

## Overview

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Nondestructive testing (NDT), the examination of materials in ways that do not impair the intended uses of the materials, represents technology central to the concept of improved quality. Although the quality of materials, components, and products has always been important, it is clear that recent shifts in world trade and the growing awareness of the life-cycle costs of products has resulted in an increased appreciation of quality concepts and NDT. In order to achieve a better understanding of the role of NDT standards and their impact on world trade, ASTM Committee E-7 on Nondestructive Testing organized a three-day Symposium on Nondestructive Testing Standards II: New Opportunities for Increased World Trade Through Accepted Standards for NDT and Quality. The Symposium was held 9–11 April 1991 at the National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland, under the joint sponsorship of Committee E-7 and NIST, and in cooperation with the American Society for Nondestructive Testing and the American Welding Society. James Borucki, chairman of Committee E-7, served as General Chairperson of the Symposium.

This special technical publication (STP) presents peer-reviewed versions of most of the papers presented at the Symposium. The title of the book was changed from the Symposium title to *Nondestructive Testing Standards—Present and Future* during the editing process when it became evident that the authors of the papers, almost without exception, had provided us with knowledgeable projections of what we may expect to see in the way of new NDT standards in the years ahead. We feel that this aspect of the book may well represent its most unique value, coming at a time when American industry is focused on quality considerations and European Community standards are becoming an additional factor in international trade.

The book has been divided into four sections: (1) NDT Standards: The ASTM Program; (2) NDT Standards: NIST, DoD, ASME, SAE, ISO, EC; (3) NDT Personnel Qualification: Here and Abroad; (4) NDT Standards: Advanced Applications.

### **NDT Standards: The ASTM Program**

The standards development program of ASTM Committee E-7 is the largest and most comprehensive standards program for NDT in the country. It is appropriate, therefore, that the first section is devoted to this program.

The first paper, by Borucki, in addition to serving as a preamble to the symposium as a whole, provides an introduction to ASTM's NDT program. It describes the organization and operations of Committee E-7 and its excellent record of accomplishment in the development of NDT standards since its inception more than 50 years ago. Not content to discuss this sterling record, Borucki also discusses the ongoing efforts of the Committee to improve its operations in order to be even more responsive to industrial needs for NDT standards in the years ahead.

The next three papers address the Committee's work in radiologic NDT. Subcommittee E07.01 on Radiology (X and Gamma) Method evolved from an earlier committee on radiography that constituted one of the nuclei around which E-7 was originally established. As described by Graber, the longtime chairman of E07.01, this subcommittee has been extremely

prolific, constituting the foremost authority and source for radiographic NDT standards in the country. But the Subcommittee continues to keep ahead of industry's needs, continually seeking to develop documents that will facilitate the adoption and utilization of new technologies such as radioscopy, computed tomography, and the special techniques needed for effective examination of composite materials.

In the next paper, Jones and Goldspiel describe the use of reference radiographs to assist in the interpretation and evaluation of radiographic images. They review the sets of reference radiographs which have been developed by and for Subcommittee E07.02 on Reference Radiographs and which are disseminated by the Society, and then go on to discuss the challenges which the future holds for this essential activity, e.g., composites, ceramics, and exotic alloys which exhibit different radiographic characteristics, and advanced radioscopy imaging systems in which radiologic interpretation is performed using video displays rather than traditional film viewers.

Committee E-7's program to develop standards for radiologic NDT is not limited to X- and gamma-ray radiology. In the next paper, Brenizer discusses the activities relating to neutron radiology. He reviews the basic physics of the method and describes the existing ASTM standards on the subject and the new standards under development, their benefits to industry, and the ongoing efforts to promulgate similar documents through the International Organization for Standardization (ISO).

Perhaps the most commonly used NDT methods are those used to detect surface flaws, namely, liquid penetrant testing and magnetic particle testing. ASTM's program to develop standards for these methods is described by Fenton, the chairman of Subcommittee E07.03 on Liquid Penetrant and Magnetic Particle Methods. He points out that the traditional output of the activity, i.e., standard guides, standard practices, and reference photographs, will soon be supplemented by *specifications* which the Subcommittee is now preparing. These new documents parallel respective military specifications and are expected to replace them in accordance with the Defense Department's policy to adopt nongovernment standards and specifications in lieu of military documents wherever possible.

The next paper traces the historic development of ultrasonic techniques for NDT. In it, VanValkenburg, chairman of Subcommittee E07.06 on Ultrasonic Method during its most productive period, shows how the ultrasonic testing standards developed in this and other ASTM committees and elsewhere have paralleled the technology for more than four decades and continue to do so now, addressing topics such as the detection of intergranular stress-corrosion cracking and the computerized transfer of ultrasonic test data.

One of the newer NDT methods, acoustic emission testing, is discussed by Jolly in the next paper. He reviews the development of the technology and outlines its areas of application before describing the standards—including test methods, practices, and guides—that have been prepared by Subcommittee E07.04 on Acoustic Emission Method and other organizations. This discussion is followed by a summary of the new standards, presently under development, that address emerging topics such as acousto-ultrasound.

McEleney's paper on electromagnetic (eddy current) testing begins with an extensive summary of the basic principles and applications of this NDT method before proceeding into a discussion of the different types of standards that have been developed and the various product forms for which they are useful. As longtime chairman of Subcommittee E07.07 on Electromagnetic Method, McEleney also includes an interesting review of the Subcommittee's history, which leaves the reader with an enhanced appreciation of many of the Subcommittee's documents and how they were developed.

Subcommittee E07.10 on Other NDT Methods was established by McClung to serve as a home within Committee E-7 for standards activities on emerging or other NDT technologies that are not individually large enough to justify an independent subcommittee. He describes

the program of the Subcommittee and the standards which it has developed, conveying the excitement that comes from harnessing—by means of standards—some of the newer NDT methods and related technologies.

Unlike the other technical subcommittees of Committee E-7, Subcommittee E07.09 on Nondestructive Testing Laboratories does not address a specific NDT method or methods. Rather, it is concerned with the administrative and operational requirements of a qualified NDT laboratory. In the next paper, Plumstead and Jaycox describe the standards which this subcommittee has developed and some of the rationales upon which they are based. They succeed in generating an appreciation for the value of such standards as well as for the enormous difficulties involved in their development.

The last paper in this section of the book was not part of the symposium upon which this STP is based. Rather, it was presented at an earlier ASTM symposium dealing with the standardization of technical terminology. However, the paper is included here because it addresses an important aspect of Committee E-7's standardization program for NDT, namely, the development of standard terminologies. In the paper, McKee describes the process which was used to combine separate glossaries, each dealing with a single NDT method, into a single, consistent, terminology compilation for all of Committee E-7's documents. The process was actually completed after the paper was prepared; the result is ASTM E 1316: Terminology for Non-destructive Evaluations.

### **NDT Standards: NIST, DoD, ASME, SAE, ISO, EC**

The second section of this volume is devoted to NDT standards development activities outside of ASTM. The first paper, by Birnbaum, Eitzen, and Mordfin, surveys the NDT standards developed at NIST (formerly the National Bureau of Standards) since the previous ASTM Symposium on Nondestructive Testing Standards in 1976. NIST's standards are primarily measurement standards, as opposed to the documentary standards developed by ASTM and others, and this paper delves into the theoretical and experimental bases of the standards.

The Defense Department's standards development program for NDT is described in the next paper by Strauss. This program involves close collaborations between the Department, NIST, and various nongovernment standards-writing organizations, including ASTM and SAE. Strauss describes the process used to adopt nongovernment standards in lieu of military standards and the criteria which the nongovernment documents must meet in order for them to be acceptable to the DoD. The paper also addresses NDT standardization activities in JANNAF (the Joint Army-Navy-NASA-Air Force Interagency Propulsion Committee) and in some international military organizations such as NATO and ABCA.

The evolution of NDT requirements and standards in the ASME Boiler and Pressure Vessel Code is the subject of the next paper by Spanner. He describes the manner in which ASME Code rules are organized and the interrelationships between the several Code sections, the piping codes, and ASTM standards. Particular attention is focused on the significant changes in the Code relative to NDT that took place during the 1980s, and projections and trends for the 1990s.

The development of NDT standards for the aerospace industry is a particular function of Committee K in the Aerospace Materials Division of SAE International. As described by Cooper and Nethercutt, these documents, called Aerospace Materials Specifications, address various NDT methods and materials and are acquiring greater importance in light of the Defense Department's policy, cited above, of replacing military standards and specifications, where possible, with nongovernment consensus standards. The authors trace the history and the organization of the Committee and outline its plans to expand its efforts in order to better cover all of the major NDT methods.

The final two papers in this section address international standards for NDT. The paper by Mordfin briefly describes the process for developing standards which is used by ISO and the manner in which the United States participates in this process. The role of international standards in international trade and the importance of having international standards that are consistent with the practices of American industry are stressed, and a plea is made for greater support, from both government and industry, for enhanced U.S. participation in the development of international standards for NDT.

As part of the European Community's plan to become a single market by the end of 1992, an intensive effort is underway to harmonize the existing national regulations of the various countries in order to eliminate some barriers to trade. As described by Borloo, this effort is carried out under the European Committee for Standardization, in which one technical committee has been established specifically to focus on NDT, and another, on welding, which also addresses NDT issues. The paper reviews the organization and the program of work of these two technical committees. Borloo makes the point that, in the development of European standards for NDT, the technical committees consider documents of non-European origin (e.g., ASTM) as well as those from the European national standardizing bodies.

This section of the book concludes with a report, by Spanner, on a panel discussion that was held during the Symposium.

### **NDT Personnel Qualification: Here and Abroad**

Because standards for NDT personnel qualification are different from standards for NDT methods, and because the subject of NDT personnel qualification and certification has generated enormous interest—and controversy—in recent years, a separate section of this book was assigned to this topic. Two papers are included. In the first, Wheeler reviews the status of NDT personnel qualification and certification from the point of view of various U.S. organizations and practitioners and compares this with the practices of some other countries. He also presents some interesting results of a survey to evaluate the spectrum of current U.S. attitudes on the subject and concludes that an international standard on NDT personnel qualification that is generally acceptable to the United States as well as to most other nations is now realistically achievable.

The ISO effort to develop such a standard is the subject of the next paper. In it, Zirnhelt describes the need for the standard and traces the historical background of the effort, including the various meetings and ballots which have served to narrow differences and approach consensus among the member countries. In keeping with his role as the chairman of the effort, he goes on to discuss, in a nonpartisan way, the influence of the European Community on the development of the standard and the national implications of such a document. The paper concludes with a review of some of the standard's more contentious issues and a glimpse at some of the related challenges that still lie ahead.

### **NDT Standards: Advanced Applications**

The final section of the book deals with NDT standards for advanced applications. The first paper, by Berger and Hsieh, addresses the challenging need for standards to facilitate the transfer, exchange, and combination of data from computerized NDT equipment. Related documents are reviewed, and progress toward the development of the needed standards is described.

Most of today's NDT standards were developed with metals in mind, whether consciously or not. However, these standards will not be adequate for the high-temperature materials needed for tomorrow's automotive gas turbines and various aerospace applications. These

applications and others like them will likely require structural ceramics and complex composite materials with stringent NDT needs that exceed current capabilities. Examples of these needs include the reliable detection of flaws less than 100  $\mu\text{m}$  in size, and high-definition imaging systems. In an extremely thorough and well-documented paper, Vary elaborates on these and other needs and discusses the standards that ASTM must begin to address.

The next paper deals with an advanced application of NDT standards, rather than NDT standards for an advanced application. Based largely on his own observations, Plumstead describes the excessive and long-term costs to the construction industry that result from the all-too-common practice of using unqualified NDT subcontractors to perform the required nondestructive examinations. In response to this deficiency, he presents a thoughtful proposal for a system that would require prequalification of NDT subcontractors to ASTM E 543: Practice for Determining the Qualification of Nondestructive Testing Agencies, and other standards.

The last paper in the book is concerned with the problems involved in magnetic particle testing when inspection must simultaneously satisfy standards of different countries or organizations. As an approach to easing such difficulties, Stadthaus presents here a review of a new German guide which provides comparisons and comments on several important national and international standards for magnetic particle testing.

This volume, which provides a comprehensive review of NDT standards from many points of view, serves as a valuable update to the NDT standards review symposium held in 1976. That symposium, the proceedings of which were published in ASTM STP 624, represented a serious effort by the NDT community to examine its standards to see if there were topics that had not been satisfactorily addressed. One of the results was greater attention being paid, in the ensuing years, to requirements for quantitative NDT measurements. In the present symposium, the pervasive global thinking seemed always to move the focus from the current status of NDT standards to the needs of the future and the increasing role that NDT standards will play in world trade. It is the hope of the symposium organizing committee and the symposium sponsors that these papers will serve to provide useful guidance and direction to our continuing efforts to develop new and improved NDT standards and thereby enhance our capabilities for NDT measurements and the quality of our products.

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