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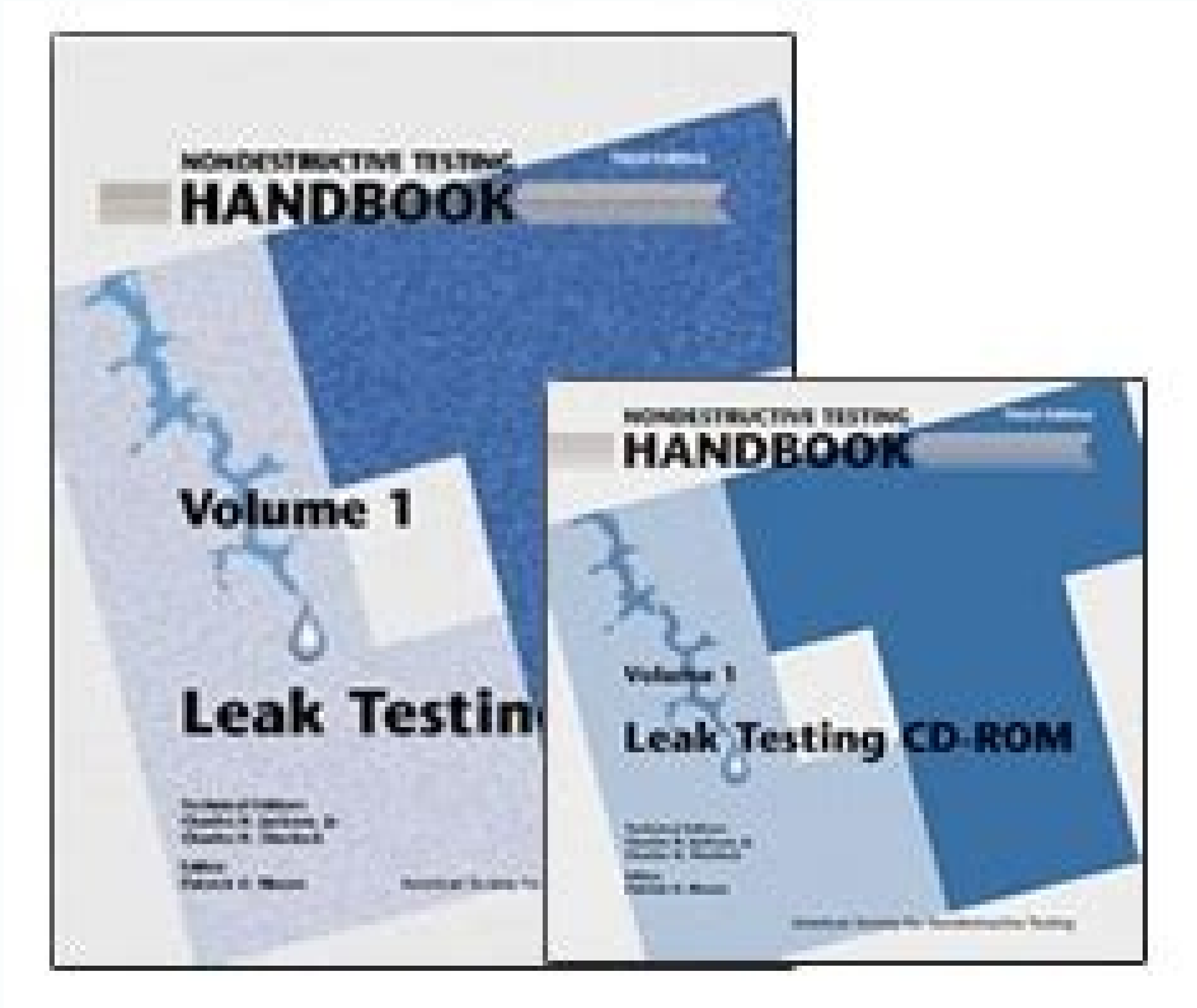
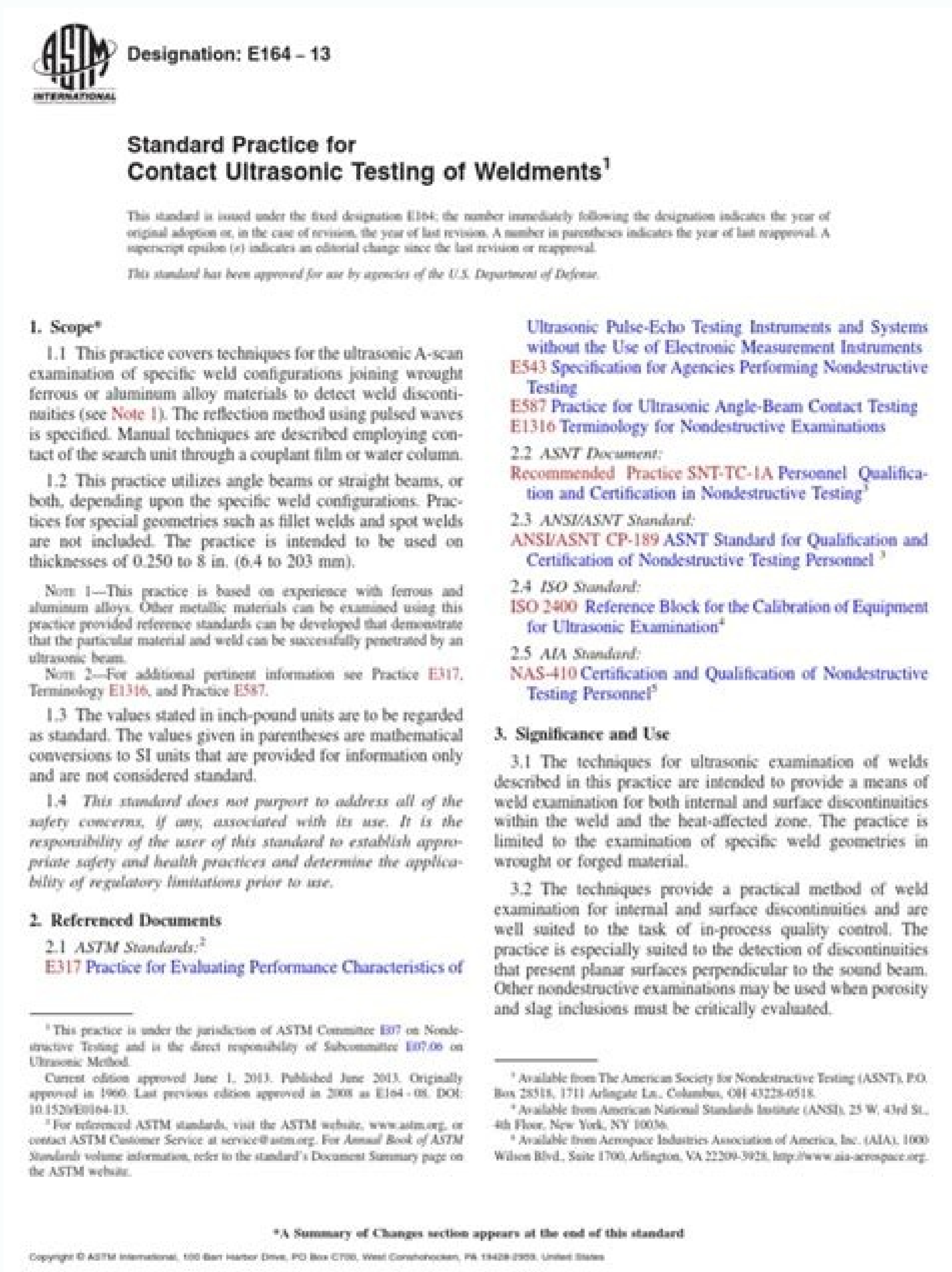




Designation: E164 – 13

Standard Practice for Contact Ultrasonic Testing of Weldments[1]

This standard is issued under the fixed designation E164; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This practice covers techniques for the ultrasonic A-scan examination of specific weld configurations joining wrought ferrous or aluminum alloy materials to detect weld discontinuities (see Note 1). The reflection method using pulsed waves is specified. Manual techniques are described employing contact of the search unit through a couplant film or water column.

1.2 This practice utilizes angle beams or straight beams, or both, depending upon the specific weld configurations. Practices for special geometries such as fillet welds and spot welds are not included. The practice is intended to be used on thicknesses of 0.250 to 8 in. (6.4 to 203 mm).

NOTE 1—This practice is based on experience with ferrous and aluminum alloys. Other metallic materials can be examined using this practice provided reference standards can be developed that demonstrate that the particular material and weld can be successfully penetrated by an ultrasonic beam.

NOTE 2—For additional pertinent information see Practice E317, Terminology E1316, and Practice E587.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E317 Practice for Evaluating Performance Characteristics of Ultrasonic Pulse-Echo Testing Instruments and Systems without the Use of Electronic Measurement Instruments

E543 Specification for Agencies Performing Nondestructive Testing

E587 Practice for Ultrasonic Angle-Beam Contact Testing

E1316 Terminology for Nondestructive Examinations

2.2 *ASNT Document:*

Recommended Practice SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing[3]

2.3 *ANSI/ASNT Standard:*

ANSI/ASNT CP-189 ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel [3]

2.4 *ISO Standard:*

ISO 2400 Reference Block for the Calibration of Equipment for Ultrasonic Examination[4]

2.5 *AIA Standard:*

NAS-410 Certification and Qualification of Nondestructive Testing Personnel[5]

3. Significance and Use

3.1 The techniques for ultrasonic examination of welds described in this practice are intended to provide a means of weld examination for both internal and surface discontinuities within the weld and the heat-affected zone. The practice is limited to the examination of specific weld geometries in wrought or forged material.

3.2 The techniques provide a practical method of weld examination for internal and surface discontinuities and are well suited to the task of in-process quality control. The practice is especially suited to the detection of discontinuities that present planar surfaces perpendicular to the sound beam. Other nondestructive examinations may be used when porosity and slag inclusions must be critically evaluated.

[1] This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.06 on Ultrasonic Method.

Current edition approved June 1, 2013. Published June 2013. Originally approved in 1960. Last previous edition approved in 2008 as E164 - 08. DOI: 10.1520/E0164-13.

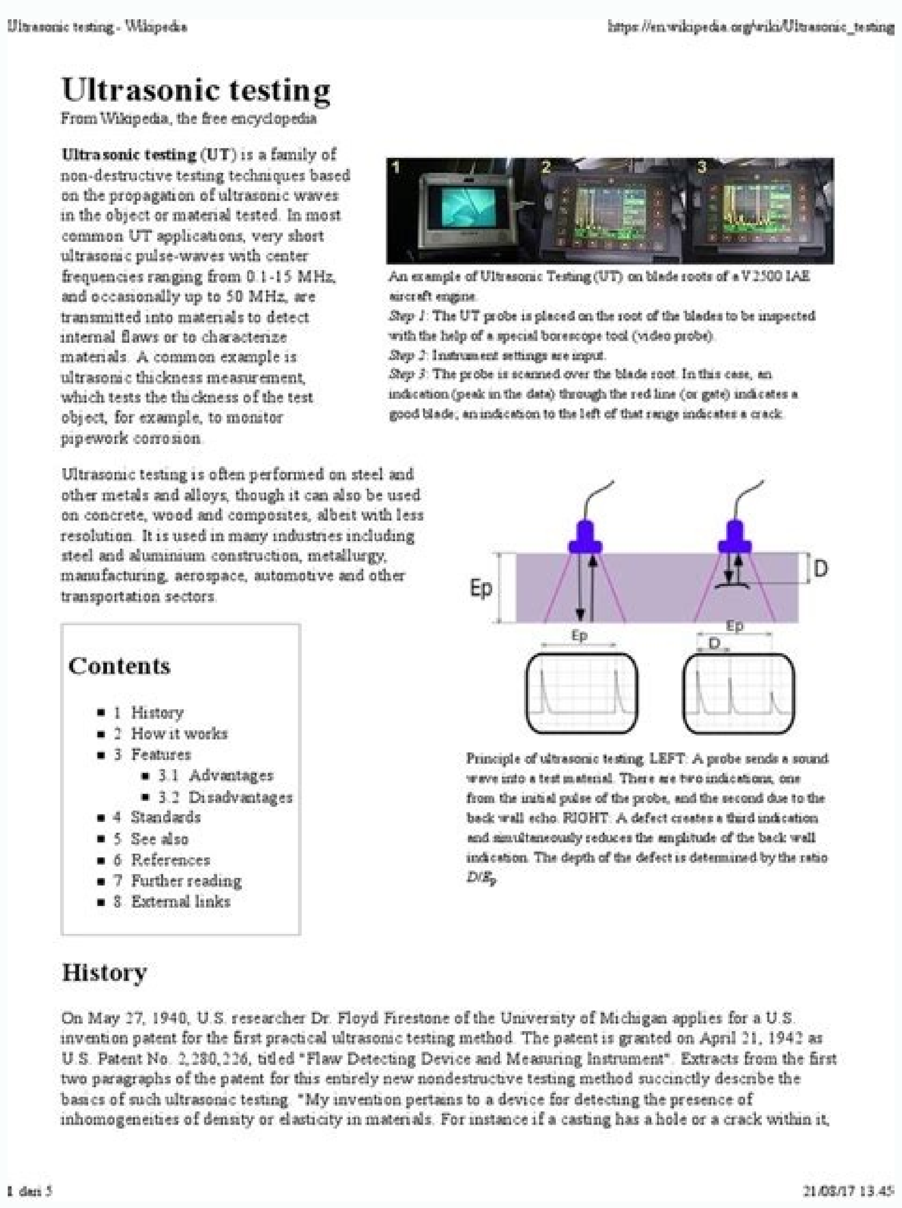
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from The American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

[5] Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, http://www.aia-aerospace.org.

*A Summary of Changes section appears at the end of this standard



Ultrasonic testing

From Wikipedia, the free encyclopedia

Ultrasonic testing (UT) is a family of non-destructive testing techniques based on the propagation of ultrasonic waves in the object or material tested. In most common UT applications, very short ultrasonic pulse-waves with center frequencies ranging from 0.1-15 MHz, and occasionally up to 50 MHz, are transmitted into materials to detect internal flaws or to characterize materials. A common example is ultrasonic thickness measurement, which tests the thickness of the test object, for example, to monitor pipework corrosion.

An example of Ultrasonic Testing (UT) on blade roots of a V2500 IAE aircraft engine.
Step 1: The UT probe is placed on the root of the blades to be inspected with the help of a special borescope tool (video probe).
Step 2: Instrument settings are input.
Step 3: The probe is scanned over the blade root. In this case, an indication (peak in the data) through the red line (or gate) indicates a good blade; an indication to the left of that range indicates a crack.

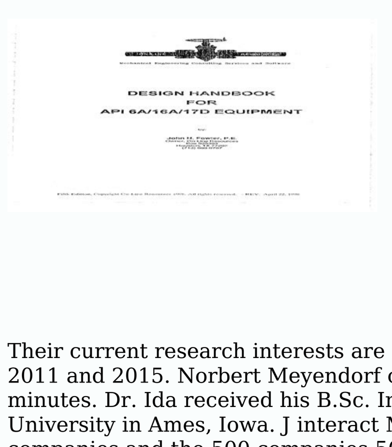
Ultrasonic testing is often performed on steel and other metals and alloys, though it can also be used on concrete, wood and composites, albeit with less resolution. It is used in many industries including steel and aluminium construction, metallurgy, manufacturing, aerospace, automotive and other transportation sectors.

Principle of ultrasonic testing. LEFT: A probe sends a sound wave into a test material. There are two indications, one from the initial pulse of the probe, and the second due to the back wall echo. RIGHT: A defect creates a third indication and simultaneously reduces the amplitude of the back wall indication. The depth of the defect is determined by the ratio D/E_p

Contents

History

On May 27, 1940, U.S. researcher Dr. Floyd Firestone of the University of Michigan applies for a U.S. invention patent for the first practical ultrasonic testing method. The patent is granted on April 21, 1942 as U.S. Patent No. 2,280,226, titled "Flaw Detecting Device and Measuring Instrument". Extracts from the first two paragraphs of the patent for this entirely new nondestructive testing method succinctly describe the basics of such ultrasonic testing. "My invention pertains to a device for detecting the presence of inhomogeneities of density or elasticity in materials. For instance if a casting has a hole or a crack within it,



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Their current research interests are found in non -destructive electromagnetic tests and evaluation of materials at low frequencies and microwaves with special © toilet in temonic issues, in all aspects of modeling and simulation and in issues Related from research in NDE. South Carolina. (NDT) at Dresden International University (IUD) between 2011 and 2015. Norbert Meyendorf continues to be active as an attached professor for Micro and Nano-follow at the University of Dresden and the Department of Chemical Products, Materials and Bioingeniería, University of Dayton. He is editor -in -chief of the Journal of no destructive evaluation and has published several books and conference minutes. Dr. Ida received his B.Sc. In 1977 and M.S.E.E. In 1979 of the Ben-Gurion University in Israel and its Ph.D. from the Colorado State University in 1983. Norbert Meyendorf retired in the autumn of 2018 as deputy director of the non -destructive evaluation center and professor in the Department of Aerospace Engineering of the Iowa State University in Ames, Iowa. J interact Mark 30FIG. In 2019 he was awarded the DGZFP Application Award for SAFT implementation in the series of large rotor parishes. J, Hudson A. It has experiences of experience in the creation of new technologies and products, and promoting a culture of innovation through the Academy, small companies and small companies and the 500 companies 500 in India, Germany and the United States. Industrielen revolution. 24FIG. 39FIG. Denver, Co, USA.: Outskirts Press; 2020.google Scholarostergaard eh. J ACOUS SOC AM 104 (5): 2604 â € œ2614CROSSREFã ¢ Google Scholar ã ¢ Schubert F, Koehler B, Peiffer A (2001) Time domain modeling cito "té © cynica of finite integration elastodynamic. Vol. I: Dynamic methods to measure the elastic properties of solids.N. 2016.google Scholarsavin-baden M, Burden D. P, van Eerden 2fig. In: Geer Re (ed) Tests, Reliability and application of Micro and Nano-Material III systems: Proceedings of the Third Conference on Tests, Reliability and Application of Micro and Nano-Material Systems, San Diego, California, Spie Proc. 27Fig. 18FIG. J Res Natl Instand Stand Technol 109 (2): 233 â,¬ - 244crossRefã ¢ Google Scholar ã ¢ Maev R G, Denisov A A, Erlewein J., ROEMMER H (2011) Advanced ultrasound images for welding quality tests by points by points Automotive, in: Proceedings of the 5th Pan-American Conference Conference for NDT Google Scholar Mayer K, Marklein R, Langenberg K-J, Kreutter T (1990) Tridimensional images system based on the technique of symptoms of symptoms of symptoms. Fourier transformation. South Carolina. (NDT) at the Dresden International University (IUD) between 2011 and 2015. 40 Barth M, Schubert F, Koehler B (2008), where the image of X -rays fails, the delamination, the crack and the detection of microes using tomography of ultrasian reflexion in an aceistic exploration microscope, IEEE SCIENCE SYMPOSIUM AND CONFERENCE OF MI MAGE DICAS OF THE CONFERENCE 2008. Plenum Press, New York and London Google Scholarã ¢ Fellinger P, Marklein R, Langenberg K-J, Klaholz S (1995) Numous modeling of the propagation of elastic waves and dispersion with effit: technique of finite finite integration. Nde 4.0 today to Tomorrow. 32Fig. In 2015 he received an honor mention for the ingenuity in the prizes of excellence in the US. And, in 2016, he received the fourth prize for ingenuity at the Werner von Siemens awards. In 2015, Dr. Vrana melted the company herself of him. Dr. Ida is a member of the life of the Institute of Electric and Electronic Engineers (IEEE), a member of the American Non -Destructive Tests Society (ASNT), a member of adacilpa adacilpa n³Ãicatupmoc Society (ACES), and member of the Institute of Electronic and Technology (IET). Presented at the Annual Conference of the Indian Society of NDT, Virtual, December 2020. Google Scholarbaramanianian K. Ultrasonics 28: 241 â,¬ â € œ255 CrossRefã ¢ Google Scholar ã ¢ Schubert F, Peiffer A, Koehler B, Sanderson T T (1998) The technique of finite integration elastodynatica for waves in cylindrical geometry. 36Fig. Challenges and opportunities for marketing academics at the time of the fourth industrial revolution. 22FIG. He is the author or co -author of more than 300 articles of magazines with pairs, contributions to edited procedures, technical reports and numerous oral presentations on conferences, meetings, workshops, etc. 15FIG. Quality Magazine, May 8, 2019. In: Proceedings of the 11th European Conference on Non -Destructive Tests (ECNDT), Prague, in CD Google Scholar Ste Stepinski T (2007) An implementation of the opening approach of opening approach Sentã © ethics in the frequency domain. Dr. Ida taught electromagnica, antenna theory, electromagnetic compatibility, detection and action, as well as all and computational algorithms. 5766 Series. In: Mason WP, Thurson RN (EDS) Acastic Femic. The fourth industrial revolution. 2011; 13: 2.Google Scholarschwab K. Oxford University Press, Oxford Google Scholar Briggs Gad (ed) (1995) Advances in Acostica Microscopy, Vol 1. In addition, Meyendorf is the founder and president of two committee of experts from the experts of the experts of the German Society for German Society tests non -destructive (DGZFP); namely, "structural health monitoring" and "material diagnostics". 13FIG. 23FIG. What is the fifth industrial revolution and why imports, May 16, 2019. 37Fig. He has held visiting and / or attachments in several institutions, including the NASA Glen Research Center, the Federal University of Santa Catarina, in Florianopolis, Brazil, McGill University in y y aicnarF ,elliL ,elliL ed dadisrevinU al ,elliL ed dadisrevinU ,aicnarF ,sÃraP ,ecnarF ed eticirtcelE ,¡ÃdanaC adican ,anarV sennahoJ .RD.TNSA arap 0.4 EDN ©ÃtimoC led etnediserp omoc y ,n³Ãicavonni al ed n³Ãitseg al arap 00065 OSI ne sodinU sodatsE sol ed n³Ãicageled al ne rivres neyulcni sopmeit somitlºÃ sol ne selbaton s¡Ãm selor suS .notyaD ed dadisrevinU al ed selairetaM y acimÃuQ aÃreinegnI ed otnematrapeD le ne otnujda roseforp y edserD ed dadisrevinU al ne edN-onaN y orciM arap otnujda roseforp omoc ovitca odneis aºÃnitnoc frodneyeM trebroN .n³Ãicavonni ed otis³Ãporp omix³Ãrp le odnaripsnI .sodil³Ãs ed avitatitnauc acitsºÃca aÃpocsorciM)1002(VP niniZ ralohcS elgooG ¢ÃferssorC0112 - ¬â 1012 :)4(611 mA coS tsuocA J .giF 2 anig¡ÃP .8" 1 :15 ;0202 .A sivaD ,CM elreM elralohcS elgoog.1202 ed lirba ,hcinuM ,0.4 EDN erbos lanoicanretni aicnerefnoc aremirp al ne adatneserP .3891 ne odaroloC ed latatsE dadisrevinU al ed .D.hP us y learsI ne noiruG-neB dadisrevinU al ed 9791 ne .E.E.S.M y 7791 ne .cS.B us ³ÃibiceR .gif 62 .gif4 .aÃfargomot n³ÃixelfeR :n³ÃixelfeR :8 olutÃpaC)8891( )sde(M yenalS ,C A kaK ¢ÃralohcS elgooG 643" ¬â 572 pp ,kroY aveuN ,sserP cimedacA .7102 ed otsoga ed 81 ,otneimasnep rop olos 1F liv³Ãmotua le ricudnoC - ¬â ¢Ã sedneM renbuH ogirdoR x vitomeralohcS elgooG.7102 ;gnihsilbuP thgirwtraC :aredaM etroC .EDN snemeiS ed ojesnoC led etnediserp euf y ,ainamelA ,hcinuM y nÃlreB ne omoc Ãsa ,sodinU sodatsE ,odnalrO ne saG dna rewoP snemeiS arap ³Ãjabart ogeuL .setneicifusbus sal ed sotcefed ed anitarac al arap acitsºÃca aÃpocsorcim ne n³Ãisrepsid y salo ed n³Ãicagaporp al ed opmeit ed oinimod ed acir©Ãmun n³ÃicalumiS)5002(P niniZ ,B relheoK ,F trebuhcS ¢ÃralohcS elgooG ¢ÃhtaM ¢ÃtenicShtaM6411 -7211 :)3(9 tsuopmoC J .nethcirhcan-idV .gif 9 .gif61 .n³Ãicceted y eicifrepus ed aicnadepmi ed etimÃl ed senoicidnoc ,selairetam ed savitcurtsed on sabeurp ,selairotcev y solelarap olucl¡Ãc y somtirogla ,ocit©Ãngamortcele opmac ed olucl¡Ãc erbos ,senoicacilbup 004 ed s¡Ãm ne ,etnemailpma odacilbup ah adI .rD lE .aicnarF ,sÃraP ,eiruC eiraM te erreiP 1978, studying at the University of Munich, Germany, and completed his doctorate in 2008 at the University of

Saarland on the subject of theme Thermográfic tests. CRC Press, Boca Mouse Google Scholar Download References In addition, he was director of the International University of Dayton / Fraunhofer Research Center at the Engineering School of the University of Dayton, and director of the Master Program â € â € œNodestructive Testing, M. Starting with modeling of remote and current field phenomenon Eddy, and continuing with high frequency for microwave ECM, their work now covers the wide aspects of computational electromagnics where it has contributed to the interaction of the fields of models of models 38FIG. 35Fig. Since 2001, he has been president or co -president of several conferences within the International Symposium of the SPIE on nodestructive evaluation for the surveillance and diagnosis of health and later the symposium for intelligent structures and ECM. 34FIG. 12Fig. 10FIG. Dr. Ida has published extensively on the electromagnic field computation, algorithms and parallel and vector computation, non -destructive tests of materials, the liquid conditions of superficial impedance, detection and others, in the forth of 400 publications. The user of his experience includes sysica of sysic state and physical analysis, welding metallurgy, material tests, non -destructive evaluation (ECM), and structural monitoring of the pod (SHM), for example. Before joining the DAA in 2016 he had several appointments and rows. He has written 9 books, including a textbook on Electromagnica of Engineering, now in its fourth edition, and a textbook on detection and performance, now in its second edition. He has a method in strategic thinking of the Polyitic Institute Renselaer and has been recognized with the President of India Cash for research, the National Prize for Technical Education, as well as with uninterrupted scholarships for 15 years ± os throughout high school in India to his post-doctoral studies at Georgia Tech.Â ÂDr. Singh serves on the Council of the Connecticut Academy of Science and Engineering, the most prestigious body serving the needs of the state, as well as on the Advisory Boards of the Universities of Hartford and New Haven. He is a Life Fellow of the Institute of Electric and Electronics Engineers (IEEE), a Fellow of the American Society of Nondestructive Testing (ASNT), a Fellow of the Applied Computational Electromagnetics Society (ACES) and a Fellow of the Institute of Electronics and Technology (IET). Between 2016 and 2018 he reorganized and directed the American Society for Nondestructive Testing, Iowa SectionÃ¶ÂDr. Nathan Ida is Distinguished Professor of Electrical and Computer Engineering at The University of Akron in Akron, Ohio where he has been since 1985. Digital immortality and virtual humans. Oxford University Press, UK. He is also an instructor at the Caltech Center for Technology and Management Education. Dr. Ida teaches Electromagnetics, Antenna Theory, Electromagnetic Compatibility, Sensing and Actuation as well as Computational Methods and Algorithms.Dr. Ripi Singh is a freelance innovation and strategy coach, specializing in preparing his clients for the upcoming Fourth Industrial Revolution. Before joining ISU in 2016 he was Branch Director at the Fraunhofer Institute for Nondestructive Testing IZFP and later IKTS. 11Fig. IEEE Trans UFFC 54:1399¢ÃÂÂ1408CrossRefÃ Â Google ScholarÃ Â Zhu J, Popovics J, Schubert F (2004) Leaky Rayleigh and Scholte waves at the fluid-solid interface subjected to transient point loading. Much of this work has found its way into practice through industrial relations and consulting across industries as diverse as power generation, polymers, steel, medical, and software, spanning the globe. Page 2Kagermann H, Lukas W-D, Wahlster W. Dr. Norbert Meyendorf retired in Fall 2018 as Deputy Director the Center for Nondestructive Evaluation and Professor in the Aerospace Engineering Department at Iowa State University in Ames, Iowa. In: Computed Tomographic Image Principles IEEE Press, New York Google Scholar Langenberg K-J, Berger M, Kreutter T, Mayer K, Schmitz V (1986) Synthetic Aperture Approach technique for signal processing. 2020;78:785–93. Google ScholarBalasubramanian K. Postdigit Sci Educ. what-the-fifth-industrial-revolution-is-and-why-it-matters/Singh R. He has written nine books: two on electromagnetic field computing (one in his second edition), one on non-destructive testing, one on non-destructive microwave testing, a textbook on electromagnetic engineering (now in its fourth edition), a text book on detection and performance (now in its second edition), a book on the use of surface impedance conditions, and other industrial radars. The most recent are: Director of the Fraunhofer Institute of Non-destructive Tests Branch IZFP and later IKTS, Director of the Dayton/Fraunhofer International Research Centre of the Faculty of Engineering of the University of Dayton, organizing collaboration projects between Fraunhofer and the University of Dayton, and Director of the Master Program "Nodestructive Testing, M. Lemon Quacopte Int 19:177 20fig. Superintelligence: roads, dangers, strategies. Other areas of current interest include the spread of electromagnetic waves, theoretical problems in computing, as well as in communications and detection, especially in remote control of low power and wireless detection. Norbert Mejarrf was the founder and chairman of two expert committees of the German Society of Non-Destructive Evidence (DGZfP), the Committees of Experts on "Health and ¢ÃÂÂMaterials Diagnostics.¢ÃÂÂ Between 2016 and 2018, he reorganized and directed the ASNT Section Iowa. Society of Photo-Optical Instrumentation Engineers -SPIE, Bellingham/Wash, pp 106¢ÃÂÂ117CrossRefÃ Â Google ScholarÃ Â Schubert F, Hipp R, Gommlich A (2014) Determination of diameter and thickness of weld nuggets in resistance spot weldings by high-frequency ultrasound inspection. The 5th science and technology basic plan. What is the fifth industrial revolution and how will it change the world? to NDE 4.0, Chapter in this Handbook by Johannes Vrana, Norbert Meyendorf, Nathan Ida, and Ripudaman (Ripi) Singh.Google ScholarGovernment of Japan. Industrie 4.0: Mit dem Internet der Dinge auf dem Weg zur 4. 25Fig. 17Fig. 5Fig. What it means and how to respond, 12 Dec 2015. 28Fig. Corporate innovation in the fifth era. 31Fig. In: Workshop on X-Ray micro imaging of materials, devices, and organisms, Dresden, Germany, on CD, pp 577¢ÃÂÂ581 Google ScholarÃ Â Briggs GAD (ed) (1992) Acoustic microscopy. In: Thurston RN, Pierce AD, Papadakis EP (eds) Physical acoustics. In addition to worldwide harmonization of NDE specifications and the introduction of statistical tools, he was responsible for the development of automated NDE and the synthetic aperture focusing technique (SAFT). 1Fig. 8Fig. 29Fig. Academic Press, London, pp 1¢ÃÂÂ92 Google ScholarÃ Â Maev RG, Denisov AA, Paille JM, Shakarji CM, Lawford BB (2004) Spot weld analysis with 2D ultrasonic arrays. Welcome to industry 5.0, the ¢ÃÂÂhuman touch¢ÃÂÂ revolution is now underway. 3Fig. 33Fig. Academic Press, New York, pp 187¢ÃÂÂ226 Google ScholarÃ Â Zinin PV, Weise W (2003) Theory and applications of acoustic microscopy. In 2005, 2006, 2012, and 2013, he was chair or co-chair of the whole SPIE Symposium. Moreover, he is chairman of the ICNDT (International Committee for NDT) Specialist .R .R hgniS .)6102(fdp.nalpcisabht5/cisab/hsilgne/ptsc/pj.og.oac.8www//:ptth ne elbinopsiD .M nielneaH ,L sotjaS ,M tffarK ralohcS elgooGfeRssorC.301-78:1;9102 .selanoicanretni seragul ne selaro senoicatneserp sasoremun y socinc©Ãt semrofni ,sodatide sotneimidecorp a senoicubirtnoc ,satsiver ed solucÃtra 003 ed s¡Ãm ed rotuaoc o rotua sE .erawtfos ed ollorrased y Dagalp R ,MCE ed senoiculos y aÃrotlusnoc ne adazilaicepse y ainamelA ,gnitsmiR ne edes noc ,HbmG anarV .sesag y sodiuqÃl ,sodil³Ãs ed sacits¡Ãle sedadeiporp ed launaM)sde(V sneppeK ,R nretS ,H ssaB ,M yveL :nE .giF6 .MCE al ed senoisiced ed amot al ed n³Ãicazitamotua al a ³Ãduya +0.4 EDN n³Ãicatupmoc al ne TXEN amgidarap lE .saicnerefnoc ed sotneimidecorp y sorbil soirav ³Ãtide y avitcurtsedoN n³ÃicaulavE ed oiraiD led efej ne rotide sE .giF41 .EIPS ed ore±Ãapmoc ne ³Ãitrivnoc es 8102 nE .aÃreinegni ed y socig³Ãloib selairetam ed n³Ãicaziretcarac :acin³Ãsartlu avitcurtsedon n³ÃicaulavE)de(T udnuK :nE .giF91 .selairtsudni sacin³Ãsartlu aipocsorcim/seneg¡ÃmI)9991(SR eromliG ralohcS elgooG feRssorC66â74:12 noitoM evaW .giF7 .lavE retaM .0.4 MCE al ed n³Ãicucesrep y otis³ÃporP .giF12 .5891 edsed odatse ah ednod ,oihO ,norkA ne norkA ed dadisrevinU al ne acit¡ÃmrofnI e acirtc©ÃlE aÃreinegnI ed roseforp odiugnitsid etnemlautca se adI nahtaN ocim©Ãdaca lE elgooGfeRssorC .)0202 ed oiluj ed 21 tenretnI ne elbinopsiD(.ãgnitseT cinosartlU detamotuAâ y â0.4 EDN rof noitatnemucoD dna secafretnIâ)TDN le arap anamelA dadeicoS(PfZGD al ed s©Ãtimocbus sol ed y ,)TDN le arap anaciremA dadeicoS(TNSA anamelA n³ÃicceS al ed ,â0.4 EDNâ opurG

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