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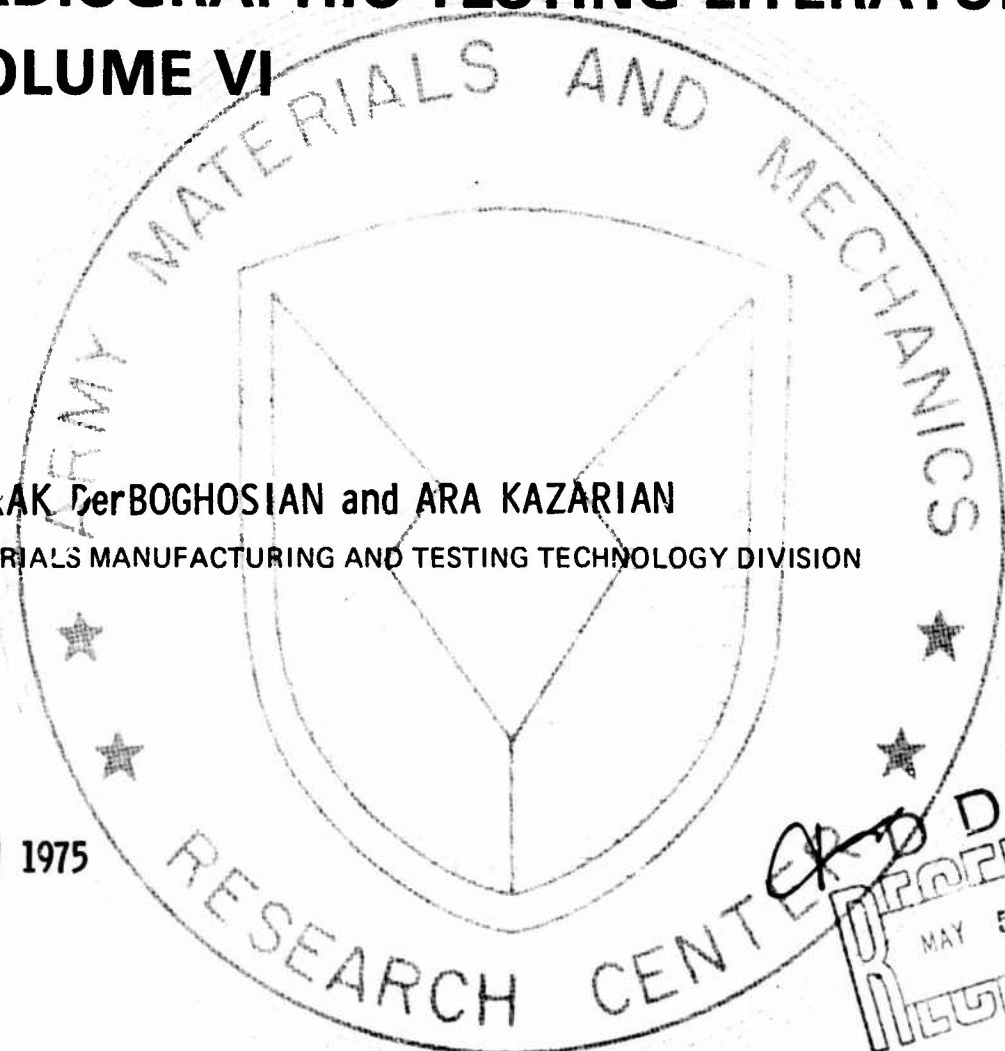
A REPORT GUIDE TO RADIOGRAPHIC TESTING LITERATURE - VOLUME VI

SATRAK DerBOGHOSIAN and ARA KAZARIAN
MATERIALS MANUFACTURING AND TESTING TECHNOLOGY DIVISION

April 1975

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ARMY MATERIALS AND MECHANICS RESEARCH CENTER
Watertown, Massachusetts 02172



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PREFACE

The literature survey contained herein has been prepared by the U. S. Army Materials and Mechanics Research Center (AMMRC) and is the sixth volume of a series on radiographic testing. Through necessity, a series of volumes has been planned because of the large amount of literature available in the field of radiography. The volumes will be published as compiled and will appear to be chronological since the oldest publications generally are contained in Volume I, etc. All items included in this volume have been taken from the holdings of the Department of Defense Nondestructive Testing Information Analysis Center (NTIAC) which is housed, staffed, and maintained at AMMRC.

The publications and articles documented herein are in some way related to radiographic testing, hence the use of certain seemingly unrelated descriptors. For the sake of completeness, each item is described by a profusion of descriptors to insure complete and accurate coverage of the subject matter.

The intent of this publication is to make available, under one cover, an exhaustive literature survey of the subject matter. By means of these report guides, items of interest may be rapidly and easily retrieved by industrial and scientific users.

Input to the NTIAC is accomplished by obtaining information from all leading and recognized sources such as the Defense Documentation Center (DDC); NASA; Engineering Index; foreign translations; numerous books, technical journals, etc. Many of the items listed have been taken from reports currently on file at AMMRC, while others may have been taken directly from abstract cards on the subject matter supplied by DDC, World Information Files, etc.

Special thanks go to the Documentation Service of the American Society for Metals, Metals Park, Ohio, and the Engineering Index, Inc., 345-47th Street, New York, New York for their kind and generous permission to reproduce their abstracts. The following copyright holders are also thanked for their courtesy in granting reproduction rights:

American Society of Mechanical Engineering
Brutcher, Henry
Forest Products Journal
Iron Age
Journal of Applied Physics
Magnafacts
Materials Evaluation
Materials Research and Standards
Metal Treating
Modern Castings
Nuclear Science and Engineering
Oil and Gas Journal
Steel
Test Engineering and Management
Welding Engineer
Welding Journal

This project has been accomplished as part of the U. S. Army Materials Testing Technology Program, which has for its objective the timely establishment of testing techniques, procedures or prototype equipment (in mechanical, chemical, or nondestructive testing) to insure efficient inspection methods for materiel/material procured or maintained by AMC.

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INTRODUCTION

Where available, each item in this publication consists of the following information: (1) item, report, or article title, (2) author or authors, (3) source or facility, (4) report number or identification, (5) date and (6) abstract.

Word descriptors pertinent to each item are listed in alphabetical order and are cross referenced by the AMMRC identification number. Also provided is an author index or, if no author is available, then the issuing organization is listed.

OBJECTIVE

The main objective of this compilation is to provide a simple and fast access to information on the subject of radiographic testing and also to provide sufficient information in the form of abstracts and word descriptors to make the listing useful.

SCOPE

This guide is Volume VI of a series of planned report guides consisting of the complete coverage of items in the Department of Defense Nondestructive Testing Information Analysis Center covering the subject of radiographic testing. Subsequent volumes will be published as the work load permits.

The following is a list of report guides previously published by the Department of Defense Nondestructive Testing Information Analysis Center. The guides may be obtained from the National Technical Information Service, Springfield, Virginia 22151.

AMRA MS 64-10	<i>A Report Guide to Autoradiographic and Microradiographic Literature</i> , August 1964, AD-612 047
AMRA MS 64-11	<i>A Report Guide to Gamma Radiographic Literature</i> , August 1964, AD-612 042
AMRA MS 64-12	<i>A Report Guide to Liquid Penetrant Literature</i> , August 1964, AD-612 044
AMRA MS 64-13	<i>A Report Guide to Literature in the Fields of Fluoroscopy and Remote Viewing</i> , August 1964, AD-612 045
AMRA MS 64-14	<i>A Report Guide to Thermal Testing Literature</i> , August 1964, AD-612 043
AMRA MS 65-03	<i>A Report Guide to Electromagnetic Literature</i> , April 1965, AD-615 346
AMRA MS 65-04	<i>A Report Guide to Magnetic Particle Testing Literature</i> , June 1965, AD-617 758
AMRA MS 65-09	<i>A Report Guide to Ultrasonic Attenuation Literature</i> , December 1965, AD-627 565

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|----------------|---|
| AMRA MS 66-02 | <i>A Report Guide to Ultrasonic Testing Literature, Volume I,</i>
March 1966, AD-630 652 |
| AMRA MS 66-05 | <i>A Report Guide to Ultrasonic Testing Literature, Volume II,</i>
June 1966, AD-638 749 |
| AMRA MS 66-11 | <i>A Report Guide to Ultrasonic Testing Literature, Volume III,</i>
December 1966, AD-648 905 |
| AMRA MS 67-03 | <i>A Report Guide to Ultrasonic Testing Literature, Volume IV,</i>
April 1967, AD-650 279 |
| AMRA MS 67-06 | <i>A Report Guide to Ultrasonic Testing Literature, Volume V,</i>
June 1967, AD-660 790 |
| AMMRC MS 67-03 | <i>A Report Guide to Radiographic Testing Literature, Volume I,</i>
December 1967, AD-664 780 |
| AMMRC MS 67-05 | <i>A Report Guide to Fatigue Testing Literature,</i> May 1967, AD-652 881 |
| AMMRC MS 68-02 | <i>A Report Guide to Radiographic Testing Literature, Volume II,</i>
February 1968, AD-667 400 |
| AMMRC MS 68-08 | <i>A Report Guide to Radiographic Testing Literature, Volume III,</i>
AD-676 835 |
| AMMRC MS 69-03 | <i>A Report Guide to Ultrasonic Testing Literature, Volume VI,</i>
April 1969, AD-689 455 |
| AMMRC MS 72-4 | <i>A Report Guide to Radiographic Testing Literature, Volume IV,</i>
June 1972, AD-749 258 |
| AMMRC MS 72-3 | <i>A Report Guide to Thermal Testing Literature, Volume II,</i>
April 1972, AD-740 654 |
| AMMRC MS 73-5 | <i>A Report Guide to Radiographic Testing Literature, Volume V,</i>
December 1973, AD-772 929 |

USAGE

All word descriptors included in this guide are listed in alphabetical order and are cross referenced to the AMMRC report identification number. Also listed is an author index, or, if no author name is available, then the issuing organization is listed. Users have only to refer to those descriptors that they are concerned with at the time and read only those abstracts which the descriptor cross references.

The abstracts normally refer the reader to the source where the complete report may be obtained.

ABSTRACTS

AMMRC IDENTIFICATION NUMBER

5002 X-RAY FLUOROSCOPY OF MOVING OBJECTS BY MEANS OF ELECTRON-OPTICAL CONVERTERS

S. T. Nazarov

The Bouman Technical College in Moscow; Translated from *Zavodskaya Laboratoriya*, Vol. 29, No. 10, Oct. 1963; *Industrial Laboratory*, Vol. 29, No. 10, April 1964

This paper reports on the studies conducted on the use of electron-optical converters to determine resolution of defects in aluminum and steel while in motion.

5011 X-RAY DIFFRACTION STUDY OF PLASTICALLY DEFORMED COPPER (AD-609 189)

C. N. J. Wagner, J. P. Boisseau, E. N. Aqua

Hammond Lab., Yale University, New Haven, Conn., Technical Report No. 12, ONR Contract 609(43) Sept. 1964

Purpose of this study was to perform a detailed X-ray analysis on a bulk specimen of fcc metal temperature and on powder of the same material deformed by compaction, and to compare these results with those previously obtained on cold worked filings.

5021 FUEL UNIFORMITY IN SANDWICH PLATES

P. DeMeester, M. J. Brabers, R. Deknock

S.C.K./C.E.N.-Mol, Belgium, *British Journal of NDT*, Dec. 1964

A discussion of beta-gamma scanning as a means of testing fuel plates for uniformity after rolling. Measurement of gamma and beta emission simultaneously gives information on total fuel content and cladding thickness.

5022 DEVELOPMENT OF REFERENCE RADIOGRAPHS FOR HEAVY-WALLED STEEL CASTINGS (AD-450 522)

S. Goldspiel

U. S. Naval Applied Science Lab., Naval Base, Brooklyn 1, N. Y.

This report describes work on the development of Reference Radiographs for heavy-walled steel castings, conducted in cooperation with the American Society for Testing and Materials. Two sets of steel plate castings, i.e., of 3" and 6" thickness, were selected to develop reference radiographs showing representative discontinuity types of graded severity levels for use as standards of acceptance of production castings with section thicknesses up to 12" in two ranges, i.e., 2 to 4½" and 4½ to 12", respectively. For each thickness range a prototype set of radiographs is presented for one of several applicable sources of radiation, together with the text material accompanying or planned to accompany the related ASTM Document. Recommendations are made on the use of the new Reference Radiographs consistent with existing Navy specifications. Work needed to publish the references in quantity is outlined.

5027

FILM PACKAGE SPEEDS X-RAYING OF HEAVY METAL SECTIONS

Iron Age, April 30, 1964

This article describes a film package essentially consisting of a dispenser, with an internal film sealing machine. As the film is pulled from the dispenser it is automatically sealed between lead foil, is light-tight and flexible. The film package can be cut into any desired length with scissors.

5028

X-RAY UNIT SPEEDS SCRAP ANALYSIS

The Iron Age, April 23, 1964

This article describes a new x-ray spectograph used to sort scrap steel for fast analysis of shipments. Results are obtained now in 7 to 12 minutes.

5029

X-RAYS RECORD COATING WEIGHTS

The Iron Age, April 16, 1964

An x-ray gage with 2 sensing heads now measures the weight of tin coated on steel strip to prevent overplating. Instrumentation is described.

5030

X-RAY "MIKE" READS STRIP THICKNESS

The Iron Age, April 9, 1964

An x-ray micrometer has been teamed with a non-contracting optical width scanner of an 86 inch wide hot strip mill. Results show a complete record of the width and the thickness of each length of rolled strip. Thickness accuracy is said to be better than ± 0.002 inch.

5036

ULTRASONIC INSPECTION OF WELDS AS A SUPPLEMENT OR SUBSTITUTE OF RADIOGRAPHY

H. J. Meyer

Translated from Veröffentlichungen des Deutschen Stahlbau-Verbandes, 1962

Henry Bratcher Technical Translation, Altadena, California No. 5776

Performance of the recent ultrasonic testing techniques in the field of welding, compared with radiography. Development of equipment, coupling conditions and their influence on weld inspection. Calibration, interpretation and typical display of indications. Advantages of ultrasonics over radiography.

5059

A LIFETIME EXPERIENCE OF NONDESTRUCTIVE TESTING IN THE STEEL INDUSTRY

E. W. Colbeck

Charles Croxson Memorial Lecture, U. K., Proceedings of the Fourth International Conference on Nondestructive Testing, September, 1963 pp 16-25

A general type lecture covering some applications of magnetic particle, ultrasonic, and radiographic examination of forgings, castings and weldments.

5060

RADIOGRAPHIC SAMPLING IN THE INSPECTION OF SHIP STRUCTURE

H. Kihara

University of Tokyo, Proceedings of the Fourth International Conference of Nondestructive Testing, September, 1963, pp 35-37

A new method of random sampling for the inspection of welds in ships structures is proposed in this paper. Systems has been in use now for two years and has proven practical.

5065

RADIOISOTOPES AS INDUSTRIAL TOOLS IN CANADA

L. J. O'Riley, Atomic Energy of Canada Limited, Ottawa, Canada,
Engineering Journal, Vol 47, No. 5, May 1964

This is a general type article which discusses the many possibilities of uses to which radioactive tracers could be made. Under discussion are location of lost sewerage pipes, contamination of water, chip tracing in pulp and paper industry and tracing grease on a railway.

5070

NONDESTRUCTIVE TESTING IN THE SPACE AGE

Paul Dick

General Electric Co., Philadelphia, Pa.

Proceedings of the Fourth International Conference on Nondestructive Testing, September, 1963
pp 29-34

This paper discusses the design, development and typical results obtained from several nondestructive measurement systems currently in use at the Missile and Space Division of the General Electric Co. Some details given on future requirements of nondestructive test systems for inspection or evaluation of spacecraft of the future.

5074

PROGRESS IN NONDESTRUCTIVE TESTING (a summary of Hanford Achievements in these programs under General Electric)

D. C. Worlton 1952-1964

Hanford Laboratories, Richland, Washington HW-83608—August 1964 A.E.C.

R&D Report. Contract No. AT(45-1)—1350

Hanfords nondestructive testing programs from 1952 to 1964 are reviewed. Following the chronological development of these programs, this report first summarizes the fuel testing effort under which three separate, fully automatic inspection stations were developed and applied to the AISL fuel processes to insure core, cladding, and closure integrity of each fuel element. Following beneficial use of these test systems, similar inspection equipment was developed and successfully applied to the N-Reactor fuel process, results of this program are also summarized. Long range research and development programs oriented toward the development of advanced ultrasonic, eddy current, thermal, and nuclear particle counting techniques were established as an outgrowth of the fuels effort, and progress under these programs is reviewed.

5075

**RESEARCH ON RADIOGRAPHIC TECHNIQUES OF GRAPHITE EVALUATION
(AD-609 877) (N 65-1577)**

Merle L. Rhoten

Ohio State University, Columbus, Ohio, ML-TDR-64-277, Nov. 1964,
Wright-Patterson AFB Contract AF 33(657)11245

Technique charts are presented for the radiography of graphite in the medium thickness range 2-14 inches using typical industrial x-ray equipments. Results of experimental data demonstrates that problems encountered are due to scatter and economics of inspection. The thickness of graphite billets present geometrical unsharpness problems as related to economy of inspection. When the x-ray source is removed from the film sufficient distances to obtain a reasonable D/T ratio, exposure times are not economical. Techniques reported also demonstrate that better than 1% radiography can be obtained using typical industrial techniques and lead filtering, for the ranges of thicknesses from 1/2 inch to 40 inches.

5077

NASA CHECKS SPACE CRAFT BY X-RAY

Welding Engineer, October, 1964

A brief description of a fluoroscopy system utilizing image intensification and remote viewing.

5079

DEVELOPMENT OF KRYPTON-85 AS A UNIVERSAL TRACER

O. Cucchiara and P. Goodman

Panametrics, 201 Crescent St., Waltham, Mass. NYO-2757-6.

Final Report, Dec. 1, 1964 to Nov. 30, 1966

Discusses the application of kryptonates to the detection of wear and to the study of wear parameters, and the feasibility of preparing phosphor kryptonates for luminescent panels, signs, and signal lights. Comparison of the accuracy of the Kryptonate technique for the measurement of surface temperatures of various steel alloys with the accuracy obtained by thermocouples, optical pyrometers, photographic techniques and temperature sensitive paints described. Additional areas outlined: application of kryptonates to the detection of hazardous vapors and an investigation of the kryptonate technique for the assessment and study of ultraviolet induced degradation in thermal control coatings.

5080

EXPLOSIVE GAS GUN FOR RE-ENTRY SIMULATION (AD-481 431)

Physics International Co., San Leandro, Calif. Rpt. PI-PRS-021.

Semi-annual Report. March 1965, 23 p.

The objective of this research is the development of an explosive gas gun which will accelerate a 5- to 10-lb. projectile to velocities of approximately 20,000 ft/sec (about 0.6 Cm/microsec). To this end, a small, inexpensive model gun, in a scalable geometry, has been used for acceleration experiments. The model gun requires about two pounds of explosive and accelerates projectiles of about four-grams mass. Two simple gun designs (with and without diaphragm) both permitting systematic variation of the experimental parameters, have evolved from the experiments to date. Techniques have been developed for using radiographic, photographic, and electronic instrumentation in conjunction with these experiments. Velocities of about 15,000 ft/sec (or 75% of the goal) have been reached by varying the experimental configuration only slightly; calculations indicate modifications that should enable the full velocity to be attained.

5090

A POCKET SIZE RADIOGRAPHIC UNIT

James J. Ezop
IIT Research Institute, Chicago, Ill.
Welding Engineer, June 1964

A short article on the development of a pocket size radiographic unit using a pellet of Promethium 147 as its radioactive source, used for defect detection in Irin castings, welus, and electronic circuitry.

5094

NONDESTRUCTIVE INSPECTION OF FUEL ELEMENTS FOR NUCLEAR ROCKETS

Gerald H. Tenney
University of California, New Mexico U.S.A., Proceedings of the Fourth International Conference on Nondestructive Testing, Sept. 1962, pp 43-47

This paper describes some of the contributions nondestructive testing has made towards the development of the KIWI-A fuel element. Radiography was used for checking uniformity of uranium distribution in graphite; inclusions, laminations, and other defects were studied. Radiation gaging, and ultrasonic are also discussed.

5096

FLUOROSCOPY WITH HIGH ENERGY X-RAYS

R. L. Durant and B. J. Vincent
Royal Armament R&D Establishment, Fort Halstead, Swenoaks, Kent,
Proceedings of the Fourth Intern'l Conference on Nondestructive Testing, Sept. 1963 pp 61-64

A review of previous work in the field of high energy fluoroscopy is given. It is noted that high energy fluoroscopy is still in its early stages and a very wide field for experiment still exists. Main requirement is to improve radiographic sensitivity.

5097

IMPROVEMENTS IN XERORADIOGRAPHIC TECHNIQUE

A. Nemet, W. F. Cox and W. G. Hill
Consulting Engineer, Watson & Sons Lt'd, Nort Wembly, Middlesex, Inspectorate of Armaments, War Office, London, Proceedings of the Fourth International Conference on Nondestructive Testing, September 1963, pp 65-74

Xeroradiography was applied to a variety of armament stores with X-rays up to 1 MEV energy, using xeroradiographic plates with standard and thick coatings of 80 and 160 micron thickness, respectively. In the inspection of fuses, where it is primarily necessary to show the position of internal parts, xeroradiography has been found to be particularly useful. Thick coatings of 160 micron showed a speed approximately four times higher than that with thicknesses of 80 microns. Resolutions and contrast remained the same.

5098

CHARACTERISTICS OF INDUSTRIAL ZERORADIOGRAPHIC PLATES

R. L. Durant
Royal Armament R&D Establishment, Fort Halstead, Sevenoaks, Kent
Proceedings of the Fourth International Conference on Nondestructive Testing, September 1963, pp 75-79

This paper covers the characteristics of the subject matter in brief form. Discussion is given on photoconductive layer, charging and response of the plate. Present limitations and possible future developments are covered.

5099

CHARACTERISTICS OF METALLIC SCREENS IN THE MEGAVOLT X-RAY REGION

D. Polansky, J. A. Holloway and E. L. Criscuolo
U. S. Naval Ordnance Lab, Md., Proceedings of the 4th International Conference on
Nondestructive Testing, September 1963, pp 80-83

Conclusions reached indicate that for an absorber thickness of 3-6 ft. (90-180 cm) of low density material, it has been determined that the intensification factor is a linear function of the atomic number. Most of this intensification is due to the back screen. When backscattering conditions are minimized, the best resolution is obtained without a back screen. If scattering requires the use of a back screen, 0.25-0.75 mm of lead may be used.

5105

NONDESTRUCTIVE TESTING OF SOLDERED JOINTS AND ELECTRONIC CIRCUIT BOARD COMPONENTS (AD-465 857)

by H. Heffan
Quality Evaluation Laboratory, Naval Weapons Station, Concord, California
Progress Report QE/CO Report No. 64-14, 2 March 1964

Nondestructive test methods and equipment investigated include visual inspection, radiography, sonics and ultrasonics, fluoroscopy, heat quenching phosphors, Baird-Atomic Evaporograph and Barnes Infrared Camera. A listing of recommended interim nondestructive test methods and methods for further investigation and development are included in the Summary. An outline of work remaining to be done on this program including radiography and x-ray image systems, r.f. noise detection, vibration analysis and infrared image systems is also included.

5106

FUNCTION SEQUENCE DESCRIPTION AND FLOW (AD-490 956)

Document No. D2-4458
Boeing Airplane Company, Seattle, Washington

This document provides a (preliminary) definitized operation of the "Function Sequence Description and Flow" for The AMR WS-133A Minuteman Program. Presented are the items of support equipment required to perform these functions, the area in which they will be performed, and the approximate manpower and hours required in the performance of each operation.

5111

CINE-RADIOGRAPHY OF THE CASTING OF STEEL (AD-482 231)

R. Halrshaw, R. L. Durant, J. D. Lavender March 1966
Royal Armament Research and Development Establishment
R.A.R.D.E. Memorandum 10/66, also Iron & Steel, V 39, No. 9, Aug. 1966, pp 381-387

A description of the use of a television/fluoroscopy x-ray image intensifier equipment for the study of the pouring and solidification of small steel castings is given. This equipment has been used in conjunction with a 300 kV x-ray set and a synchronized cine camera to study the flow of molten steel into small moulds with various gating arrangements. The developments of internal defects during solidification of the castings has also been shown and the influence of the material of the mould is demonstrated. Possible developments in the equipment to extend its usefulness in this application are discussed.

5112

AN AUTORADIOGRAPHIC TECHNIQUE FOR STUDYING CRACK GROWTH IN PLASTICS COMPOSITE MATERIALS (AD-633 236)

By Marlin A. Kinna 1 April 1966

Naval Ordnance Laboratory, White Oak, Md.

Nol technical report 66-2.

Preliminary work has been conducted on segments of NOL rings to study crack propagation characteristics in fiber reinforced plastics composite materials. Samples were immersed in a tritiated water-ethylene glycol solution and auto-radiograms were prepared for analysis. Radiation emanating from the solution retained by the samples indicated minute cracks and fissures were present in all of the specimens, and that the radiation intensity varied in direct proportion to the severity of fatigue loading conditions.

5121

POTENTIAL APPLICATIONS OF RADIOISOTOPES IN THE NAVY (AD-633 785)

L. B. Gardner, A. E. Hanna and H. E. Stanton

U. S. Naval Civil Engineering Laboratory, Port Hueneme, California.

TR-R445, May 1966

The Naval Civil Engineering Laboratory has conducted a study of the potential applications of isotopic devices and techniques within the Naval Shore Establishment. Radiation characteristics, general applications of isotopic devices, and specific problem areas are discussed. Recommendations are included for the use of surface density and moisture gages in the inspection of compacted earth, and for additional work in the determination of the thickness of in-place steel sheet piling and the thickness and density of concrete.

5143

CORROSION - OUR \$1 BILLION WRITE-OFF

J. D. Palmer

Can Chem Process, V. 50, No. 3, March 1966, pp 55-57, 59, 61

Applications of protective coatings, material substitutions and environmental adjustments are evaluated as means of preventing and controlling corrosion on carbon steel parts. Nondestructive testing is recommended to prevent costly failures. Ultrasonic resonance and pulse echo methods, penetrant methods and radiography are compared as to cost, accuracy and applications.

5145

X-RAY THICKNESS GAUGING

Pickler Industrial Inspector, Vol. X, No. 1, February 2, 1966

An article describing the principles of operation of x-ray thickness gauges. Covers both capabilities and shortcomings.

5150

THIN FILM MICROCIRCUIT INTERCONNECTIONS (AD-631 412)

H. M. Greenhouse et al

The Bendix Corporation, Bendix Radio Division, Baltimore, Md., March 1966

ECOM Contract No. DA-28-043-01482(E)

Infrared photography has been evaluated as a nondestructive test for the quality of thin film interconnections, and it was found to be not very useful. A new interfacial interconnection pattern is proposed which will make possible precise quantitative values for the interfacial resistance. No correlation between capacitance and breakdown voltage has been found. An automatic tester for breakdown voltage determinations is being designed.

5151

NONDESTRUCTIVE WELD STUDIES EURAEC - 1519

United States - Euratom Joint Research and Development Program

Rontgen Technische Dienst N. V. Rotterdam

Quarterly Report No. 17, 18 November 1965

The investigation of weld studies cover the ultrasonic examination and radiographic examination of test welds. Of particular interest is the investigation of "B" scan ultrasonic equipment. Improved resolving power is required.

5164

RADIOGRAPHIC INSPECTION OF SEMICONDUCTORS AND COMPONENTS

L. D. Clark and R. E. McCullough

Texas Instruments, Inc., Dallas, Texas, Materials Evaluation, October 1966, p. 577

This paper discusses the subject matter and covers selection, procurement, and installation of equipment, development of techniques, defining of capabilities, and training of personnel. Fixtures for handling and orienting components must be designed and constructed. Particular emphasis is placed on penetrameters suitable for semiconductors and similar components and on techniques for obtaining optimum resolution.

5165

CHARACTERISTICS OF A THERMAL NEUTRON TELEVISION IMAGING SYSTEM

Harold Berger

Argonne National Laboratory, Argonne, Ill., Materials Evaluation, September 1966

This article describes a thermal neutron sensitive image-intensifier tube said to be capable of presenting a demagnified, bright-visible image of a thermal neutron beam. The system is capable of following fast moving objects without objectionable blurring, and displays a contrast sensitivity of 4 per cent in a narrow thickness range for steel and uranium. Resolution and contrast sensitivities are analyzed and application areas are indicated.

5166

INFLUENCE OF HIGH VOLTAGE WAVE FORM AND INHERENT FILTRATION OF X-RAY GENERATORS ON IMAGE QUALITY

Joseph H. d'Adler-Racz

Balteau Electric Corp., Stamford, Conn., and Liege, Belgium. Materials Evaluation, September 1966

Image quality in a radiograph is dependent on a number of factors. Only two of these factors are considered in this paper. Discussed is the effect of the high voltage applied to the x-ray tube and the inherent filtration on film contrast. Basic physical laws and the different types of high voltage circuits are covered in the introduction. Some practical suggestions are made and some practical devices are described.

5168

ULTRASONIC TESTING IN SUBMARINE CONSTRUCTION

Charles J. Hellier

General Dynamics, Electric Boat Division, Groton, Conn.

Materials Evaluation, September 1966

Ultrasonic testing of submarine components permits defect resolution with a speed and accuracy never before realized without delays to production or radiation hazards normally encountered with radiography. This paper describes present day applications of ultrasonics in submarine construction. Personnel training and qualification in this field are also covered.

5169

RADIOGRAPHIC EXAMINATION OF LARGE, FILAMENT-WOUND, SOLID-PROPELLANT MOTOR CASES

Cecil R. French

Aerojet-General Corporation, Sacramento, California

Materials Evaluation, August 1966

A discussion of radiographic examination of large filament-wound, solid-propellant motor cases in the research and development phase is presented. A number of insulation and structural defects from a volume of radiographic qualitative standards are illustrated with sectional photographs. Reference films were established for the reporting and correlation of design and fabrication problems of several concerns working concurrently on an accelerated R&D program. Fabrication methods and supplemental nondestructive tests of candling and spark discharge are briefly discussed. Additional work is required to establish and evaluate graduations of the characteristics depicted by the standard films for accept/reject criteria.

5171

NEUTRON RADIOGRAPHY OF PYROTECHNIC CARTRIDGES

Merle L. Rhoten and Walter E. Carey

Ohio State University

Materials Evaluation, August 1966

This paper describes neutron radiographic techniques which were utilized to answer the unique NDT problem of pyrotechnic cartridge inspection. The techniques and results are given, as well as the results of possible deterioration of the encased explosive powder. The paper is intended to alert quality control personnel to the possible use of neutron radiographic techniques as an inspection tool.

5173

APPLICATION OF ULTRASONICS TO DETECTION OF FATIGUE CRACKS

S. J. Klima, D. J. Lesco and J. C. Freche

Experimental Mechanics, Vol. 6, March 1966, Materials Evaluation, August 1966

The ultrasonic method can be used to advantage because it is not limited to detection of surface cracks, does not require interruption of fatigue test, and can be applied to many materials, regardless of their electrical or magnetic properties.

5179

THREE DIMENSION X-RAY

Robert C. Gibbons

Utica Division, The Bendix Corporation, Utica, New York

Materials Evaluation, July 1966

Three dimensional pictures can be obtained by photographing objects from two angles and viewing through a stereoscope. Three dimension views of radiographs can be made in the same manner. To determine the location of a defect as regards to distance below the surface, two exposures should be taken from known different angles; then the change in location of the defect can be measured from the shadow of a lead marker placed at the surface and the depth below the surface easily calculated by triangulation.

5185

NDT - CHOOSING BETWEEN FILM RADIOGRAPHY AND FLUOROSCOPY

Mark Rosumny and Matthew Corrigan

Weld Eng., V. 51, No. 6, June 1966, pp 41-44

Both film radiography and electronic fluoroscopy are used increasingly in the nondestructive testing of weldments. Radiographic processes employ either X-rays produced by generators or gamma radiation emitted from radioactive isotopes. A penetrameter is recommended as a means of determining the correct combination of voltage, milliamperage and exposure in X-ray radiography. X-rays provide an adjustable source of radiation energy suitable for a wide range of formulations; gamma systems are inflexible but are portable and less costly. In image intensified fluoroscopy, X-rays passing through the weld form an image on the input element of an electronic image amplifier. The method is rapid, versatile and capable of inspecting thin weldments in light metals of more than 1 1/2 in. thick steel.

5186

THE INSPECTOR'S ROLE IN ONSTREAM INSPECTION

E. F. Ehmke

American Petroleum Institute, Proceedings. Section III, Refining, V.45(3), 1965, pp 163-168

Inspection techniques for corrosion, onstream inspection methods and inspection tools used in the application of these techniques are described. Some equipment used in the detection of troubles and maintenance of assemblies is discussed. Ultrasonic translators are used to detect minor leaks and pinpoint the location in a flange where effective tightening could be applied. Vacuum leaks in valves of compressors and engines can be detected. Infrared pyrometers find use in checking hot spots and temperature gradients in internally insulated vessels. A systematic approach to the investigation of corrosion problems and expected failure in weldments is given. A preliminary investigation is followed by actual inspection. Radiographic and pulse-echo inspection are two commonly used methods. A case history of inspection of a weldment of 304 stainless steel piping using a variety of techniques, including ultrasonic shear wave testing, eddy current inspection and techniques mentioned above, is described, where the aim was to determine the extent and nature of the corrosion effects

5188

APPLICATIONS OF RADIOLOGICAL INSPECTION

R. Halmshaw and R. L. Durant

Paper from "Physics of Industrial Radiology". 1966.

American Elsevier Publishing Co., Inc., 52 Vanderbilt Ave., N. Y. pp. 359-406

Radiographic methods are used to determine weld defects such as pitting, overlap, undercut, cratering, blowholes, porosity, inclusions, cracks and incomplete penetration in pressure vessels, stream pipes, transmission pipelines, storage tanks, ship hulls, nuclear reactors, jet engine turbine blades and rocket casings. Radiography is also used to inspect welds of such non-ferrous materials as Al-alloy and polythene sheet. Casting defects such as voids, microporosity, sponginess, worm-hole, shrinkage, cracks, tears, segregations, inclusions and cold sheets are detected in ferrous and nonferrous castings by X-ray and gamma radiographic techniques. Radiography is used to determine positioning or absence of key components in assemblies such as radio tubes, automobile engines, shells and warheads. Other areas discussed include metrology and stereoradiography.

5190

LIST OF MILITARY AND CIVIL DEFENSE RADIAC DEVICES (AD-859 338)

DASA 1243 Revised (1966) August

Defense Atomic Support Agency, Washington, D. C. 20301

A compilation of radiac devices currently available to the Department of Defense is presented. The list is separated into rate meters, dosimeters, miscellaneous radiac equipment for calibration and special purposes, and major research and development items. Each item includes nomenclature, classification, federal stock numbers, cost, sponsoring agency and a description of the item.

5191

STUDY, DESIGN, AND APPLICATIONS OF BETA-EXCITED X-RAY SOURCES

J. J. Ezop and T. G. Stinchcomb

Illinois Institute of Technology Research Institute, 10 W. 35th St., Chicago, Illinois

Proceedings of Symposium on Low-Energy X and Gamma Sources and Applications

IITRI, Chicago, Ill., 21-22 October 1964, ORNL-11C5, UC-23-Isotopes-Industrial Technology,

November 1965

This investigation indicated that beta-excited x-ray sources are extremely useful as complementary devices to existing machines. The small size and portability of these isotopic sources make them very attractive for field uses and for nondestructive testing problems where the situation limits the use of conventional x-ray machines. The relative monochromatic output of such sources is another advantage. The only limitations of beta excited x-ray sources are centered around the limited photon outputs per unit source area. Approximate formulae for the design and optimization of these sources were derived, tested, and found satisfactory.

5192

RECENT DEVELOPMENTS IN PRODUCTION OF LOW-ENERGY GAMMA- AND X-RAY EMITTERS

F. N. Case and R. S. Pressly

Isotopes Development Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee

Proceedings of Symposium on Low-Energy X and Gamma Sources and Applications

IITRI, Chicago, Ill., 21-22 October 1964, ORNL-11C5, UC-23-Isotopes-Industrial Technology

November 1965

The design of radioactive sources for maximum output of low-energy gamma and x radiation is described. Methods of fabrication and encapsulation and measurement of the energies of the radiation from the sources are considered, and new radioisotopes being investigated and their availability are discussed.

5193

X-RAY ABSORPTIOMETRY WITH BETA-STIMULATED X-RAY SOURCES AND PROGRESS REPORT ON COMPILATION OF BETA-EXCITED SPECTRA

Luther E. Preuss, H. Collins, J. Kann

Edsel B. Ford Institute for Medical Research, 2799 W. Grand Blvd., Detroit, Mich.

Proceedings of Symposium on Low-Energy X and Gamma Sources and Applications

IITRI, Chicago, Ill., 21-22 October 1964. ORNL-11C5, US-23-Isotopes-Industrial Technology, November 1965

Characteristic x radiation and bremsstrahlung photons, produced by ^{147}Pm betas in copper, iron and molybdenum targets, have been studied for their application in absorptiometry. A device designed specifically for absorptiometry with beta-excited sources was used in this investigation. Spectral hardening proved to be a prevalent phenomenon with some of these sources. Properly designed beta-stimulated sources showed promise. Progress in the compilation of a comprehensive series of beta excited spectra is also reported.

5194

ANALYSIS AND MEASUREMENT OF MATERIALS WITH LOW-ENERGY RADIATION

Charles O. Badgett

Industrial Nucleonics Corp., 650 Ackerman Road, Columbus, Ohio 43202

Proceedings of Symposium on Low-Energy X and Gamma Sources and Applications

IITRI, Chicago, Ill., 21-22 October 1964. ORNL-11C5, UC-23-Isotopes-Industrial Technology, November, 1965

The newly available low-energy gamma-photon radioisotope sources permit measurements of stream properties intermediate between two energy extremes, — ev to mev — and open up new opportunities in material measurements previously possible only with gamma-photon machines (e.g., x-ray tubes). Added advantages are stability and geometric design. Some of these measurements and advantages are discussed tutorially.

5195

BREMSSTRAHLUNG FROM ^{90}Sr - ^{90}Y IN THIN ABSORBERS

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Joseph Silverman**

*Hittman Associates Inc., P.O. Box 2685, Baltimore, Md. 21215

**University of Maryland, College Park

Proceedings of Symposium on Low-Energy X and Gamma Sources and Applications

IITRI, Chicago, Ill., 21-22 October 1964. ORNL-11C5, UC-34-Isotopes-Industrial Technology, November, 1965

The bremsstrahlung yields from targets ranging in atomic number from 13 to 73 with a thin, point source of ^{90}Sr - ^{90}Y are presented. A novel method of obtaining these yields was used, the bremsstrahlung spectra being measured as they are built up and attenuated through targets whose mass thicknesses are less than the range of the ^{90}Y maximum-energy beta particle. The resulting bremsstrahlung yields are then compared to those calculable from the Evans approximation to thick target theory.

5196

EXTERNAL BREMSSTRAHLUNG PRODUCED IN THIN FOILS BY ^{147}Pm

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*Martin Company, Martin Marietta Corporation, Baltimore, Md. 21203

**University of Maryland, College Park

Proceedings of Symposium on Low-Energy X and Gamma Sources and Applications
 IITRI, Chicago, Ill., 21-22 October 1964. ORNL-11C5, UC-23-Isotopes-Industrial Technology,
 November 1965

A. NaI (Tl) scintillation spectrometer was used in conjunction with a 512-channel pulse height analyzer to study the spectral distribution of the external bremsstrahlung produced by ^{147}Pm betas in thin foil targets. The bremsstrahlung was found to be linearly dependent on the atomic number of the target material as predicted by theory. It was further determined that the experimental data could be represented by the empirical relations:

$$\begin{aligned}\text{Photon yield} &= 3.7 \times 10^{-4} Z \text{ Photons/B} \\ \text{Photon Intensity} &= 4.5 \times 10^{-6} Z \text{ Mev/B}\end{aligned}$$

5197

HEAVY ELEMENTS CONTENT MEASUREMENT BY MEANS OF A GAMMA-EXCITED X-RAY FLUORESCENCE

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*Commissariat à l'Energie Atomique, France

**Société Minerais et Metaux, France

Proceedings of Symposium on Low-Energy X and Gamma Sources and Applications
 IITRI, Chicago, Ill., 21-22 October 1964. ORNL-11C5, UC-23-Isotopes-Industrial Technology,
 November 1965

The determination of heavy metals by measurement of the intensities of their K x-ray lines has decisive advantages in industrial control. Very intense K x-ray lines can be obtained; thus a 1-curie source of ^{192}Ir gives a counting rate of 100,000 counts/second under the K x-ray peak of lead if we consider a lead target in the described arrangement. The use of ^{137}Cs could also be interesting. Application of the method of the ratio of the K x-ray lines over Compton-scattered gamma rays, could permit automatic sorting of low-content ores of heavy elements: tungsten, gold, mercury, lead, and bismuth. Coating thicknesses could also be controlled by this means.

5198

AMERICIUM-241 AS A NDT TOOL FOR THE AIRCRAFT AND SPACE INDUSTRY

Gordon Locher

Western Radiation Laboratory, 1107 W. 24th St., Los Angeles 7, California

Proceedings of Symposium on Low-Energy X and Gamma Sources and Applications
 IITRI, Chicago, Ill., 21-22 October 1964. ORNL-11C5, UC-23-Isotopes-Industrial Technology,
 November 1965

Panoramic radiography was done at source-film distances as low as 1/8 inch, using a long, thin ^{241}Am gamma source inside steel tubes up to 0.100 in. thick. Penetrameter sensitivities of 2% and unsharpness values as low as 0.002 in. were obtained. There was no geometrical distortion of radiographs. Double-wall radiography was done on small tubing at source-film distances of 1.5 to 2.0 in. in another crowded-component application, using devices resembling a fountain pen, 3/8 in. outside diameter. Americium-241 sources ranged from 20 mc (1.0 mm focal spot) to 50 mc (1.5 mm focal spot) to 150 mc (2.0 mm focal spot). Simultaneous use of many units is expected to speed radiographic output. Transmission thickness gages were used with ^{241}Am sources up to 0.001 in. These are replacing the high-energy beta sources formerly used.

5199

PRELIMINARY RESULTS OF X-RAY FLUORESCENCE ANALYSIS IN THE ENERGY RANGE 1 to 5 KEV

Troy C. Martin, Kenneth R. Blake and Ira L. Morgan

Texas Nuclear Corporation, P. O. Box 9267, Austin 17, Texas

Proceedings of Symposium on Low-Energy X and Gamma Sources and Applications

ITRI, Chicago, Ill., 21-22 October 1964. ORNL-11C5, US-23-Isotopes-Industrial Technology, November 1965

A gas proportional counter was constructed with a thin beryllium window which is able to detect the K x-rays of elements down to and including the fluorine K x-ray (0.677 KeV) and silicon (1.74 keV) in an Fe_2O_3 matrix. Errors due to matrix or interelement effects are shown.

5200

DEVELOPMENTS IN A PORTABLE X-RAY FLUORESCENCE INSTRUMENT USING RADIO-ISOTOPE EXCITATION SOURCES

John O. Karttunen and Dale J. Henderson

Argonne National Laboratory, Argonne, Illinois 60440

Proceedings of Symposium on Low-Energy X and Gamma Sources and Applications

ITRI, Chicago, Illinois, 21-22 October 1964. ORNL-11C5, UC-23-Isotopes-Industrial Technology, November 1965

Tritium absorbed in zirconium is an excellent excitation source for generation of fluorescence x-rays in elements where 3 to 12 keV is required. The bremsstrahlung from this source is used to excite the characteristic fluorescence x-rays of elements in the Z ranges 16 to 35 and 45 to 62. The apparatus is miniaturized, has a total weight of 11 lbs., and can be contained in a volume of less than 1 ft.³. Because of its relatively low cost, compactness, versatility, and simplicity, the apparatus developed has merit as a possible lunar probe and as a geological field instrument, as well as in other applications.

5201

RADIOISOTOPE SOURCES OF LOW-ENERGY ELECTROMAGNETIC RADIATION AND THEIR USE IN ANALYSIS AND MEASUREMENT OF COATING THICKNESS

J. F. Cameron and T. Florkowski

International Atomic Energy Agency, Kaerntnerring, Vienna 1, Austria

Proceedings of Symposium on Low-Energy X and Gamma Sources and Applications

ITRI, Chicago, Illinois, 21-22 October 1964. ORNL-11C5, UC-23-Isotopes-Industrial Technology, November 1965.

A review of recent developments in the application of radioisotope sources of low-energy electromagnetic radiation outside the USA. Such sources have advantages over electrical x-ray generators, viz., their small physical size, comparatively low cost, stability of output in terms of energy and time, and independence of power supplies. They are being increasingly applied in industry, particularly for analysis, the techniques of which are discussed here in some detail. The use in measuring coating thickness is discussed only briefly.

5202

ORE AND COAL ANALYSIS USING RADIOISOTOPE TECHNIQUES

J. R. Rhodes

Isotope Research Division (AERE) Wantage Research Laboratory, Wantage, Berkshire,
Proceedings of Symposium on Low-Energy x and Gamma Sources and Applications
IITRI, Chicago, Illinois, 21-22 October 1964. ORNL-11C5, UC-23-Isotopes-Industrial Technology,
November 1965

X-ray excitation by radioisotope sources and energy selection with filters are briefly reviewed and discussed. A new arrangement of source and secondary target for efficient production of spectrally pure K- x-rays is described and its use in x-ray fluorescence analysis to obtain detection limits of 10 to 40 ppm of tin in tin ores is reported. A "Isotope Portable Analyzer" is being made commercially available for geological applications in prospecting and field assay and for industrial use in the measurements of coating thickness and alloy composition.

5203

INDUSTRIAL ANALYSIS OF PROMETHIUM-147 X-RAYS FOR RADIOGRAPHY AND IMAGING READOUT

E. W. Coleman, et al

Picker X-Ray Corporation, 17325 Euclid Avenue, Cleveland, Ohio

Proceedings of Symposium on Low-Energy X and Gamma Sources and applications
IITRI, Chicago, Illinois, 21-22 October 1964. ORNL-11C5, UC-23-Isotopes-Industrial Technology,
November 1965

In experiments with a 100-curie ^{147}Pm source on radiography and fluoroscopy of medical phantoms and of various metal step wedges with standard penetrameters, exposure times required generally were excessively long. Studies of the spectral output and use of the source to excite secondary spectra, which were evaluated with a scintillation detector and 400-channel pulse-height analyzer, demonstrated interesting capabilities on sorting materials. A third series of experiments was on determination of the effective focal spot size and relating this to theoretical excitation conditions in the source.

5204

RECENT RESEARCH DEVELOPMENTS AT POLAROID CORPORATION AND THEIR APPLICATION TO LOW-ENERGY RADIOGRAPHY

Herbert J. Frede

Polaroid X-Ray Research Laboratories, Waltham, Mass.

Proceedings of Symposium on Low-Energy X and Gamma Sources and Applications
IITRI, Chicago, Illinois, 21-22 October 1964. ORNL-11C5, UC-23-Isotopes-Industrial Technology,
November 1965

Polaroid radiography is a tool that can record and provide information with a degree of sensitivity and speed not otherwise possible if used properly for a specific task. This article presents a discussion of its limitations as well as its applications.

5208

(Book - German) MATERIAL TESTING - METALS

P. Riebensahm and Paul W. Schmidt. 1965, p 68. Springer-Verlag, Berlin, Germany

A compilation of industrial testing methods and procedures based on pertinent German industrial (DIN) specifications is discussed. The following tests are included: mechanical testing, including static stress (tensile, creep, compression, bending, torsion, shear); impact (impact and impact compression, bending and notched impact); alternating fatigue; hardness (Brinell, Vickers, Knoop, Rockwell, dynamic hardness, conversions); spark testing, fracture testing; microstructure (Metallography, X-ray); nondestructive testing, including residual stresses (brittle coatings, mechanical and optical, pneumatic, electrical, X-ray); grade and state identification (electromagnetic, coercive); defects (penetrating, induction, eddy current, ultrasonic, X-ray and gamma radiation). Sampling, specimen and specifications for procedure are given for each method. Standard machinery is described in detail.

5209

AIR-COUPLED ULTRASONIC INSPECTION SYSTEM

Ministry of Aviation, Rocket Propulsion Establishments, Wescott Buck, England INF. 2/66/IEA/G

This paper describes briefly a method utilizing air coupling on both sides of a specimen for inspecting rocket motor tubes. By utilizing lead zirconite titanate transducers and focusing the 2.5 cm diameter transducer from a 10 cm air focal length, good results are obtained. Natural frequency oscillations of short bursts, undamped, at 100 c/s are employed. Power output is said to be many times that of single pulse excitations.

5212

MEASUREMENT OF SPATIAL FREQUENCY RESPONSE OF CERTAIN FILM SCREEN COMBINATIONS TO 10 MEV X RAYS

C. H. Dyer and F. L. Criscuolo

U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland

Materials Evaluation, November 1966

A mechanical system has been devised to measure the line spatial frequency response of a film-screen combination. This apparatus is capable of generating spatial frequencies from about 0.3 to 10 lines/mm. As the limit of resolution on a radiograph is approached, the amplitude of the line pattern decreases. A plot of the amplitude as a function of spatial frequency gives an indication of resolution. Experimental data are presented on spatial resolution of several film-screen combinations at 10 Mev.

5218

N.D.T. APPLIED TO PIPELINE CONSTRUCTION AND OPERATION IN THE U.S.A.

Pt. 1. A. G. Barkow

Brit J Non-Destructive Test, V. 8, No. 2, June 1966, pp 22-38

Definition, purpose and history of nondestructive testing of pipelines are given. API standards on oil and gas pipeline field welding practices, including radiographic practices and standards of acceptability, are discussed. Nondestructive testing in pipe mills - visual inspection, radiographic, ultrasonic and fluoroscopic and their specific capabilities in detecting defects such discontinuities, porosities, slag inclusions and cracks, is reviewed. Use of hydrostatic testing a X-radiation, electromagnetic or eddy-current tests to examine pipe welds in pipe mill are described. Nondestructive testing in pipeline construction includes radiographic inspection using film, visual inspection, hydrostatic yield testing and ultrasonic inspection. A detailed description of radiographic inspection, divided into internal and external methods, using either X-rays or gamma-rays, is given.

5228

DEVELOPMENT OF NONDESTRUCTIVE SYSTEM FOR ANALYSIS AND CONTROL OF RESIDUAL MACHINING STRESSES (AD-480 251)

W. J. McGonnagle et al

ITT Research Institute, Chicago, Ill.

Wright-Patterson A.F.B. Contract No. AF33(615)-1400. IR-7-718, V. 3, 1 Sept.-30 Nov. 1965

This report describes the initial phases of an experimental program to develop a nondestructive testing system for the quantitative determination of surface residual stress produced by edge tool machining or grinding processes. NDT methods being evaluated are ultrasonics, x-ray, beta back-scatter, and elastic-plastic deformation.

5231

DEVELOPMENT OF NONDESTRUCTIVE TESTING TECHNIQUES FOR LARGE SOLID ROCKET NOZZLES (AD-479 721)

R. L. Willison, N. D. Passerell, L. J. Cameron et al

Thompson, Ramo, Woolridge Structures Division, 23555 Euclid Ave., Cleveland, Ohio -

ER-5875-16, March 1966

Air Force Systems Command, Edwards, California. AFRPL-TR-66-57

Engineering analyses providing techniques of determining rejection levels for imperfections common to large solid rocket nozzles is discussed. Defects are classified in accordance with relative severity. NDT tests indicated that ultrasonics for the acquisition of defects and radiography for confirmation and identification resulted in the most economical NDT inspection program, and was not size limited. The most significant application was to the fabrication of nozzles for the 260 Inch Large Booster Motor. The ultrasonic/radiographic method proved adequate for this task.

5233

MEASURING METALLIC CORROSION BY RADIATION BACK-SCATTERING AND RADIATION INDUCED X-RAYS (AD-630 814)

Sigmund Berk

Frankford Arsenal, Philadelphia, Pa. Reprinted from V. 4, No. 11, pp 39-41 (1965)

November "Metals Protection"

A Pm^{147} beta-backscattering device was used to determine the relative amount of corrosion on several metallic specimens. The method was found effective in measuring extent of oxidation or corrosion of nickel, niobium, and tantalum. A brief description of a beta-particle induced x-ray method for measuring corrosion of copper, steel, and brass is also described.

5235

ULTRASONIC IN-PROCESS INSPECTION OF RESISTANCE SPOT WELDS (AD-633 340)

George E. Burbank and Wallace D. Taylor

Frankford Arsenal, Philadelphia, Pa.

Report No. R-1811, April 1966, Final Report

In the continued evaluation of the in-process ultrasonic approach to the nondestructive inspection of resistance spot welds, ultrasonic through-transmission measurements were extended to several types of metals to establish signal sensitivity and behavior with respect to metallurgical changes. In addition, the test results are reviewed from the standpoint of meaningful trends and reproducibility required for the development of go-no-go or absolute measurement type quality control devices.

5243

(Italian) RESOTRON 2000 USED IN THE RADIOGRAPHIC LABORATORY OF THE TERNI SOCIETY

Edmondo Marianeschi and Fausto Orazi
Riv Ital Saldatura, V. 17, No. 6, 1965, pp 262-271

Design and Operating parameters are given for an X-ray apparatus capable of examining large steel castings and forgings, welded structures and plates up to 300 mm thick retaining high sensitivity and accuracy. The unit emits X-rays of various energies and penetrating power and makes use of radiographic films to determine the nature and position of defects. The unit is easily movable and lends itself to fast analysis of complex structures. A comparison is made between Resotron 2000 and Betatron and Van de Graaff Resotron with regard to their sensitivity as a function of thickness.

5246

DEVELOPMENT OF NONDESTRUCTIVE METHODS FOR EVALUATING DIFFUSION-FORMED COATING ON METALLIC SUBSTRATES

R. C. Stinebring & T. Sturiale
Avco Corp., Lowell, Mass. Tech. Rpt. AFML-TR-221, September 1966

This program was originated to detect, define and characterize by NDT methods, those variables which significantly affect the service life of diffusion-formed coatings on refractory alloys. The following were studied: a) TZM alloy with W-3 coating, b) Cb 752 alloy with Cr-Ti-Si Coating, c) B-66 alloy with PFR 30 coating. All specimens were screened using such NDT methods as visual, microscope (40x), radiography, eddy currents, optical reflectometry, infrared, ultrasonic velocity, dye penetrant, wax replica, thermoelectric and electron beam. After screening, the specimens were heated at 2600°F and 2800°F and to plasma arc at 3000°F at reduced pressures (0.5mm Hg); removed periodically from the high temperature environments and evaluated to determine extent of degradation as a function of exposure time. NDT techniques applied on this program were adequate for detection of significant variables.

5248

APPLICATION OF BETA-RADIATION IN CONTROL OF THIN-WALLED ALUMINUM PIPES (AD-477 043)

V. Brozek and M. Novatny
Strojirenstvi, 1965, V. 15, No. 4
U. S. Army Foreign Science and Technology Center, FSTC 381-T-65-417, December 1965

The authors explain briefly the reasons why the applications of beta-radiation in defectoscopy is limited in practice for the time being only to studies of thin-walled products. The authors study the theoretical aspect of the problem and then show on the basis of experimental results how it is possible to use the procedure which they propose. In their experiments they used a RA²²⁶ and SR⁹⁰ as radiators. By using the method described, it was possible to determine defects 0.05 mm wide in pipes with walls 1 mm thick.

5251

NONDESTRUCTIVE METHODS FOR THE EVALUATION OF CERAMIC COATINGS

W. E. Lawrie and R. A. Semmler

IIT Research Institute, Chicago, Illinois, Wright-Patterson A.F.B. Contract No. AF 33(657)-8938.

WADD-TDR-61-91-Part VI, June 1966

The development of ultrasonic and nuclear techniques, for the evaluation of oxidation resistant coatings for refractory metals and superalloys, has continued. An ultrasonic method has been used for measuring the dynamic shear modulus of the coating. Ultrasonic detection of physical discontinuities has not yet been achieved. The nuclear investigations have continued the examination of beta backscatter techniques for coating thickness measurements. The preferred techniques for measuring thin multilayer coatings and the instrumentation required for these techniques is given.

5256

AUTOMOBILE TIRE HOT-SPOT DETECTION

Theory, Application and Instrumentation for Infrared Nondestructive Testing

Barnes Engineering Co., 30 Commerce Rd., Stamford, Connecticut

The Barnes Models R-4D1 and R4C1 Industrial Radiometers were successfully used in rubber tire experiments conducted at two different tire manufacturers. Tests were performed to check the uniformity of manufacture by monitoring the temperature of the rubber materials with the tires placed on conventional tire test stands and the tires rapidly rotated. Any hot spots or widely varying temperature gradients were determined using the Barnes Industrial Radiometer and an electronic monitoring network.

5259

THE USE OF AUTORADIOGRAPHY IN METALLURGICAL RESEARCH

R. H. Condit

Lawrence Radiation Laboratory L-503, Livermore, California (October 1966)

To be published in "Techniques in Metallurgical Research", R. F. Bانشaw, Ed.

A bibliography containing a list of titles on the subject "The Use of Autoradiography in Metallurgical Research", including articles on activation analysis, film techniques in autoradiography in some other field such as biology, geology, and nuclear physics, and the use of autoradiography in studies of diffusion, solubilities, chemical analysis of alloys, abrasion of metals, and miscellaneous metallurgical problems. A list of over 400 references.

5267

X-RAY FILM DEFECTS AND AUTORADIOGRAPHY OF FUEL ELEMENTS FOR CLADDING THICKNESS MEASUREMENTS (N65-36037)

H. P. Roth in its Tech. Papers of the 14th Metallographic Group Meeting, 6 January 1964, pp 149-163 (See N65-36025 24-17) CFSTI

Radiography of fuel element cladding can be performed by using the natural radioactivity of the core material as the source of exposure. X-ray film is placed in close contact with the surface of the cladding for several hours and the film is exposed by rays from the uranium which penetrate the cladding. The resulting density of the processed film at any specific location is related to the thickness of the cladding at the same location on the fuel element. By measuring photographic film density and comparing it with that of a standard film, which has been exposed and processed at the same time as the subject film, one can determine cladding thickness. The degree of accuracy depends on carefulness in control of the entire autoradiographic procedure. Plus or minus 10 percent accuracy is normal for cladding below 20-mils in thickness. This method is not suitable for measuring more than 30-mils of Zircaloy or 50-mils of aluminum.

5268

NONDESTRUCTIVE TESTING OF WELDED PIPE

R. N. Cressman

Iron Steel Eng., V. 43, No. 9, September 1966, pp 147-150

Ultrasonic, eddy current and X-ray nondestructive test methods are compared for three groupings of pipe sizes, from 3/4 to 4-1/2 in., from 4-1/2 to 20 in. and above 20 in. The advantages and disadvantages of these methods and variations in relation to pipe diameter, class of defect, welding technique and production factors are noted.

5273

ISOTOPES GO OUT FOR MEASUREMENT

Iron Age, V. 198, No. 15, October 13, 1966, pp 68-69

A radioisotope thickness gaging system for measuring the thickness of steel strip is made up of three major elements: the radiation source, the process and the detector. Radiation received by the detector gives a direct thickness measurement. In such a system, there are three variables: density, radiation absorption and mass attenuation coefficient. The important types of radiation for thickness gaging systems are beta particles and electromagnetic or gamma photons.

5287

A CLOSER LOOK AT ULTRASONIC FLAW DETECTION CALIBRATION

C. D. Wells

Wells-Krautkramer Ltd., Letchworth, Hertfordshire, Great Britain

The British Journal of Nondestructive Testing, Vol. 8, No. 4, December 1966

A good article discussing ultrasonic equipment calibration and covering time base, wall thickness measurements, angle probes and amplifiers.

5291

GUIDE FOR INTERPRETATION OF NON-DESTRUCTIVE TESTS OF WELDS IN SHIP HULL STRUCTURES

No. SSC-177 - Prepared by the Ship Structure Committee, National Academy of Sciences - National Research Council, September 1956

A guide in pamphlet form is presented for the interpretation of radiographs; liquid penetrant indications; magnetic particle indications and the use of ultrasonics in reference to welded ship hull structures.

5298

NONDESTRUCTIVE TESTING OF MINE BATTERIES

Naval Weapons Station, Concord, California (QE/CO 67-13) February 1967 45 p.

Describes the investigative work that was performed and the test results that were obtained on the applicability of the nondestructive testing methods to Leclance type mine batteries for the purpose of indicating their capability and service life.

5304

UNDERWATER NEUTRON RADIOGRAPHY WITH CONICAL COLLIMATOR

J. P. Barton and J. P. Perves

Brit. Journal Non-Destructive Test, V. 8, No. 4, December 1966, pp 79-83

An apparatus for neutron radiography in operation at a pool reactor is described. The design has two special features: the apparatus permits radiographic examination of highly radioactive objects irradiated within the reactor core without their being extracted from the adequate depth of shielding water, and the neutron collimator is of a funnel shape, which gives a very high picture definition with large picture frame size and absence of lines characteristic of multi-slit collimators. Indium transfer foils, 100 microns thick, have been found to be most practical, although Dy and Au have been used. Neutron radiographs of portions of a test element are shown. The object is highly radioactive (over 10,000 curies). The vertical uranium rod is held under tension and heated by an enveloping electrical circuit while being irradiated in the pile.

5305

NEW YORK HARBOR CORROSION — PORT OF NEW YORK AUTHORITY CONDUCTS PILE SURVEY

E. R. Kennedy and J. S. Wilson

Mater Protect., V. 6, No. 1, Kansas 1967, pp 53-55

A corrosion survey of cathodically protected and unprotected steel wharf and pier pilings and bulkheads in the harbor has been performed, using an ultrasonic probe to determine underwater metal thicknesses. Corrosion rates of unprotected steel ranging from 2.4-5.2 mils/yr. have been observed. Corrosion is greatest at the mean low water level of a submerged pile, but this level does not necessarily represent the location of maximum structural stress in a bulkhead. Inward facing sheet has considerably less corrosion than outward facing pilings. Variations in metal thickness with depth of water are shown.

5306

RADIOGRAPHIC EXAMINATION THROUGH STEEL USING COLD NEUTRONS

J. P. Barton

Brit. Journal Applied Physics, V. 16, No. 12, December 1965, pp 1833-1839

A neutron beam of energy below 0.005 ev is obtained by placing a polycrystalline beryllium neutron filter and a single crystal bismuth gamma-ray filter in a beam tube inside the reactor shield. The emergent beam is relatively free of fast neutrons and gamma rays and therefore requires little extra shielding. Since the coherent scattering cross section of iron is reduced for neutrons below 0.005 ev, the penetration of the beam is significantly increased. It is also shown that the intensity of scattered neutrons reaching the radiograph is reduced to negligible proportions. Measurements of radiographic contrast confirm that thicknesses of less than 0.01 in. of plastic or other hydro-genous material will remain equally discernible through at least 4 in. of mild steel.

5315

REFERENCE STANDARDS OF RESOLUTION BY X-RAYING AND GAMMA RAYING

M. Ya. Balazovskii

Defectoscopy, Number 1, Jan-Feb 1965 pp 43-54

This paper presents a review of both Soviet and Western literature concerning the development of suitable reference standards. The five points selected for discussion include: (1) standards of detectability of the method of monitoring and their classification; (2) the statistical nature of the detectability of a standard; (3) standards for reproducing the sensitivity and determining the constancy of the method; (4) coefficient of the relative detectability; and (5) reference standards for selecting the radiographic conditions and for investigating the influence of various parameters. (46 references cited)

5317

NONDESTRUCTIVE TEST METHOD ACCURATELY SORTS MIXED BOLTS

NASA TECH BRIEF 66-10574, December 1966

CFSTI, Springfield, Va. 22151

The problem of sorting copper plated steel bolts from nickel plated steel bolts was solved by a method using neutron activation analysis. Copper and nickel plated steel bolt specimen of the same configuration are irradiated with thermal neutrons in a test reactor for a short time. After irradiation, the bolts are analyzed using scintillation energy readout equipment. The bolts having copper plating show a copper peak at 0.51 Mev as distinguished from Ni at 0.848 Mev.

5324

A SHORTENED PROCESSING TIME TECHNIQUE FOR COLOR INDUSTRIAL RADIOGRAPHY

Norman P. Lapinski

Metallurgy Div. Argonne National Lab., Argonne, Illinois, Materials Evaluation, Vol. 25, No. 2, February 1967

By eliminating some of the steps when processing Ektachrome film a desirable color radiograph can be obtained. The length of processing time required to generate a color radiograph by the shortened method is reduced by about a factor of 3. The techniques employed to produce color radiographs as well as a description of the shortened processing technique are reviewed. Some black and white reproductions of color radiographs are included.

5334

AN EVALUATION OF DEEP SUBMERGENCE BUOYANCY MATERIAL UTILIZING PENETRATING RADIATION TECHNIQUES

Bethel R. Johnson

Materials Evaluation Vol. XXV, August 1967, No. 8, pp 191-200

This paper presents some information concerning the syntactic foam used as the buoyancy material in the DEEP QUEST submergence vehicle. In addition, the various nondestructive testing methods employed are reviewed. The specific method developed to measure the very important factor of density deviations is thoroughly discussed. Subject matter includes the technique used, test procedures, results obtained, recommendations, and conclusions.

5335

MICROWAVES DETECT FLAWS IN COMPOSITE MATERIALS

Anthony Hannavy

Product Engineering, July 31, 1967, pp 75-76

A new short-range radar system developed to inspect the solid-propellant and the glass-filament would structure of the Polaris missile for defects is described. The microwave system which utilizes a swept-frequency modulation (FM) technique is compared with standard radar equipment for detecting flaws in the complicated geometry and thicker materials of rockets. The drawbacks of existing NDT techniques such as ultrasonics and x-ray for this work are discussed.

5349

IS THERE ANY CORRELATION BETWEEN FLAWS AND SERVICE PERFORMANCE?

R. Halmshaw

Royal Armament Research and Development Establishment, Fort Halstead, England

Symposium on Correlation of Material Characteristics with Systems Performance, USAF Conference Facility, Orlando AFB, Florida, 10-12 May 1967

By non-destructive testing, most people understand the five techniques — radiography, ultrasonics, magnetic crack detection, penetrants and eddy current testing — and the commonest use of these is for flaw detection in welds, castings and forgings. Evidence is also building up from static and fatigue tests that the flaws found by these NDT techniques are not generally the most significant ones from the point of view of performance in service. Much more significance needs to be given to small surface notches and cracks, and crack-detection inspection methods may prove to be more useful tests. Studies of failures in service suggest that a large proportion of these is due to mistakes in design or to the use of wrong material, e.g. wrongly heat-treated steel, or steel used at temperatures below the brittle/ductile transition region.

5351

AN ENGINEERING BASIS FOR ESTABLISHING RADIOGRAPHIC ACCEPTANCE STANDARDS FOR POROSITY IN STEEL WELDMENTS

H. Greenberg

Westinghouse Labs, Metallurgy Application Section, Pittsburgh, Pa. Symposium on Correlation of Mat. Charac. with Systems Performance, USAF Conference Facility, Orlando AFB, Florida, 10-12 May 1967

Radiographic acceptance standards, such as the ASME Unfired Pressure Vessel Code are critically reviewed. Limits on the size and distribution of porosity in steel welds are analyzed from the viewpoint of susceptibility to failure in service. Radiographic acceptance standards in use today do not reflect the significant advances being made in (1) the fracture mechanics approach to designing for prevention of failure, (2) theoretical studies of the stress concentration effects of holes in close proximity to one another, and (3) the possible use of complementary NDT techniques. Considerable emphasis is placed on the proposition that radiographic acceptance standards for weldments must be designed specifically for each particular application. Considerations applicable to welds in the 120" diameter rocket motor case are cited.

5353

DESIGNING NONDESTRUCTIVE TESTS TO DEFINE MATERIAL CHARACTERISTICS

R. S. Sharpe

Nondestructive Testing Centre, Atomic Energy Research Establishment, Harwell, England.
Symposium on Correlation of Material Characteristics with Systems Performance, USAF Conference Facility, Orlando AFB, Florida, 10-12 May 1967

Before any attempt can be made to correlate material characteristics with systems performance, variability in the characteristics themselves must be carefully particularized. With radiographic techniques spatial information can readily be resolved, but with most of the other forms of non-destructive testing currently in use, the display of test data is generally inadequate for detailed quantitative analysis. Techniques have been developed that now enable structural variables to be identified using conventional principles, but with the results quantitatively displayed as a contoured three dimensional facsimile recording. Several applications where this type of data presentation has been effectively utilized are described and the further potential of the technique is assessed.

5356

RESEARCH AND DEVELOPMENT OF NONDESTRUCTIVE TESTING TECHNIQUES FOR COMPOSITES (AD-825 636)

G. Martin and J. F. Moore

North American Aviation, Technical Report AFML-TR-67-166, June 1967, Wright-Patterson Air Force Base, Ohio

Results of a continuing program to develop nondestructive testing techniques for fiber reinforced metallic matrix composites are described. A literature survey evaluation to determine the potential applicability of nonroutine inspection methods including neutron radiography, neutron activation, nuclear resonance, etc., is presented. Conventional radiographic, acoustic, and electromagnetic inspection methods were applied to four composite material systems and evaluated in terms of defect detection and correlation with the material properties. The results of this investigation were discussed and recommendations for method improvement or development were outlined.

5359

EVALUATION OF NUCLEAR MOISTURE AND DENSITY GAGES

M. S. Kersten and E. L. Skok

U. of Minnesota, Minneapolis, Minnesota, June 30, 1966

Results of an investigation of two types of nuclear density apparatus, a direct transmission device and a backscatter device, for testing soils are described. Measurements of moisture with the backscatter device and of the density of bituminous pavements with a nuclear device are also described. The time requirements for various types of density tests and notes on the maintenance of the equipment are briefly discussed. The summary and conclusions list the probable errors in the nuclear methods and also list the recommended equations for determining densities from count ratios. The manner in which the equipment could be used for additional measurements is indicated.

5360

CERMET BODY NONDESTRUCTIVE TEST DATA EVALUATED BY SPIN TESTS OF BLADES AND BEND TESTS OF BARS

A. G. Holms and A. J. Repko

Journal of NDT, Vol. XVII, No. 3, May-June 1959, pp 156-164

High quality cermet blades, previously screened by surface inspections for flaws were re-inspected at the root by means of several flaw detection and property measurement tests. Statistical techniques were used to compare the correlation of the blade root and modulus of rupture strengths with the several nondestructive test variables. A strong correlation was observed between electrical conductivity and bending strength. The latter also correlated strongly with hardness and some aspects of microstructure.

5361

RADIOGRAPHY WITH A LARGE COBALT 60 SOURCE

V. G. Behal

Journal of NDT, Vol. XVII, No. 3, May-June 1959, pp 172-176

Although there appears to be an optimum thickness for Cobalt 60 radiography, very satisfactory results, from a practical view, were attained on steel sections well outside of this range using a 755 curie source. While a sufficiently intense Cobalt 60 source will produce radiographs of satisfactory sensitivity in relatively heavy sections, it is not possible to avoid excessive scattering by masking the specimen. Therefore, except under ideal conditions, there appears to be a limit for practical radiography in spite of the indications obtained under laboratory conditions.

5366

TOMOGRAPH FOR INDUSTRIAL RADIOGRAPHY

D. Charles

Journal Sci. Inst., Vol. 37, August 1960, p 257

Tomography is a radiographic technique in which relative movements of x-ray tube, subject, and film are controlled so that a defined section of the subject is recorded as a sharp image, superimposed on a diffuse background due to blurred images of the rest of the subject. The capabilities of the tomograph for industrial use are assessed by tests on an assembly of wire mesh gauges. Its practical application has been demonstrated with two types of heat exchangers on which useful detailed observations were made. Tomography is considered to be particularly effective for examination of such assemblies in which repetitive detail is masked by overlying layers.

5370

SIMPLE AUTORADIOGRAPHS TECHNIQUE

T. K. Bierlein and B. Mastel

Rev. Sci. Inst., Vol. 30, No. 1, January 1959, p 46

A new technique which offers excellent definition, contrast, and correlation of tracks in the emulsion with their source has been devised.

5373

NEUTRON RADIOGRAPHY TO DETERMINE THE CONDITION OF THE CHARGE IN EXPLOSIVE DEVICES

H. Heffan, Naval Weapons System, Concord, California

Minutes of the 15th Defense Conference on Nondestructive Testing, 4,5,6 October 1966, Army Materials & Mechanics Research Center, Watertown, Mass. 02172

In recent studies of the applicability of ndt methods for the POLARIS Missile EBW Detonator, containing powdered Pentaerythrite Tetranitrate (PETN), neutron radiography showed the ability to detect slight separations, density change, recrystallization, and moisture in the charge. Further application of neutron radiography to explosive cord assemblies, conventional ammunition primers, detonators, and other loaded items in which the steel, brass, or lead case prevents application of any other ndt method, shows that neutron radiography can satisfy the need for a sensitive examination. Work is continuing with the development of optimum screens, a practical neutron source, other imaging methods, and further perfection of the technique.

5391

CANADIAN GOVERNMENT SPECIFICATIONS BOARD STANDARD FOR CERTIFICATION OF INDUSTRIAL RADIOGRAPHIC PERSONNEL

Nondestructive Testing, Vol. XIX, No. 6, November-December 1961, pp 406-407

This standard provides a recommended procedure by which personnel may be certified to perform industrial radiography according to the following classifications:

- (a) Junior industrial radiographer
- (b) Senior industrial radiographer

5407

NONDESTRUCTIVE INSPECTION TECHNIQUES FOR MULTILAYER CIRCUIT BOARDS

G. B. Mathers

Materials Evaluation, Vol. 25, No. 6, June 1967

When Autonetics undertook a program to miniaturize its computers, a reliable method was needed for interconnecting microelectronic components. The multi-layer printed circuit-board system was selected. Process control problems that developed during multilayer-board fabrication included the determination of proper interconnect alignment, bond integrity, and plating thickness. This paper describes the application of x-ray, ultrasonics, and beta-ray backscatter NDT techniques to these process-control problems.

5408

IDENTIFICATION AND MEASUREMENT OF ULTRASONIC SEARCH UNIT CHARACTERISTICS

Jerry T. McElroy

Materials Evaluation, Vol. 25, No. 6, June 1967

Any standards programs for ultrasonic testing must logically start with an accurate knowledge and understanding of the search unit beam characteristics. The methods used to analyze the sound beam must provide a high degree of signal "purity". The crystal excitation and the amplification of the information must be accomplished without distortion. With a pure system of analysis, such factors as frequency, sensitivity, damping factor, beam profile, and distance amplitude characteristics can be expressed in basic units of measurement. This paper discusses approaches to the evaluation of ultrasonic search units.

5418

RADIOGRAPHIC INDICATIONS AND MECHANICAL PROPERTIES OF BRONZE CASTINGS

S. Goldspiel and H. W. Lloyd

Mod Cast, Vol. 49, No. 1, January 1966, pp 80-90

The report describes development of reference radiographs for bronze castings and some data on the correlation of radiographic indications with mechanical properties for more meaningful application of the former. It is concluded that the severity of radiographic indications can be used to evaluate castings loaded in tension. Radiography, however, cannot be used alone for the evaluation of performance of castings which are loaded in bending. In these cases greater reliance must be placed on nondestructive testing methods which evaluate surface or near-surface discontinuities.

5420

RECENT DEVELOPMENTS IN PIPE CORROSION INSPECTION TECHNIQUES

G. G. Page

Corrosion Tech, Vol. 12, No. 10, October 1965, pp 40-44

Advantages and limitations are discussed of test methods for pipelines and tubing in petrochemical and power plants. On-stream inspection is limited to ultrasonic, radiographic and electrical resistivity techniques which may be supplemented with optical aids such as television and cine camera equipment during downtime inspection. Generally the eddy current method is limited to the testing of nonferrous tube materials such as brass and Ti. Caliper gaging is used to internally survey the cores of oil well pipes.

5422

SELECTION/DEVELOPMENT OF NDT FOR QUANTITATIVE PREDICTION OF MATERIALS PERFORMANCE

C. H. Hastings

AVCO, Space Systems Division, Lowell, Mass. Symposium on correlation of Material Characteristics with Systems Performance, USAF Conference Facility, Orlando, AFB, Florida, 10-12 May 1967

An oversimplified relationship can express systems performance in terms of the quantitative definition of materials properties or behavior characteristics under environmental stresses. Materials properties are in turn controlled by chemical or structural variables in the materials which, if understood, can frequently be quantitatively defined by nondestructive tests. Ideally, therefore, carefully selected and applied NDT should permit quantitative prediction of at least some aspects of systems performance. This paper discusses three examples of NDT selection/development in which thermal conductivity of graphite for re-entry heat shields or rocket nozzles, mechanical properties of glass reinforced plastics, and oxidation resistance of diffusion-formed coatings on refractory metals are discussed.

5435

ULTRASONIC INSPECTION OF WRAPPED SOLDERED TUBING

A. T. Nikolaenko, et al

Defectoscopy, No. 3, May-June 1965, pp 201-205

Methods are described for the inspection of soldered tubing to test for segregation, wherein a high rate of inspection is achieved. A description of ultrasonic direct-transmitting-receiving units is given, along with a block diagram of a flaw detector for the inspection of soldered tubing at rates up to 50 meters/minute.

5439

RADIOGRAPHIC SENSITIVITY

A. J. Stevens

Materials Evaluation, Vol. XXV, No. 7, July 1967, pp 167-172

Radiographic sensitivity is defined, and a mathematical expression describing it is derived. Evidence is presented that radiographic sensitivity, contrary to popular opinion, is independent of specimen thickness per se, and that modern penetrameter design is based on invalid assumptions. Designs for penetrameters are offered that provide a more realistic measure of the quality of a radiographer's techniques.

5441

THE X-RAY VIDICON TELEVISION IMAGE SYSTEM*

R. C. McMaster, et al

Materials Evaluation, Vol. XXV, No. 3, March 1967, pp 46-52

A television X-ray image enlargement system has been developed for inspection of missile case wall materials and weldments. Small vidicon television camera tubes with photoconductive target layers are used to transform X-ray images directly into video signals. After transmission and amplification of these signals in the closed-circuit television system, the X-ray images are reproduced with 30-diameter enlargements on the output picture tube. Two per cent (IT hole) penetrameter sensitivities have been obtained with 1/8- and 1/4-in. steel specimens, and resolution of the order of 10 microns (400 μ in.) has been attained with both stationary and in-motion inspection.

*"X-Ray Image System for Nondestructive Testing of Solid Propellant Missile Case Walls and Weldments", Final Report, WALTR 142.5/1-4, August 1962

5445

USING THE HALF-VALUE LAYER TO SOLVE RADIOGRAPHIC PROBLEMS

A. E. Oaks

Nondestructive Testing, Vol. XVI, No. 5, Sept.-Oct. 1958, pp 381-384

The half-value layer (HVL) of a material is often thought to be a theoretical concept which has little or no practical application in the solution of industrial radiographic problems. This is unfortunate because a working knowledge of the effective or polychromatic HVL such as is obtained with an x-ray machine often leads both to a better understanding of the effect of different radiographic problems which are sometimes more than just theoretical interest to the practicing radiographer. The application of HVL data to the solution of these problems are presented.

5446

RADIOGRAPHY AND AUTORADIOGRAPHY OF PLUTONIUM

D. E. Elliot and G. H. Tenney

Nondestructive Testing, Vol. XVI, No. 5, Sept.-Oct. 1958, pp 430-437

By selecting the right energy of radiation, satisfactory radiographic inspection of plutonium can be performed, thereby giving valuable information about the internal physical condition of the material. When familiar with the type of radiation originating in this metal, radiographers can undertake preventive measures to avoid its damaging influence on the radiographic image. At the same time, the presence of radiation can be utilized to study the quality of the protective coatings surrounding the material. Such study is absolutely necessary to protect the objects under investigation as well as the lives of the workers handling this material.

5447

NONDESTRUCTIVE TESTING METHODS OF QUARTERMASTER ITEMS AND AERIAL DELIVERY EVALUATION

R. W. Browne

Nondestructive Testing, Vol. XVI, No. 5, Sept.-Oct. 1958, pp 385-396

Throughout industry and most other Defense Departments, Nondestructive Testing is used extensively for inspection and quality control. Quality control in the generally accepted meaning of the term, means controlling quality at the time of production. The Quartermaster Corps has an unusual position in that quality must be controlled at the time of production, during testing and evaluation, and throughout storage until use. As a quality control and an inspection method, non-destructive testing presents a triple use throughout the Quartermaster Corps—it is used as an inspection method before testing, a control method during testing, and an evaluation application following the test.

5448

DESCRIPTION AND PROPERTIES OF THE PANEL X-RAY AMPLIFIER

B. Kazan

Nondestructive Testing, Vol. XVI, No. 5, Sept.-Oct. 1958, pp 438-447

The present experimental fluoroscope screen, produces images 100 times brighter. For exciting the amplifier a total x-ray exposure comparable to or less than Type F film is required. After cutting off the x-rays, the slowly decaying image persists for a period up to 30 seconds or longer. However, the image can be erased at any arbitrary time by electronic means and the panel excited with a new image. The best panels have a limiting resolution of 80 lines per inch. Because of the high gamma, the image contrast is increased. Contrast sensitivities of about 4% and detail sensitivities of about 6% have been obtained.

5455

CINÉ—RADIOGRAPHY OF THE CASTING OF STEEL

R. Halmshaw, et al

Royal Armament Research and Development Establishment Memorandum Report, R.A.R.D.E. Memorandum 10/66, March 1966, 16 p

A description of the use of a television/fluoroscopy X-ray image intensifier equipment for the study of the pouring and solidification of small steel castings is given. This equipment has been used in conjunction with a 300 kV x-ray set and a synchronized ciné camera to study the flow of molten steel into small moulds with various gating arrangements. The development of internal defects during solidification of the castings has also been shown and the influence of the material of the mould is demonstrated. Possible developments in the equipment to extend its usefulness in this application are discussed.

5461

NONDESTRUCTIVE TESTING TECHNIQUES FOR MULTILAYER PRINTED WIRING BOARDS

J. F. Blanche

Nondestructive Testing: Trends & Techniques, NASA SP-5082. Proceedings of the Second Technology Status and Trends Symposium, Marshall Space Flight Center, 26-27 October 1966

A number of methods for nondestructively examining multilayer printed circuit boards is considered. Among these are thermal, eddy current, intermodulation, E-field sensors, and radiography. The two methods showing the greatest promise are radiography using an axial transverse laminographic technique and a mutual coupling eddy current method. Details of both methods are given and the laminographic technique appears to offer potential in several types of radiographic inspection problems.

5468

X-RAY SPECTROCHEMICAL METHODS FOR ANALYSIS OF COPPER ALLOYS

L. J. Moorhead and O. J. Littig

Rock Island Arsenal Tech. Rpt. No. 67-8-49, March 1967

X-ray spectrochemical methods were developed for both solid and solution samples. Solid standards were prepared in an induction furnace or a small arc furnace. The standards were analyzed by wet chemical methods and by X-ray solution techniques. Analytical working curves were prepared for manganese bronzes, aluminum bronzes, and brasses using the Rock Island Arsenal secondary standards and available primary standards. Problems of short time instrumental drift were minimized by alternating samples and standards and averaging results. Problems in long time instrumental drift were solved by applying a mathematical computation method suggested by Loranger.

5471

NUMERICAL VALUES OF ACOUSTIC SURFACE WAVE VELOCITIES (AD-675 971)

G. Mayer and B. Lamers

Georgetown Univ., Washington, D. C., Dept. of Physics, Rept. No. TR-1, October 1966, 38 pp

The velocity of acoustic surface waves on solids is calculated in terms of the values of the transverse wave velocities for Poisson's ratios from 0.0001 to 0.5000 in steps smaller than 0.004.

5475

NONDESTRUCTIVE DETERMINATION AND EVALUATION OF METALLURGICAL MICROSTRUCTURES OF STEEL GUN TUBES

The Applied Physics Branch, U. S. Army Materials and Mechanics Research Center, Letter Report, 26 October 1966

Summary of actions taken in regard to effecting a solution to the problem of nondestructively determining and evaluating metallurgical microstructures of steel gun tubes. Limited technical content.

5476

RADIATION SAFETY IN RADIOGRAPHY

H. Heffan

Materials Evaluation, Vol. 25, No. 4, April 1967, pp 83-90

A general review of the methods and criteria for establishing radiation safety procedures in industrial x-ray and gamma-ray radiography programs is presented. The use and importance of the hazards analysis is discussed in relation to three types of installations, and the current thinking regarding the health of radiation workers and the Maximum Permissible Dose are reviewed.

5492

CERTIFICATION OF INDUSTRIAL RADIOGRAPHERS IN CANADA

E. T. Watterud

Nondestructive Testing, Vol. XIX, No. Nov.-Dec. 1961, pp 402-405

It is the purpose of this presentation to report on the work that has been done in Canada toward a certification arrangement for industrial radiographers. Included is a discussion of this project from its birth in early radiographic standards work that led to the idea for a certification program, through the range of problems encountered during its development, and a report on the program as it stands today.

5495

NONDESTRUCTIVE TESTING FOR SPACE APPLICATION (N67-27429)

W. A. Zoran

Phase I, July-September 1966

Hamilton Standard Report for NASA, Huntsville, Ala.

The need for development of nondestructive testing technology for in-space use is clearly defined by a thorough examination of current and proposed future space programs. Its use, and selection of the best methods/methods of inspection considering ultrasonics, eddy current and radiography are also discussed. These are related to proposed in-space fabrication, repair and other functional requirements such as medical, preventive maintenance and scientific research aid. A preliminary design concept of an integrated ultrasonic-eddy current instrument with a detachable radiograph unit is presented. The space environments compatibility and the required human engineering aspects are defined with a test plan for their evaluation.

5497

ELECTRON RADIOGRAPHY

W. L. Shelton

Technical Report AFML-TR-67-114, June 1967

Air Force Materials Laboratory (NAMN), Wright-Patterson Air Force Base, Ohio 45433

Electron radiography has been investigated as a method for inspecting ultra-thin materials and for determining the quality of refractory coatings. A brief review of the basic x-ray absorption process is presented which is applicable to both conventional and electron radiography. The electron transmission and back emission techniques are described in detail, followed by experimental results and a discussion of potential areas of application. The feasibility of the back emission technique has been demonstrated for detecting failure sites in Cr-Ti-Si refractory coatings on Cb 752 substrates and low and high density areas in a silicide coating on a TZM substrate.

5498

NONDESTRUCTIVE TESTING OF PLASTICS FOR AEROSPACE APPLICATIONS

L. C. Lynnworth

AVCO Corporation, Wilmington, Mass.

Presented before Metropolitan Section, Society for Nondestructive Testing, January 10, 1962, New York City

This paper illustrates how the research and inspection functions of nondestructive tests allow us to exploit the full capabilities of plastics for aerospace or other critical applications. Measurement of dielectric constant, ultrasonic response, x-ray absorption and thickness are correlated with service behavior of plastic materials, aerospace illustrations show that suitable nondestructive test combinations, chosen from the electromagnetic and mechanical spectra, contribute to accelerated R&D, and improved reliability of production parts.

5502

A QUANTIZED EDDYFAX TECHNIQUE APPLIED TO THE INSPECTION OF REACTOR-GRADE GRAPHITE

R. S. Sharpe, et al

The British Journal of Nondestructive Testing, Vol. 9, No. 3, September 1967, pp 80-85

This report describes the Eddyfax eddy current technique which has provided a satisfactory production inspection procedure for graphite components for reactor. Limitations of radiographic, ultrasonic, and penetrant techniques for inspection of graphites are discussed. Results of quantizing the Eddyfax facsimile records are presented.

5505

FIELD PERFORMANCE OF A TELEVISION X-RAY SYSTEM

H. Berger and A. L. Pace

Nondestructive Testing, Vol. XV, No. 1, Jan.-Feb. 1957, pp 26-29

A television x-ray system employing a large-area photoconductive x-ray pickup tube is described. An outstanding characteristic of this system is the very great range of x-ray energies that yield a useful response. Contrast sensitivities of the order of 2 to 6 per cent are observed over the range from 40 to 300 kvp, increasing to 10 per cent at 2 Mev and to 20 per cent at 6 Mev. Detail sensitivity is such that objects of the order of 0.01 in. can be resolved readily. These, and other characteristics of the system, such as the advantage of remote viewing of the x-ray image in a normally illuminated room, make it readily adaptable to many x-ray inspection problems. Some typical applications are discussed.

5508

CESIUM-137 AS A VERSATILE RADIOGRAPHIC TOOL

M. Rhoten

Nondestructive Testing, Vol. XVI, No. 3, May-June 1958, pp 261-264

For the foundry or manufacturer whose demands for radiography are 8 to 10 films per day or less, it has been shown that isotopes will adequately and economically do the job. In choosing an isotope, cesium-137 answers the demand for a source that will cover the most widely used range of thicknesses. Giving 2 per cent sensitivity on a range of 3/4 to 3-1/2 inches of steel, with its 30 year half life, it is less expensive than any other source of radiation.

5509

GAMMA RADIOGRAPHY OF LIGHT METALS

E. T. Clarke

Nondestructive Testing, Vol. XVI, No. 3, May-June 1958, pp 265-268

Characteristics of the two most promising soft gamma ray emitters thulium-170 and iridium-192 are presented. With iridium-192, two per cent radiography is achievable on thicknesses greater than about 2 inches of aluminum or 3 inches of magnesium. Typical exposure time is 1/2 minute for a 30 Rhm source at 12 inches from the medium speed film with lead screens. With thulium-170, two per cent radiography can be obtained on 0.030 inch steel, 1/2 inch aluminum, or 3/4 inch magnesium. Medium speed film requires 1/2 hour exposure to a 0.1-0.2 Rhm source at 12 inch distance, through this can be reduced to 1/3 minute if the graininess of Kodak Type F with Hi-speed Patterson screens can be tolerated.

5513

THICKNESS MEASUREMENTS BY NONDESTRUCTIVE TESTING METHODS

R. E. Cofield

AEC R&D Report Y-1535. Union Carbide Corp., Nuclear Division, Oak Ridge Y-12 Plant, Contract W-7405 eng 26, 21 June 1966

Dimensional parameters such as thickness can frequently be measured by nondestructive testing methods which are normally used for the evaluation of internal quality. These methods generally respond to the nature of the test object material rather than merely to the relative location of its surfaces. Thus, many of the techniques can measure thickness when only one surface is accessible or when the thicknesses of several layers of materials are involved. Tangential projection radiography, narrow-beam radiation absorption gaging, radiation backscatter, electromagnetic induction, microwave interaction and ultrasonic wave propagation are practical thickness-measurement techniques that are discussed in this report.

5520 **NONDESTRUCTIVE DESIGN PROPERTY EVALUATION OF FABRIC REINFORCED COMPOSITES (AD-801 547)**

J. R. Zurbrick and A. W. Schultz

Testing Techniques for Filament Reinforced Plastics - Sponsored by AFML and ASTM
Sept. 1966, AFML-TR-274, pp 675-700

Ultrasonic, dielectric and penetrating radiation methods have been investigated to determine their separate and combined capabilities for quantitatively predicting design properties of glass and carbon fabric reinforced composites, such as resin content, glass content, porosity. The resin systems evaluated were epoxy, phenolic, polybenzimidazole, polyester and silicone. The ability to draw meaningful correlations between quantitative NDT responses and such properties as density and tensile modulus is demonstrated. The use of these quantitative measurements for identifying uncontrolled variables and monitoring process steps for minimizing manufacturing variability is discussed.

5523 **EXPERIMENTAL DETERMINATION OF FILM FACTOR OF SCATTERED RADIATION**

M. Ya. Balazovskii

Defectoscopy, No. 6, Nov.-Dec. 1965, pp 482-484. Available from: Consultants Bureau,
227 W. 17th St., N. Y. 10011

A method is described for determining the film factor of scattered radiation by means of a film detector. It is shown that the relationship between the film factor and radiation hardness has a peak. For small specimen thickness, the peak is observed at a radiation hardness of up to 200 kV, and shifts to the right as the thickness of the x-rayed layer increases.

5527 **THALLIUM²⁰⁴ X-RADIOGRAPHY**

J. G. Kereiakes and G. R. Kraft

Nondestructive Testing, Vol. XVI, No. 6, Nov.-Dec. 1958, pp 490-494

X-radiation emitted by a thallium²⁰⁴ source can be used for technical radiography of fairly thin objects. The radiograph of a radiation dosimeter shows rather good definition and contrast. Scintillation spectrometer measurements of the energy spectrum emitted by the source used in this study shows a good 70 Kev energy peak. Methods for increasing source efficiency are discussed to extend the use of this source and similar sources to certain practical applications in the low energy region (below 100 Kev).

5228 **INDUSTRIAL APPLICATIONS OF RADIOISOTOPES, NUCLEAR LIQUID LEVEL GAUGES**

S. Regal

Nondestructive Testing, Vol. XVI, No. 6, Nov.-Dec. 1958, pp 493-494

Among the instruments that use radioisotopes, one that has found many applications is the liquid level gauge. As its name indicates it determines the level of a liquid or granular substance in a container. There are many cases when a simple level device like a glass tube or a simple float, would not work, such as coke levels, sanitary containers, etc. In those cases the problem can be solved by the use of a nuclear instrument. The industrial applications of nuclear liquid level gauges to increase yields and quality, control processes, and decrease costs are the subject of this article.

5531

A RADIOACTIVE METHOD FOR MEASURING VARIATIONS IN DENSITY IN CONCRETE CORES, CUBES & BEAMS

D. G. Harland

Magazine of Concrete Research, Vol. 18, No. 55, June 1966

This paper describes in detail apparatus for measuring the variation of density along cores and beams of concrete. The variation of density is determined by measuring the change in the absorption of gamma radiation from a one millicurie source of cesium 137. Calibration, accuracy, effect of position of sample, speed of testing, and materials tested are discussed as test parameters.

5535

DEVELOPMENT OF NONDESTRUCTIVE METHODS FOR THE QUANTITATIVE EVALUATION OF GLASS-REINFORCED PLASTICS (AD-815 360)

J. R. Zurbrick

Avco Corporation, Lowell, Mass. — Technical Report AFML-TR-66-269, March 1967

Wright-Patterson Air Force Base, Ohio

This report describes an effort devoted to experimental development, correlation, and consideration of practical NDT technique and instrumentation problems associated with several glass-reinforced resin laminate systems typical of those used in structural aerospace components. Test specimens were produced under laboratory conditions in order that resin content and void content could be intentionally varied. The laminates so acquired were screened qualitatively for defects and quantitatively for variability, using NDT techniques. Appropriate destructive test specimens were cut from them. Quantitative NDT response values were obtained from the specimens, destructive tests were performed to obtain physical and mechanical properties, and correlations between NDT responses and laminate properties were derived and statistically analyzed.

5537

AN X-RAY TELEVISION SYSTEM FOR ELECTRONICS PARTS INSPECTION (AD-656 892)

D. B. Gilmore and F. T. Marcellino

Technical Memorandum TG-920, July 1967. The Johns Hopkins University--Applied Physics Lab, 8621 Georgia Ave., Silver Spring, Md. 20910

This report describes an x-ray television system which is a refinement of the Ohio State University--AMK System for the inspection of electronics parts. The article discusses the advantages and limitations of the method, correlation between film and "filmless" radiography, and presents actual inspection experience with the x-ray television system.

5548

DEVELOPMENT OF A RADIOGRAPHIC TECHNIQUE FOR MATED ELECTRICAL CONNECTORS

R. W. Browne and W. B. Robertson

Materials Evaluation, Vol. XXV, No. 10, October 1967, pp 221-225

The use of penetrating radiation for the inspection of Polaris missile mated electrical connectors is described. Inspection techniques and equipment for use in-house, in the field and on submarine tenders is discussed. A new, compact radioisotopic camera, with all accessories for complete radiography, is described and illustrated. Problems encountered with multi-pin connectors are discussed, as are design recommendations to eliminate technical difficulties involved in observing inserts and receptacles. A summary of the advanced connector design, as applied to Poseidon, is also included.

5560

THE FUNDAMENTALS OF DIFFERENTIAL RADIATION MEASUREMENTS

R. Nickerson

Nondestructive Testing, Vol. XVI, No. 2, March-April 1958, pp 157-161. Also published in Vol. XVI, No. 1, January-February 1958

The use of radiation as a means of nondestructive testing or gauging is based upon the ability of the user to discriminate between changes of small magnitude in the amount of radiation which interacts with the work. It is the purpose of this paper to summarize the mathematical treatment of absorption processes and to clarify the factors which affect the sensitivity of one's ability to discriminate between these small differences.

5561

AN X-RAY IMAGE INTENSIFIER OF THE CLOSED CIRCUIT TELEVISION TYPE

A. Wegener

Nondestructive Testing, Vol. XVI, No. 1, January-February 1958, pp 16-23

Each one of the four basic intensifier systems known today have characteristic limitations but all have one fundamental limitation, namely, statistical fluctuation. These fluctuations in the various transducing processes (regardless of the type of chain or system) set the ultimate limit of any system to gather intelligence, including the human eye. With the light intensifier to be described, a number of valuable results have been obtained in the x-ray field as well as other low light level applications. Penetrameter sensitivities close to radiographic levels have been obtained some ranges. Also included is a review of the four basic types of image intensifiers, namely: 1) the closed circuit television type, 2) the solid state type (electroluminescent), 3) the Coltman image tube and variations thereof, 4) the "flying spot" system.

5563

NONDESTRUCTIVE TESTING OF FUEL ELEMENTS FOR DIDO

J. Thewlis and R. T. P. Derbyshire

Nondestructive Testing, Vol. XVI, No. 2, March-April 1958, pp 154-157

A description is given of the methods employed in the nondestructive testing of DIDO fuel plates for bonding, homogeneity, and size and location of core. The main part of the paper is devoted to the description of an x-ray fluoroscopic apparatus by the use of which the size and location of the fuel core can be rapidly and easily determined by semi-skilled labor. The size is checked by referring the projected x-ray image of the core to the image of gauge-wires projected on a fluorescent screen equipped with suitable scales, and the position of the core is also established with respect to these. Locating holes are punched when the fuel core is correctly positioned. The holes then serve to locate the fuel plate in a cropping machine which trims off the surplus sheath metal.

5564

REVIEW OF NONDESTRUCTIVE TESTING TECHNIQUES FOR DETECTING LACK OF PENETRATION IN ALUMINUM FUSION WELDS (AD-661-044)

J. A. Gibson

Battelle Memorial Institute

Redstone Scientific Information Center, Redstone Arsenal, Alabama RSIC-701

October 1967

This report summarizes a literature survey on the detection of incomplete penetration in butt joints in aluminum fusion welded from two sides. Two approaches to radiographic inspection also are reviewed which might be developed into satisfactory inspection techniques for improved reliability in detection of incomplete joint penetration. In addition two approaches to improve ultrasonic inspection are reviewed. Recommendations are made for future research to develop the potential of these approaches.

5570

APPLICABILITY OF RADIOGRAPHY TO INSPECTION OF WOOD PRODUCTS

J. S. Mathershead & S. S. Stacey

Proceedings Second Symposium on the Nondestructive Testing of Wood, April, 1965, Spokane, Washington, Washington State University, pp 307-336

The application of radiographic techniques to the inspection problems of the wood-utilization industries is reported. The radiographic method is described in terms of exposure parameters and their effect on the radiographic image. Problems unique to wood radiography are discussed. Field examinations of utility poles containing varying amounts of decay are detailed to illustrate application of the techniques. Potentialities of x-ray inspection in assessing quality and properties of various wood products are discussed.

5573

BETA RADIATION CORROSION DETECTION STUDY (Not at DDC)

A. M. Malloy, et al

Industrial Nucleonics Corp., Columbus, Ohio

Naval Air Systems Command Contract No. NOW 66-0440-C, 31 May 1967

The design of a gauge to demonstrate the use of beta radiation for detecting corrosion occurring at the interface between an aluminum substrate and an overlying organic protective coating is described. Test results with calibrated surface corrosion samples fabricated from aluminum corrosion products (al 203) and results of work concerning corrosion and pitting detection on the underside of thin metals such as aluminum and magnesium aircraft skins are discussed. Also, photographs of the test results are given for surface and sub-surface corrosion detection.

5575

THE VISIBILITY OF DETAIL OBTAINABLE WITH INDUSTRIAL X-RAY FILM

H. R. Splettstosser

Materials Evaluation, Vol. XXV, No. 11, November 1967, pp 245-253

The signal contrast (AE/E , where E is exposure) required for threshold visibility of circular detail, that is, detail which is similar to a penetrometer hole, has been determined as a function of image diameter for Kodak Industrial X-ray Films, Types AA, KK, M and R. Data were obtained under "scatter-free" conditions with 30-kv radiation. The exposure times required to render visible penetrometer holes of various sizes were calculated. These results were checked against those obtained by practical radiographic techniques, and it is shown that, for a given exposure time, radiographic sensitivity increases in a quantitative manner with decreasing film speed.

5578

BROAD AND NARROW BEAM ATTENUATION OF Ir^{192} GAMMA RAYS IN CONCRETE, STEEL, AND LEAD

V. H. Ritz

Radiation Physics Lab. National Bureau of Standards, Washington, D. C.

Broad and narrow beam attenuation curves were obtained experimentally for Ir^{192} gamma rays in concrete, steel, and lead. The results were compared with those of other workers. The narrow beam attenuation curves were found to agree with the theoretical curves calculated from the spectrum of Johns and Nablo and the X-ray attenuation coefficients of White.

5579 **PRINCIPLES OF HIGH ENERGY RADIOGRAPHY**

S. S. Stacey

ANSCO, A Division of General Aniline and Film Corp., Binghamton, N. Y.

More sources of high-energy radiation — radioisotopes and super-voltage X-ray generators — are being used each day in the field of industrial radiography. Since the quality of a radiograph is related to the energy of the exposing radiation it is important that the basic principles governing this relationship be thoroughly understood. Consequently, the effects of energy upon scattered radiation, radiographic contrast and image sharpness are discussed and illustrated. In addition, means for exercising control over radiographic quality are reviewed. These include the choice of the proper radiation source, film type and film density for the job at hand.

5582 **INFLUENCE OF ABSORPTION DISCONTINUITIES ON RADIOGRAPHS MADE WITH MASKING TECHNIQUES**

H. K. Herglotz

Institute of Experimental Physics, Tech. Univ. in Vienna, Austria

Nondestructive Testing, Vol. XV, No. 6, November-December 1957, pp 356-358

The difficulties in x-radiography arising from the characteristic absorption of an imbedding fluid can be avoided in some cases by proper choice of solution. The explanation of the effect given by F. Regler determines the choice of solution. Uniform film exposure can be obtained behind samples of constant thickness but composed of different layers of aluminum and uranyl nitrate solution. This was shown to be true up to tube voltages of 100 kvp.

5587 **ON THE RELATION BETWEEN THE NONDESTRUCTIVE TESTING INFORMATION OF STEEL WELDS AND THEIR MECHANICAL STRENGTH**

Y. Ishii, et al

Japan Welding Engineering Society, The Japanese Society for Nondestructive Inspection — 196.

The study was conducted to determine the effect of defects in steel welds on their mechanical strength. Various defects were artificially introduced in steel butt welds ranging in thickness from 10 to 100 mm. The welds were then subjected to static and fatigue loading over a wide temperature range. Defects were found not to have a great effect on the static strength at room and elevated temperatures, but their effect became apparent at temperatures lower than 100°C was dramatic. Defects affected the fatigue strength even at room and elevated temperatures.

5592 **RADIOISOTOPE GAUGES SHELL STRENGTHS**

News Release Oak Ridge National Laboratory, Oak Ridge, Tenn. No. NR-ORNL-323

March 16, 1967

A pinpoint-size source of radioactive material which can be used in the non-destructive determination of the thickness of many very thin objects, or even coatings on the outer surface of an object is briefly described. Current and possible uses of the source are listed.

5594

DEVELOPMENT OF NONDESTRUCTIVE DYNAMIC MONITORING INSTRUMENTATION FOR RESIN IMPREGNATED GLASS ROVING (AD-819 204)

R. L. Novkov

Ferro Corporation, Mobile, Alabama, July, 1967 — U. S. Naval Applied Science Lab.

The feasibility of dynamically measuring certain properties of preimpregnated fiberglass roving during its manufacture is reported. The properties to be monitored non-destructively include band width, glass weight per yard, resin/glass ratio and state of resin advancement. The program has shown that nondestructive measurement of band width using light sensing elements is both accurate and economical. The measurement of the uniformity of glass weight with a beta gauge is not economical, nor as accurate as desired and the dynamic measurement of the degree of resin advancement by the same technique is not feasible.

5608

NEW NDT METHODS PROBE: THE LOOK, SOUND, AND SMELL OF QUALITY

Steel, February 14, 1966, pp S-1—S-8

A feature article on new trends in NDT, and written for the layman. Covered briefly are micro-waves, infrared, microradiography, ultrasonics, eddy, and olfactronics, the latter being the art of detecting odors peculiar to corrosion, plastic impurities, surface microorganisms, etc.

5620

BOND INSPECTION BY SCANNING IMAGES IN SCINTILLATING CRYSTALS (AD-650 876)

C. H. Dyer, et al

U. S. Naval Ordnance Laboratory, White Oak, Md. NOLTR 67-36, 15 March 1967

Characteristics of filmless methods of bond inspection for large diameter motors are presented. A system which makes use of sodium iodide crystals to transform radiation intensity into light patterns is described. Limitations of the system due to the relatively poor image formation ability of a scintillating crystal are given. Potential developments to improve its performance are listed.

5621

A REFERENCE WEDGE X-RAY GAGE

S. Bernstein

Nondestructive Testing, Vol. XV1, No. 4, July-August 1958, pp 305-312

X-ray thickness gages of several types are available on the market at present for a large variety of applications. One of the most recently developed gages is described here, and is unusual in its high stability, simplicity, and versatility.

5626

CLASSIFICATION OF CONTRACTORS' STANDARDS FOR THE PROCUREMENT OF BUREAU OF AERONAUTICS ALUMINUM AND MAGNESIUM CASTINGS

E. Criscuolo and N. Modine

Nondestructive Testing, Vol. XIV, No. 6, November-December 1956, pp 28-31

The analysis of films submitted to the Bureau of Aeronautics by four airframe manufacturers as acceptance standards for the procurement of aluminum and magnesium aircraft castings has been completed. Each defect of reference radiographs of aluminum and magnesium castings. The acceptable grade limit was found to vary for manufacturers between Grades 4 and 5. Defects as high as Grade 7 were found. These data are based on a survey of approximately 800 castings representing about 1686 films

5627

BROAD BEAM ATTENUATION DATA FOR 50 TO 300 KVP X-RAYS

E. Trout, et al

Nondestructive Testing, Vol. XIV, No. 6, November-December 1956, pp 24-27

X-ray installations operating at voltages up to 300 kvp have generally made use of lead shielding. The use of concrete as a shielding material has usually been considered in the case of installations operating at 400 kvp or more. At the lower voltages, lead is a very effective barrier since photo-electric absorption accounts for most of the attenuation at the lower energies. In the planning of new installations it may be desirable to use concrete even at the lower voltages because of the ease of installation or for structural reasons. There are also instances where existing concrete structures may be used to provide all or part of the necessary shielding.

5628

RADIOGRAPHY IN PRODUCTION CONTROL AND INSPECTION OF SUBMINIATURE TUBES

E. Kolm

Nondestructive Testing, Vol. XIV, No. 6, November-December 1956, pp 20-23

The basic requirement for precision radiography lie in the smallness of x-ray source, the constant potential of the voltage across the tube, the adequacy of target cooling, permitting relatively long exposures necessary for the required contrast, and the ability to mass-radiograph while treating the accuracy of the geometrical relation between the x-rays and the tubes. In essence, no basically new principles are involved but rather a refinement of x-ray tube design, power supplies, and the mechanics of mass producing photographic images with detail normally expected from laboratory environments.

5636

NONDESTRUCTIVE TESTING OF MECHANICAL PROPERTIES OF REFRACTORY MATERIALS

G. E. Lockyer and E. A. Proudfoot

Avco Space Systems Div., Lowell, Mass. American Ceramic Society Bulletin, Vol. 46, No. 5, May 1967, pp 521-526 AVCO Report No. AVSSD-0068-66-PP, June 1966

Ultrasonic and radiomatic techniques for application to the nondestructive evaluation of refractory materials are discussed. Material density is obtained from gamma ray transmission. Ultrasonic velocity measurements are used to evaluate Young's modulus and to estimate the ultimate tensile strength. Although measurements were mainly confined to graphite, application of the same techniques to other materials systems is indicated.

5639

QUANTITATIVE ANALYSIS OF IRON ORES BY SCATTERED B-RADIATION

N. V. Gorbatyuk

Zavodskaya Laboratoriya, Vol. 29, No. 6, pp 730-732, June 1963

A method is described for determining the amount of iron in ores by the intensity of scattered B-radiation from Sr^{90} . The analysis takes 3-5 minutes. The maximum difference between these results and the results of chemical analysis is 0.3-0.4%. The apparatus was calibrated by using samples of the same ores used in chemical analysis.

5642

HIGH RELIABILITY SCREENING OF SEMICONDUCTOR AND INTEGRATED CIRCUIT DEVICES

J. Lombardi, et al

NASA Contractor Report, NASA CR-721, April 1967, pp 63-98

Grumman Aircraft Eng. Corp., Bethpage, N. Y.

This report on a series of nondestructive tests on ICs to evaluate their performance, develop general specification requirements and limits, and provide a basis for sample selection prior to destructive testing. Test methods include external visual and mechanical inspection, x-ray vidicon analysis, electrical tests, burn-in with variables data, and computerized variables analysis. The latter two are marginally considered to fall into any accepted NDT category. A summary of results and recommendations for application of the methods to specifications are included.

5643

A SYSTEM TO MEASURE FLUX RESIDUE ON CIRCUIT BOARDS

I. Sturman and I. Wright

Materials Evaluation, Vol. XXV, No. 12, December 1967, pp 278-282

The amount of residual flux on automatically processed circuit boards was determined by an inspection system which measured a radioisotope tracer in the flux. A large flat-area beta detector was developed for this purpose. Measurements indicated that less than one per cent of the flux remained after board processing to applicable specifications. Because the study was performed with the use of production personnel in a production area, more extensive and detailed than usual radiological health precautions were necessary. These were shown to be economically reasonable, thereby qualifying the radioisotope inspection technique as a production tool for predicting corrosion potential due to production residue.

5646

INVESTIGATION OF NONDESTRUCTIVE METHODS FOR THE EVALUATION OF GRAPHITE MATERIALS (AD-816 960L)

G. E. Lockyer, et al

Avco Corp., R&D Division, Lowell, Mass.

Wright-Patterson AFB, Ohio 45433, Technical Report AFML-TR-67-128, June 1967

Continuation of investigation begun in April 1964. Verification of the applicability of the various NDT techniques and correlation to characterize graphite in relation to service performance stressed. Statistical analysis of these correlations were performed thereby establishing the significance of the correlations for predicting the related material properties. An extensive analysis of the application of NDT flaw testing and properties evaluation in regard to quality and reliability presented. A detailed discussion of infrared technique development activities for measuring thermal properties given, and the influence of attenuation and the related effects of frequency distortion on velocity measurements evaluated and described.

5662

RADIOGRAPHIC STANDARDS FOR PRODUCTION AND REPAIR WELDS Not at DDC

Bureau of Ships, Navy Department, Washington, D. C., NAVSHIPS 0900-9000, August, 1965

This document provides radiographic standards to determine the acceptability of welds when specified by the applicable Bureau of Ships drawing, specification, contract, order, or directive. They are applicable to ferritic, austenitic, and non-ferrous materials. Acceptance criteria are described for slag, porosity and other defects.

5663

AN AUTOMATIC SYSTEM FOR THE DETERMINATION OF OXYGEN IN BERYLLIUM METAL COMPONENTS

J. T. Byrne, et al

Kaman Nuclear, Colorado Springs, Colorado, Presented at the 1965 International Conference on Modern Trends in Activation Analysis, held at Texas A & M University, April 19-22, 1965

An automatic activation analysis instrument to nondestructively determine the amount of oxygen in beryllium components is described. The theory, equipment and procedure for oxygen activation analysis are presented in detail. Sources of error are discussed. Activation data are composed to chemical data. A summary of results is given.

5673

ADAPTATION OF X-RAY DIFFRACTION RESIDUAL STRESS MEASUREMENTS TO A VARIETY OF PRODUCTION CONDITIONS

M. S. Werkema

Martin Company, Denver Division, November, 1966. Final Report: TOS 7062-437-871

The problems involved in the adaptation of x-ray stress analysis to production conditions are discussed. The x-ray stress analysis method, its capability, and applicability are described. Its limitations and the significance of the results are presented for users whose technical background in this field is limited. The measurement of x-ray elastic constants, and the theoretical development which is basic and unique to the capability development are presented for readers who are interested in the technique of x-ray stress analysis. A summary lists the accomplishments of the program and describes the laboratory capability.

5675

NONDESTRUCTIVE WELDING TESTS

Quarterly Report No. 15 Rontgen Technische Dienst NV, Holland, 31 May 1965
United States-Euratom Joint Research and Development Program - EURAEC-1393

Investigations to correlate the ultrasonic findings with the appearance of discontinuities in the cross sections of welded test blocks after polishing, etching or magnetic particle test are presented. Results of radiographic examination of the test block with the use of a Cobalt 60 source are given. Results obtained with cracks introduced by copper penetration are described.

5679

IMPROVED X-RAY RADIOGRAPHY OF INTRICATE OBJECTS WITH FULL-FIELD OPTICAL SIGHTS (AD-820 474)

R. Matthes

Die Technik (Technology) Vol. 21, No. 9, pp 565-567

Translation: U. S. Army Foreign Science & Technology Center

FSTC-HT - 23-39-67 - NOTSMTL Beyond U. S. Govt. Agencies

In addition to conventional rod and optical sights, a newly designed optical sight for the focusing of x-ray test equipment in industrial material testing is described. The device, which essentially consists of a light source and a parallel mirror, fully illuminates the field to be examined and assists in restricting the field to a minimum cross section.

5680

**COLOR RADIOGRAPHY — A NEW PROCESS OF INDUSTRIAL MATERIALS TESTING
(AD-820 474)**

H. U. Richter and D. Linke

Die Technik (Technology) Vol. 21, No. 9, pp 561-565

Translation: U. S. Army Foreign Science & Technology Center

FSTC-HT-23-39-67 — NOTSMTL Beyond U. S. Govt. Agencies

In color x-ray testing (color radiography), differences in the thickness and density of the material and thus material discontinuities and defects, are detected not only by a brightness graduation but also by a change in color tone. Examples presented include the testing of an Al casting at 100 kv and C steel welds at 15 mev.

5682

THE ADVANTAGES OF EPICADMIUM NEUTRON BEAMS IN NEUTRON RADIOGRAPHY

A. R. Spowart

Nondestructive Testing, Vol. 1, No. 3, February 1968, p 151

The technique was developed as a complement to neutron and x-radiography to further extend the unit of penetration, particularly in highly absorbent materials. Neutrons with energies above 0.4eV are defined as epicadmium and are produced by inserting a metal cadmium filter in the neutron beam before the beam reaches the detector. A "transfer" neutron radiography technique is described for making autoradiographs. This technique is completely gamma insensitive and provides a considerable advantage over conventional techniques. A direct detection technique, using TV for viewing, is briefly described.

5695

NONDESTRUCTIVE EVALUATION OF METAL FATIGUE (AD-631 679)

F. N. Kusenberger, et al

Southwest Research Institute, San Antonio, Texas

Scientific Report, 1965-1966, 85 pp

The primary purpose of the recent studies conducted on this program was to improve and evaluate existing ultrasonic Rayleigh wave and magnetic perturbation equipment for the detection of fatigue damage in aluminum and steel stress cycled specimens. Ultrasonic results obtained from a 7075-T6 aluminum specimen stress cycled in direct uniaxial tension are presented. On steel stress cycled specimens, both ultrasonic and magnetic technique results are presented. Experimental investigations to determine the retraction properties of surface waves in laboratory size metallic specimens are described and the results discussed. The results obtained from the analysis of many x-ray diffraction exposures near the tip of a fatigue crack using a 0.004 inch diameter collimator are reported.

5697

IN-MOTION RADIOGRAPHY

W. K. Hopkins

Lockheed-Georgia Co., Marietta, Georgia

This article outlines findings of five years original research into desirability and effectiveness of in-motion radiography. The overall in-motion radiographic process is described and the advantages are enumerated. Applications are discussed and radiographs are presented.

5701

STUDY OF THE BORDONI PEAK IN A SILVER SINGLE CRYSTAL

M. Mongy, et al

Il Nuovo Cimento, Series X, Vol. 36, pp 10-17, 1 March 1965

The Bordoni peak has been investigated in the (100), (111) and (110) orientations of a silver single crystal. The measurements have been made at frequencies 10, 20 and 50 MHz in the temperature range 80° to 300°K. The activation energies and the relaxation frequencies are found to be different from one orientation to the other; the minimum values are obtained when the ultrasonic waves are applied parallel to the (100) direction.

5718

LIMITS OF FLAW DETECTION IN STEAM GENERATOR TUBES FOR NUCLEAR POWER STATIONS

A. Kuhlmann and F. I. Adamsky

Atomwirtschaft-Atomtechnik, Vol. 11, 1966, pp 174-178. Henry Bratcher Translation No. 7246, P. O. Box 157, Altadena, California 91001

Problems posed by the nondestructive testing of compactly designed steam generators inside a nuclear reactor pressure vessel; advisability of the most comprehensive testing possible to insure maximum operating reliability. Included is information on ultrasonic testing of straight tubes with particulars on equipment; the use of standard defects when testing large quantities of tubing; testing of tube bends with very small bend radii; intergranular cracks; and radiographic findings confirmed by internal hydraulic tests.

5720

MECHANICAL RADIOGRAPHY OF WELDED PIPELINES

A. C. Richardson

Nondestructive Testing, Vol. 1, No. 3, February 1968, p 156

An apparatus for carrying an isotope into pipe to permit radiography of welded joints is described. The apparatus is driven by a battery powered motor, and can go as far as 3 miles per battery charge. The isotope container will hold as much as 100c of Ir 192. The apparatus can be stopped, a weld exposed, and the unit started from outside the pipe by an external gamma ray source. The unit can also be operated manually. Design problems and safety aspects are also discussed.

5737

STUDIES OF STRESS CORROSION CRACKING BY THE MOSSBAUER EFFECT

J. H. Terrell, et al

Mithras, Inc., 701 Concord Avenue, Cambridge, Mass., NRO39-095/1-23-67, MC 66-133C-R1

An investigation into various techniques for carrying out Mossbauer effect (ME) measurements in a nondestructive, in situ manner requiring no sample preparation (backscatter ME measurements) is reported. The research was directed toward detecting the 2% abundant Fe⁵⁷ nucleus which is common to iron alloys so that environmental changes brought about by stress and/or corrosion could be followed. It is found that the most efficient technique for performing backscatter ME measurements is to use a geometrical arrangement designated as "around-the-corner" detecting 6.3 kev internal conversion x-rays. A discussion of the background count rate is given along with a description of an anti-coincidence system which can be used to significantly reduce the background but only for weak sources.

5741

NONDESTRUCTIVE TESTING OF SILICA-PHENOLIC MATERIALS FOR SMALL ABLATIVE THRUST CHAMBERS (AD-801 547)

D. Hagamaier

Testing Techniques for Filament Reinforced Plastics-Sponsored by AFML and ASTM
September 1966, AFML-TR-66-274, pp 531-575

This report describes ultrasonic, radiographic and liquid penetrant nondestructive testing of silica phenolic molded and tape wrapped parts and materials used in the manufacture of small ablative engines. Various test techniques are illustrated and described. The application of x-ray image intensifier equipment for cinefluorographic studies during hot-fire tests and to determine failure analysis modes is described. The application of x-ray image intensifiers for process and quality control is discussed. Also included are illustrations of various flaws associated with molded or tape-wrapped silica-phenolic materials and the applicable nondestructive test methods and techniques used to detect them.

5745

INSPECTION METHODS CATCH HONEYCOMB FAULTS (SP 329)

W. F. Roberts

SAE Journal, March 1960, p 94

The three basic nondestructive inspection methods for brazed honeycomb sandwich at present are: 1) Film Radiography; 2) Fluoroscopy; 3) Ultrasonics. Three additional nondestructive techniques being investigated at this time are: 1) Thermographic methods; 2) Zinc hot-shot testing and 3) Radioisotopes. The application of each method in honeycomb inspection are listed.

5749

X-RAY TO OPTICAL CONVERSION BY THE USE OF X-RAY SCREENS AND MONO-CRYSTAL SCINTILLATORS

A. M. Yakobson and K. M. Dzhgalyan

Industrial Lab., translated from Zavodskaya Laboratoriya, Vol. 30, No. 4, pp 445-447, April 1964

Comparison of resolving power and radiation response are reported for ZnS.CdS-Ag fluoroscopic screens relative to CsI(Tl) and NaI(Tl) monocrystals used as converters at x-ray tube voltages of 100-200 kV. Commercial ZnS.CdS-Ag screens and monocrystals of CsI(Tl) are used for the direct conversion of x-ray images to optical ones. The present work deals with the image quality for the two methods.

5752

DETERMINATION OF THE GRAIN ORIENTATION IN TRANSFORMER STEEL

G. M. Vorob'ev and L. I. Kotova

Translated from Zavodskaya Laboratoriya, Vol. 30, No. 10, October 1964, Ind. Lab, pp 1224-1227

The article describes an x-ray method for determining the grain orientation in macrocrystalline transformer steel by photographing specimens consisting of strips cut from the sheet in the directions parallel and perpendicular to the directions of rolling. The design of an adapter for determining the grain orientation, to be used with a URS-501 diffractometer, is proposed.

5753

ULTRASONIC METHOD OF TESTING THE OPERATING FLUIDS OF HYDRAULIC SYSTEMS FOR BREAKDOWN

K. Ya. Sergeeva and M. F. Maksimova

Industrial Lab., translated from Zavodskaya Laboratoriya, Vol. 30, No. 10, October 1964, pp 1239-1241

An ultrasonic method is proposed for determining the resistance of operating fluids to mechanical breakdown. The volume of the fluid tested is 10 ml, the ultrasonic frequency is 18 to 22 kc and the exposure time to the sound is 1.5 h.

5754

A COMPARISON OF THE ELASTIC CONSTANTS OF CHROMIUM AS DETERMINED FROM DIFFUSE X-RAY AND ULTRASONICS TECHNIQUES

A. Sumer and J. F. Smith

Journal of Applied Physics, Vol. 34, No. 9, September 1963, p 2691

The elastic constants of the same single crystal of chromium have been determined by both ultrasonic pulse echo and thermal diffuse x-ray techniques. The difference between the numerical results of the two sets of measurements is primarily attributable to the limited precision which attends the measurement of diffuse x-ray intensities. Any additional factors which may contribute to the difference are masked by the precision. If suitable single crystals can be prepared, the ultrasonic technique is much to be preferred.

5765

DEVELOPMENT OF NONDESTRUCTIVE METHODS FOR EVALUATING DIFFUSION-FORMED COATING ON METALLIC SUBSTRATES (AD-823 889)

R. C. Stinebring, R. Cannon

AVCO, Lowell Industrial Park, Lowell, Mass. 01852. AFML-TR-178, October 1967 NO FORN

This report covers work (during 2nd year) to detect, define, and characterize by NDT methods those variables which significantly affect the service life of diffusion-formed coatings on refractory alloys. A discussion of the failure modes and mechanisms and the NDT methods for detecting variables which cause the failures in these coatings is presented. Of special interest is a thermoelectric test for evaluating edgings for coating thickness and chemistry variations. The proper application of such NDT methods as eddy currents, thermoelectrics, x-ray backscatter, and dye penetrants may hold the key to reliable coated alloys.

5773

DEVELOPMENT OF NONDESTRUCTIVE TESTS FOR QUANTITATIVELY EVALUATING GLASS FABRIC REINFORCED LAMINATES (AD-835 951)

J. Zurbrick

AVCO Corp., Lowell Industrial Park, Lowell, Mass.

AFML-TR-67-170, December 1967 NO FORN

The 3rd year of this study (under the same contract) was devoted to four related but distant areas: (1) Continued evaluation of thick laminates fabricated during the 2nd year (2) Evaluation of thinner laminates fabricated during the 3rd year (3) Significant defect evaluation (4) Development of low-frequency dielectric probes for nondestructive testing. The theoretical basis for the various probes and probe design are all discussed in detail. Micrographs of the laminates evaluated are displayed with typical destructive and nondestructive test values in the appendix.

5775

NONDESTRUCTIVE TESTING OF CONCRETE: A SURVEY

L. J. I. Browne

Nondestructive Testing, Vol. 1, No. 3, February 1968, p 159

The survey discusses the variations existing in concrete, the various properties and the different test methods used. Most important is the determination of the in situ strength and elastic properties of concrete. The Ndt methods include resonance testing, ultrasonic pulse testing, hardness testing, and indentation methods. Determination of thickness and elastic properties density, depth of cover and moisture are also discussed using radiography, radiometry, microwaves and neutron absorption as appropriate.

5784

MOBILE UNIT FOR NEUTRON RADIOGRAPHY

A. R. Spowart

U.K.AEA Dounreay

Nuclear Engineering, May 1968

The design and expected performance of a neutron radiography mobile unit are described. The unit is based on a sealed tube fast neutron generator coupled to a neutron scintillator-image intensifier viewing system. Presently initial tests are being carried out in a shielded cave 17 feet wide, 7 feet wide with 5-1/2 feet thick concrete walls. Basically the unit consists of a neutron generator positioned in the center of a 3 foot diameter steel tank with 3 feet of oil. Normally, 3 feet of water is needed for external shielding, but the cave is being used instead for the initial tests.

5785

NONDESTRUCTIVE TESTING FOR SPACE APPLICATIONS (N68-10953) (N68-10792) (N68-10958)

W. A. Zoran

Hamilton Standard, Windsor Locks, Conn.; SP 67115; (Phase II) (Final Report) Parts I, II, III

Part I: The objective is (1) to establish feasibility of performing ultrasonic and radiographic inspection in the space environment and (2) to design and fabricate an integrated prototype ndt unit to accomplish these functions.

Part II: This is a manual describing specific operating and maintenance procedures for a prototype in-space ndt unit.

Part III: This portion defines expected problem areas, actual flight hardware requirements, and the scope of a flight hardware program.

(See No. 5495 for Phase I)

5788

THE 100-N FUEL ENRICHMENT TESTER

B. E. Dozer

BNWL-CC-920. Battelle Memorial Institute, Pacific Northwest Laboratory, for the USAEC under Contract AT(45-1)-1830. November 10, 1966

An instrument system was developed to measure the enrichment level of the U-235 in uranium reactor fuel before loading into the reactor. The tester determines the activity ratio of two different gamma energy levels emitted from the uranium fuel. It is easily detected three different enrichments with a 20-second nominal count for each determination. Installed on the monotube loading mechanism, the tester is designed to check on the accuracy of the fuel loading procedure.

5793

ANALYSIS OF M114 VEHICLE REPLACEMENT SUSPENSION ARM

John M. Ingraham

AMRA preliminary letter report April 1966

Examination of one M114 vehicle replacement suspension arm indicated that with the exception of a heavy wall thickness this casting otherwise satisfied the existing procurement requirements. These requirements, however, permit tensile properties to be obtained from a test coupon block and the results do not agree with tensile properties obtained from the casting itself. Five tensile specimens, taken from the casting, failed to satisfy the ductility requirements of class 150-125 steel and it is recommended that future tests be taken from the casting in order to insure representative test results.

5794

NONDESTRUCTIVE INSPECTION METHODS APPLIED TO MULTI-FINDED SAP TUBING FOR NUCLEAR FUEL ELEMENTS

*S. A. Lund

**Per Knudsen

*Danish Central Welding Institution, Copenhagen

**Danish Atomic Energy Commission

Symposium on Nondestructive Testing in Nuclear Technology, Bucharest, Romania, 17-21 May 1965

Quality control of the canning tubes for heavy-water-moderated power reactors is discussed in this report. An account is presented of the nondestructive techniques developed for the measurement of wall thickness and diameters as well as flaw detection. Special recording beta gauge techniques based upon the attenuation of beta radiation from a Sr^{90} source is used for wall thickness measurements. Ultrasonic resonance method is used for continuous recording of wall thickness of more simple tube design. Inner and outer fin tip diameters are continuously recorded by rapid air-gauge systems. Flaw detection is carried out by the immersed ultrasonic pulse echo technique and by eddy current.

5800

INVESTIGATION OF NONDESTRUCTIVE METHODS FOR THE EVALUATION OF GRAPHITE MATERIALS (AD-851 233)

G. E. Lockyer, et al

AVCO SSD, Lowell, Mass. AFML-TR-67-128, 1968. Contract No. AF33(615)-1601

Verification of the applicability of various NDT techniques and correlations to characterize graphite is presented. Statistical analysis of data establishes prediction capabilities of NDT/properties correlations. Infrared technique development for measuring thermal properties is described. Attenuation of ultrasound and related effects of frequency distortion on velocity measurements is presented.

5804

RADIOGRAPHIC ANALYSIS CHECKS PARTICLE SIZE

Ogden Technology Laboratories, Inc., 58-17 37th Ave., Woodside, N. Y.

Radiographic facilities can be included as part of the clean room complex in combination with standard flush cleaning for contamination control. Particles normally undetectable by conventional flush rinse methods can be picked up by the radiographic technique and their size determined down to 10 microns.

5808

LARGE MOTOR CASE TECHNOLOGY EVALUATION (AD-820 268)

C. F. Tiffany, et al

The Boeing Co. AFML TR-67-190, August 1967 NOFORN

Material and process requirements for large motor cases fabricated with roll-and-weld procedures were studied. Fracture toughness and flaw growth studies were performed on a variety of steels and associated welds to define allowable flaw sizes for materials tested. NDT techniques were developed and evaluated. Minimum detectable flaw sizes were determined for both ultrasonic and radiographic techniques in relation to the variety of parent metals and welds investigated.

5809

DESIGN AND SPECTRAL DETERMINATION OF A LOW-ENERGY, FLASH X-RAY DEVICE (AD-820 126)

R. I. Liebman

TR No. AFSWC TR-67-21, September 1967, AFSC Kirtland AFB, New Mexico NO FORN

Study of production, effect, and detection of x-rays is presented. Device to produce low-energy, flash x-rays and method of determining spectral output is discussed. Design information on a 60 KV x-ray device using a triode x-ray tube to produce shot pulses of 30 nanosec is described.

5810

EFFECT OF INCLUSIONS AS MEASURED BY ULTRASONIC METHODS ON THE MECHANICAL PROPERTIES OF AIRCRAFT QUALITY STEEL (AD-853 178)

C. J. Carter

International Harvester Company Contract No. AF33(615)-5053, 1R-9-168 (VI-VII), May 1968 NOFORN

Interim report dealing with correlation of mechanical property and ultrasonic cleanliness. Axial fatigue tests were conducted at a stress ratio of 0.1, wherein life cycle range of 100,000 to 200,000 cycles at all cleanliness levels (ultrasonic) were observed to converge. Inclusions influenced failure more markedly in high cycle region for these test parameters. For transverse specimens inclusion size influenced fatigue in low, medium and high cycle regions. Impact energy noted to be more sensitive to process than inclusion magnitude.

5811

A METHOD FOR CLASSIFYING X-RAY FILM (AD-668 697)

D. Polansky and E. L. Criscuolo

U. S. Naval Ordnance Laboratory, White Oak, Maryland, NOLTR-68-39, 12 March 1968

A study has been conducted to evaluate the parameters that could be used to characterize x-ray film. Factors such as speed, graininess, resolution, contrast and uniformity of emulsion are discussed. Recently developed methods of measuring resolution such as the modulation transfer function will be reviewed. At the present time it is felt that the characteristics of speed and average gradient should form the basis of a film classification system. It is proposed that a contrast-speed index $\pi = \bar{G} \sqrt{r}$ be used to characterize x-ray film. $\bar{G}$ is defined as the average gradient between two arbitrary densities d_1 and d_2 , and r is the number of roentgens necessary to produce the density midway between d_1 and d_2 .

5816 CONTINUOUS NONDESTRUCTIVE MEASUREMENT OF BULK DENSITY BY GAMMA-RAY TRANSMISSION THROUGH SEDIMENTS INSIDE CORE BARRELS

A. F. Richards & T. Baumgartner

Dept. of Geology and Dept. of Civil Engineering, U. of Illinois, Urbana, Illinois, April 1968

Development of a gamma ray transmission densitometer for nondestructive measurement of bulk density in core barrels is described and illustrated.

5817 THE DEVELOPMENT AND USE OF FLUOROSCOPY FOR THE INSPECTION OF THE LONGITUDINAL WELD OF DOUBLE SUBMERGED-ARC WELDED LINE PIPE

R. P. Stripay

U. S. Steel Corp., McKeesport, Pa., Materials Evaluation, July 1968

The basic principles of fluoroscopy are discussed with specific reference to the inspection of the longitudinal weld of double submerged-arc welded line pipe. Included is a discussion of the preliminary development work that led to the installation of a fluoroscope unit for the continuous inspection, on a production basis, of a large-diameter line pipe. Subsequent modifications to the equipment and conversion to improved TV systems that have resulted in rapid and reliable continuous inspection of line pipe by fluoroscopic inspection are described.

5819 THE NONDESTRUCTIVE TESTING OF PASSENGER TIRES

G. H. Halsey

Scientific Testing Laboratory, Indiana, Pa. Materials Evaluation, July 1968

Ever-increasing performance and quality requirements for passenger tires has kindled a new interest in nondestructive testing in the tire industry. Fluoroscopic test methods have been widely accepted for defect detection. Innovations in equipment and methods for ultrasonic inspection of tires has opened new opportunities to measure important tire characteristics. Variations in tire tread thickness have been measured and correlated to tire performance.

5829 INCORPORATION OF ADDITIVES IN ADHESIVES FOR RADIOGRAPHIC INSPECTION OF ADHESIVE BONDED HONEYCOMB STRUCTURES TECHNICAL SUMMARY REPORT

R. J. Patton

North American Aviation, Inc., Space and Information Systems Div., January 1965

Contract NAS8-11051. Document No. SID 64-2087

This report describes evaluation of 3 structural adhesive films which were modified by incorporation of radiographic absorptive devices. Radiographic inspection is evaluated, and bond strength over a temperature range is studied.

5833 PROPERTIES DETERMINATION AND PROCESS CONTROL OF BORON FILAMENT COMPOSITES USING NDT METHODS

R. C. Stinebring and J. R. Zurbrick

AVCO SSD, Lowell, Mass., 10th National Symposium of Aerospace Material and Process Engineers, San Diego, Calif. November 1966

Material variability in boron filament composites which control strength is monitored by nondestructive testing methods. Among the NDT methods which have yielded valuable information for predicting performance of these materials are ultrasonic velocity, microradiography, dye penetrant and electric-field filament gauging.

5834

CHARACTERIZATION OF LAMINATE COMPOSITION AND PREDICTION OF DESIGN PROPERTIES: NOW POSSIBLE USING METHODS AND APPROACH OF NONDESTRUCTIVE TESTING

J. R. Zurbrick

AVCO Space Systems Division, Lowell, Mass. 01851. 23rd Annual Conference of SPI Reinforced Plastics Div., Washington, D. C., February 1968, Contract No. AF33(615)-1705

Material — NDT energy interactions which occur in a composite material are investigated. Ultrasonic and gamma-ray techniques are combined and correlations with physical properties in glass fabric reinforced laminates are sought. Prediction capabilities for glass fiber volume fraction, resin volume fraction, and porosity volume content are discussed in relation to in-service inspection for damage and aging.

5837

X-RAY FLUORESCENCE METHODS FOR DETERMINATION OF THE THICKNESS OF COATING MATERIALS ON STEEL

O. Kammori, et al

Tokyo Research Institute, Yawata Iron and Steel Co. Ltd., Kawasaki, Japan
(Translated from Tetsu To Hagane, Vol. 53, 1967, No. 11)

Discusses selection and preparation of samples in connection with determination of Zn, Cr, Cu, Ni, Sn, and Pb electrodeposit thicknesses on steel by x-ray fluorescence. Experimental apparatus is described. Calibration curves are presented and an error analysis given. Results are compared to chemical methods of analysis.

5838

NONDESTRUCTIVE TEST DEVELOPMENT FOR NUCLEAR REACTOR PROGRAMS AT THE OAK RIDGE NATIONAL LABORATORY

R. W. McClung

Metals and Ceramics Div. Oak Ridge National Lab., Oak Ridge, Tennessee
Interamerican Conf. on Materials Technology, May 1960, San Antonio, Texas

NDT development in the nuclear reactor development program at Oak Ridge is presented in general. Specific areas of interest include: eddy current development (theory, equipment, application); ultrasonic (optical imaging and viewing, standards, applications); penetrating radiation (absorption studies, radiography, X and gamma rays).

5847

DEVELOPMENT OF NDT SYSTEM FOR ANALYSIS AND CONTROL OF RESIDUAL MACHINING STRESSES (AD-830 856)

H. Schwartzbart

ITT Research Institute, Chicago, Ill. AFMC-TR-67-77, Contract No. AF33(615)-1400

The development of nondestructive testing system for identifying type, magnitude, direction and distribution of residual stresses is described. Relationship between grinding parameters and residual stresses, as well as effect of residual stresses on fatigue and stress-corrosion behavior are investigated for various materials.

5851

DEVELOPMENT OF RADIOGRAPHIC PROCEDURE AND STANDARDS FOR PARTIAL PENETRATION WELD JOINTS ON HEAVY ALUMINUM AND STEEL PLATE (AD-828 626)

W. F. Wulf

Matl's Lab. US Army Tank Automotive Command, Warren, Mich., Technical Report No. 8910 (Phase II) June 1967

Standard reference radiographs were selected from weld flaw specimens fabricated from heavy aluminum and steel plate during Phase II of a multi-year effort to establish a document containing reference radiographs and radiographic test procedures for quality control of partial penetration weldments. Recommended radiographic inspection procedures were also experimentally determined for twelve basic partial-penetration joint designs.

See: No. 4667 for Phase I

5852

INVESTIGATION OF HYDROTEST FAILURE OF THIOKOL CHEMICAL CORPORATION 260-Inch-DIAMETER SL-1 MOTOR CASE

J. E. Srawley and J. B. Esgar

Lewis Research Center, Cleveland, Ohio, NASA TMX-1194, January 1966

The subject motor case failure was shown to have originated from a defect that was not detected by NDT prior to aging the material. Failure occurred at about 56% of proof pressure. One conclusion of the report is that ultrasonic and radiographic techniques need further technique development before reliable detection of small defects felt to be responsible for failure in this low toughness manufacturing steel plate can be attained.

5856

EVALUATION OF NONDESTRUCTIVE TESTING TECHNIQUES OF DIFFUSION COATINGS (AD-836 775)

H. B. Karplus, et al

IIT Research Inst., Chicago, Illinois, AFML-TR-67-358, May 1968

Three NDT methods were checked against microscopic examination of suspected areas in various diffusion coatings. Methods used were beta backscatter, x-ray fluorescence, and eddy current. Results are presented in detail.

5858

X-RAY EXPOSURE METER BASED ON A SEMICONDUCTING DETECTOR

L. S. Gorenburg, et al

Soviet Journal of NDT, Defectoscopy, English Translation No. 1, January-February 1967, pp 77-80

An x-ray exposure meter for choosing the conditions to be employed in x-ray defectoscopy is developed on the basis of a semiconductor detector (SCD). The arrangement of the apparatus is described together with some results of its practical use under the conditions of a workshop x-ray laboratory. The possibility of increasing the efficiency of the x-ray method of defectoscopy is considered.

5859

METHOD OF ESTIMATING PERMISSIBLE NOISE CHARACTERISTICS OF A DEVICE SIGNALING THAT THE TOLERANCE OF AN INSPECTED PARAMETER HAS BEEN EXCEEDED CALCULATION OF THE PARAMETERS OF A BETATRON γ -RAY THICKNESS GAUGE FOR HIGH-SPEED DETERMINATION OF SLAB THICKNESS

A. M. Yakobson

Defectoscopy, Soviet Journal of NDT, English Translation, No. 1, January-February 1967, pp 86-94

A method is proposed for estimating the permissible noise characteristics of a device signaling that tolerance of an inspected parameter is exceeded in a given inspection regime. The calculation takes into account the rate of inspection, region of averaging the values of the inspected parameter, the probability of detecting that the measured parameter exceeds the limits of tolerance, and the permissible degree of an increase in defects owing to noises of the inspection device. The noise characteristics and parameters of a differential betatron γ -ray thickness gauge designed for inspecting steel slabs 230 mm thick at a slab travel rate of 2 m/sec and with 2% tolerance for a decrease of slab thickness.

5872

EXPERIMENTAL DETERMINATION OF THE ABSORPTION COEFFICIENTS OF BREMSSTRAHLUNG IN STEEL FOR BETATRON ENERGIES BETWEEN 3 AND 25 MeV

Yu. V. Gromov and A. M. Yakobson

Defectoscopy (Soviet Journal of NDT), Eng. Trans. No. 2, March-April 1967, pp 122-125

The absorption coefficients of wide and narrow bremsstrahlung beams obtained from a 3-to-25 MeV betatron in steel up to 300 mm thick were determined experimentally. Analysis of the experimental results show that a betatron with a maximum energy greater than 17 MeV should be used for the betatron introspection of steel objects.

5875

MEASUREMENT OF THE THICKNESS OF PROTECTIVE COATINGS BY MEANS OF RADIOISOTOPE SOURCES

Yu P. Betin, et al

Defectoscopy (Soviet Journal of NDT) Eng. Trans. No. 2, March-April 1967, pp 171-173

Radioisotope thickness gauges, in which measurement of absorption or back-scattering of β -particles is used are widely employed for checking the thickness of protective coatings. However, a method based on recording x-ray characteristic radiation excited in the coating material, or in the base material, or in the base material or backing, has recently begun to be used for these purposes. The scheme of the measurements is described and illustrated in this report.

5881

EVALUATION OF VARIABLES ON THE MEASUREMENT OF FUEL CONCENTRATION VARIATIONS IN NUCLEAR FUEL RODS

B. E. Foster and S. P. Snyder

Materials Evaluation, February 1968, pp 27-32

A gamma-ray attenuation technique has been developed for evaluating the apparent fuel "inhomogeneities", which appear as fuel concentration charges, result from particle and compaction density variations as well as tube wall and tube diameter variations. Specifications for some of the cylindrical fuel elements have required inspection for inhomogeneity of fueled areas 1/8" in diameter to ± 2 per cent. tolerance in fuel variation. The types of elements examined range from 5/16 to 3/4 in. O.D. The fuel rods have been stainless steel on Zircaloy tubes filled with compacted UO_2 , $(\text{U,Th})\text{O}_2$ or PuO_2 particles. Detailed explanations are given on the fabrication of standards and calibration of the system. The discussion also includes empirical data on effects of collimator size, source energy and scanning speeds.

5888

PLANNED NONDESTRUCTIVE TESTING AS PREVENTIVE MAINTENANCE FOR STEEL PLANTS

W. H. Tait

Materials Evaluation, April 1968, pp 54-58

Failures of heavy production equipment in steel plants are both costly and dangerous. Nondestructive testing used with "control inspection" procedures can eliminate unscheduled equipment breakdowns caused by random occurrence failures of fatigue cracking, improper functioning of rotating equipment, etc. Extensive use of vibration analysis, magnetic particle, ultrasonic, radiographic, dye penetrant and infrared tests are necessary to inspect the different equipment in blast furnaces, rolling mills and finishing divisions. The nondestructive inspection program induces maintenance and engineering to redesign and improve defective equipment.

5892

AN APPLICATION OF UNDERWATER RADIOGRAPHY

G. Lambert

Materials Evaluation, March 1968, pp 27A-30A

The first emergency welding repair of a break in a submerged, operating pipeline was made recently in the Gulf of Mexico using a diving bell and welding procedure previously tested under similar conditions on new construction. However, no successful radiography had been performed under these conditions, and it was necessary to develop a radiographic technique to inspect the repair welds in accordance with the API 1104 Standard for Welding Pipelines and Related Facilities. Almost all parameters of the finalized technique were either influenced or dictated by conditions imposed by the underwater environment, as detailed in this article. The radiography was performed successfully and the quality of the weld was acceptable. Conclusions are that similar radiography in deeper water, or open water, are feasible from both a technical and safety standpoint.

5898

SEMICONDUCTOR RADIOGRAPHY: ITS STRENGTHS, WEAKNESSES AND THE CONTROLS NECESSARY TO ASSURE ITS EFFICACY

M. M. Roth

Materials Evaluation, January 1968, pp 8-12

This paper discusses the strengths and weaknesses of semi-conductor radiography. X-ray's major strengths are: (1) its ability to see through opaque objects and (2) the permanence of the record. X-ray's major weaknesses are: (1) variations in x-ray cross section of the various materials in semi-conductors, which cause an inability to see silicon and aluminum, (2) cost, (3) variations between views and (4) difficulty in establishing effective quality standards. The techniques used to overcome semi-conductor radiographic weaknesses are explained and numerous examples taken from practice are presented in the form of photos.

5900

DIRECT PRINT RECORDING OSCILLOGRAPH PAPER AS AN X-RAY RECORDING MEDIUM

W. E. Woodmansee and R. K. Vannier

Materials Evaluation, May 1968, pp 79-82

Direct print paper may be used as an inexpensive medium for obtaining radiographs of high contrast subjects. Following exposure to penetrating radiation the papers are developed by brief illumination with fluorescent lights. The properties of some of these papers, techniques for stabilizing images obtained by development in fluorescent light, and applications for which the papers are suited will be discussed.

5903

THE MYSTERY OF REINFORCED PLASTICS VARIABILITY: NONDESTRUCTIVE TESTING HOLDS THE KEY

J. R. Zurbrick

Materials Research and Standards, Vol. 8, No. 7, July 1968, pp 25-36

The detailed physical and mechanical properties typifying reinforced plastics and their separate reinforcements and matrices were studied. This was combined with knowledge of the well-characterized energy forms used in nondestructive testing. Material energy interactions, the key to predicting material properties from NDT response values, are defined. A workable "Variability Evaluation Plan" provided the framework for laboratory investigations and the basis for value engineering in production test situations.

5904

KRYPTONATES: KR⁸⁵ BECOMES A UNIVERSAL TRACER

D. Chleck, et al

Nucleonics, 330 W. 42nd St., N. Y. 36, N. Y., Vol. 21, No. 7, pp 53-55, July 1963

Discusses the preparation, properties, stability, safety, and applications for kryptonates. Feasibility for applications to radiochemical analysis and corrosion, friction, and wear studies shown. Improves existing radioisotope techniques. Temperature-dependent leakage coupled to the fact that Kr⁸⁵ is located at or near the surface permits measurement of surface and interfacial temperatures. Other applications include detection and measurement of reactive gases, detection and analysis of species in solution such as acids in aqueous solution, and chemical kinetics studies.

5908

PROGRESS REPORT OF INFRARED NDT OF SOLID PROPELLANT MOTORS WITH LMSC MOD VI AND BARNES T-4 IR CAMERA SYSTEMS

E. M. Bergh and T. F. Jennings

In: Nondestructive Test Procedures, U. S. Naval Weapons Station, Concord, California, Part II. Section 15 [1966]

A checkout of the LMSC Mod. VI IR system modifying it as required to make it suitable for IR scans of Polaris Second Stage A-3 motors is described. Similar independent IR scans using the Barnes T-4 IR camera for evaluation and correlation of both systems were made. In addition, data processing systems using the Alden "C" scan recorder and Tektronic Storage Scope are used. The results of both systems were to be further correlated with X-rays of the motors tested. Two motors which had been radiographed several times in a previous project were scanned with the two types of IR equipment.

5910

CODES, SPECIFICATIONS AND ACCEPTANCE STANDARDS FOR WELDMENTS

E. C. Miller

Oak Ridge National Laboratory, Oak Ridge, Tennessee

ORNL-P-2615 - November 29, 1966

A general discussion of codes and specifications is presented. Many of the problems involved in practical applications are cited.

5912

NONDESTRUCTIVE TEST PROCEDURES FOR: LIQUID ROCKET MOTOR, SOLID ROCKET MOTOR, GUIDED MISSILE WARHEADS, GUN AMMUNITION

In: Nondestructive Test Procedures, U. S. Naval Weapons Station, Concord, California, Part 1, Sections 1-4, [1966]

Section I details procedure for ultrasonic inspection of weld, liquid penetrant inspection of interdigitated teeth inspection of the gas generator grain and shear slide and shear pin in liquid rocket motors. Section II details radiographic procedures for various solid rocket motors. Some ultrasonic testing procedures are included. Section III includes x-ray and gamma ray procedures for Guided Missile Warheads. Section IV includes radiographic procedures for gun ammunition. An article "Fluoroscopic Techniques of Fuze Evaluation" No. 659 is included and a letter report on the applicability of nondestructive test methods for determining the soundness of the nozzle-barrel braze.

5913

25-MEV RADIOGRAPHIC EXAMINATION POLARIS A3P SECOND STAGE MISSILE MOTORS

L. S. Turcios

In: Nondestructive Test Procedures, U. S. Naval Weapons Station, Concord, California, Part 1, Section V. [1966]

The plans and techniques used for radiographic inspection of propellant-filled chambers of the Polaris A3P Second Stage Fleet using a 25-MEV betatron are described. This procedure establishes methods for vertical radiographic examination of the cylindrical insulation the thermal insulation installation of the forward and aft domes and the solid propellant grain of the Polaris A3P second stage missile motors. In addition, methods of interpreting and reporting radiographic examinations are delineated and discussed.

5914

EVALUATION OF NONDESTRUCTIVE TEST METHODS FOR INSPECTION OF POLARIS A3 EBW SQUIBS

R. C. Smith and R. F. Harz

In: Nondestructive Test Procedures, U. S. Naval Weapons Station, Concord, California, Part 1, Section VI, [1966]

Nondestructive test methods are evaluated for inspection of Polaris A3 EBW Squibs. Tests evaluated include visual, radiographic, RF noise, ultrasonic tests and others. Special ring transducers were developed for the ultrasonic tests.

5915

FLUOROSCOPY OF FILAMENT WOUND FIBERGLAS MISSILE MOTOR CASE MATERIAL FEASIBILITY STUDY

J. H. Cusick

In: Nondestructive Test Procedures, U. S. Naval Weapons Stations, Concord, California, Part 1, Section 7, [1966]

An investigation to evaluate the applicability of a fluoroscopic method for inspecting fiberglass filament wound missile motor case material is described. This method is compared with low voltage radiography of specific interest in this program was the application of an Image Intensifier in the fluoroscopic inspection process and methods of photographic recording of fluoroscopic images.

5917

EXPERIMENTAL NEUTRON RADIOGRAPHIC SCATTER FACTORS

I. R. Kraska and H. Berger

Argonne National Laboratory, Argonne, Illinois

Materials Evaluation, September 1968

Experimental neutron scatter data for a reactor neutron beam have been obtained for steel, natural uranium and lead samples of various thicknesses. Most significant is the fact that these data have been obtained for sample thicknesses greater than those previously reported, and that a peaking of scatter factor results has been observed for all three inspection materials at large thicknesses. Contrast sensitivity degradation can be radiographically observed for samples at or near the peak scatter factor thickness. This degradation is most pronounced for steel at a thickness of 3.5 inches.

5923

BETA RADIATION CORROSION DETECTION STUDY, PHASE II (AD-654 212)

A. J. Frasca, et al

Industrial Nucleonics Corp., 650 Ackerman Road, Columbus, Ohio 63202

Naval Air Systems Command, Washington, D. C. 20360, Final Report, 31 May 1967

The development of a portable gauge using beta radiation to detect corrosion occurring at the interface between an aluminum substrate and an overlying organic protective coating is described. Test samples were fabricated from aluminum corrosion products (Al_2O_3) for calibration purposes. Corrosion sensitivity was demonstrated for depths from 2 to approximately 20 mils. The ability of the gage to detect corrosion and pitting on the underside of thin metals such as aluminum and magnesium aircraft skins for thicknesses no greater than 20 mils was shown. Test results on calibrated samples and on the underside of aircraft skins are given along with photographs of the test results for surface and sub-surface detection.

5932

MATERIAL STUDIES USING KET TECHNIQUE

Industrial Nucleonics, 650 Ackerman Road, Columbus, Ohio 43202, Date: 1968?-70?

"KET" is used to signify materials treated with KR-85 using a patented technique. Applications of KR-85 to detect material anomalies are discussed briefly. Areas of interest include: 1) Fatigue detection where parts were either kryptonated and then fatigued or vice versa; 2) Detection of defective hydraulic cylinders from the F-4B; 3) A bearing temperature alarm which provides a low cost and lightweight system of engine temperature control; 4) Detection of defective bearings; and 5) Turbine blade crack detection.

5938

NON-DESTRUCTIVE INSPECTION OF THE NUGGET ZONE IN JOINTS IN TITANIUM ALLOYS

B. D. Orlov, et al

Welding Production, Vol. 18, No. 11, November 1965, pp 54-58

The feasibility of detecting nonfusion (poor penetration) and the size of the cast zone in spot and roll welded joints by a nondestructive method is investigated. Using OT4 and VT1 Ti alloys as test metals, a new method for nondestructive inspection of the size of the cast nugget is developed. The method consists of introducing a metallic indicator with physical properties other than those of the base metal, into the lap joint. During welding the metallic indicator interacts with the molten metal of the weld pool, changing the general light-dark picture of the weld on the radiograph. The method of introducing the indicator depends upon the metal being tested. It may be added by inserting foil, a powder (with or without a binder), a galvanic coating, plasma spraying, etc. In the case of the Ti alloys, pure metals and alloys are used as indicators. They include W, Ta, Mo, Cb, Zr, Nb alloy, Ti, Ag, Zn, Pb and Bi. The size of the cast zones in the welds is clearly visible in the radiographs.

5939

NUCLEAR TECHNIQUES FOR CEMENT DETERMINATION

F. A. Iddings, et al

Louisiana State University, Baton Rouge, Louisiana, April 1968, 66 pp

The feasibility of using nuclear techniques to determine the cement content in soil-cement and concrete is presented. Techniques tried were: 1) thermal neutron activation analysis, 2) Fast neutron activation analysis, 3) activation analysis of an added stable tracer, 4) natural radioisotope content measurement, 5) isotope dilution. A brief description of each technique with regard to cement determination is given. The determination of calcium (formation of radioactive Ca-49) or silicon (formation of Al-28) offers a rapid and simple method, but by using calcium a more direct and reproducible result is obtained. Techniques 3) 4) and 5) may be applicable under certain conditions.

5967

USE OF HIGH-SPEED SEQUENTIAL RADIOGRAPHIC EXPOSURES TO RECORD MECHANICAL ACTIVATION OF AMMONIA BATTERIES (AD-823 610)

H. R. Gordon

Picatinny Arsenal, Dover, N. J. 07801, Report No. PA-TM-1813, November 1967, pp 38

Distribution: Controlled. All requests to Picatinny Arsenal, Dover, N. J. 07801

5977

RADIOACTIVE KRYPTONATES — I. PREPARATION, II. PROPERTIES, III. APPLICATIONS

D. Chleck, et al

Panametrics, 201 Crescent St., Waltham, Mass., 30 January 1963

I. Discusses the general methods of ion bombardment and diffusion at high temperatures and pressures, whereby the inert gas radioisotope Kr^{85} is incorporated stably into a variety of solids. A theoretical treatment of gas diffusion into a solid, experimental apparatus for ion bombardment and diffusion, and results of kryptonation of different solids by both methods are given. II. Solid sources prepared by either ion bombardment or diffusion display similar properties. Stability at different temperatures, depth of penetration, and the effect of kryptonation of properties of solids are discussed. III. Many applications are possible because removal or disturbance at the surface by chemical or physical means causes a proportional loss of activity. Applications of kryptonated carbon and copper given 2 ppm of O_2 can be detected by observing the rate of decrease of kryptonated C source at $1000^{\circ}C$. With kryptonated copper, ozone at temperatures less than $300^{\circ}C$ and oxygen concentrations varying from 10-5 to 1-5 ppm can be detected.

5986

DENSITY DIFFERENCES IN LOW CONTRAST X-RAY IMAGES

A. Kanno

Nondestructive Testing, Vol. 1, No. 5, August 1968, pp 308-312

The relationship between image contrast and image size for x-ray image quality indicators of the hole and wire types presented. By superimposing "scattered" radiation normal contrast is reduced. Image contrast obtained by multiplying the normal contrast by the ratio of the quantities of direct and total radiation given to the x-ray film. Contrast of wire-type image quality indicators compared with that of natural cracks.

5988

NONDESTRUCTIVE TESTING OF GRAPHITE AT THE LOS ALAMOS SCIENTIFIC LABORATORY

B. L. Blanks, et al

ASTM Special Publication No. 439, 1968

The Los Alamos Scientific Laboratory has investigated and used radiography, ultrasonics, sonics, eddy current, radiation gaging, and beta-backscatter gaging for the inspection of graphite and its protective coatings. Some applications and limitations of these techniques are review. The use of ultrasonics, sonics, eddy current, and radiation gaging to determine physical characteristics, aside from the normal flaw detection, shows promise in the inspection of graphite. Electron microscopy has proved to be a valuable tool for the evaluation of the findings of nondestructive testing.

5991

CONTACT MICRORADIOGRAPHY OF GRAPHITE

L. R. Bunnell

ASTM Special Publication No. 439, 1968

This paper describes the use of contact microradiography to define and characterize the microstructures of graphite. The technique uses a thin (20 to 500mm) specimen in contact with a fine-grained photographic emulsion. Because the source-to-film distance, ordinary X-ray sources can be used. Long wavelength x-rays were used to examine microcracks and other structural features of graphite specimens 100mm thick. The technique was also used to locate and characterize very small amounts of metal carbide in graphite-metal systems. Vacuum impregnation with liquids opaque to x-rays has proven useful in defining graphite pore structure.

- 5992 **FLASH RADIOGRAPH INVESTIGATION OF MULTIPOINT ASYMMETRICAL SELECTIVE INITIATION OF A WARHEAD CONFIDENTIAL (AD-392 936)**
W. L. Gilbertson, et al
Naval Weapons Laboratory, Dahlgren, Va. (NWL Report No. TR-2196) August 1968, 28 pp
- Flash radiograph techniques have been applied to a study of fragment patterns produced by multi-point asymmetrical initiation of a cylindrical warhead. The techniques employed give exact information on the direction and velocity of every fragment of interest in the warhead. The resulting data can be used as a basis for the design of an aimable directional warhead giving a significantly higher velocity and concentration of fragments in a target direction than a conventional warhead.
- 5993 **STRENGTH PREDICTIONS FOR GRAPHITE: A REVIEW OF PRIOR WORK AT AVCO SSD**
C. H. Hastings
ASTM Special Publication No. 439, 1968
- Strength prediction work on graphite has been going on since 1964. Accomplishments include NDT capability for predicting density in small discrete volumes of bulk graphite to better than ± 1 per cent, Young's modulus to better than ± 3 per cent, and ultimate tensile strength (all at room temperature) to better than ± 10 per cent. Predictions can be made in five or six different aerospace (fine-grained) grades of graphite, for both with- and against-the-grain orientation, employing a single set of calibration curves. Experiments indicate the strong possibility of extension to other fine-grained graphites, including graphite composites containing additives such as silicon and zirconium diboride.
- 5994 **LOW VOLTAGE RADIOGRAPHIC AND MICRORADIOGRAPHIC TECHNIQUES FOR GRAPHITE**
R. W. McClung
ASTM Special Publication No. 439, 1968
- Low-voltage radiography was studied to provide optimum techniques for graphite thickness less than 2 in. Significant improvements were made in image quality and sensitivity by use of an intermediate atmosphere of helium, bare film, and a thin beryllium-window X-ray tube. Use of a high resolution photographic emulsion allows contact microradiography to be performed on miniature specimens with a resolution of one micron. Applications include evaluation of 2.46 in. diameter graphite spheres and liquid-salt impregnation studies in various types of graphite.
- 5996 **THE APPLICABILITY OF A FRACTURE MECHANICS-NONDESTRUCTIVE TESTING DESIGN CRITERION (AD-832 042)**
P. F. Packman, et al
Lockheed-Georgia Co., Marietta, Ga. Air Force Materials Laboratory, Wright-Patterson AFB, Ohio. AFML-TR-68-32, May 1968 NOFORN
- Investigated the potential applicability of a combined fracture mechanics-NDT inspection procedure as a design approach for aircraft structures. Work consisted of (1) A literature survey to determine if sufficient fracture toughness information exists to determine a statistically valid value of K_{Ic} ; (2) A test program to determine the minimum size of a crack that can be detected by each of four NDT methods: X-ray, magnetic-particle, penetrant, and ultrasonics; and (3) A test program to determine if fracture mechanics, when combined with flaw size as determined by NDT, can accurately predict the failure load of selected structures. Fracture mechanics-NDT failure load predictions agreed with actual failure loads to within 10%. Results on 7075-T6511 Aluminum Cylinders and 4330 Modified Steel Cylinders given.

DESCRIPTOR INDEX

All descriptors listed in alphabetical order pertain to the information contained in the report or item that is identified by the AMMRC number following descriptor. This journal is concerned with radiographic testing literature and every item in the journal contains some aspect of radiographic testing. A complete breakdown of each subject item by descriptors was deemed necessary in order to make the journal useful.

Reviewers need only to look up the item numbers which apply to the particular descriptors of interest and turn to the abstract applicable to those referenced numbers.

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