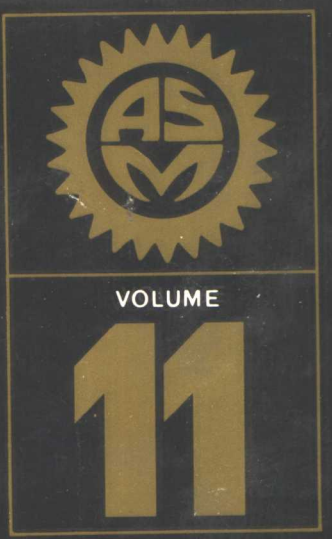

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EIGHTH EDITION

nondestructive inspection and quality control

American Society for Metals

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8th Edition

VOL. 11

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FOREWORD

TO MEMBERS of the American Society for Metals and to readers of METALS HANDBOOK throughout the world, publication of Volume 11, "Nondestructive Inspection and Quality Control", marks an auspicious and memorable occasion. For this volume not only completes the unprecedented 8th Edition, but does so by addressing subjects that many consider to be the foundations of product reliability, product standardization, and industrial vitality. And, in common with all preceding volumes, it does so by compiling the knowledge, experience and skill of hundreds of authorities in their respective disciplines.

The eleven volumes of this 8th Edition represent the largest single source of usable information on the technology of metals that has ever been compiled. Completion of this monumental reference warrants special tribute to the many whose dedicated efforts and support sustained this edition from inception through publication. Over the many years, the members of the American Society for Metals and the ASM Handbook Committee have been unstinting in their financial, technical and moral support. Scores of author committees, hundreds of other contributors and technical reviewers, and a devoted editorial staff have collaborated in this long-term venture to produce reference books that are both comprehensive in their coverage and of dependably high quality. The 8th Edition — all eleven volumes — is their enduring accomplishment. To all these men and women we extend our sincere appreciation, our heartfelt thanks.

ROBERT H. SHOEMAKER
President, ASM

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PREFACE

THE FOREWORD TO VOLUME 2, written when the 8th Edition of METALS HANDBOOK was planned for publication in five volumes, contains the statement, "When all five volumes of this new edition can be lined up side-by-side on a sturdy shelf, they will represent the largest single source of usable information on the technology of metals that has ever been compiled." Although the five-volume plan has been considerably exceeded (as publication of this, the eleventh and final volume in the 8th Edition, attests), the remainder of the statement was an accurate prediction.

The comprehensive coverage in Volume 11 of the subjects of nondestructive inspection and quality control again expands the scope of the 8th Edition to include topics that are without precedent in previous editions. Volume 11, as do the ten earlier volumes, emphasizes clear, reliable and objective presentation of useful technical information. Nowhere else can such a wide-ranging discussion of nondestructive inspection and quality control be found in a single book.

Inspection encompasses much more than measurement of dimensions or visual judgment of the appearance of a product. Inevitably, there is some vital characteristic of almost every manufactured part that cannot be measured directly without rendering the part unfit for use. Most of these vital characteristics, fortunately, can be measured indirectly or can be inferred from the measurement of some other characteristic. Often, such measurements can be made without harm to the part — that is, nondestructively.

Certain dangers, however, must be faced when indirectly assessing quality. For instance, indirect measurements require interpretation, which introduces a factor of human error usually not present when quality is measured directly. Also, there must be a known relation between the characteristic actually being measured and the quality feature that is important in service. Otherwise, nondestructive inspection provides information that has no meaning.

Nondestructive inspection usually implies a process for finding "defective" parts while avoiding damage to good parts. In this context, the word "defective" means failure to possess one or more of the specified quality characteristics — in other words, nonconformance to specifications. In recent years, the words "defective" and "defect" have often been interpreted as meaning unfit for service, and their use is declining in favor of terms such as flaw, imperfection, discontinuity and nonconformance. As used in this volume, all these terms are more or less synonymous, although "nonconformance" refers only to specified characteristics whereas the other terms are more general.

The aim of this volume is to present detailed technical information that will enable readers to select, use and interpret nondestructive methods for evaluating the quality of parts and assemblies that they make or use. It is not the intention of the authors or editors to say what characteristics are desirable or undesirable; that decision is up to the reader. Many of the undesirable "defects" that lead to failure in service are discussed in Volume 10 ("Failure Analysis and Prevention"). Volume 11 is a natural companion to Volume 10, for in order to prevent failure caused by the presence of a flaw, first the flaw must be found and then the flawed part must be repaired or be replaced by a flaw-free part.

Volume 11 is divided into three sections. The first section contains 17 articles and is devoted to various methods for nondestructively inspecting metal parts. Both common methods (such as hardness testing, radiographic inspection, and ultrasonic inspection) and unusual methods (such as inspection by optical and acoustical holography, inspection by neutron radiography, and thermal inspection) are described in detail. In addition to text, this 286-page section contains 684 illustrations, 52 tables of useful technical data, and 26 examples of industrial applications of specific inspection methods.

In the second section, 112 pages containing 309 illustrations and 61 examples describe the application of nondestructive-inspection methods to specific types of metal products for evaluation of quality. One-piece products (such as forgings, castings, bars, tubular products, fasteners, and powder metallurgy parts) and assemblies that have been welded, brazed, soldered or joined with adhesives are dealt with in this section.

The third section presents fundamentals of controlling and assuring product quality. The information in this section was prepared with the cooperation and assistance of the American Society for Quality Control. It covers both management concepts and operational procedures in sufficient detail to enable the reader to conceive, organize and put into operation a system for controlling product quality and for ensuring that quality objectives are being met on a continuing basis.

Three of the six pages of reference tables following the last article contain revised tables of hardness conversions for steel. These tables differ from those appearing in Volumes 1 and 2 chiefly in that (*a*) the new tables include Knoop hardness numbers, (*b*) the columns for estimated tensile strengths have been revised to reflect recent investigations and (*c*) a table has been added that gives conversions from Rockwell B hardness numbers to values on other hardness scales.

The subject matter discussed on the 424 pages of text in this volume is noteworthy not only for its variety but also for its detail. For example, one of the many items presented in the book-length article on radiographic inspection is a step-by-step procedure for making accurate radiographic exposure charts. All the major inspection methods — hardness tests, eddy-current and electromagnetic tests, magnetic-particle and liquid-penetrant inspection, radiography and ultrasonics — are discussed with a depth ordinarily expected only in textbooks and training courses.

Information that has never before appeared in print is contained in almost every article in the book. As an example, the concluding article, on reliability of flaw detection by nondestructive inspection, has not previously been available in published form. Using the principles described by the authors of this article, inspection reliability can be defined as a probability of finding any given quality characteristic, desirable or undesirable. To apply these principles, however, quality characteristics must be given in quantitative terms. No longer will phrases like "must be free of porosity" or "shall not contain any cracks" suffice for the description of required quality. The diameter of the smallest pore or the length of the smallest crack that is to be detected with a given probability and confidence must be defined in the quality specifications.

THIS VOLUME represents the collective effort of 167 experts in the field of nondestructive inspection. In all, more than 4500 individual contributors were involved in providing information for the 8th Edition. The American Society for Metals commends each and every one for their contributions. Each deserves the gratitude of the entire technical community. Thanks also is due to members of the editorial staff for their dedication to the pursuit of excellence — a legacy of the late Dr. Taylor Lyman, who was Editor of METALS HANDBOOK from 1945 to 1973.

But the work is not done; much of the technology that provided the basis for early volumes of the 8th Edition has changed since they were published. Already, work has begun on a 9th Edition, which will continue to keep pace with the ever-expanding technology of metals.

HOWARD E. BOYER
Editor – Metals Handbook

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