

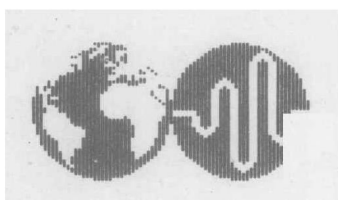
Non-Destructive Testing

Vol.1

Non-Destructive Testing

Volume I

Proceedings of the 12th World Conference on
Non-Destructive Testing, Amsterdam, The Netherlands,
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edited by

J. Boogaard and G. M. van Dijk



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FOREWORD

These "Proceedings of the 12th WCNDT" represent the bulk of the technical material presented during the five days of the conference. Because the proceedings are compiled from preprints, it did put high pressure on authors to prepare their contributions far in advance of the conference date. Nevertheless, the majority sent us their papers in time and the editors are very grateful for their collaboration.

The resulting two volumes cover a total of over 400 papers, giving a rather complete overview of the technical material presented. Although technically and application oriented papers predominate, many contributions about aspects such as reliability, quality assurance, management of NDT, education, qualification and certification, and application and organization of NDT in newly industrialized countries are included.

Proceedings of large conferences such as the WCNDT tend to consist of many rather unrelated and differently styled pieces. Here too, this is unavoidable with so many different authors, subjects, viewpoints and interests. The editors aimed for the proceedings to serve a dual purpose, as a guide during the conference days, providing more detailed technical information than available in the abstract book, and as a book of reference during days and years after the conference. To allow convenient access to the information for both purposes the contents of technically oriented sessions and poster clusters on related subjects are grouped into chapters. The sequence of contributions in a particular session or poster cluster has been kept.

In addition several indexes are provided. Aside from the author index subject indexes are included, using the classification for "technique", "field of application" and "topic" the authors themselves originally conferred upon their submitted contributions. In the indexes the key indications are arranged in order of resp. technique, application and topic.

The two volumes contain work and opinions of many well-known and leading NDT people from major industries, service companies, manufacturers and research and training institutes. The high quality of the papers, the technical level and the state of the art guarantees their usefulness, for some as a mirror to reflect and compare their own ideas, for others as a guideline how to start or to proceed.

The Editors hope and trust that these proceedings will be of value for many years and will contribute to a high standard of safety and environmental care all over the world.

J. Boogaard, Chairman Scientific Committee 12th WCNDT

PREFACE

Dear delegates,

We are very pleased to welcome you to the 12th World Conference on Non-Destructive Testing in Amsterdam, hosted by KINT (Dutch Quality Surveillance and Non-Destructive Testing Society).

When thinking of Holland, Dutch masters, tulips, cheese, wooden shoes and polders probably first come to mind. And, of course, the Dutch are very proud of their rural tradition and of the land reclaimed from the sea. But times are changing and industry has taken over as the motor of the economy. As in painting and agriculture the quality of the product is our first concern. In this densely populated country there is also a pronounced interest in the safety of installations and in the preservation of the environment.

A fine example of our concern with safety as well as human environment may be seen in the Delta Works, the dikes and technical installations protecting the river delta Zeeland against the sea. Here too, the natural environment of the Oosterschelde, including the traditional oysters and mussel breeding beds, is preserved with a half open dam that is closed in case of a storm. Technology and preservation of our human environment prove to go along very well. You will not be surprised to find a session on "NDT applications in civil engineering" in the conference program.

The organisation of this World Congress was made possible by the members of KINT and the support of various institutes and industries. We feel confident that with more than 500 papers and an excellent exhibition the congress will have something of interest to offer to all delegates. We are ready to serve you and hope to have contributed thereto by organizing this world encompassing NDT event.

KINT membership is rooted in the Dutch chemical, petrochemical, steel, aerospace and nuclear and electricity supply industries and, of course, in the universities, research institutes, NDT service companies and equipment suppliers.

We hope that the 12th WCNDT will broaden and deepen your NDT interest, will extend your personal contacts with international colleagues and will earn a special place in your memories, next to the wind-mills and any other Dutch experiences.

G.M. van Dijk, president ICNDT/12th WCNDT
president KINT.

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SUBJECT INDEXES

To facilitate the retrieval of information, three subject indexes, resp. the "Techniques", the "Applications" and the "Topics" index have been compiled. Key items are the classification which authors themselves conferred upon their contributions. To find e.g. the contributions concerning "ultrasonic inspection techniques in nuclear industry", the "Techniques Index" has to be searched for the Technique key item "ultrasonic" and the Application (AP) key item "nuclear industry".

The codes used for the classifications of "Techniques (TE)", Application (AP) and "Topics (TO)" are listed below.

TECHNIQUES

AC Acoustics
 AE Acoustic Emission
 AL All techniques
 EL Electric
 ET Eddy current
 MA Magnetic
 OT Other techniques
 OU Optical and ultraviolet
 PT Penetrant
 RA Radiation
 RT Radiography
 TI Thermal and infrared
 UT Ultrasonic
 VI Visual

Field of APPLICATION

AL All applications
 AS Aerospace
 BS Bonded structures
 CC Concrete
 CE Ceramics
 CI Civil structures
 CO Composites
 ED Education and training
 MA Manufacturing of products
 MI Mining
 MR Materials research
 NU Nuclear industry
 OM Other materials
 OS Off-shore
 OT Other applications
 PI Petrochem., chem. process industry
 SA Steel and alloys
 WE Welds

TOPICS

1 Corrosion
 2 Cracks
 3 Material degradation
 4 Leak detection
 5 Stress, strain
 6 Material characterization
 7 Defect characterization
 8 Quality control
 9 Microstructures
 10 Microscopy
 11 Automation
 12 Imaging, data presentation
 13 Image analysis
 14 Signal processing
 15 Tomography
 16 pattern recognition
 17 Intelligent vision systems
 18 Expert systems
 19 Trend analysis
 20 Mathematic modelling
 21 Sensors
 22 Instrumentation
 23 In-service inspection
 24 Condition monitoring
 25 Fitness for purpose
 26 Design for inspectibility
 27 Round robin tests
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