PERSONNEL TRAINING

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VISUAL TESTING

VT

CLASSROOM TRAINING BOOK

The American Society for Nondestructive Testing

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CLASSROOM TRAINING BOOK

Written for ASNT by:

Dietmar F. Henning

Level III Service LLC

The American Society for Nondestructive Testing

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ASNT Mission Statement:
ASNT exists to create a safer world by advancing scientific, engineering, and technical knowledge in the field of nondestructive testing.

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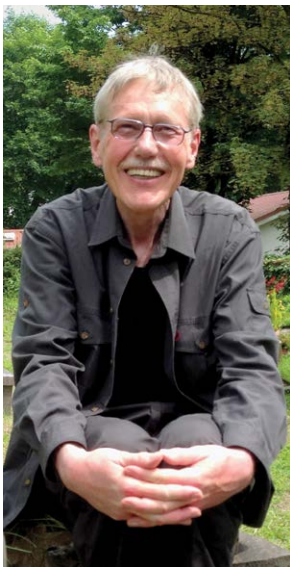
About the Author



Dietmar F. Henning graduated in 1975 with a master's degree in Chemical Engineering from the Technical University of Darmstadt, Germany, where he prepared his Ph.D. thesis in 1979. During his first series of jobs in the chemical industry, he became acquainted with NDT. After taking several Level III classes at the German Society for NDT (DGZfP), he found employment in 1983 with LVZ, an NDT service company and training center. As their classes were mostly focused on U.S. standards, in 1986 Henning went to Columbus, Ohio, to take the ASNT Level III examinations, which he passed in six methods. He has been a member of the Certification Management Council, as well as the IR, ET, VT, UT, RT, PT, LT, ML, and MT Committees. In addition he has worked on the Handbook Development Committee, in particular toward development of the fourth edition of the *Leak Testing Handbook*. Henning is also a member of the *Materials Evaluation* Committee, where he serves as an associate technical editor. Henning maintained his relationship with ASNT when he formed his own business, VECTOR, in 1989.

As a German delegate, Henning served in several European and ISO standard committees for personnel certification in NDT, visual testing, and thermography. In 1993, the European NDT certification system (EN 473) was initialized, and Henning founded his own Certification Body, SECTOR Cert. The company provides ISO certifications for several industries in a multitude of countries, such as Germany, Czech Republic, Turkey, and the United States. Henning sold his company in 2007 and retired in 2010. At that time, he immigrated to the United States where he worked part-time for Central Piedmont Community College (CPCC) in Charlotte, North Carolina. Henning is married to a U.S. citizen and became a U.S. citizen himself in 2015.

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Foreword

Purpose

The American Society for Nondestructive Testing, Inc. (ASNT) has prepared this series of Personnel Training Publications to provide an overview in a classroom setting of a given nondestructive testing method. Each classroom training book in the series is organized to follow the body of knowledge found in *ANSI/ASNT CP-105: ASNT Standard Topical Outlines for Qualification of Nondestructive Testing Personnel* (2016). Level I and Level II candidates should use this classroom training book as a preparation tool for nondestructive testing certification. Note, however, that an NDT Level I or Level II may be expected to know additional information based on industry or employer requirements.

Supplementary Material

Although the classroom training book may be purchased and read as a standalone product, it is intended to be used in conjunction with the Lecture Guide and PowerPoint™ presentation for instructors and Student Guide for students. These guides contain a condensed version of the material in the classroom training book and quiz questions per chapter (lesson) for review purposes.

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Preface

Visual testing (VT) is a diverse NDT method. Applications are manifold; many are simple and need almost no training, whereas some are complex and hard to learn. Imagine a technician in a manufacturing facility who uses his or her naked eye to look for discontinuities on the outer surface of tubes. This is a relatively simple task, which requires several hours of mostly practical training. Compare this with a visual technician in a nuclear plant who has to look inside a tube in a high-radiation area. A lot of classroom training hours, on-site training, and experience will be necessary to do this job properly. Depending of the specific application, the training program and the necessary number of training hours can be very different.

Readers may question what distinguishes a Level I topic from a Level II topic. In large part, the organization of this book follows the sequence for visual testing in *ANSI/ASNT CP-105*: *ASNT Standard Topical Outlines for Qualification of Nondestructive Testing Personnel* (2016). Keep in mind, however, that the content that has been put under Level I (chapters 1-7) does not necessarily address Level I applications for every company. Thus, the decision was made to focus on VT during manufacturing, including typical discontinuities, in chapters 5 and 6 (Level I), whereas inservice applications, including associated discontinuities, are located in chapter 12 (Level II). This might be adequate for most technicians in an NDT service company, but NDT personnel employed at a foundry or a nuclear facility may require additional information. With regard to employer certification, a Level I is whatever the employer defines as such in the certification procedure, referred to as the *written practice*. The employer is fully responsible for this program. Thus, the responsible Level III should select from this book whatever is determined to be adequate for personnel qualifying to Level I or II.

Historically, the certified welding inspector (CWI) program of the American Welding Society dominated the perception of what a VT technician should know. Although this central certification program is focused on a limited number of special applications, it is widely used in the welding industry. However, it is not applicable to the numerous applications outside of welding. This book tries to cover more industries (without claiming to be exhaustive), as well as give guidance for the VT of welds and products other than welds and for inservice examination. The examples provided, however, cannot cover all imaginable applications. Therefore, where this book describes certain techniques only generally, employers (users) should add their specific procedures to set up their certification program.

Today, one-third of ASNT's members live and work outside of the U.S. Therefore, a classroom training book should consider industrial practices and specialties with regard to international standards. For the most part, there are no major differences or contradictive practices in the VT of globalized industry. However, a difference between what is defined as *direct visual examination* and *remote visual examination* should be mentioned. The European standard EN 13018 calls all techniques "direct" wherein the light from the examined surface travels to the observer's eyes without interruption. An interruption would clearly be the use of a digital camera, which converts light into electric signals and vice versa. This would be called *remote visual testing*. Likewise, *ASME Boiler & Pressure Vessel Cod*e, Section V, Article 9, defines direct visual examination as a "technique performed by eye and without any visual aids."

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ASME defines remote visual examination (VE) as a "VE technique used with visual aids for conditions where the area to be examined is inaccessible for direct VE." This definition implies that the use of borescopes that transport light by lenses or fibers could constitute a remote examination. In ASME, we find, however, a third definition of *enhanced visual examination*: a "VE technique using visual aids to improve the viewing capability." This includes magnifying aids, borescopes, video probes, fiber optics, and so forth. It is obvious that the ASME and European definitions do not match fully. Additional inconsistencies can be found when consulting more standards and literature. For example, the *ASNT Handbook: Visual Testing* uses the term *indirect VT*.

After a multitude of discussions with people in the NDT community, it was decided to use the following terms for the purpose of this book:

- **Direct Visual Testing**: VT applying no visual aids except mirrors and magnifiers.
- **Indirect or Remote Visual Testing**: VT using aids for enhanced vision including borescopes as well as equipment that is remotely driven because the area examined is inaccessible.

The user should consult the applicable standard for the wording that is deemed adequate in a specific application.

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