applied in design.

Source 39. Published Standards of Underwriters' Laboratories, Inc.

Publisher or Custodian: Underwriters' Laboratories, Inc., 207 E. Ohio Street, Chicago, Illinois 60611.

Scope: The *Standards of Underwriters' Laboratories, Inc.* provide specifications and requirements for the construction and the performance (under test and in actual use) of systems, devices, materials, and appliances of numerous classes submitted to the Laboratories.

Properties Covered: The U.L. Standards include: tension data, shear data, bend data, proof test loads, vibration data, torque data, peel test data, impact data, and stress-corrosion data.

Source of the Data: The data are provided from component testing by the Underwriters' Laboratories and from data of manufacturers wishing to be listed by U.L.

Size of the Data Bank: There are over 280 published U.L. Standards. Approximately one-half of the standards include metallic components. Less than a page of mechanical property data is found in any of the standards.

Data Storage and Search: The U.L. Standards are grouped under the following headings:

| | |
|-------------------------------|--|
| Casualty and Chemical Hazards | Heat, Air Conditioning and Refrigeration |
| Electrical | Burglary Protection and Signaling |
| Fire Protection | Marine |

The data seeker must guess at which standards in each group might have metallic property data and then procure the document. Most documents are less than 50 pages in length and general scanning locates any listed mechanical property data.

Selectivity of the Data: The standards are drawn up by the engineering councils of Underwriters' Laboratories, Inc. with the assistance of outside groups. The engineering councils are made up of persons having enforcement authority in the field of public safety, government officials having responsibility in establishing safety standards, and others having special knowledge and experience in the area of interest of the council. Data come from field experience, laboratory tests and engineering judgment.

Timeliness of the Data: Over seventy-five percent of the standards are dated in the 1970's with the remaining standards dated primarily in the mid- and late-1960's.

Availability: The standards are available to all individuals or organizations involved with standards for safety. Copies may be obtained at the Chicago address or at offices and testing stations in Northbrook, Illinois; Melville, New York; Santa Clara, California; or Tampa, Florida.

Cost of Access to the Data: There is no charge for a single copy. Multiple copies will require billing by the Chicago office.

General Comments: The mechanical properties data are different from generally published data of typical values or maximum and minimum values. The data are presented as values that are safe for the applications. Use of the U.L. Standards for gathering mechanical property data is recommended only to those interested in similar applications to the standards.

Appendix

Miscellaneous Sources

Source:

Aerospace Materials Information Center
AF Materials Laboratory/DO
Wright-Patterson A.F.B.
Ohio

Scope: This agency formerly functioned as a materials information center for various groups connected directly or indirectly with defense programs. Use of the center is now restricted to personnel of the Air Force Materials Laboratory. Under its previous policy, this Center was responsible for the initiation and the development of handbooks covering the properties of metals and their alloys. These are now published and maintained up to date by other organizations. For example: *Aerospace Structural Metals Handbook*; custodian: Mechanical Properties Data Center, Traverse City, Michigan. The most recently sponsored handbook is the *Titanium Alloys Handbook*.

General Comments: This is not a direct source of data for mechanical properties.

Source:

American Petroleum Institute
1801 K Street, Northwest
Washington, D.C. 20006

Scope: The American Petroleum Institute publishes little or no mechanical property information. Their yearly catalog, called *Publications and Materials*, describes all currently listed publications of the API. Most of this consists of allowable working loads for components used in the petroleum industry.

General Comments: For general information on the mechanical properties of metals, the API refers inquiries to: Metals Properties Council, 345 East 47th Street, New York, New York 10017.

Source:

Consultants Bureau
227 West 17th Street
New York, New York 10011

Scope: Important Russian technical books, journals, and reports are selected from the Soviet literature by the Editors of Consultants Bureau and are then translated and sold through the usual technical book markets.

General Comments: Selection of items for translation and publication is based as much on marketability as on technical importance. There is no means of surveying the total output for information on particular materials or properties.

Source: General Electric EMPIS system

Publisher or Custodian: General Electric Company, Materials Information Services, Corporate Research and Development, Bldg. 36, 1 River Road, Schenectady, New York 12345.

Scope: Provides mechanical property information, including specification requirements and ordering lists of approximately 2000 ferrous and nonferrous materials used in the General Electric Company.

Properties Covered: Typical mechanical properties as well as required properties are presented for each GE specification in the EMPIS system. Property data are given primarily at room temperature but elevated and low temperature data are also presented.

Properties include: Tension data, hardness data, impact data, bending data, torsion data, fracture data, creep rupture properties, fatigue properties, elastic properties, and modulus of elasticity data. Fastener strength data are also covered.

Included is a system of indices and tables to facilitate material identification, selection, specification, and procurement.

Sources of Data: Handbooks; trade association compilations; original technical literature; industrial, national, and international standards; research reports, GE test reports and in-service failure records.

Size of the Data Bank: There are 51 volumes of information assembled in standard looseleaf binders. There are three Metallic Materials books, three Nonmetallic Materials books, five books covering Machine Parts, three books covering Chemical Materials, three books on Supplies and Equipment, one Test Method book, two Finishes books, one Drafting Manual, one Processes book, one Design Data book and one Index book. Mechanical properties of metals are primarily contained in books *BP Metallic Materials; Properties*, and *CP Machine Parts; Properties*. The other books have scattered amounts of mechanical property information. There are approximately 12,000 total pages covering metallic materials. Approximately 15 percent of these represent data devoted to mechanical properties. The remainder covers chemical properties, thermal properties, electrical properties, magnetic properties, fabrication information, and tolerance information.

Data Storage and Search: Data are stored as printed looseleaf pages with the information shown in tables and graphs. Data are stored under an alphanumeric system as follows:

| | | | |
|-----|--|---------|----------------------------------|
| B1 | Ferrous Raw Materials | B21 | Alloys for Specific Purposes |
| B2 | Cast Iron and Steel | B24 | Molybdenum and Molybdenum Alloys |
| B3 | Magnetic Materials | B25 | Tungsten and Tungsten Alloys |
| B4 | Carbon Steel for Structural Purposes | B26 | Zirconium and Zirconium Alloys |
| B5 | Alloy Steels for Structural Purposes | B27 | Tantalum and Tantalum Alloys |
| B6 | Tool Steels | B28 | Beryllium and Beryllium Alloys |
| B7 | Stainless Steels and Other Related Alloys | B29 | Columbium and Columbium Alloys |
| B8 | Mechanical Sheet and Strip Steel | B33 | Structural Composites |
| B10 | Nonferrous Raw Materials (Pure or Alloyed) | C1-C9 | Fastening Devices |
| B11 | Copper and Copper Alloys | C2 | Nuts |
| B12 | Aluminum and Aluminum Alloys | C3 | Rivets |
| B13 | Zinc and Zinc Alloys | C4 | Washers |
| B14 | Nickel and Nickel Alloys | C5 | Pins |
| B15 | Tin and Tin Alloys | C10-C19 | Current-Carrying Parts |
| B16 | Magnesium and Magnesium Alloys | C20-C29 | Bearing Devices |
| B17 | Lead and Lead Alloys | C30-C39 | Motion Transfer Parts |
| B18 | Titanium and Titanium Alloys | C52-C59 | Other Mechanical Parts |
| B19 | Cobalt and Cobalt Alloys | C60-C69 | Products |
| B20 | Fusible Alloys | C70-C79 | Functional Components |

Within each of these classes a further breakdown is provided by form or major application areas, as for example B13 lists:

Die Castings
Sand Castings
Ingot

Rod
Sheet
Strip
Wire

There are several search procedures to retrieve the data:

- (1) Section Index.
- (2) Subject Index.
- (3) Trade Name Index.
- (4) Society designation cross indices for: Aluminum Association, American Casting Institute, American Iron and Steel Institute, American Society for Testing and Materials, American Welding Society, Copper Development Association, National Electrical Manufacturers Association, Military Specifications, and Federal Specifications.

Selectivity of the Data: Input of data into the *EMPIS* system is primarily initiated by requests for specification and property documentation from GE departments. For each specification grade there is an associated property sheet which details the properties of the grade. The data for each grade are collected and screened by materials engineers within GE Materials Information Services. Data reference cards are maintained for important entries identifying the source of the data entered into the system. Files are maintained on each listed material. They contain vendor responses, originating correspondence, and chronological documentation. Specimen types and test methods are established by *ASTM* or *EMPIS* referee methods for specification properties. Statistical confidence is not listed.

Timeliness of the Data: The *EMPIS* data sheets are issued in groups of new and updated documents three or four times per year. The majority of the published data sheets are dated in the late 1960's with the remainder primarily in the early 1970's and early 1960's.

Availability: The *EMPIS* system is an internal document system of the General Electric Company and is not generally available to the outside. Only the specifications portion of the system is regarded as public information and hence is available to all.

Cost of Access to the Data: Individual specifications are free to active suppliers; grouped specification sets, e.g. steels, fasteners, etc., are specially priced. Data questions may be directed to General Electric Company (EMPIS), Schenectady, New York 12345 where special inquiries are sometimes accommodated on a professional courtesy basis. Regular data search assistance in the *EMPIS* system is provided only to subscribing GE departments.

General Comments: This data source is excellent for general industrial metals information. The selection of metals is biased to the specification needs of the General Electric Company. The data are not ranked in the order of increasing property values hence the use of the system as a general materials selection tool is somewhat awkward. The mechanical property information represents mostly typical data and/or maximum-minimum property limits of the specifications. Reliability of the data is based on a "used successfully elsewhere in GE" criterion.

Source:

Magnesium Association
12 Willow Drive
Selma, Ala. 36701

Scope: This association is made up of three Divisions; Casting, Fabricating and Foundry. They publish a monthly Newsletter, sponsor competitions and offer an annual Design Award. They have no publications covering mechanical properties, nor do they maintain any data files in this area. Inquiries pertaining to mechanical properties are referred to the manufacturers and processors of magnesium and its alloys.

General Comments: The Magnesium Association is not a source for mechanical property data.

Source:

Metallurgical Documentation and Information System (SDIM)
Centre for Information and Documentation (CID)
Luxembourg City, Luxembourg

Scope: A coordinated operation for the collection, indexing, storage, processing and dissemination of metallurgical literature in both the ferrous and nonferrous fields. All member nations of the European Economic Community participate. The CID designed the indexing and information handling system and has the responsibility for coordinating, checking and correcting the work of the individual national participating bodies. It is intended to cover all significant metallurgical information of a scientific, technical, or economic character appearing from January 1, 1972 on.

General Comments: The system at present is limited to bibliographic treatment of the periodical literature. It does not provide direct access to source documents and hence mechanical property data sought cannot be seen directly. It competes with *Metals Abstracts*.

Source:

The Metal Properties Council
345 East 47th Street
New York, New York 10017

Scope: The Metal Properties Council, sponsored by The American Society of Mechanical Engineers, The American Society for Metals, The American Society for Testing and Materials, and The Engineering Foundation, is a voluntary organization whose purpose is to identify major unfilled needs for reliable data on the engineering properties of metals and alloys, and to conduct programs for collecting, generating, evaluating, and disseminating such data. Much of its work is concerned with mechanical properties. Its publications are issued by one of the sponsoring societies, described elsewhere in this Survey.

Source:

Metals and Ceramics Information Center (MCIC)
Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

Scope: Collects, evaluates and disseminates information on the characteristics, processing, testing and utilization of advanced metallic, ceramic, and composite materials, particularly those of interest in defense and aerospace activities.

General Comments: MCIC is one of seven materials information centers managed by the Army Materials and Mechanics Research Center (AMMRC), Watertown, Mass., for the Defense Department. While MCIC files may include some mechanical property information, its sister center, the Mechanical Properties Data Center in Traverse City, Mich., also managed by AMMRC, is regarded as the primary source of mechanical property data for DoD.

Source:

Research Materials Information Center
Oak Ridge National Laboratory
P.O. Box X
Oak Ridge, Tennessee 37830

Scope: Covers the availability, properties and preparation procedures for high purity specimens of materials for research purposes. The properties included are primarily those which may provide inference as to purity and structure.

General Comments: No engineering or mechanical property information are included.

Source:

Smithsonian Science Information Exchange
Smithsonian Institution
1730 M Street, N.W.
Washington, D. C. 20036

Scope: The Smithsonian Science Information Exchange (SSIE) is an annually updated source of scientific information on research in progress and technical information *yet to be published*. The SSIE services include the Physical Sciences areas and Life Sciences areas. Mechanical Properties of Metals falls under the Physical Sciences (materials) area.

General Comments: Although the Exchange currently files more than 150,000 documents, only about 1 percent of the data involves mechanical properties of metals. Searches (for a fee) may be made of the files by Exchange personnel by subject, by investigating organization, or by individual investigator's name. The service is most useful where a complete, thorough investigation of all available information must be carried out.

Source:

Welding Research Council
345 East 47th Street
New York, N. Y. 10017

Scope: Operates under the Engineering Foundation and is sponsored by several engineering societies. Plans and arranges for cooperative conduct of welding research, disseminates research results, interpretive reports, and literature reviews in welding and related fields both through its own publications and particularly through *Welding Research*, a supplement to the *Welding Journal*, a publication of the American Welding Society, 2501 NW 7th St., Miami, Fla., 33142.

General Comments: While *Welding Research* and other WRC publications often include mechanical property data, such information is not segregated in any way and hence is very difficult to retrieve.

Other Sources of Mechanical Property Information on Metals

Certain other sources of mechanical property information exist which were not examined in detail for this survey but which may be valuable in special instances. Brief reference is made to them here for the convenience of the reader.

| Information on | Source |
|------------------------------------|---|
| Cobalt | Cobalt Information Center Battelle-Columbus 505 King Avenue Columbus, Ohio 43201 |
| High temperature alloys | Cabot Corporation-Stellite Division 1020 West Park Avenue Kokomo, Indiana 46901 |
| High temperature alloys | Timken Company Canton, Ohio 44706 |
| Magnesium | Dow Chemical Company Midland, Michigan 48640 |
| Molybdenum | Climax Molybdenum Company 2929 Plymouth Road Ann Arbor, Michigan 48106 |
| Nickel | International Nickel Company One New York Plaza New York, New York 10004 |
| Platinum and other precious metals | Johnson Matthey & Company, Inc. 608 Fifth Avenue New York, New York 10020 |
| Rare earth metals | Rare Earth Information Center Institute for Atomic Research Iowa State University Ames, Iowa 50010 |
| Titanium | Titanium Metal Corporation of America 1140 Bloomfield Avenue West Caldwell, New Jersey 07006 |

Metals and Alloys Index

| | Source Number |
|---|--|
| Aluminum | 1,2,3,5,6,8,9,10,11,12,13,15,16,18,20,27,32 |
| Bearing Alloys | 10 |
| Beryllium | 1,8,12 |
| Boron | 12 |
| Cadmium | 8,12 |
| Carbon | 12 |
| Chromium | 2,12 |
| Cobalt | 1,5,12,26 |
| Columbium (Niobium) | 1,2,5,12 |
| Copper | 2,5,8,9,10,13,16,17,24,32 |
| Gold | 2 |
| Graphite | 12 |
| Hafnium | 12 |
| Heat Resistant Alloys | 5,11,13,20,21 |
| Iron and its Alloys (other than Steels, q.v.) | 2,5,8,9,10,15,16,18,21,26,28,32 |
| cast | 2,10,15,16,32 |
| wrought | 16 |
| Lead | 2,5,8,9,10,32,36 |
| Magnesium | 1,2,5,8,9,10,11,12,13,16,32 |
| Manganese | 2 |
| Molybdenum | 1,2,8,12 |
| Nickel | 1,2,5,8,9,10,12,13,16,20,26 |
| Niobium | See Columbium |
| Platinum | 2,8 |
| Plutonium | 12 |
| Precious Metals | 2,5,8,9 |
| Rare Earth Metals | 12 |
| Rhenium | 2,5 |
| Silver | 2 |
| Sodium | 8 |
| Steels | 1,2,4,9,11,12,13,15,16,18,21,26,27,28,29,30,32,34,35 |
| alloy | 1,2,11,15,16,25,29,30,34 |
| carbon | 1,11,15,16,25,29,30 |
| stainless | 1,11,12,15,16,20,29,30,32 |
| tool | 2,9,13 |
| Superalloys | 5,11,13,20,21 |
| Tantalum | 1,2,5,8,12 |
| Thorium | 12 |
| Tin | 2,5,8,9,32,37 |
| Titanium | 1,2,5,6,8,9,10,11,12,16,20,27 |
| Tungsten | 1,2,5,12 |
| Vanadium | 1,12 |
| Zinc | 2,5,8,10,13,16,32,38 |
| Zirconium | 1,2,5,8,12 |
| All Metals and Alloys, not otherwise classified | 4,11,12,13,14,15,16,21,22,25,31,33,35,39 |

Properties Index

| Property | Source Number |
|--|--|
| Abrasion resistance | 16,21 |
| Bearing strength | 1,5,11,15,25,34 |
| Bending properties | 1,2,9,12,13,15,16,22,34,35,36,39 |
| Burst strength | 5,15,25 |
| Charpy strength | See Impact strength |
| Compressive strength | 1,2,5,9,11,12,13,14,15,16,17,22,25,34,37 |
| stress-strain | 1 |
| creep | 15 |
| Crack growth rate | 6,15,25 |
| Creep | 1,2,5,10,11,12,13,16,17,21,22,26,28,32,34,36,37,38 |
| in compression | 15 |
| reduction-in-area | 28 |
| rupture | 1,7,26,29,30,34 |
| strain | 28 |
| strength | 20 |
| Crushing strength | 13 |
| Damping capacity | 10,37 |
| Deflection | 21 |
| Drop-weight test | See Impact strength |
| Ductility | See Elongation, Bending Properties |
| Effects of Variables on Mechanical Properties* | |
| cold work | 39 |
| combined loads | 1 |
| heat treatment | 2,9,13,15 |
| hydrogen | 15 |
| irradiation | 12,34 |
| microstructure and inclusions | 34 |
| oxidation | 15 |
| strain | 18 |
| strain rate | 11 |
| stress concentration | 1 |
| temperature | 13,16,23,29,30, see also Creep, Hot-hardness, Stress-rupture |
| Elastic properties | 1,10,14,16,34 |
| Elongation | 2,3,4,5,7,8,9,12,13,15,16,17,20,21,25,29,30,35,36,38 |
| Endurance limit | See Fatigue Properties |
| Fastener strength | 15,17,25 |
| Fatigue properties | 1,2,3,5,6,7,9,10,11,13,15,16,17,18,20,21,22,25,27,32,34,36,37,38 |
| Flexural strength | See Bending Properties |
| Flow stress | 28 |
| Fracture | 2,9,10,11,18,34 |
| bending | 25 |
| elongation | 28 |
| tensile | 25 |
| toughness | 1,6,15,16,22,25 |

*Shown here are references where the effects of the variable on one or more mechanical properties are treated in a separate section; many unlisted references also consider the effects of these and similar variables but the data are not so segregated.

Metals and Alloys Index

| | Source Number |
|---|--|
| Aluminum | 1,2,3,5,6,8,9,10,11,12,13,15,16,18,20,27,32 |
| Bearing Alloys | 10 |
| Beryllium | 1,8,12 |
| Boron | 12 |
| Cadmium | 8,12 |
| Carbon | 12 |
| Chromium | 2,12 |
| Cobalt | 1,5,12,26 |
| Columbium (Niobium) | 1,2,5,12 |
| Copper | 2,5,8,9,10,13,16,17,24,32 |
| Gold | 2 |
| Graphite | 12 |
| Hafnium | 12 |
| Heat Resistant Alloys | 5,11,13,20,21 |
| Iron and its Alloys (other than Steels, q.v.) | 2,5,8,9,10,15,16,18,21,26,28,32 |
| cast | 2,10,15,16,32 |
| wrought | 16 |
| Lead | 2,5,8,9,10,32,36 |
| Magnesium | 1,2,5,8,9,10,11,12,13,16,32 |
| Manganese | 2 |
| Molybdenum | 1,2,8,12 |
| Nickel | 1,2,5,8,9,10,12,13,16,20,26 |
| Niobium | See Columbium |
| Platinum | 2,8 |
| Plutonium | 12 |
| Precious Metals | 2,5,8,9 |
| Rare Earth Metals | 12 |
| Rhenium | 2,5 |
| Silver | 2 |
| Sodium | 8 |
| Steels | 1,2,4,9,11,12,13,15,16,18,21,26,27,28,29,30,32,34,35 |
| alloy | 1,2,11,15,16,25,29,30,34 |
| carbon | 1,11,15,16,25,29,30 |
| stainless | 1,11,12,15,16,20,29,30,32 |
| tool | 2,9,13 |
| Superalloys | 5,11,13,20,21 |
| Tantalum | 1,2,5,8,12 |
| Thorium | 12 |
| Tin | 2,5,8,9,32,37 |
| Titanium | 1,2,5,6,8,9,10,11,12,16,20,27 |
| Tungsten | 1,2,5,12 |
| Vanadium | 1,12 |
| Zinc | 2,5,8,10,13,16,32,38 |
| Zirconium | 1,2,5,8,12 |
| All Metals and Alloys, not otherwise classified | 4,11,12,13,14,15,16,21,22,25,31,33,35,39 |

Properties Index—Continued

| Property | Source Number |
|--|---|
| Hardenability | 2,5,7,13,15,16,21,25 |
| Hardness | 2,3,4,5,7,8,9,12,13,15,16,17,20,21,22,25,28,32,34,35,36,37,38 |
| hot | 5,13 |
| Hydraulic and ring expansion test | 34 |
| Impact strength | 1,2,5,7,9,12,13,15,16,17,20,21,22,28,32,34,35,39 |
| Charpy | 7,9,12,15,16,25 |
| drop weight | 15,16,34 |
| Izod | 7,9,12,15,25 |
| Izod strength | See Impact strength |
| Mechanical properties (not otherwise classified) | 10,11,24,31,33,34 |
| Modulus | 21 |
| bulk | 14,28 |
| design curves | 11 |
| of Elasticity | 3,5,9,11,12,13,17,18,20,32,37 |
| of Rigidity | 1,11,17,20,37 |
| of Rupture | 12 |
| Young's | 14,28,38 |
| Notch Properties | 1,5,15,16,25,28,34, see also Toughness |
| Peel test | 39 |
| Poisson's ratio | 1,11,12,14,20,28,37 |
| Proof | |
| loads | 13 |
| strength | 8 |
| stress | 7,29,30 |
| test | 34,39 |
| Proportionality Limit | 11,17,37 |
| Propagation of Cracks | 15 |
| Punch Shear | 15,25 |
| Radiation Hardening | 34 |
| Reduction-of-Area | 2,4,5,7,9,12,13,15,16,18,21,25,28,29,30,35 |
| Rupture strength | See Effect of Temperature, Stress-Rupture Strength |
| Shear data | 1,3,5,7,11,12,13,15,16,17,25,37,38,39 |
| Sound velocity | 14,28 |
| Strain aging behavior | 13 |
| gage data | 34 |
| Strength coefficient | 18 |
| Stress | |
| concentration | 1,21 |
| corrosion | 2,9,13,15,25,39 |
| relaxation | 34 |
| rupture strength | 2,5,7,10,11,12,13,15,16,21,22,34 |
| strain curves | 1,9,11,15,25 |
| Tear resistance | 16 |
| Tensile strength | 1,2,3,4,5,7,8,9,11,12,13,15,16,17,20,21,22,25,26,28,29,30,32,35,36,37,38,39 |
| notched | 25 |
| Thermal shock resistance | 12 |
| Threshold stress intensity | 6 |
| Torque | See Torsion |

Metals and Alloys Index

| | Source Number |
|---|--|
| Aluminum | 1,2,3,5,6,8,9,10,11,12,13,15,16,18,20,27,32 |
| Bearing Alloys | 10 |
| Beryllium | 1,8,12 |
| Boron | 12 |
| Cadmium | 8,12 |
| Carbon | 12 |
| Chromium | 2,12 |
| Cobalt | 1,5,12,26 |
| Columbium (Niobium) | 1,2,5,12 |
| Copper | 2,5,8,9,10,13,16,17,24,32 |
| Gold | 2 |
| Graphite | 12 |
| Hafnium | 12 |
| Heat Resistant Alloys | 5,11,13,20,21 |
| Iron and its Alloys (other than Steels, q.v.) | 2,5,8,9,10,15,16,18,21,26,28,32 |
| cast | 2,10,15,16,32 |
| wrought | 16 |
| Lead | 2,5,8,9,10,32,36 |
| Magnesium | 1,2,5,8,9,10,11,12,13,16,32 |
| Manganese | 2 |
| Molybdenum | 1,2,8,12 |
| Nickel | 1,2,5,8,9,10,12,13,16,20,26 |
| Niobium | See Columbium |
| Platinum | 2,8 |
| Plutonium | 12 |
| Precious Metals | 2,5,8,9 |
| Rare Earth Metals | 12 |
| Rhenium | 2,5 |
| Silver | 2 |
| Sodium | 8 |
| Steels | 1,2,4,9,11,12,13,15,16,18,21,26,27,28,29,30,32,34,35 |
| alloy | 1,2,11,15,16,25,29,30,34 |
| carbon | 1,11,15,16,25,29,30 |
| stainless | 1,11,12,15,16,20,29,30,32 |
| tool | 2,9,13 |
| Superalloys | 5,11,13,20,21 |
| Tantalum | 1,2,5,8,12 |
| Thorium | 12 |
| Tin | 2,5,8,9,32,37 |
| Titanium | 1,2,5,6,8,9,10,11,12,16,20,27 |
| Tungsten | 1,2,5,12 |
| Vanadium | 1,12 |
| Zinc | 2,5,8,10,13,16,32,38 |
| Zirconium | 1,2,5,8,12 |
| All Metals and Alloys, not otherwise classified | 4,11,12,13,14,15,16,21,22,25,31,33,35,39 |

Properties Index—Continued

| Property | Source Number |
|----------------------------------|--|
| Torsion | 1,7,9,13,16,39 |
| Toughness | 6,15,16,18,22,25,28,34, see also Fracture, Reduction-of-Area |
| Transverse Fiber strength | See Bending Properties |
| Ultimate strength | 18 |
| Velocity | |
| of compressional waves | 14 |
| of shear waves | 14 |
| Vibration data | 39 |
| Weldability | 15 |
| Welded | |
| joint strength | 11,20 |
| structural beam properties | 16 |
| Workability | 15 |
| Yield strength | 3,4,7,9,11,12,13,15,16,17,18,20,21,25,28,29,30,32,35,38 |

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