

Jefferson's

WELDING ENCYCLOPEDIA

18th Edition



American Welding Society

Jefferson's
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Eighteenth Edition

Edited by
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Contents

Dedication.....	iii
Foreword.....	vi
Acknowledgments	vi
Preface	vii
Guide to Using the Encyclopedia	viii
Alphabetical Entries.....	1
Appendixes	615
1. History of Welding and Cutting.....	615
2. Major Associations of the Welding Industry	631
3. Master Chart of Welding and Allied Processes	634
4. Welding Test Positions.....	635
5. Types of Weld Joints.....	638
6. Weld Joint Preparation.....	639
7. Welding Symbols.....	642
8. Weld Discontinuities.....	644
9. Types of Weld Cracks	645
10. Torch Nomenclature	646
11. Weld Sizes.....	648
12. Joint Penetration	650
13. Safety	651
14. Metric Conversions.....	662
15. Elements—Chemical Symbols and Atomic Numbers.....	666
16. Standards for Welding, Cutting, and Allied Processes	667
17. Filler Metal Specifications.....	683
18. Recommended Eye Protection.....	685
19. Automatic Welding Programs.....	687
Buyer's Guide	689

Foreword

Jefferson's WELDING ENCYCLOPEDIA

The first four editions of The Welding Encyclopedia were published annually from 1921 through 1924 by L. B. MacKenzie. Mr. MacKenzie was given editorial assistance in this endeavor by H. S. Card. Both were on the staff of *The Welding Engineer*, a monthly publication of the Welding Engineer Publishing Company in Chicago, Illinois.

In his preface to the Fifth Edition in 1926, Mr. Card advised of the death of L. B. MacKenzie. The four editions from 1926 to 1932 were edited by Mr. Card, with Stuart Plumley succeeding him as editor for the 8th, 9th and 10th editions.

Ted Jefferson, by then a principal of the Welding Engineer Publishing Company, revised the Encyclopedia in 1943. He edited and published the 11th through 17th editions over a period of 33 years. Ted Jefferson died on July 6, 1988, at the age of eighty.

The American Welding Society has obtained publication rights for the Welding Encyclopedia. Because of Jefferson's long association with this book and his dedication to continuing its publication, we are changing the name of this book to *Jefferson's Welding Encyclopedia*.

The following is an excerpt from Ted Jefferson's Preface to the 17th Edition of the Welding Encyclopedia in 1976:

"In 1921 the coverage of welding involved a discussion of only three very basic processes used principally for maintenance or repair applications. Down through the years, the ever-changing and expanding field of welding has grown to include more than fifty welding processes, capable of joining a wide variety of materials."

In 1997, more than ninety welding and allied processes are listed in the literature, and the number continues to grow.

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ROBERT L. O'BRIEN
Editor

Preface

Eighteenth Edition

This edition represents a major revision of this encyclopedia, changing its orientation to the authoritative information base of the American Welding Society, and providing access to its resources.

Welding technology becomes more complex with every passing year, and has expanded to an extent that defies containment between the covers of a book. This encyclopedia presents as much information as is practical, but it is impossible to provide an exhaustive report on every welding process, variation, application, technique or material involved in the welding industry.

The Editor hopes Jefferson's Welding Encyclopedia will be a helpful resource to those who need authoritative welding information at their fingertips, and that it will be an effective starting point for those pursuing further scientific or engineering information. Following are some significant additions to the Eighteenth Edition:

Welding terms and definitions standardized by the American Welding Society are presented dictionary-style throughout the encyclopedia. They are identified by reference to Standard Welding Terms. Standard definitions are printed in italics.

Consensus standards, codes, specifications, recommended practices, classifications, methods, and guides for welding processes and applications documented by AWS are appropriately referenced. Standards of related organizations are referenced when applicable.

U.S. customary units are converted to the International System of Units (SI); conversion figures are appropriate to the application.

Nineteen appendixes have been included; most of these supply technical information from major American Welding Society documents. Appendix 1 contains historical notes of interest to the welding community.

A buyer's guide is provided; companies or organizations listed were exhibitors at the 1996 AWS International Welding and Fabricating Exposition in Chicago.

The primary editorial effort is directed to presenting new and updated material, although some of the basics of early welding processes are retained from previous editions, and much of the instructional material remains. An effort is made to meet the needs of persons associated with various areas of welding, and persons at many levels of expertise who are working with available equipment, old or new.

Most of the information available to the welding industry, and in this book, is the result of a continuous sharing of information involving every sector of the industry and spanning several generations. Contributors include research and development groups from manufacturers of welding equipment and consumables, universities, fabricators and job shops, as well as individual welders. All who are involved in the welding industry are grateful to those who have contributed and those who are continuing to develop and share technology. In that same spirit, we welcome comments, as well as contributions of further information.

ROBERT L. O'BRIEN
Editor

Guide to Using the Encyclopedia

The definition of an entry is presented in dictionary style. Terms and definitions standardized by the American Welding Society (AWS) are presented throughout the encyclopedia. Each AWS standard term is identified by reference to STANDARD WELDING TERMS. AWS standard definitions are printed in italics.

To find a specific consensus standard, code, specification, recommended practice, classification, method, or guide documented by AWS, refer to Appendix 16, Standards for Welding, Cutting, and Allied Processes. Refer also to the process, application, material or product involved. For example, to find standards or codes covering boilers, see BOILER CONSTRUCTION, as well as Appendix 16. To find AWS filler metal specifications, consult Appendix 17.

U.S. customary units are converted to the International System of Units (SI); conversion figures are appropriate to the application. For example, a postweld heat treat temperature of 1200°F converts exactly to 648.88°C, but the decimal figures are not meaningful. Therefore, the SI temperature is rounded off to 650°C. In critical cases, however, such as the melting point of an element or compound, the exact temperature in both scales is presented.

Appendixes 4 through 9, and Appendixes 11 and 12 have been designed to provide specific technical information about welds that is easy to find by consulting the appropriate appendix.

Welding and related processes are described in separate entries, for example, gas metal arc welding, laser beam welding, thermal spraying, or oxyfuel cutting. Refer also to the metal involved in a given project. Additional process information specific to the metal involved has been added to discussions under entries such as aluminum, cast iron, nickel, magnesium, and steel.

To use the Buyer's Guide, consult the product category, then refer to the alphabetical list of manufacturers and suppliers for a specific address, telephone or fax number. The Buyer's Guide is not all-inclusive; companies or organizations listed were exhibitors at the 1996 AWS International Welding and Fabricating Exposition in Chicago.

A

ABNORMAL GRAIN GROWTH

The formation of unusually large polycrystalline grains in a metal. This condition frequently occurs when a critical amount of strain (in the range of 2%) is present during heating to elevated temperatures.

ABRASION

A grinding action caused by abrasive solids sliding, rolling or rubbing against a surface; a scraped, ground, or worn area. Base plates are sometimes hardfaced to provide abrasion, or wear, resistance.

ABRASION SOLDERING

A soldering process variation during which the faying surface of the base metal is mechanically abraded. See STANDARD WELDING TERMS.

ABRASIVE

See GRINDING MATERIALS.

ABRASIVE BELT

A cloth or paper belt coated with abrasives used to rub, grind, or wear away by friction. The abrasive coating material may be sand or Carborundum, available in various grades and hardness factors.

ABRASIVE BELT GRINDER

A grinder which uses an abrasive belt for the removal of surplus material.

ABRASIVE BLASTING

A method of cleaning or surface roughening by a forcibly projected stream of abrasive particles. See STANDARD WELDING TERMS.

ABSORPTIONMETER

An instrument for measuring absorption of gases by liquids.

ABSORPTION BANDS

Dark bands in a spectrum produced by the selective absorption of light. The absorbing media are generally solids or liquids through which the light of the spectrum has been transmitted.

ABSORPTIVE LENS

A filter lens designed to attenuate the effects of glare and reflected and stray light. See STANDARD WELDING TERMS. See also FILTER PLATE.

AC or A-C

Abbreviation for alternating current. It is written *ac* when used as a noun and written as *a-c* when used as an adjective.

A-C ARC WELDING

An arc welding process using a power source that supplies an alternating current to the welding arc.

ACCELERATING POTENTIAL, Electron Beam Welding and Cutting

The potential that imparts velocity to electrons. See STANDARD WELDING TERMS.

ACCEPTABLE WELD

A weld that meets the applicable requirements. See STANDARD WELDING TERMS.

ACETONE

(C₃H₆O) A compound of carbon, hydrogen and oxygen; it is a volatile, flammable, liquid ketone used mainly as a solvent for such materials as resins, gums, oils, and cellulose.

Acetone is odorless and colorless; it evaporates rapidly. Acetone boils at 56°C (133°F). One liter of acetone weighs about 1 kg.

An important use for acetone is to stabilize acetylene gas. The safe, practical use of acetylene gas for welding and other applications would not be possible without acetone. Compressed acetylene itself is highly explosive; however, it can be safely compressed and stored in high-pressure cylinders if the cylinders are lined with absorbent material soaked with acetone. As a solvent agent for acetylene gas, acetone has an absorptive capacity of 25 volumes of acetylene per volume of acetone per atmosphere of pressure, or about 420 volumes of acetylene at 1724 kPa (250 psi) pressure.

Another important feature of the acetone-acetylene solution is that the exothermic properties of the