

Souvenir Book



organised by
**Indian Society for
Non-Destructive Testing
(ISNT)**

Conference & Exhibition on **NON DESTRUCTIVE EVALUATION**

Theme:
eNDEavours from detection to prediction



NDE 2019

DECEMBER 5-7, 2019 • BENGALURU

OLYMPUS[®]

You've Been Waiting.

Introducing the
OmniScan[®] X3 Flaw Detector

- › Acoustic Influence Map (AIM) Modeling
- › Live TFM Envelope Filter
- › Fast Calibration
- › IP65 Certified



ND= 2019

DECEMBER 5-7, 2019 • BENGALURU

PRINCIPLE SPONSOR



PLATINUM SPONSOR



DIAMOND SPONSOR



GOLD SPONSOR



PUBLISHING PARTNER





GOVERNMENT WORK IS GOD'S WORK

INDEX



MESSAGES	6
MEMORIAL TALKS	26
PLENARY TALKS	29
INVITED TALKS	36
CONTRIBUTORY TALKS	66
SPONSORS & EXHIBITORS	242
ADVERTISEMENTS	281
ORGANIZING COMMITTEE	313

MESSAGES





FOREWORD

It gives me great pleasure and pride to present to you the Souvenir prepared on the occasion of NDE2019. The conference and exhibition have taken a great shape over the last few months and has attracted an overwhelming response from professionals, researchers, academicians, students, manufacturers and service providers. The organizing committee is delighted with the support it has received and gratefully thanks every individual and organization who have helped made this possible. Several tall leaders from the government, strategic sectors and industry have sent in their messages of best wishes for the event and are part of this Souvenir. The theme of this year's conference is ***"eNDEavours from Detection to Prediction"*** which highlights the changing trends in the world of industrial inspection and will offer an opportunity for professionals to be a thought leader in driving this vision. With 800+ delegates, 200+ papers, 70+ exhibition stalls, NDE2019 promises to be one more landmark event for ISNT. We have introduced new events like NDT Hackathon and NDT quiz this year to encourage students and others to be more engaged with ISNT and the NDT profession. Our special thanks to all sponsors, supporters, advertisers, exhibitors, technical paper contributors, invited speakers and of course, the Delegates !

On behalf of my organizing committee, I extend a warm welcome to each one of you who have travelled from different places in India and abroad to be a part of NDE 2019 and welcome you to the city of Bangalore, officially called Bengaluru. I am sure you will enjoy your stay and the event which has been planned meticulously to ensure each one of you returns home delighted. Welcome to NDE2019 !

A handwritten signature in black ink that reads "Shyamsunder Mandayam".

Dr. Shyamsunder Mandayam

Chairman, NDE 2019



MESSAGE

It is my proud privilege and pleasure to invite you all for the NDE-2019, National conference and Exhibition, the annual Mega event of ISNT to be held in Bengaluru from 5th to 7th December 2019. The theme of this year's conference is "eNDEavours from Detection to Prediction. This is the first time the NDE conference is being held at Bengaluru, the hub of Aerospace and IT industries. It is understandable that the focus would be placed on NDE in Aerospace industry. However, the topics will encompass a vast spectrum from conventional to advanced NDE including innovative methods, sensors, procedures and data analytics as applied to all industry segments for Quality control, Inservice inspection, life assessment, structural integrity and related areas.

NDE must be seen more as a part of the wide field of engineering, as an interdisciplinary endeavor, that brings together the expertise of materials science and metrology, together with the underlying physics for inspection methods, as well as statistics.

NDT technology is crucial for the development of new manufacturing methods and engineering materials, for assuring the integrity of much of the infrastructure and for asset life management. NDT delivers high impact in terms of safety, asset value maximization and competitive benefits for client industries such as aerospace, power generation, oil and gas, defence and transport.

It is expected that NDE-2019 will have over 30+ invited talks and 200+ presentations from eminent experts from India and abroad. over 80 exhibitors will be showcasing their products and around 1000 delegates would participate in the conference.

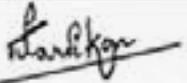
Looking at the various topics going to be discussed during the Conference and the participation of international experts, you can rest be assured that the three days of deliberations will provide opportunity for stimulating interactions, knowledge sharing and forging research collaborations.

The conference will provide an excellent platform for developing new ideas and technologies.

My sincere appreciation and compliments to the entire team of NDE-2019 including the members of various committees. I am sure this conference will go a long way in propagating NDE technology and help in overall growth of the Indian industry.

I am sure that ISNT will keep on contributing more effectively in order to achieve the goal for which ISNT was established. In my dual capacity, I can assure you that, in my view, nothing is more important in the present world than the striving for the common good which finds expression in the honest collaboration among experts, individuals, peoples and nations.

I wish all participants fruitful debates and full success, for the sake of the common good ! I am confident that every delegate will learn something new and takeback with him inspiration to excel.



Dr. R J PARDIKAR

PRESIDENT-ISNT

Dr. B. VENKATRAMAN, FISNT, FSAEST
Distinguished Scientist
Director, Safety Quality & Environment Group
Engineering Services Group



भारत सरकार
परमाणु ऊर्जा विभाग
इन्दिरा गौधी परमाणु अनुसंधान केन्द्र
कल्पक्कम 603 102, तमिलनाडु, भारत
GOVERNMENT OF INDIA
DEPARTMENT OF ATOMIC ENERGY
INDIRA GANDHI CENTRE FOR ATOMIC RESEARCH
KALPAKKAM – 603102, TAMIL NADU, INDIA

November 23, 2109



MESSAGE

I am happy to note that Indian Society for Non Destructive Testing (ISNT) is organizing its National Conference NDE-2019 during December 5-7, 2019 at Bengaluru to bring together NDE Professionals from research, academic and industry to discuss the latest trends and achievements in NDE.

As all of us are well aware, NDE is an indispensable part of strategic, core sectors, healthcare and heritage. The concurrent achievements in the fields such as materials, modelling, electronics, robotics and sensors have revolutionised the field of NDE also. I am happy to note that this year the theme of the Conference is "eNDEavours from detection to prediction" which rightly brings to the fore the changing perspectives and also the current thinking and trends in the field of NDE. It is heartening to that over 30+ Keynote Speakers from India and abroad are participating in this event and over 70+ exhibitors would be participating and exhibiting the state of art and developments which I am sure would be of immense benefit to the practicing NDE professionals and the NDE colleagues from industries and organisations.

I am sure that under the Chairmanship of Dr. M.T. Shyamsunder, Presidentship of Dr. R.J. Pardikar and the dynamic team from Bengaluru and other NGC members, this event would be another benchmark in the annals of ISNT.

I wish NDE 2019 all Success.

(B. Venkatraman)
President Elect, ISNT

भारतीय अन्तरिक्ष अनुसंधान संगठन
अन्तरिक्ष विभाग
भारत सरकार
अन्तरिक्ष भवन
न्यू बी ई एल रोड, बेंगलूरु - 560 231, भारत
दूरभाष : +91-80-2341 5241 / 2217 2333
फैक्स : +91-80-2341 5328



Indian Space Research Organisation
Department of Space
Government of India
Antariksh Bhavan
New BEL Road, Bangalore - 560 231, India
Telephone: +91-80-2341 5241 / 2217 2333
Fax : +91-80-2341 5328
e-mail : chairman@isro.gov.in

डॉ.के. शिवन / Dr K. SIVAN
अध्यक्ष / Chairman

MESSAGE

It gives me great pleasure to know that the Indian Society for Non Destructive Testing (ISNT) is organising a three-day conference, NDE 2019 in Bangalore during December 5th to 7th 2019.

Ensuring quality is a major requirement of ISRO's space programme and NDT has played a stellar role in the success and reliability demonstrated by our launch vehicle and satellite programmes. The conference is being organised at the right time when our major programmes are picking up, where the safety and reliability demands will be one order more than conventional space flights.

I am sure that this conference will bring together working professionals and aspiring engineers on a common platform to not only learn about the state-of-the-art but also share their professional experiences. The deliberations and advanced topics and the elaborate exhibition in NDE 2019 will further inspire the current and the future generations of practicing NDT professionals.

I extend my warm greetings and felicitations to the organizers and the participants. I also congratulate the organizers for attracting a wide range of papers from experts and wish all the speakers and delegates a very fruitful conference

Dated: November 22, 2019

(के. शिवन / K. Sivan)



के. शिवन
22/11/2019

के. एन. व्यास
K. N. Vyas



अध्यक्ष, परमाणु ऊर्जा आयोग
राष्ट्रिय, परमाणु ऊर्जा विभाग
Chairman, Atomic Energy Commission
&
Secretary, Department of Atomic Energy



MESSAGE

I am happy to know that the annual event of Indian Society for Non-Destructive Testing, NDE 2019, Conference & Exhibition on Non-Destructive Evaluation will be held at Bengaluru from December 5-7, 2019. The theme of the event 'Endeavours from Detection to Prediction' has been aptly chosen. It truly reflects the changing scenario in the development and application of non-destructive examination in various industrial sectors.

The demands from nuclear industry has been the driving force in the development of several innovative technologies in the field of science and engineering, and NDE is no exception. These innovations have not only helped the nuclear industry in overcoming several inspection related challenges but have also benefitted other strategic sectors like space & defence, healthcare and other industrial sectors at large. As the industrial world is getting ready to embrace 'Industry 4.0', the NDT fraternity is faced with the challenges and the opportunities like never before. In this context, an event like NDE 2019 provides an ideal platform for NDT professionals to assemble under one roof and share their problems and ideas for mutual benefit.

I am happy to note that NDE 2019 has attracted the attention of scientists and engineers alike. With over 180 technical papers to be presented and over 50 exhibitors displaying NDT equipment and technologies, the event will surely be an enriching experience for the delegates.

I wish NDE 2019 all the success.

(K.N. Vyas)



अणुविभाग, एन.टी. सिविल बिल्डिंग कॉम्प्लेक्स - 400 001, मुंबई • Anushakti Bhawan, Chhatrapati Shivaji Maharaj Marg, Mumbai - 400 001, India
दूरध्वनि/Phone: + (91) (22) 2202 2543 • दूरध्वनि/Fax: + (91) (22) 2204 6478 / 2264 3688
ई-मेल/E-mail: chairman@dae.gov.in

डॉ जी. सतीश रेड्डी
Dr G. Satheesh Reddy
FNAE, NCDI (R&D), FMAE (R&D), FMAE (R&D) (R&D),
FPMAN, FSDMR, FET (R&D), FIE, FAPNG, FETE, AFAR (USA)



सत्यमेव जयते

भारत सरकार
Government of India

सचिव, रक्षा अनुसंधान तथा विकास विभाग
एवं
अध्यक्ष, डीआरडीओ

Secretary, Department of Defence R&D
&
Chairman, DRDO



MESSAGE

I am glad to know that the Indian Society for Non-Destructive Testing (ISNT) is organising a three day conference, NDE 2019 and exhibition in Bengaluru during December 5th to 7th 2019. It is a matter of great significance that India is hosting this prestigious conference on annual basis.

The advancement of technologies has seen a wide range of innovations forming an important part of Research and Development. Strategic sectors like Defence need advanced and state-of-the-art Non-Destructive Testing and Evaluation (NDT&E) to ensure safety, reliability and quality, which is of paramount importance considering the nature of modern era weapon systems.

In the last few decades, testing has seen a paradigm shift and the desired results at the end of the process are only acceptable. NDT&E in DRDO labs has progressed significantly keeping pace with the service requirements.

I am happy to note that the conference has attracted excellent response in the form of more than 200 abstracts from all over the world and more than 30 speakers from a galaxy of eminent national and international experts are participating. I also understand that organisers have arranged an excellent exhibition with the state-of-the-art equipments.

I extend my warm greeting and felicitations to the organisers and the participants and wish the conference all the success.

Jai Hind.

(G Satheesh Reddy)

रक्षा मंत्रालय, रक्षा अनुसंधान तथा विकास विभाग, डीआरडीओ भवन, राजजी मार्ग, नई दिल्ली-110011
Ministry of Defence, Department of Defence R&D, DRDO Bhawan, Rajaji Marg, New Delhi-110011
दूरभाष/Phone : 011-23011519, 23014350, फैक्स/Fax : 011-23016216, ई-मेल/E-mail : secydrdo@bqr.drdo.in



Established in the year 1948

Dr. R.K. Tyagi

PRESIDENT

B.E. (Electronics & Telecom), MBA, Ph.D
MAeSI, FIETE, FIE, MIDSA, MMNF, MRWSI,
Former Chairman

- Hindustan Aeronautics Limited (HAL)
- Pawan Hans Helicopters Limited (PHHL)



I am extremely happy to learn that Indian Society for Non-Destructive Testing (ISNT) is organising a three-day conference, NDE 2019 and Exhibition in Bangalore during December 5th to 7th 2019.

We all realize the developments in NDT Science & Technology are now taking place at a rapid pace compared to the earlier years to meet the variety of challenging needs and requirements of different industries, in particular Aerospace industries- both supplier of critical systems, components to aeronautical production units

I am sure and certain that the conference will prove to be a very rewarding & useful event for all participants who attend the conference and then to face the exciting challenges in the pertinent work activities with satisfaction and immense confidence. The exhibition is an added attraction for the display and demonstration of all modern equipment.

I wish the conference all the success.


(Dr. R.K. Tyagi)

26.11.2019.

THE AERONAUTICAL SOCIETY OF INDIA

13-B, INDRAPRASTHA ESTATE, NEW DELHI-110002
Mob. : +91 9971807766, Phone : 011-23370495, 23370516 Fax: 011-23370768
Email: rkyagi.hal@gmail.com, aerosoci@bol.net.in
Web: www.aerosocietyindia.in



परमाणु
ऊर्जा
नियामक
परिषद



Atomic
Energy
Regulatory
Board

भारत सरकार

GOVERNMENT OF INDIA

गुंदूर नागेश्वर राव
G. NAGESWARA RAO

अध्यक्ष
CHAIRMAN

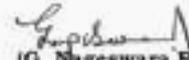
Message

I am delighted to know that the Indian Society for Non-Destructive Testing (ISNT) is organising the Conference & Exhibition on Non Destructive Evaluation in Bengaluru from December 5 - 7, 2019 with an objective to provide an opportunity and effective platform for NDE professionals from India and all over the world to meet and exchange ideas and information of interest to NDE community. NDT equipments are undergoing fast changes covering all NDE methods because of the state-of-the-art equipment and advanced procedures. Importance of NDE is growing continuously in nuclear industry and other industries like mechanical engineering, electrical engineering, civil engineering, forensic engineering, aeronautical engineering.

Rapid growth of NDE practices using ionising radiation sources such as industrial radiography, nucleonic control systems, and industrial scanners indicate remarkable industrial development in our country. Apart from well-established industrial radiography technique for testing of welds & castings, the radiation sources are extensively being used in the country as Radiation Gauging Devices//Nucleonic Gauges for on-line monitoring and measurement of industrial physical parameters like level indicators, density and thickness measurement, material composition. X-ray / Gamma based industrial scanners are being commonly used at sea ports, airports & strategic locations. Use of radiation and NDT equipment should be handled properly to avoid potential radiation exposures. Cases of unusual incidents involving radiation sources are reported from industrial radiography practice. It is therefore imperative that radiation sources are managed safely & securely by qualified and certified personnel. It shall be ensured that radiography devices and sources are handled after obtaining license from the Atomic Energy Regulatory Board (AERB) and in accordance with the requirements of the regulatory documents published by AERB.

I am sure that NDE-2019 will provide updated information to NDE professionals in this rapidly growing field so that they can present their work from conventional to advanced NDE techniques, related research & development areas, education, training & certification in NDE.

I congratulate the NDE-2019 organising team and wish grand success for NDE-2019 event.


(G. Nageswara Rao)



November 15, 2019

नियामक भवन, अणुशक्तिनगर, मुंबई - 400 094
NIYAMAK BHAVAN, ANUSHAKTINAGAR, MUMBAI - 400 094

दुर्धारा / TELEPHONE : +91-22-2556 2343, 2556 0604
दुर्धारा / FAX : +91-22-2556 2344, 2556 5717, 2556 3220
ई-मेल / E-mail : chairman@aerb.gov.in
gnageswaraao@aerb.gov.in
वेबसाइट / WEBSITE : www.aerb.gov.in

डॉ. टेस्सी थॉमस
Dr. Tessa Thomas
विशिष्ट वैज्ञानिक
Distinguished Scientist
महानिदेशक - वैमानिकीय प्रणाली
Director General - Aeronautical Systems



महानिदेशक - वैमानिकीय प्रणाली
Director General - Aeronautical Systems
भारत सरकार, रक्षा मंत्रालय
Government of India - Ministry of Defence
रक्षा अनुसंधान तथा विकास संगठन
Defence Research & Development Organisation
एडीई कैम्पस
ADE Campus, Raman Gate, Suranjan Das Road
न्यू थिप्पसन्ड्रा पोस्ट, बेंगलूरु-560 075
New Thippasandra Post, Bengaluru - 560 075

No. DG (Aero)/Sect/DG-DO/2/013

Dated: 25 Nov 2019



MESSAGE

I am happy to learn that Indian Society for Non-Destructive Testing is organizing a National Conference on Non-Destructive Evaluation & Exhibition (NDE 2019) in Bengaluru, the aerospace hub of the nation during 5th – 7th December, 2019.

I understand that this conference is specifically focused to assimilate technical information and knowledge on NDT processes, equipments, standards, personnel certification etc across various fields like automotive, aerospace, nuclear power, civil structures. The exhibition consists of display and demonstration of state-of-the-art equipments.

I hope that this event will immensely benefit DRDO fraternity in general and aerospace community in particular to improve their working knowledge, acquire latest inspection technologies, network with personnel involved in similar areas of work world-wide to enhance the reliability of inspection, testing and evaluation.

I extend my greetings and good wishes to the organizers and the participants. I wish the conference all success.

Tessa Thomas
25/11/19

Delhi Office : Room No. 28 B-wing, DRDO Bhawan, Rajaji, New Delhi-110011
कार्यालय दूरभाष/Office Telephone : + 91 080 2528 3021 / 2251 1402, फैक्स/Fax : 080 2528 3028, 2528 3022
ई-मेल/e-mail : dgaero@hq.drdo.in

एस. के. शर्मा
अध्यक्ष एवं प्रबंध निदेशक

S. K. Sharma
Chairman & Managing Director



न्यूक्लियर पावर कॉर्पोरेशन
ऑफ इंडिया लिमिटेड
NUCLEAR POWER CORPORATION
OF INDIA LIMITED



MESSAGE

I am happy to note that the Indian Society for Non-Destructive Testing (ISNT) is organizing **NDE 2019 Conference & Exhibition on Non Destructive Evaluation**. The theme of the conference '**eNDEavours from detection to Prediction**' which highlights the changing trends in the world of industrial inspection and reflects the ever increasing demands and challenges in the field of non-destructive examination from various industrial sectors.

The demands from nuclear industry has been a major driving force for the development of NDE science & technology all over the world. NDE not only plays a crucial role in meeting stringent quality control requirements during manufacturing of critical core components, but is also heavily relied on while carrying out fitness-for-service assessment of these components to ensure that they operate safely without failure. The integrity of core components is central to the safety of nuclear power plants. The NDT professionals in the nuclear industry have to ensure that not only they avoid any catastrophic failure but they detect the damage at a very early stage so that corrective actions can be taken well in advance. Events like NDE 2019 provide an ideal platform for scientists and technologists to come together and deliberate on possible solutions to such challenging problems.

It is very heartening to know that special sessions targeting various industries will be conducted during NDE 2019. Such sessions are essential in bridging the gap between R&D organizations and the industries. I am happy to note that over 200 technical papers and over 50 keynote lectures will be delivered during the conference on topics ranging from conventional to advanced to novel NDE techniques. I am pleased to know that NDE 2019 has attracted large number of exhibitors from all over the world. I am sure delegates from various industrial sectors and R&D organizations will find the exhibition interesting & enlightening.

I wish NDE 2019 all the success.

(S.K. Sharma)

Place : Mumbai
Date : 21st November 2019

3 रा उत्तर, नाथिकीय ऊर्जा भवन, अनुसंधाननगर, मुंबई - 400 094. 3rd Floor, Nathikiya Urja Bhavan, Anushaktinagar, Mumbai - 400 094.
दूरध्वनि/Phone : +91-22-2599 3333 / 2556 5176, फैक्स/Fax : +91-22-2555 7278

पंजीकृत कार्यालय : 16 वीं उत्तर, सेंट्रल-1, विश्व व्यापार केंद्र, कल्ले पारदे, कोलाबा, मुंबई - 400 005.
Regd. Office : 16th Floor, Centre - 1, World Trade Centre, Cuffe Parade, Colaba, Mumbai - 400 005.
दूरध्वनि/Phone : +91-22-2218 4456 / फैक्स/Fax : +91-22-2218 2008, ई-मेल/E-mail : cnd@npcil.co.in
Corporate Identification No. U40104 MH 1987 GOI 149458 / Website : www.npcil.nic.in



एम.एस.ईश्वरन, विभिन्न वैज्ञानिक
M. S. Easwaran, Distinguished Scientist
निदेशक / Director

भारत सरकार - रक्षा मंत्रालय
Government of India - Ministry of Defence
रक्षा अनुसंधान तथा विकास संगठन
Defence Research & Development Organisation
वायुवाहित प्रणाली केंद्र
CENTRE FOR AIR BORNE SYSTEMS (CABS)
एएस 9100 डी & आई एस ओ 9001:2015 प्रमाणित संस्थान
AS 9100D & ISO 9001:2015 CERTIFIED ESTT.
बेलूर, यमलूर तपाल, बेंगलूरु - 560 037. भारत
Behur, Yemlur Post, Bengaluru - 560 037. INDIA

CABS/1001/3/1/TSO

29 Nov 2019

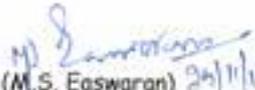
MESSAGE

It gives me immense pleasure to know that the Indian Society for Non-Destructive Testing (ISNT) is organising a three-day conference, NDE 2019 and Exhibition in Bangalore during December 5th to 7th 2019.

Non-Destructive Testing & Evaluation plays a central role in assuring quality in a multitude of applications. The Centre for Airborne Systems has been developing world class Airborne electronic systems for Military applications. There has been immense contribution of NDE in maintaining the quality. The inspection specialists have been using variety of NDEs to assess the integrity of the assets. Basic necessity of aspiring the success lies on its quality of the product.

I am sure the conference will be a delight for the current and future generation as practicing NDT professionals.

I extend my warm greetings and felicitations to the organizers and the participants. My congratulations go to the organizers as well for attracting a wide range of papers from experts and wish all the speakers and delegates a very fruitful conference


(M.S. Easwaran) 29/11/19
DS & Director

कार्यालय दूरभाष / Office Telephone : 2522 0685 / 2522 5121 फैक्स/Fax : 2522 2326, 2522 3748
ईमेल / E-mail : easwaran_ms@yahoo.com, mseaswaran@cabs.drdo.in



गैस टरबाइन अनुसंधान स्थापन
GAS TURBINE RESEARCH
ESTABLISHMENT
रक्षा अनुसंधान तथा विकास संगठन
Defence Research & Development
Organization
रक्षा मंत्रालय / Ministry of Defence
पत्र पेटी सं. 9302, सी.वी.रामन नगर
Post Box No. 9302, C.V. Raman
Nagar
बंगलूरु /Bengaluru - 560 093

एम.जेड. सिद्दिक
विशिष्ट वैज्ञानिक
एवं निदेशक

**M.Z.SIDDIQUE
DS & DIRECTOR**



MESSAGE

It gives me immense pleasure to note that a National Conference on Non-Destructive Evaluation & Exhibition (NDE 2019) is being convened at Clarks Exotica Resorts & Spa, Bengaluru.

I am also delighted that Gas Turbine Research Establishment is sponsoring this mega event and senior officers are actively associated in organizing the event.

Non-Destructive Testing methods play significant role in determining the reliability and integrity of parts throughout the product life cycle. The criticality and complexity of NDT is significantly different for aero space hardware owing to their design, methods of manufacturing, operating environment, and safe life management issues. Timely detection of these defects will prevent catastrophic failures, loss of platforms, human life etc. It is important for DRDO scientists and officers to have basic understanding and information on NDT, methodologies and associated infrastructure, training requirements, standards, latest developments etc.

I am sure that this conference will provide a wide technical platform for inspiring new technical ideas, networking of specialists and successful interaction with exhibitors/ service providers.

My best wishes to the participants and the organizers and wish them a grand success.

ZLif
26.11.19

डॉ. एस वेणुगोपाल
उत्कृष्ट वैज्ञानिक एवं निदेशक
Dr. S Venugopal
Outstanding Scientist & Director



वैमानिकीय विकास संस्थान
Aeronautical Development Establishment
रक्षा अनुसंधान तथा विकास संगठन
Defence Research & Development Organisation
रक्षा मंत्रालय, भारत सरकार
Ministry of Defence, Govt. of India
न्यू थिप्पसन्दा पोस्ट, बेंगलूरु - 560 075
New Thippasandra Post, Bengaluru - 560 075



MESSAGE

It is heartening to know that the Indian Society for Non Destructive Testing (ISNT) is organising a three-day conference, NDE 2019 in Bangalore during December 5th to 7th 2019.

Ensuring quality is a major requirement of any organisation and in GTRE, NDT group has played a stellar role in the success and reliability demonstrated by our Aeronautical systems and related programmes. The conference is being organised at the opportune time when our major programmes are picking up, where the safety and reliability demands will be one order more than conventional aero engines.

Non-destructive testing and evaluation plays a central role in assuring quality in a multitude of applications especially in a strategic sector like military applications NDE has a crucial role wherein techniques based on electromagnetic NDE are used for various systems and programmes.

I am sure that the conference & Exhibition will inspire the NDE professionals, research scholars and students to exchange the views on the subjects, meet the peers and also serve for enhancing the national and international collaborations.

I wish the conference and the exhibition all the success.

(Dr S VENUGOPAL)



Dated: 25th Nov 2019

MESSAGE

I am delighted to know that the Indian Society for Non-Destructive Testing (ISNT) is organizing a three-day Conference, NDE-2019 in Bangalore during December 05th to 07th 2019.

The basic necessity of aspiring the success lies on its quality of the products. In the present scenario, NDT plays a major role in ensuring the quality and thereby the success and reliability of the products. The Conference is being organized at the opportune time when our major Programmes are picking up, where the Safety and Reliability demands will be one order more than conventional products.

In our Defence Bio Engineering & Electro medical Laboratory (DEBEL), WHERE in the development of Protective and Life Support Equipment including On-Board Oxygen Generation Systems (OBOGS) for the LCA & AMCA and Bio medical devices viz., indigenous Cochlear Implant System & Upper Knee Prosthesis etc., and Systems specific to Service Combatants, the utmost importance is given to Quality and reliability. NDT & E has played a major role in ensuring these qualities.

It is heartening to note that special Sessions targeting the various industries are being conducted during the three-day event which is essential in bridging the gap between the R&D Organizations and the Industries.

I extend my warm Greetings and Felicitations to the Organizers and the Participants. My Congratulations go to the Organizers as well for attracting a wide range of Papers from experts and wish all the Speakers and Delegates a very fruitful Conference.

Manimozhi M.

(Manimozhi Theodore)
OS & DIRECTOR
DEBEL, Bangalore

**MESSAGE FROM THE CHIEF EXECUTIVE (AIRWORTHINESS),
CEMILAC**



I am indeed very happy to know that the Indian Society for Non Destructive Testing (ISNT) is organising a three-day exhibition & conference, NDE 2019 at Bangalore during December 5th to 7th 2019.

As the certifying authority for Military Airworthiness, CEMILAC has been extensively encouraging the NOE at all DRDO laboratories. NDE is an integral part of the modern engineering world contributing significantly to quality, reliability and safety of the industrial components and systems.

I congratulate the organizers for the effort in arranging the conference & exhibition which I am sure will be a great success.

I wish the conference and the exhibition all the success.

A handwritten signature in blue ink, appearing to read 'APVS Prasad'.

(APVS Prasad)
OS & Chief Executive (Airworthiness)

Date: 27-11-19

MESSAGE

The technical committee of NDE 2019 welcomes all delegates, speakers and exhibitors to NDE2019, the flagship event of ISNT and one of the largest NDT/NDE conferences in ASIA. I thank each one of you to be part of the wonderful gathering of academicians, professionals, researchers, manufacturers working in the area of Non-Destructive Evaluation. The foot fall at the Conference is expected to be in excess of 1200 with wide international participation from countries including USA, UK, Russia, France, Germany, China, Singapore, Malaysia, and Middle East among others.

The conference will focus on the recent topics in NDE which includes Radiography, Tomography, Guided Wave Ultrasonic, Thermography, Acoustic Emission, Microwave and Tera-Hertz NDE, Automation, Robotics, Sensors, Condition monitoring, Life assessment, NDE in Industry 4.0, Imaging in NDE and Image processing etc. The conference will also focus on topics pertaining to various sectors such as NDE in Power sector, Nuclear Industry, Concrete, Oil & gas, Aerospace etc. From conventional to advanced NDE techniques, from quality assessment during manufacturing to structural health monitoring during service, from fundamental research to simple industrial case study, from education in NDE to training and certification, all contributions relevant to the field of NDE will be presented by researchers from various academic institutes of international repute, industries and manufacturers. The talks to be delivered in the 3 days are aptly suited to the theme of the conference "eNDEavours from detection to prediction".

There will be 2 memorial talks and 5 Plenary addresses on topics of larger interest to be delivered by experienced speakers in the field of NDE. The 30 keynote talks will focus on in-depth of specific topics. About 193 contributed papers from scientific and industrial community along with the 30 keynote talks will be presented during the 3 days of conference running in 5 parallel technical sessions. About 30 papers will be presented in e-Poster session which will run concurrently for first two full days and the delegates have flexibility to visit the poster area throughout the day as per the convenience. In total, about 230 talks will be delivered in the scientific sessions and about 12 keynote talks will be delivered in 4 Industry sessions.

For the very first time, Springer Nature will publish the Conference Proceeding of NDE 2019 on behalf of ISNT. The full papers to be published in the Conference Proceeding are selected through blind Peer Review of each paper by two independent reviewers and finally by the editors. The initiative to publish the full paper in the indexed proceeding will definitely add value to the researchers associated with NDE2019.

The NDE2019 have made the right balance for the delegates from all fraternity by making the provision for indexed peer reviewed conference proceeding, publication of papers on ISNT website, product launch, international product exhibition, renewal points for Level-III, business opportunity etc.

I thank all the authors for considering the platform of NDE2019 for presenting their work. I also express my deep sense of gratitude to memorial speakers, plenary speakers and invited speakers for accepting our invitation to deliver talks on various facets of NDE and graced the event. I thank our publishing partner Springer Nature for agreeing to bring out the conference proceeding.

I thank Dr CK Mukhopadhyay and Dr Ravibabu Mulaveesala for accepting our request to be the editors for the Conference proceeding to be brought out by Springer Nature.

I wish all the speakers, delegates, exhibitors for a fruitful and memorable event.



Bikash Ghose

Chairman, Technical Committee (Scientific)



CONVENOR MESSAGE

It gives me a great pleasure and truly delighted to welcome each and every one of you to NDE -2019 Conference and Exhibition to be held on 5-7 Dec 2019. Bengaluru, India. It is remarkably noticed that this event is happening after 3 decades in Bengaluru and most awaited show for all our ISNT Fraternity.

I truly believe that this mega event is a great platform for all with the same vision and mission, get together to share, discuss and network in improving our delivery of high quality and products care to all our Customer's NDE needs. We are delighted to have you here to participate in this event, and thank you for coming.

NDE-2019 provides a good opportunity for those who have a thirst in knowing the present technological developments and also share their ideas. Furthermore, this conference and exhibition will also facilitate the participants to expose and share various novel ideas as well show casing their contemporary NDE Equipments and products.

This conference & exhibition aims to bridge the researchers working in academia and other professionals through research presentations, latest Equipment display and keynote addresses in current technological trends. The topic chosen for PCT are inspiring and relevant, It reflects the growing importance of advance NDE systems as a field of research and practice. I am sure each one returns home with ample knowledge and opportunities to widen their knowledge & network.

I am proud to be part of this ISNT event with a spectacle of fine blend of Technology and modernity. Finally I would like to thank all the Speakers, Authors, Exhibitors, Event Managers and persons who directly or indirectly contributed to the conference without their cooperation and full support, this conference would not have been possible. Special thanks to President ISNT, Chairman NDE-2019 and all office bearers as well as local organising committee members.

Shashidhar P Pallakki

Convenor NDE-2019

conference & exhibition on
NON DESTRUCTIVE EVALUATION



Organized by: Indian Society for Non-Destructive Testing (ISNT)
Theme: eNDEavours from Detection to Prediction
Venue: Clark Centre/Convention Rooms 3, 4, Bangalore



MESSAGE

It has been challenging and enterprising to closely associate with the NDE 2019 Organising team for the past few months. The very first interaction, when Chairman of Industrial Relation Committee and Co-convenor intimating suggestion of the enthusiastic Organising Committee and President ISNT according the consent, I had no other choice and option but to accept the Government Sector Liaison (GSLO) task which hitherto in NDE has been understood to be on a reactive mode.

Becoming integrated with the NDE Conference Secretariat, the goals set forth to have full spectrum of outreach to Aero Sector Govt. Organizations, has been a stupendous task and to very large extent has been accomplished satisfactorily. The conference template and wide spread participation could be a testimony besides the overwhelming interest of Aerospace Organizational leadership to get connected with this emerging topic 'eNDEavours from Detection to Prediction'. Several face to face interactions and many noteworthy first time outcomes are on the anvil.

With full freedom to execute tasks with impartiality, full transparency and integrity and the seamless integration with NDE 2019 leadership, the event is poised to become a benchmark. Wishing the very best for an outstanding outcome and evolving frame work for NDE in Aerospace for future of the Aerospace fraternity of this nation.

Syed Haroon Basha 26.11.2019
Syed Haroon Basha, MA, LLB
Former Senior Finance Officer
CDA (R&D), Bangalore

Conference Secretariat: ISNT Bangalore Chapter
No 415A, 11th Cross, 4th Phase, Peenya Industrial Area, Bangalore 560096, INDIA
email: info@nde2019.in
web: www.nde2019.in



MEMORIAL TALKS



Shri Ramesh Bhai Parikh Memorial Talk

Management of Safety on Indian Railways through Non-destructive Testing

A K Mandal

Formerly RDSO, Ministry of Railways

SYNOPSIS

Indian Railways (IR) are the life line and premier Transportation System of the entire Indian sub-continent. It employs huge engineering assets (Rolling Stock, Permanent way, Bridges, Structures etc) to manage the ever-increasing freight (annually over 1 Billion GMT) and passenger transportation (22 Crores annually) needs of the country. Failure of any of the components/assemblies during trains operation is catastrophic, gravely endangering safety of travelling public with associated consequential loss of invaluable life, property and valuable assets. Hence ensuring safety during traffic operation assumes paramount significance for reliable, trouble-free and quality service to its esteemed customers. Towards this twin objective of coping with ever increasing traffic and all-time high emphasis on safety, Indian Railways are employing various operational, systemic and institutional measures of which Non-Destructive Testing (NDT) forms the basic, vital and most significant intervention embracing almost all critical and safety components, assemblies and structures. This presentation traces the history and growth story of NDT application over Indian Railways right from its inception six decades ago, chronological sequence of technological developmental efforts towards improved test methodologies, optimised test periodicity, efficient equipment and systems of improved flaw detection capability, sensitivity and reliability, data acquisition system, data analysis and interpretation to match the ever changing pattern of defects with traffic and processing methodologies, training and certification of NDT personnel, bringing in more and more assets/components under its ambit, benefits derived from various interventions, key areas of attention, strategies for consolidation and road map for further improvement areas to make the NDT system fool-proof and serve as the most reliable and vital component of the Entire Safety Management edifice of Indian Railways.

The strategy for NDT intervention on IR is two-fold, first at the time of introduction of the asset in the system(acceptance inspection) and the other during service through regular periodic examination of the assets at pre-determined intervals with scientifically and statistically evolved acceptance criteria for prevention against any undesirable failure, premature or without any previous warning. This paper discusses in detail salient features of NDT as applied to some critical components like Rail, Rail Welds, Axles, Wheels & Bogies. their test procedure, test periodicity, experience gained, results arrived at and finally the benefits accrued towards ensuring safety. Periodicity decision of the assets is a highly involved subject based on several operating factors e.g. speed, axle load, gradient/curve, material quality, failure history, defect generation rate and evolved through detailed failure analysis, defect characterisation, scientific investigations embracing fatigue and fracture mechanics studies. Rails are accordingly examined every 8 GMT traffic and axles examined between 18-24 months depending upon the speed and utilisation level. Similar periodicity has been arrived at and laid down for all items.

All the big 5 NDT methods (UT, RT, MPT, LPT & ECT) are heavily employed on Indian Railways covering a large number of components, Ultrasonic and Radiographic Testing forming the foundation of examination of assets like Rails, Rail Welds, Axles, Wheels, Bridge Girders, Cast & Fabricated Bogies. A rigorous and strict testing regime under well documented protocol (standards, specifications, codes, manuals, guidelines) is in vogue for all the assets (at various stages of their usage) specifying the critical test parameters e.g., flaw detection sensitivity, equipment quality, test method, acceptance criteria and test personnel eligibility. 100% of the rails, wheels, axles and all critical components are examined strictly to these norms by suitably qualified, trained and certified NDT personnel. Remedial, corrective and preventive measures have also been evolved for all the items.

These well-strategized NDT interventions have resulted in drastic reduction in in-service failures of Rails, AT Welds, Axles and Wheels and many critical components through timely detection of the failure-prone assets and thus ensuring safety on IR. This is exemplified and supported by the statistical data of tests conducted. However, to make the NDT systems further robust and equipped with still higher capability and reliability level, several newer technologies and equipment e.g. C-Scan AT weld Tester, Vehicular Ultrasonic systems, RCF defect detection system, B-Scan for Rails, Phased Array Ultrasonic for wheels for wheels, Rail Fracture Detector, enhanced defect data acquisition and analysis system are at various stages of introduction on IR. These measures are expected to result in a far more improved, advanced safe ecosystem in the near future for esteemed users of Indian Railways.

Dr. Baldev Raj Memorial Talk

NDE contributions to recreating our past cultural heritage

Prof. Srinivasa Ranganathan
National Institute of Advanced Studies

SYNOPSIS

ISrinivasa Ranganathan is Emeritus Professor at Department of Materials Engineering at the Indian Institute of Science, Honorary Homi Bhabha Visiting Professor at the National Institute of Advanced Studies. His interests cover physical metallurgy, history of science and materials heritage. He has coauthored a much acclaimed book on India's Legendary Wootz Steel: An advanced material of the ancient world.(2004), a book on New Geometries for New Materials(2006), translated into Russian and Japanese and a book on High Entropy Alloys (2015, 2019) . He is a Fellow of four Indian Academies of Science and Engineering and the World Academy of Sciences (TWAS). The Indian Institute of Metals, the Electron Microscope Society of India and the Indian national Academy of Engineering have conferred on him Lifetime Achievement Awards in 2012, 2013 and 2014 respectively. His international Prizes include RQ 14 Distinguished Fellow 2014 and ISMANAM senior scientist 2019.



PLENARY TALKS



Ultrasonic methods for concrete: To boldly see, what we have not seen before

Ernst Niederleithinger

BAM, Germany

Abstract

Ultrasonic methods are used in concrete investigations since decades. Echo measurements for structural investigations and condition assessment have made their way into practical application in the past 20 years. However, several challenges remain. On one side, there are technical issues as limitations in depth of penetration, resolution and imaging capabilities. On the other side there are still gaps in validation, standardization and certification, which are limiting the applicability in condition or load capacity assessment.

A couple of recent developments will help to overcome these issues. This includes technical developments as new commercial devices which are easier to handle on site, are directly connected via the Internet to the cloud for storage and interpretation or including new capabilities as Total Matrix Capture. Other research has gone into developing devices with a much deeper penetration depth (e.g. the LAUS device at BAM) as well as improvements in imaging by hardware update (e. g. air coupled ultrasound or coded signals) or new software (e. g. RTM imaging).

To allow application in the real projects we need validated methods and have to work on standardization and certification. For this reason, we are working with international partners on the development of new reference specimen with cracks, delaminations, honeycombs and corrosion to ensure comparability of ultrasonic and other methods and quality assurance codes. Further, non-destructive methods are being used to update probabilistic models used for the reassessment of existing structures to support the structural engineer's decisions.

Air Coupled Ultrasonic NDE: An Overview eluding to New Frontiers in Inspection

Krishnan Balasubramaniam

CNDE, IIT Madras

Abstract

The use of Air Coupled Ultrasonics, particularly for industry applications, is fast becoming a reality largely due to the advent of highly efficient and even wide-band transducers, the selection of wave modes that have lower acoustic impedances, the improved understanding of the physics of guided wave interaction with features of the structure as well as defects, and finally the emergence of advanced signal processing methods. The coupling through air allows for a wider use of the ultrasonic NDT technologies when compared with the conventional couplant based methods. The increased speed of inspection, the portability of the systems (since couplants are not required), the sensitivity to defects, inspection of hidden regions, etc. are some of the key advantages of the air coupled ultrasonic techniques. The dis-advantages of the technique include the limitation of the frequency of operation and the requirement of high voltage for excitation. In this paper, the application of Longitudinal, Shear, and Lamb wave modes that are excited and received by air coupled ultrasound transducers will be discussed. The technique is applied to aerospace components, composite pipes, adhesive bonded components, among others. The defects considered include weld inspection, delamination characterisation in composite structures, interfacial weakness in bonded components, etc. that are made with metals and or composites. Some of the recent work on turning modes based defect sizing, meta-materials based imaging, and wave-field visualization will also be presented.

Digital Twin: Fusion of Physical-Digital for Driving Digital Transformation

Vinay Jammu

Abstract

Over the past few decades, dramatic improvements in communication and computing technologies have driven the growth of consumer internet which has improved efficiencies, increased customer base and created new business models in many industries including retail, banking, hospitality, and transportation. A confluence of these technologies is rapidly changing the landscape of what is possible in industrial internet area as well including power, transportation and healthcare industries by driving new outcomes and efficiencies that were not possible before. For example, 1% fuel saving in airline industry today is worth \$30B over the next 15 years in the industry.

This talk will focus on Digital Twin technologies GE is driving for Digital Transformation of industries to improve efficiencies of industrial assets by bringing together sensing, monitoring, control, prognostics and optimization. Digital Twins are live personalized learning models of different assets that assist in improved decision making related to operation and maintenance of these assets. For example, Digital Twins models of turbine system in GE90 engine are used to optimize maintenance saving tens of millions of dollars in unnecessary overhauls. In manufacturing, Digital Thread and Digital Twins are being connected to reduce cycle time and improve manufacturing productivity. GE is building Predix platform where templates of these solutions are provided so partners and customers can use these services to build their own digital strategy.

Recent Advances at CEA LIST for the Development of Guided Waves SHM Solutions : Techniques, Imaging and Simulation

Pierre Calmon

CEA LIST, Gif sur Yvette, France

pierre.calmon@cea.fr

Abstract

Guided waves based Structural Health Monitoring (SHM) have motivated since several years an active research activity at CEA LIST, driven by industrial partnership in various sectors such as aircraft or energy. Ultrasonic guided waves, propagating on long distances, are well adapted to the monitoring of large structures with a limited density of sensors.

In this communication, we will present recent advances achieved in terms of techniques, data processing and simulation. We will present several applications of guided waves imaging techniques for detecting defects in plate-like structures or pipes. We will give a focus on tomographic techniques and we will demonstrate the potential of passive tomography. This technique exploits natural ambient noise on the structure and opens the way to the use of optical fibers as ultrasonic sensors.

Due to the complexity of the phenomena involved in GW-SHM, the availability of efficient modelling and simulation is a crucial issue. We will introduce the numerical code (based on spectral finite element method) currently developed at CEA LIST in the framework of the CIVA platform.

We will illustrate the capability of the code on several applications. In particular, we will show how computations can be used for the training of machine learning algorithms. As it is widely acknowledged, reliability assessment is one key challenge for the deployment of SHM solutions. We will show on examples what can bring how simulation can contribute to the construction of a methodology for the estimation of POD (Probability of detection).

Keywords: SHM, guided waves, simulation, imaging, POD

Use of Artificial Intelligence for Phased-Array Data Analysis

Richard Rhéaume¹, Samuel Duclos¹, Neil Harrap²

¹Ondia Inc., 979 avenue de Bourgogne, suite 525, Québec, Qc, G1W 2L4, Canada

²TWI Ltd, Granta Park, Abington, Cambridge, CB216AL, England

Abstract

In the past 20 years, several steps have been taken to better the quality of non-destructive testing. The introduction of portable phased-array instruments led to recorded ultrasonic data which in turn led to a better control of the quality of the inspections. The introduction of online training led to a standardization of theoretical teaching which in turn led to better trained inspector and analysts. Still, problems remain in terms of defect detection, identification and sizing. Data analysis still fully relies on the skills of a human analyst even if the volume of data is exploding. Unfortunately, while there is an explosion in the volume of data to analyze, the number of qualified data analysts is not increasing accordingly. The result is shorter time to assess the data and longer working hours for the data analysts. New tools must be provided to data analysts, so they can perform their task more efficiently and accurately. In this paper, we review the challenges of analysing phased-array ultrasound data and the unique solutions provided by Artificial Intelligence.



INVITED TALKS



Multimodal imaging methodologies for NDT of concrete structures

Abhijit Ganguli

Indian Institute of Technology, Tirupati

Abstract

Degradation of concrete structures, which constitute a significant majority of the built infrastructure, due to increased demand, environmental exposure, natural and man-made calamities may lead to catastrophic failure, causing loss of human lives and to the economy. To achieve sustainability and resilience and to obtain quality service and optimal benefit from investment, research needs to be carried out on development of accurate and fast non-destructive testing techniques for assessment of concrete structures.

The first part of my talk deals with the application of ultrasonic imaging as a tool for non-destructive evaluation of concrete media. In contrast to traditional approaches, where ultrasonic pulse velocity measurements are used to assess the quality of concrete, our work applies two advanced techniques, the Synthetic Aperture Focusing Technique (SAFT), typically used in remote sensing and medical ultrasound and the Reverse Time Migration (RTM) algorithm prevalent in geophysical exploration, for detection of small debonds around rebars in laboratory scale concrete samples. The debonding is a serious issue with regard to safety and originates due to bad workmanship, slip of the rebars during casting, honeycombing etc. Our computational work and experimental investigations reveal that ultrasonic images have very consistent features that can distinguish between intact and debonded rebars.

In the second part of my talk, I demonstrate that a combination of ultrasonic bulk and surface wave based assessments and thermographic imaging can constitute a powerful multimodal tool for detection of rebar corrosion. An accelerated corrosion setup is developed on which both ultrasonic and thermographic imaging are performed. By applying a Fourier Transform based thermographic imaging technique, we are able to detect fine surface-breaking cracks in concrete that may otherwise be ignored. The study shows that thermal imaging being a non-contact technique has potential of assessment of large areas of the concrete structure to detect the troubled spots, which can further be assessed in detail with ultrasonic imaging. The ultrasonic bulk wave based imaging methodology shows that with progress of corrosion, the rebars disappear from the images. In contrast, the Rayleigh wave based imaging indicates the development of near surface radial cracks, which complements findings from the other techniques. The combination has potential of being a useful diagnostic indicator for progressing corrosion.

X-ray and Gamma-ray based Radiological Evaluation of Typical Industrial Specimen for Defect Visualisation and Quality Assessment

Dr. Umesh Kumar

Head, Industrial Tomography & Instrumentation Section

Isotope & Radiation Application Division

Bhabha Atomic Research Centre, Mumbai, India

Email: umeshkum@barc.gov.in

Abstract

X-ray and gamma-ray based prominent industrial radio-diagnostic techniques e.g. conventional radiographic imaging and industrial radiometry have over the years, evolved to be more versatile and computational in nature. The technologically-enhanced and robust imaging methods have paved way for advanced non-destructive testing and evaluation (NDT&E) applications with possibilities for complex image evaluation and analysis in reasonable time frame for cost-effective use. Non-destructive testing and evaluation (NDT&E) of industrial products and specimen is intended to ensure their satisfactory performance over a predicted time span by determining their structural soundness and integrity without disturbing intended usefulness. It is often part of the overall quality assurance regime in a product development cycle and industrial manufacturing in addition to predictive maintenance programme.

At present, Computed Radiography (CR), Digital Radiography (DR) and Industrial Computed Tomography (ICT) are some of the now commercially-available and to some extent, affordable electronic imaging technologies for sector-specific applications which make use of penetrating radiation. Among the newer radiation-based NDT technologies, though ICT is highly versatile and may offer unique imaging solutions for a range of industrial specimen, some factors including high cost still inhibit their use in regular NDT practices. Large institutions engaged in broad-based research and development activities and select academic and industrial establishments have also taken up in-house ICT development work to meet their own specific requirements. This approach may also enable them to have greater maneuverability of the available resources, carry out applied research work and create teaching and training environment for students and fresh scientific work-force.

Isotope & Radiation Application Division (IRAD) at the Bhabha Atomic Research Centre has been in the research, development and practice of gamma and X-ray based conventional and digital NDT techniques for quite long time. The talk will endeavor to present selected industrial radio-diagnostic investigations using CR, DR and ICT for some typical manufactured assemblies and other specimen using standard equipment and in-house developed ICT facility.

Keywords: Radiography, Radiometry, CR, DR, Industrial Tomography.

Characterising microstructures of polycrystals with elastic waves

Bo Lan

Imperial College London, Exhibition Road, London, UK, SW7 2AZ

Abstract

Polycrystalline materials (e.g. metals) have rather complex microstructures. These include crystallographic texture (preferred orientation distribution) and grain morphologies (sizes and shapes) - both have profound effects on material properties and component performances. Commonly used techniques, such as EBSD, X-ray or neutron diffraction, are not able to characterize these features cost-effectively and non-destructively, and this talk presents a systematic effort towards achieving this goal using elastic waves.

The first contribution of the talk is on the determination of texture using compressional ultrasonic waves. This was based on a theoretical platform [1,2] developed by the authors, which demonstrated that the polycrystal wave speed variations in 3D could be approximated as a spherical convolution between texture and single crystal speeds, allowing texture to be extracted through a simple de-convolution process. This was then validated by two lab-based platforms: one based on conventional water-bath ultrasonic scanning system [3], and the other Resonant Ultrasound Spectroscopy (RUS) [4], both of which served the purpose of accurate measurements of polycrystal wave speeds, and hence texture. They also proved that the methodology itself was general, and it was capable of delivering critical texture information for sample materials including titanium, zirconium and steels.

Building upon the texture capability, further efforts have been made to characterize grain morphologies using the combinations of compressional and shear ultrasound. Positive correlation of both wave modes with grain sizes have been observed, with shear waves demonstrating higher sensitivity, thus spurring further research to deepen the understanding. To tackle difficulty caused by the polarisations of shear waves, finite-element computational models have been established to simulate their propagation in crystalline materials, and immersion tests and EMAT technology have been combined to allow systematic experimental investigations. Preliminary results will be reported on these fronts.

References:

1. B Lan, MJS Lowe, FPE Dunne, "A spherical harmonic approach for the determination of HCP texture from ultrasound: a solution to the inverse problem", *J Mech Phys Solids*, Vol. 83, pp. 179-198, 2015.
2. B Lan, MJS Lowe, FPE Dunne, "A generalised spherical harmonic deconvolution to obtain texture from ultrasonic wave speed", *J Mech Phys solids*, Vol. 83, pp. 221-242, 2015.
3. B Lan, et al. "Direct volumetric measurement of crystallographic texture using acoustic waves." *Acta Materialia* Vol 159: 384-394, 2018.
4. B Lan, et al. "Rapid measurement of volumetric texture using resonant ultrasound spectroscopy." *Scripta Materialia* Vol 157: 44-48, 2018.

Sensors and Devices for Non-destructive Evaluation and Structural Health Monitoring @CSIR-NML

Sarmishtha Palit Sagar

Senior Principal Scientist and Group Leader

NDE&MM Group

CSIR-National Metallurgical Laboratory, Jamshedpur, India

Email: sarmi@nmlindia.org

Abstract

The necessity for monitoring the health of critical components of various industries along with stringent requirements for safety and quality has resulted in the development of nondestructive evaluation (NDE) techniques for characterising materials and defects. The presence of any abnormalities or defects may result in the structural integrity which in turn may leads to failure without any notice. Structural health monitoring (SHM) is an extension of NDE where the goal is to estimate the characteristics of the components without damaging the structure by installing appropriate sensing devices and data management systems, beyond traditional condition monitoring. As the demand increases for improved and superior prediction of abnormalities in materials, emphasis would be placed on both equipment and data analysis. Substantial research activities have been carried out at CSIR-NML for last two decades on NDE and SHM and as a result couple of sensing devices have been developed like MagStar and MagSys for the detection of microstructural degradation in ferro-magnetic components, FlawGuard for severity detection of defects in moving wires, Zincometer for realtime weight measurement of galvanised wire, and ultrasonic flow gauge to find the flow rate of fluids in a narrow tube and have been transferred to Indian manufacturer and also implemented in the plant. This presentation will highlight the sensing devices developed at CSIR-NML and are in operation at various components in steel plant.

Key words: sensor, device, SHM, NDE, steel plant

Recent developments in advanced ultrasonic methodologies for in-service inspection of PFBR

Anish Kumar

Metallurgy and Materials Group

Indira Gandhi Centre for Atomic Research

Kalpakkam, Tamil Nadu-603102, India

anish@igcar.gov.in

Abstract

Prototype fast breeder reactor (PFBR), a sodium cooled pool type fast breeder reactor, is under advanced stage of commissioning at Kalpakkam, Tamil Nadu. In PFBR, the primary heat transfer circuit including the entire core will be submerged in a pool of liquid sodium filled in the main vessel. Due to opaque nature of liquid sodium, ultrasound is the only mean of viewing the components inside the main vessel. It is also required to inspect the critical welds in the main vessel remotely during in-service inspection. Another critical component of PFBR that requires in-service inspection to be performed at regular intervals is steam generators (SGs) that comprise of SG tubes inside the SG shell. Water/ steam flowing through the SG tubes extracts heat from the liquid sodium flowing through the shell side. Due to vigorous reaction between sodium and water/steam, it is of paramount importance to ensure the integrity of the SG tubes. The talk presents a few recent developments of advanced ultrasonic inspection methodologies in the author's laboratory for in-service inspection of PFBR components.

A guided wave based ultrasonic methodology developed for fast and reliable inspection of SG tubes will be presented. To launch the guided wave remotely, magnetostriction based noncontact ultrasonic transducers have been developed and demonstrated for detection of different types of defects in SG mock-up tubes. Propagation of guided wave for the full length of the tube (23 m) and successful detection of different types of defects in the tube including in the thermal expansion bend will be presented. Non-contact electro-magnetic acoustic transducers (EMAT) are also being explored for remote inspection of critical welds in the main vessel of PFBR. A few recent results of applications of phased array EMAT for inspection of stainless steel weld joints will also be presented. A new ultrasonic glancing angle based imaging methodology (GAIM) developed for mapping of subassembly (SA) heads in the reactor core will also be presented. Applications of GAIM for detection of protrusion and bowing of SAs will be presented.

NDT Training and Certification - The Next Level

Diwakar Joshi, Director,

Insight Quality Services, Office No. 507/508, 5th Floor, Building No.1 , Siddharth Towers,
Sr. No. 12/3B, Near Sangam Press, Kothrud, Pune - 411 029, Maharashtra, India
E-mail ID: diwakarj@gmail.com

Abstract

The role of NDT in Quality and Reliability of products and processes is indispensable. NDT has become a very important tool for all general industries, automobile, power generation, railways, oil and gas, nuclear, shipping, aerospace and so on. The success of NDT depends on Qualified Manpower, Correct equipment and Qualified Procedures.

Training and Certification is as old as NDT itself. However, the methodology of training and Certification is continuously changing. With the present developments in computerized equipments and communication technology, this area is undergoing a vertical change.

This paper summarizes the history of NDT, developments and its application, the original concept of Training and Certification, different certification schemes (Employer Based and Central Certification), their advantages and disadvantages and the end results. It encompasses the basic requirements of certification like education, experience, training, vision test and examinations. A summary of pitfalls in the schemes is also addressed. It also addresses what is expected in the next level on the background of computerized training, online examinations and higher level computer based NDT techniques in place.

Key Words: NDT, Training and Certification, Quality and Reliability, Computerized Training

Industrial Volumetric CT: Trends and Challenges

Debasish Mishra

GE Research, Bangalore

debasish.mishra@ge.com

Abstract

Volumetric CT is a powerful modality in non-destructive evaluation applications. Industrial Volumetric CT scanner (VCT) has undergone many milestones of improvement in the last two decades. After the publications of digital radiography and VCT standards end users have all the tools available for them to deploy this technology in production floors. Especially with the rapid penetration of additive manufacturing in the industries, VCT is a modality of choice for quality control. This market is also the major driver for technology development for VCT system. Current trends in industrial VCT is faster inspection and higher resolution images.

Making things faster in industrial VCT system has many knobs to play with. Components enhancement, automation and machine learning all are playing a key role to meet this demand. Similarly, the high-resolution images which are mainly driven by metrology applications are being addressed by enhancing better image quality. This presentation will discuss various developments in these two major areas and the challenges associated with those.

Key words: Volumetric CT, X-ray, DR

Title: Low power EMATs, coded excitation and robotic inspection

Speaker: Frederic Cegla

NDE group, Imperial College London, SW7 2AZ

Abstract

This paper will report on research progress in relation to coded excitation of ultrasonic signals and, in particular, their application to acquire data from EMATs. This technology can be employed to build low power EMATs. It can also enable simultaneous transmission and reception of ultrasonic data from several channels. The methodology has the potential to open up new ways of inspecting structures. The second part of the presentation will report on my team's efforts to integrate this technology onto robotic platforms for inspection in harsh environments as part of the UK EPSRC funded ORCA hub. Examples that show the manipulation of EMATs from land based (wheeled) robotic and air based (UAV/drones) robotic manipulators will be presented.

Sound Beam Focusing using Phased Array - SAFT

Paritosh Nanekar

Quality Assurance Division

Bhabha Atomic Research Centre

Trombay, Mumbai 400085

Email: pnanekar@barc.gov.in

Abstract

Sound beam focusing has always been a subject of interest in ultrasonic non-destructive evaluation. Focusing not only helps to achieve better sensitivity and signal to noise ratio, but also in precisely locating the flaw extremities for their accurate depth sizing. Over the last couple of decades array based techniques are increasingly being used to examine the materials using a focused sound beam. One of the most popular technique employed to achieve this is by phased array. In phased array ultrasonic testing (PAUT), the elements of an array are excited in a pre-determined sequence to focus the sound beam at a given depth and direction. In last decade or so an advanced approach called Full Matrix Capture (FMC) has gained lot of attention. The approach is based on acquiring huge amount of data using each element of an array as transmitter and others as receiver. The data is then processed using an algorithm called Total Focusing Method (TFM) to achieve sound beam focusing in the area of interest.

PAUT needs high end instrumentation and an array with large number of elements to achieve focusing at a significantly deeper depth. On the other hand, with FMC since the transmission is by a single element, the sensitivity for flaw detection at higher depth is inferior. In order to overcome these limitations, a novel approach called Phased Array-Synthetic Aperture Focusing Technique (PA-SAFT) has been developed. The approach employs an aperture, which is relatively much smaller than what is required using PAUT, for acquiring the data. The data is then processed by time-based SAFT algorithm to achieve sound beam focusing through-out the thickness of the component. Since, the aperture size using PA-SAFT is much smaller, the instrumentation requirements are much lower than what would be required using PAUT. Also the fact that the sound beam transmission is through a group of elements, the sensitivity at higher depth is better using PA-SAFT as compared to FMC + TFM.

This paper briefly describes the methodology followed for data acquisition and processing by PA-SAFT. The results of simulation studies carried out to optimize the number of elements to be used in an active aperture during data acquisition has been described in detail. The results of the experimental work carried out on the characterization of simulated planar flaws and real flaw in a weld joint by PA-SAFT has been reported.

Challenges for Ensuring Quality and Safety in Large Engineering Projects and Ways to Mitigate

B P C Rao

Fast Reactor Fuel Cycle Facility

Indira Gandhi Centre for Atomic Research

Kalpakkam, TN – 603 102, INDIA

e-mail: bpcrao@igcar.gov.in

Abstract

Large engineering projects involve civil construction, mechanical fabrication of complex engineering structures & components and material handling, electrical, mechanical & instrumentation systems in various structures or facilities for commissioning in a phased manner. Quality of raw materials, quality assurance during construction and NDE during manufacturing and commissioning stages are very important. With large quantities of steel and concrete to be handled during the construction phases, quality and safety take front-stage for successful commissioning of large projects. Apart from civil engineering construction, erection, installation and commissioning of critical equipment are crucial. In a large project the author is involved, a large number of stainless steel tanks, a few hundreds of km of stainless steel piping, scores of cranes as well as ventilation units etc. exist and these need to be seismically qualified with respect to stability, radiation shielding, and functionality.

The role played by QA, NDE and safety is very important in large projects. A clear need exists for deployment of skilled and certified manpower to meet the QA and NDE inspection needs. Systematic planning, sequencing, interfacing, execution of civil, mechanical, electrical and E&I activities with embedded QA, inspection and safety is necessary. The QA procedures in these disciplines are different and hence, the required skill set & training. Inspection of every raw material including heavy density aggregate, concrete, steel, and every inch of the fabricated component is the goal. Every weld joint in storage tanks, process tanks and pipelines is required to be tested and cleared non-destructively. In this context, careful design of QA plans and their implementations hold the key. Advanced NDE techniques for inspection/monitoring of critical regions for detection of flaws are planned ahead and suitable provisions are made in the design stage itself considering the access and modularity for maintenance, learning from the past experiences. This presentation will highlight the challenges for stringent QA practices and NDE inspections during the construction and commissioning stages of a large project, with associated data management, third-party inspections, audits, operator training etc. while giving due emphasis to the project schedules and the critical-path issues. It will also present the ways to mitigate.

Keywords: Project Management, Quality Assurance, NDE, Safety

Nondestructive Evaluation of Service Life of Metals Materials and Structures Based on Infrared Thermography

Oleg Plekhov

Ivan Panteleev, Alexii Vshivkov and Maxim Zelnin

Institute of Continuous Media Mechanics of the UB RAS, Akademika Koroleva str, 1, 614013, Perm,

Russian Federation

poa@icmm.ru

Abstract

This work is devoted to the development of mathematical algorithms for infrared data treatment with a goal to improve an accuracy of assessment of the current state and service life of metal materials. The presentation includes two parts. In the first part, the original approach for monitoring of fatigue crack propagation will be presented. The contact heat flux sensor was used for calibration of infrared data and use energy-based approach for study of fatigue crack propagation. The proposed approach allows one to measure the dissipated energy from the crack tip and estimate the kinetics of fatigue crack propagation based on the new crack propagation law. The crack propagation law is formulated as a correlation of fatigue crack rate with real value of dissipated energy and or indirect energy parameter (such as D-mode of temperature evolution). The analysis of fatigue crack propagation study reveal the key role of noise reduction algorithms for results of infrared data treatment.

The second part of the presentation will be focused on the development of noise reduction algorithms and infrared thermography application for nondestructive testing. We will present one of the example of noncontact nondestructive control of a mine shaft cast iron concrete lining by active infrared thermography. The study have shown that the active infrared thermography can be used for defects and cavities detection placed in a concrete layer of the lining. The theoretical investigation related to numerical modeling of optical lock-in thermography and data processing of temperature field containing an artificial noise. For data processing of noisy temperature field, the original algorithm of filtering and smoothing has been developed. The algorithms are based on the use of a reference temperature distribution at the defect-free tubing boundary and include Kalman filter, Rauch-Tung-Striebel procedure for time smoothing and spline method for smoothing over the surface coordinate. Results of the theoretical investigation have shown that the optical lock-in thermography can be used for relatively fast and robust defect detection in mine shaft cast iron concrete lining.

Keywords: infrared thermography, inelastic deformation, crack propagation, thermomechanical properties of metals.

Ultrasonic guided waves for detection and assessment of pitting corrosion in reinforced concrete structures using embedded piezoelectric wafer transducers

Sauvik Banerjee, Professor

Department of Civil Engineering

Indian Institute of Technology Bombay, Powai, Mumbai - 400076, India

Abstract

Corrosion poses a great threat to ageing civil infrastructure in the world, and researchers are seeking methods to monitor the corrosion in reinforced concrete structures. Detection of corrosion at its incipient stage has been an impending task in the non-destructive testing of materials. The process of corrosion is complex, and it leads to a simultaneous reduction in the diameter and the debonding between concrete and reinforcing steel bars in reinforced concrete structures. The most commonly used non-destructive techniques, e.g, half-cell potential potentiometer, can only assist in qualitative assessment of corrosion damages. Further, these methods require a numerous measurement with a dense array of sensors to evaluate the entire structure. Guided wave-based monitoring overcomes these limitations because a large area can be scanned using fewer sensors.

Towards this, a coordinated numerical and experimental study is presented in an effort to efficiently detect and assess pitting corrosion in reinforced concrete beams using guided waves. An accelerated corrosion setup is deployed to induce pitting corrosion using the impressed current method. These beams are continuously monitored using ultrasonic guided waves that are generated and received by piezoelectric wafer transducers attached to the rebars. It is shown that the incipient stage of pitting corrosion can be detected successfully, and the mechanism of corrosion process, which involves the corrosion initiation, progression, and diameter reduction-and-cracking phases, can be established from the signal characteristics of the longitudinal and flexural-guided wave modes. The impressed current flow in the corrosion cell also confirms the various phases of corrosion.

Novel high performance robotic based systems for NDT and Metrology in Aerospace

Subtitle: “1st Application & Kinematics independent Approach for Aerospace Manufacturing Systems in NDT & Metrology”

Thomas Gramberger¹, Wolfgang Haase²

¹Fill GmbH, Fillstraße 1, 4942 Gurten, Austria

²Fill GmbH, Fillstraße 1, 4942 Gurten, Austria

thomas.gramberger@fill.co.at

Abstract

Automation and Automated processes in NDT have increased drastically in the last decades. Especially for Ultrasonic inspection, some manufacturers have developed dedicated solutions based on standard robots to comply with the needs of one single process. Such systems are mostly tailored to one single inspection technique or task.

Although robots are becoming more and more popular for NDT in Aerospace since years, the time and experience has shown that the usage of standard industrial robots is usually causing several challenges. Resistance against splash water for through transmission application, path accuracy for dual robot inspection and operator convenience in operating these systems are just some samples for expectations.

A new way to bring all these requirements together is the so-called “1st Application & Kinematics independent Approach for Aerospace Manufacturing Systems in NDT & Metrology”.

The motivation for this development was, to add several modalities like UT, X-Ray, Defect Marking and Metrology in one automated inspection system and by that generate the maximum Return of Invest for the customer. New technologies like “LEDI – Laser excited Dry Inspection” can easily be implemented in such a setup.

On the other hand, the operability for the inspector should be as “easy to use” as possible. This was the main reason to develop a software Suite named “FILL.Studio” to present in every case exactly the user interface, which is required for this specific situation.

Furthermore, the whole HMI is independent from the kinematics, which guides the end effector to or along the specimen. Whether a single- or double robot or a Gantry kinematics is used –look and feel from operator point of view is the same.

Keywords: UT / TTU / PA / XRAY / optical Microphone / Xarion / CMM / Metrology / Robot / OLP / Simulation / Digital Twin / Siemens Sinumerik 840D sl / Structured Light / adaptive Kinematics.

X-RAY SOLUTIONS IN THE DIGITAL WORLD: New added values for the manufacturing industry

Thomas Wenzel

YXLON International GmbH, Essener Bogen 15, 22419 Hamburg, Germany

Thomas.Wenzel@hbg.yxlon.com

Abstract

Nowadays, solutions for the industrial application of testing technologies must meet the requirements of an industry 4.0 environment.

Data plays a key role here. However, data from the 2D or 3D domain alone is not sufficient to enable meaningful interaction between inspection systems and the surrounding process landscape. These data, which are generated in an inspection system, for X-ray systems mainly X-ray images and computed tomography (CT) volumes, must be processed into information so that they can be used meaningfully in an industry 4.0 environment.

The lecture will highlight the challenges that arise for the use of X-ray inspection systems in an industry 4.0 environment and what advantages CT systems in particular have in the age of digitalization.

The focus here is on the description of an additional task for which computed tomography can make a decisive contribution: Optimization of production processes.

The example of a plastic component reinforced with short glass fibers shows the approach and the solution that provides decisive information for the process optimization and can anticipate trends in production of such mass-produced components. The importance of artificial intelligence and machine learning will also be discussed.

It is explained that for this additional task, for which the CT can be used, a change of the mindset is necessary. The focus is on the perception of the CT system as a sensor and not primarily as an inspection device.

Finally, an overview is given of the requirements that system integrators, but also end users of such systems, must meet in order to make effective use of this added value.

Keywords: X-ray, Computed tomography, process optimization, machine learning, Industry 4.0.

Digital Imaging for Industry 4.0 – A Technical Perspective

Krishna Mohan Reddy

Lucid India, Chennai

Abstract

The world is going digital. The availability of new techniques and technologies and the advancement of existing technologies requires us to take stock of the situation as it is today. This talk explores 2 main aspects of digital inspection technologies - automation of inspection data analysis and development of custom applications . It aims to walk through the workflow for Assisted/ Automated Defect Recognition (ADR), the technical challenges therein and then discuss the role and relevance of traditional ADR in the AI/ML and Cloud era. We then look at Inspection data and discuss in general the current technical, computational and infrastructural challenges in data management.

Evolution of Instrumentation in Eddy Current and Electromagnetic NDE Systems

Uday Godbole

Technofour, Pune, India

udayg@technofour.com

Abstract

Eddy Current NDE owes its existence to the discovery of electromagnetic fields almost two centuries ago. After Oersted stumbled upon magnetic effect of electric currents in the year 1820, Michael Faraday's experiments and Lenz's insight into Faraday's law of induction laid the strong foundation upon which the edifice of eddy current and electromagnetic NDE techniques stands.

The first eddy current instrument of sorts was demonstrated by David Hughes in 1879, although the first high profile implementation is attributed to Alexander Graham Bell when he tried to locate a bullet lodged in US President Garfield's body. Since then technology has evolved at ever increasing pace. From humble stand-alone devices of Industry 2.0 to the cyber-physical systems of Industry 4.0 is a dizzying journey.

The author has designed and built eddy current systems for almost half a century now, ranging from metal sorters built around vacuum tubes to robotic systems for remote eddy current in-service inspection of nuclear steam generators. This paper explores the amazing evolution in eddy current and electromagnetic NDE instrumentation witnessed first-hand by the author.

Keywords: Eddy Current, Electromagnetic NDE

High Level Based NDT Academic Education in Germany and its Potential Impact on India

Christian Boller

Dresden International University (DIU), Dresden/Germany

Chair of NDT and Quality Assurance, Saarland University, Saarbrücken/Germany

Abstract

Engineering products are generally designed such that they meet the requirements set. This is achieved through good engineering practise added by safety factors where a lack of knowledge and hence uncertainties exist. NDT in that context has traditionally been used as a technology to confirm the quality of such engineering products. As such it has come towards the end of the process chain would it be related to design or even manufacturing. In aviation NDT has obtained its firm role to guarantee the damage tolerance principle, which is a major building bloc in aviation's light weight design. However, NDT has recently also been increasingly recognised as an instrument to validate an ageing infrastructure's condition being a major building block to assess an infrastructure's residual operational life. Finally, NDT is a science which acts between physics, applied mathematics, and information science on the one side and the broad spectrum of engineering including civil, computation, electrical, mechanical, process and possibly much more on the other. NDT has therefore deserved a much more important role to be taken in the future including an engineering product's complete life cycle starting from aspects of 'design for inspectability' and ending by 'sorting for recycling'. Such a challenge requires the education and training of a next generation of NDT experts on an academically high level, that has to go far beyond technical training mainly performed nowadays. Dresden International University (DIU) has been running a two years master course specifically devoted to NDT since 2013 where an increasing number of Indian applicants have joined in the meantime. The course is organised in four semesters and has a strong scientific and hence research focus. In the first semester students are taught in all the major fundamental disciplines such as materials (metals, polymers, composites), measurement techniques, mechanics (vibration, sound, fatigue, fracture), numerical methods and signal processing, and introduction to NDT & quality management. In the second semester major emphasis is on the different NDT techniques including acoustics, optics, electromagnetism, radiology and microscopy. The third semester is devoted to participating in the Basic Course (BC) of the German Society for NDT (DGZfP) which the students have to pass and then further allow them to go directly for a Level III after a respective period of professional experience in the future. A research placement then follows in reputable research centres such as BAM in Berlin, Fraunhofer, industries or different universities, recently also abroad such as Switzerland, Poland or Italy, all with a specific dedication to NDT. During the fourth and final semester students do perform their master thesis, most likely with the institutions they already performed their research placement with. With the third semester students move to Berlin/Germany for the BC module at DGZfP before transferring to the location where they will perform their research placement most likely followed by the master thesis. Motivation of the Indian students is to study what NDT and quality mean from a German point of view with a knowledge gained that they would like to bring back to India afterwards. In this context collaborations with Indian partner organisations are not excluded. The presentation will first describe the course and then give examples of specifically Indian students recruited and how institutions may possibly partner within the course.

Pulse Compression Favorable Coded Excitation Schemes for Thermal Non-Destructive Testing and Evaluation of Solids

Ravibabu Mulaveesala*

InfraRed Imaging Laboratory, Department of Electrical Engineering, Indian Institute of Technology Ropar, Bara Phool, Birla Seed Farms, Rupnagar, Punjab, INDIA 140001

*ravibabucareiidt@yahoo.co.in

Abstract

In recent years, InfraRed Thermography (IRT) for Thermal Non-Destructive Testing & Evaluation (TNDT&E) has encountered wide spread applications for the characterization of various solid materials due to its non-contact, whole-field, quick and non-invasive inspection capabilities. The principle of this technique is based on the mapping of thermal profile over the test object in order to reveal its surface and sub-surface anomalies. Due to potential capabilities of IRT, it finds numerous applications in various fields such as electrical, aeronautical, civil, mechanical, automotive etc. It can be implemented either in passive or active mode for NDT&E applications.

Among the various active infrared thermographic methods, Pulse Thermography (PT), Lock-in Thermography (LT), and Pulsed Phase Thermography (PPT) are predominately in use. Recently introduced pulse compression favorable excitation schemes overcome the requirement of high peak power heat sources of pulsed based techniques (PT & PPT) and repetitive experimentation of LT. These excitation schemes probes thermal waves into the test object within a suitable band of frequencies in a limited time span decided by thermal properties of the specimen and its physical dimensions. Further widely used frequency domain phase based data analysis scheme redistributes the imposed energy into the individual frequency components leading to a limited test resolution and sensitivity for detecting the sub-surface defects with a chosen frequency component.

In an attempt to overcome the limitations of widely used frequency domain phase based approach, this talk highlights novel correlation based time domain (phase and correlation coefficient) analysis schemes. This analysis makes use of the advantages of energy concentration in time through matched filtering approach adopted onto the obtained thermal response to non-stationary aperiodic excitation. Further helps in analyzing phase information in the time domain instead of frequency domain to characterize the specimen without disintegrating the energies of associated frequencies contributed in defect detection.

Further, applicability of novel coded excitation schemes have been highlighted to infrared thermography. Investigations have been carried out for finding out the capabilities of these methods. Feature potential abilities of pulse compression favorable excitation schemes for NDT&E applications have been discussed.

Keywords: Thermal Non-destructive Testing; Pulse Compression; Matched Filter, Phase Images.

Acoustic Emission for Process Monitoring and Structural Integrity Monitoring Applications

C.K. Mukhopadhyay

Non Destructive Evaluation Division, Metallurgy and Materials Group, Indira Gandhi Centre for Atomic Research, Kalpakkam - 603 102, Tamil Nadu, India

Email: ckm@igcar.gov.in

Abstract

Acoustic emission technique (AET) is one of the advanced non-destructive evaluation (NDE) techniques that possesses unique capabilities for on-line monitoring applications. An acoustic emission sensor attached to a sample undergoing dynamic changes detects a part of the elastic energy that is emitted in the form of elastic waves and gives information about the nature of changes taking place in the sample. AET has been used for monitoring different processes such as bending, forming, drilling and welding. Bending and forming are sheet metal forming processes used to fabricate angles, channels etc. Plastic deformation of materials generates elastic stress waves or acoustic emission, which enables online monitoring of the deformation process which in turn can be used for optimizing the process variables. AE monitoring has been carried out during press brake bending and roll forming operations of austenitic stainless steels. The press bending was carried out to various bend angles along the rolling and perpendicular to the rolling directions. AET has been employed to investigate tool wear characteristics for different tool geometries during drilling process of aluminum alloy and Al alloy based metal matrix composite. Acoustic emission has been used for monitoring of hydrogen assisted cracking in P91 ferritic steel welds during G-Bop and implant tests. The potential of AET has also been used for structural integrity monitoring of pressure vessels during hydrotesting. Acoustic emission generated during hydrotesting of the components indicated that the AE signals generated are only due to structural noise. The absence of any AE during the repressurizing cycle confirmed the structural integrity of the components. AE technique has also been used to monitor damage growth in concrete with different curing periods, subjected to compression and four point bending loading. Various examples on the use of acoustic emission for process monitoring and structural integrity monitoring will be highlighted in this talk.

Inspection Robotics - CNDE-IITM experience and perspectives

Prabhu Rajagopal
CNDE, IIT Madras

Abstract

Abstract: Structural inspections have to be often performed under very challenging conditions, such as high temperature, radiation, altitude or submersion. Under such conditions, robotics can provide valuable tools that can not only help save the life and hazard to human operators, but also provide robust and reliable inspection data. This presentation will review the work of our group, the Center for Nondestructive Evaluation (CNDE) at IIT Madras, in regard to Inspection Robotics. The talk will first present the background and fundamental insights into the key requirements for Inspection Robots. Results from breakthrough work by CNDE in association with some of our group Startups on Robotic NDE of structures at elevation, inside tanks and pipes and under water immersion will then be presented. Extensions of this work to socially relevant domains such as Septic Tanks and Sewer Lines will be discussed. The talk will conclude with some directions for further work.

Keywords: Thermal Non-destructive Testing; Pulse Compression; Matched Filter, Phase Images.

Structural Integrity Assessment of Composite Pressure Vessels using Acousto Ultrasonic Technique

Srinivas Kuchipudi, Venu Gopal Tiwari, J Srinivas and A S Srinivas Gopal.

SITAR, R&QA

Advanced Systems Laboratory, DRDO, Kanchanbagh PO, Hyderabad-500058.

Email: Srinivask@asl.drdo.in , Srinivas.kuchipudi@gov.in, Venu.gopaltiwari@gov.in

Abstract

Composite pressure vessels consisting of multilayered structural components are often used in aerospace industry for many applications. The filament wound composite structures with insulation lining in the inside surface are fabricated for specific purposes. These multilayered structures should have intact bonded interfaces for final application. However, it is possible that defects (de-bond) at bonded interface of composite structure and rubber lining may arise during handling, storage and transportation. These structural defects may lead to poor performance due to loss of mechanical strength during loading. Hence, it is desired that structural assessment of such composite pressure vessels is performed before their use.

In this paper, we report application of Acousto Ultrasonic inspection method for NDE of composite pressure vessels. Defects at the interface of composite – rubber lining and adhesive lining-polymer binder are assessed for their bond quality using Acousto Ultrasonic data. From the data the structural integrity of the pressure vessel is determined. Results of Acousto Ultrasonic testing of composite multilayered pressure vessels data are presented.

Keywords: Composite, NDE, Ultrasonics, Quality

NDT Market Directions and Emerging Business Opportunities

Madhusudan Chakravarthy

Lucid India, Chennai

Abstract

The development of new technologies and the advancement of existing technologies is key feature of evolution of NDE 4.0. This requires us to take stock and prepare to unlock the value potential therein. NDE 4.0 has resulted in both disaggregation of the industry and the rise of new business opportunities. This talk explores the evolution of NDE 4.0 from a perspective of Automation, Specialized Applications and Inspection Data Management.

Experimental Investigations on NDE of Fiber Metal Hybrid Composites

M R Bhat

Department of Aerospace Engineering
Indian Institute of Science, Bengaluru – INDIA

Abstract

Fiber Metal Hybrid Composites can embody the advantages of both the constituents. They can have high specific strength, specific modulus and fatigue strength as input from the fiber composite phase. The metal phase can provide impact resistance and toughness. The optimization of mechanical properties depends upon type, number of layers and orientation of fiber composite phase and thickness of metal phase. In this study, hybrid Fiber Metal Laminates(FML) comprise of Al-2024 alloy metal and Aramid-epoxy composite combination. Experimental investigations have been carried out to study the effect of number of layers and fiber orientation on the properties of FML. Further, FMLs have been subjected to low velocity impact loading. Non-destructive Evaluation (NDE) of damage induced due to low velocity impact loading on the FML have been performed. Digital Radiography, Infra-red Thermography and Acoustic Wave propagation techniques have been utilized to evaluate the damage induced. The paper presents the details of experimental investigations carried out and the results obtained.

Keywords : FML, NDE, Low velocity impact

Acoustic emission study of spatial-temporal damage evolution under uniaxial tension of woven glass/epoxy laminates

Ivan Panteleev , Oleg Plekhov

Institute of Continuous Media Mechanics of the UB RAS, Akademika Koroleva str, 1, 614013, Perm,
Russian Federation

pia@icmm.ru

Abstract

Fiber-reinforced woven and non-woven laminated materials manufactured by vacuum infusion technique have found wide application in different branches of industries including aerospace engineering, automotive and ship-building industries. An active demand for such materials generates the need to elaborate appropriate techniques for the analysis of data obtained by different methods of non-destructive control in real time mode. One of the wide-spread techniques for nondestructive control of the products made of composite materials is the acoustic emission method (AE), which provides in-situ estimation of the growth rate of various defects in a wide spectrum of spatial scales. The acoustic emission data contain detailed information on the types of seed defects, the character of their evolution and spatial-temporal mechanisms of their growth. It means that the development of effective data analysis technique to gain maximum information on the acoustic emission sources is the problem of particular importance.

In this paper we study the stage-wise nature of damage accumulation process in woven fiberglass laminates under uniaxial tension based on the analysis of acoustic emission data. The emphasis is placed on the application of cluster and multifractal analysis methods allowing us to determine the time-frequency parameters of acoustic emission, to identify beginning of defects collective behavior stage and to separate AE pulses by type sources (matrix crack, delamination, fiber break etc).

Used approaches allowed us to determine the major stages of material deformation by the evolution of AE parameters. It has been shown that macrofracture preparation is accompanied by synchronization of statistical properties of continuous acoustic emission (increase in the spectral coherence measure) in the allocated frequency intervals, the width of which increases with the oncoming fracture. In experiments with threshold AE registration results of linear location of AE sources were analyzed by using of kernel density estimation method. As a result, it was shown that under uniaxial tension of a woven glass / epoxy laminate, the process of its deformation and damage accumulation has a complex spatiotemporal structure, in which there are both stages of time-dependent activation of this process, and its migration through the sample in the form of localized in space and time zones.

Keywords: acoustic emission, source types, cluster analysis, multifractal analysis, damage accumulation.

Current Practice of Robotic Inspection

Victor Klein

GE

Abstract

Robotic inspection of confined spaces such as pressure vessels, reactors or boilers is typically performed by manually remote-controlled crawler robots. As the operator has no special awareness of the crawler in the confined space the driving and navigation of the crawler inside is difficult and delicate. Onboard navigation cameras provide only little support.

The inspection data (such as images or ultrasonic wall thickness measurements) is manually captured and saved to a storage medium, with an operator taking notes on the side. The inspection report is manually created later based on saved data, and the notes taken during the mission, by copying some of the data or pictures into a template document. Consequently, there is no reliable link of the reported inspection data with the position in the asset where the data has been captured.

3D Localization & Digital Twin for Confined Space Inspections

Robotic localization technology for autonomous operation and reporting is basically available, and it is used by drones or mobile robots on plant level. However, this technology cannot be applied to confined spaces due to the lack of GPS reception, weakly textured surfaces, asset size, and geometries.

GE Inspection Robotics has developed a novel approach of confined space robot localization. The technology provides the full 3D special awareness of the robot in the asset and provides a 3D interactive robot control. Inspection data is automatically tagged with the precise position in the asset, and a digital twin containing all the inspection data is maintained. Inspection reports are generated automatically, and the data can be uploaded into asset performance management systems.

Recent Regulatory Measures For Radiation Safety In Use Of Ionizing Radiation In Non-Destructive Evaluation Practices

Avinash U. Sonawane,

Directorate of Regulatory Affairs & Communications & Secretary,

Atomic Energy Regulatory Board, Mumbai, India

Email: head.drac@aerb.gov.in / dr.avinashs@aerb.gov.in

Abstract

Major applications of ionizing radiation sources in non-destructive evaluation (NDE) practices are industrial imaging of welding, castings & engineering components; gauging instruments (also called nucleonic gauges) for measuring/monitoring of physical parameters and scanning of baggage's /consignments /human being/critical products. Industrial imaging is either radiography or fluoroscopy which ensures the integrity of structures such as vessels, pipes, welded joints, and castings while nucleonic gauges (NGs) are being used in industries for monitoring and measuring physical parameters such as thickness, level, density, moisture, elemental analysis, well logging techniques etc. Scanners based on ionising radiation are installed in various major sea-ports, land ports, strategic locations, and x-ray baggage scanners at airports. Ionising radiation sources include radioactive substances & radiation generating machines like x-rays.

Ionising radiation sources, no doubt, are beneficial to industry, however, owing to the lack of inappropriate control over sources, their unsafe handling and insecure storage can lead to potential exposures to persons leading to radiation injuries. To prevent / minimise radiological risk and in turn, harness immense benefits from NDE applications, effective regulations need to be established as well as their user-friendly implementation by end users without compromising radiation safety.

Atomic Energy Regulatory Board (AERB), constituted in November 1983, is the national regulatory authority for establishing and enforcing radiation safety regulations in handling of radiation sources used in multifarious applications for welfare of human being. Mission of AERB is to ensure that use of ionising radiation and nuclear energy does not cause undue risk to the people and the environment. Accordingly, AERB has established the effective regulatory control mechanism for ensuring radiation safety in NDE practices using ionising radiation. The on-line electronic licensing system of radiation applications (eLora) deployed by AERB since 2013 is the vital part of this mechanism. The recent regulatory measures of AERB for ensuring radiation safety in NDE applications include, inter alia, the following,

i) to enhance further the efficiency & versatility of eLora system, provisions are made for auto-approval of radiography source movement; online form, 'raise an issue' introduced; enhanced forgot user ID & Password option provided to prevent mis-utilisation; OTP provision incorporated for verification of mobile number and email ID; Help Desk for eLora is established at headquarters of AERB which is functional during all working days ii) qualifications and training program for industrial radiographers has been revised with more emphasis on radiation safety iii) emerging NDE techniques are dealt with additional regulatory measures, QA protocols and accordingly training programs have been updated iv) actions taken (e.g. conducting awareness programs, issuance of guidelines for proper use of TLD) to prevent incidents involving excessive exposure incurred by individuals working in NDE applications v) publication of safety brochures providing basic information on safety in radiography practice & responsibilities of contract award agencies in ensuring safety & security of radiography sources. vi) issuance of type approvals (design certification) to scanner equipment, nucleonic gauges vii) undertaken risk estimation studies based on Probabilistic Safety Assessment using fault tree & event tree in radiography. Results of this study revealed that the worst radiological scenario in radiography is the source stuck in guide tube when device is operated by untrained person leading to deterministic health effects like radiation skin burns. The study provided inputs for establishing additional measures to prevent such scenarios. Safety booklet has been prepared specially for trainee radiographers and circulated among radiography institutions.

AERB is committed to suitably incorporating the best practices in the area of safety and security of radiation sources in its administrative and regulatory framework and continuous improvements will be made based on experience and new developments. Nevertheless, the primary responsibility for ensuring safety and security of radiation sources rests with the employer/operating organisation and radiation workers.

ROLE OF NDE IN THE SUCCESS STORY OF INDIAN SPACE PROGRAMME

Levin G

Deputy Director, Solid Propellant Research Entity, Vikram Sarabhai Space Centre, Thiruvananthapuram

g_levin@vssc.gov.in

Abstract

Significant progress made in the last few decades in the NDE helped to improve the reliability of almost all the critical components in launch vehicle and satellite systems. The advent of newer technologies and capacities in NDT areas have helped in the precise flaw detection of systems and enabled to achieve better reliability as well as avoid failures during its service period. NDE plays a vital role in assuring quality, reliability and safety of materials in many advanced technological areas of strategic importance like aerospace, defence and other critical domains. The range of materials to which NDE is applicable in a launch vehicle is like metallic structures, propellants, composites, polyimides, insulation materials etc. Conventional NDE techniques are used in most of these applications to assess the defects present. To meet the ever-growing and challenging demands of launch vehicle applications, research and development in the field of radiography is improving and variety of X-ray sources from low kV (micro focus) to MeV (LINAC, Betatron, Microtron etc.) range are used. Since solid rocket motor consists of different layers of materials in its construction, Computed Tomography (CT) can discern in which layer actually defect is located. As far as aerospace application is concerned, Ultrasonic testing is not only aimed for defect detection during fabrication of maraging steel weld joints of rocket motor casing but also in the detection of debonds between insulation / rocket motor case and advancement in low frequency ultrasonics used for the defect detection in the low density materials. However some of the applications require custom made equipments and adapted techniques focused to the specific area. Digital Image correlation, Acousto- Ultrasonics, Neutron radiography, Acoustic emission and Thermography are some methods which are specially used for the applications in launch vehicle applications. NDT techniques and developments in the conventional techniques with the use of advance electronics, software and robotics have built confidence to the success of Indian space programmes to a great extent.

Application of terahertz pulses to NDE of coatings

Phil Taday

Teraview

Abstract

TeraView Limited is at the forefront of global developments in terahertz light, creating instruments which can generate, detect, and manipulate terahertz radiation to characterize a wide range of materials. TeraView is the world's first innovator of such terahertz imaging and spectroscopy systems, with over two decades of experience in the field. The company's expertise in designing and manufacturing reliable and robust THz sources enables customers to realize the potential of terahertz radiation and solve real-world problems. Uniquely, the company has a wealth of experience in both the technology to generate, detect and manipulate terahertz light.

There is increasing commercial need for the application of terahertz pulses in the area of non-contact and non-destructive testing of thin high value coatings. By way, of example, I will discuss in this paper our recent progress in integrating robotic systems with terahertz sensors in the area of pharmaceutical and automobile sectors.

Within the automobile we have successfully gauge R&R tests at several car manufacturing sites around the world. These results will be discussed in this presentation. Terahertz technology provides an exciting new tool for the automobile industry to increase the number of cars inspected before delivery.

TeraView continues to develop new analytical methods for the pharmaceutical industry and are currently engaged on a project to non-destructively test the hardness of tablets after the tablet press. The hardness of a tablet has an impact on the drug release to the patient and the development of this new tool based on terahertz technology provides insights into tablet-to-tablet variability of the dosage forms. Results from this project will be briefly reviewed in this presentation.



CONTRIBUTORY TALKS



Process Control in Magnetic Particle Testing

Muthu G¹

¹Peekay Steel Castings (P) Limited, Nallalam, Calicut, Kerala, India – 673 027.

muthu.g@peekaysteel.com

Abstract

Magnetic Particle Testing for Steel casting manufacturing foundry is very essential to ensure the quality of castings. As castings are made to various grades with respect to different designs / changes in sections, it shall be subjected to different NDE for assessing the quality as well as the foundry practices to meet the customer requirements. Primary surface examination method used for ferro magnetic castings like carbon and low alloy steel grades is Magnetic Particle Testing.

Magnetic Particle Testing considered to be simple to carry out, but the various process control activities plays a vital role in proper examination of the parts. Otherwise there is a chance of missing the indications and subsequently it may be detected at customer end causing customer dissatisfaction. Process control activities implemented in our foundry for Magnetic Particle Testing includes from the consumable testing and qualification till the completion of testing with complete traceability. Calibration of equipment, bath mixing, concentration of bath, sufficient field strength, lighting conditions, overlapping and direction of magnetization, inspection personnel qualification, recording of indications are some of the key areas focused for consistent inspection.

The paper mainly describes the process control requirements for reliable Magnetic Particle Testing of steel castings to meet various customer and standard / code requirements.

Keywords: Magnetic Particle Testing, Process Control, Steel Castings.

Development of Portable Wireless Non-Destructive Crack Identification Method by Using GMR Sensor Array for Overhead Crane Bridges

Arun Kumar Yadav¹, Janusz Szpytko²

¹Mechanical Engineering & Robotics ,AGH University of Science & Technology, aleja Adama Mickiewicza 30, Krakow, Poland.

²Mechanical Engineering & Robotics ,AGH University of Science & Technology, aleja Adama Mickiewicza 30, Krakow, Poland.

yadav@agh.edu.pl

Abstract

Structural Health monitoring of overhead cranes bridges by the traditional inspection system with wired and bulky instrumental technologies face many challenges during the harsh environment and under working condition. This paper proposes a portable wireless and efficient NDT method using the GMR sensor array technique for the identification of fatigue cracks in the bridges of travelling overhead cranes.

In this paper, to enhance the efficiency of overhead cranes by minimizing the inspection time, a portable wireless robot combined with GMR (Giant Magneto-resistivity) sensor and NDT technique is developed. This novel solution offers mobility, high accuracy and low power consumption. For the detection of cracks and defects in overhead crane bridge eight GMR (Giant Magneto Resistive) sensors NVE (AA006-02) placed linearly on a PCB board with equal distance. Two magnetic wheel of neodymium N42 located on both side of the GMR sensor array to magnetize the steel surface for accurate defect reorganization. Unlike MPI (Magnetic Particle Inspection) where a global magnetization requires for further inspection, this automated detection system only magnetize the surface area under the vicinity of GMR sensor array. The instrumentation circuit including eight high speed multiplexer, Operational amplifier, and one 8 bit analog to digital converter. A PIC 877A microcontroller and raspberry pie was used to perform local data storage, data processing and controlling. In order to verify its performance and efficiency, few experiments have been conducted in laboratory. This presented testing solution is quick and offers a step towards automated testing of overhead crane bridges. However, it improves the work efficiency and can meet the serious challenges within the inspection of overhead crane bridges.

Keywords: GMR Sensor Array, Non- destructive testing, Overhead crane bridges, Crack Inspection.

Condition assessment of Annular plates, Piping Supports with Short Range Ultrasonic Testing (SRUT)

D.UMAPATHI

Manager (Mech), Inspection Section, INDIAN FARMERS FERTILISER CO-OPERATIVE LIMITED (IFFCO)
Paradeep Unit. – 754142. Odisha, India. Mob: +91 9937999969 / 7077721577 | E: dumapathi@iffco.in

Abstract

Condition assessment of annular plates of Sulphuric acid storage tanks, supporting plates of ammonia vessels, piping supports of sulphuric acid & ammonia pipe lines in process plants is very essential to avoid unexpected breakdowns, interruption of production as well as to avoid the severe effects on human and environment. In our plant, Sulphuric acid storage tanks, ammonia vessels and process acid pipe lines exist in different sizes and different lengths in entire complex and port jetty. Thickness measurement, Corrosion mapping & weld joints inspection are carried out by different non-destructive methods.

In-service conditions, storage tank annular plates and piping supports condition assessment is not possible. It requires plant shut down which is highly affects the production cost as well as productivity. Due to this, we choose advanced technology like Short Range Ultrasonic Test (SRUT). In this method, detects the corrosion, pitting, erosion and percentage of wall loss with the exact location without hampering of plant activities.

Keywords: Corrosion mapping of annular plates, Piping supports, Short Range Ultrasonic Testing (SRUT).

Performance evaluation for Computed Radiography System in Aerospace Industry

Nitesh Keshri¹

¹Tata Advanced System Limited, Hyderabad, India

nkeshri@tasl.aero

Abstract

Computed radiography testing is a process of capturing radiographic data from a conventional X-ray source and processing the data digitally to produce the crisp and high quality image.

In aerospace industry, all the facility using CR scanner shall establish base line using PHANTOM. As this is very important because lot of electronics are used to make the scanners. PHANTOM is the device containing an arrangement of test target used to evaluate the image quality of the CR system. Following are the parameter for baseline setup:

1. Beam Alignment
2. Spatial resolution
3. Contrast sensitivity
4. Signal to noise ratio
5. Shading
6. Banding
7. Scanner slippage
8. Scan line drop out
9. Laser beam jitter
10. PMT non-linearity
11. Blooming
12. Spatial non linearity
13. Laser beam scan line Integrity
14. Erasure checks

Defect Classification from Weld Radiography Images Using VGG-19 Based Convolutional Neural Network

T Bharath Chandra¹

¹JNTUH College of Engineering Hyderabad, Hyderabad, India

t.bharathchandra@gmail.com

Abstract

Radiography is a non-destructive testing aid used for inspection of weld quality. Films obtained after conventional radiography are generally analyzed by the experts. The results of this process can be influenced by various external factors and it is also a time taking process. Due to these reasons, there is a great need to perform automatic weld defect detection by analyzing the images obtained directly from the digital radiographic system.

The prime objective of this work is to use a convolutional neural network in defect classification from weld radiographic images. A dataset of 3000 images belonging to 3 different classes is created to train the network. Cracks (CR), porosity or slag inclusions (PO) and good weld (GW) are the three different classes present in this dataset and the size of each image in the dataset is 128 X128 pixels. A new network is created by freezing the first five layers of VGG-19 and replacing the fully-connected layer of VGG-19 by two dense layers and a dropout layer in between them. Softmax function is placed at the last layer of the network. SGD is used as an optimizer function, with 0.0001 as learning rate and 0.9 as momentum. A batch of size 2 is used while training and the model is trained on Tesla K80 GPU for better results.

After 70 epochs of training phase, the model had converged to a training accuracy of 93.17% and a validation accuracy of 91.14%. Tensorboard has plotted the loss and accuracy curves and they have followed the expected trajectory almost precisely. To investigate whether the model is well generalized, a classification report is generated by comparing the predictions of the model on the test set and their actual labels. Then the model had attained a test accuracy of 91% and average precision and average recall as 0.91. These results corroborate that the model is universal and ready for real world usage.

Keywords: welding defects, convolutional neural network, weld radiography

Condition assessment of Sulphuric acid storage tanks – Case study

D.UMAPATHI

Manager (Mech), Inspection Section, INDIAN FARMERS FERTILISER CO-OPERATIVE LIMITED (IFFCO),
Paradeep Unit. – 754142. Odisha, India. Mob: +91 9937999969 / 7077721577 | dumapathi@iffco.in

Abstract

Condition assessment of Sulphuric acid storage tanks, its nozzles in process plants is very essential to avoid catastrophic failures, interruption of production as well as to avoid the severe effects on human and environment. In our plant, Sulphuric acid storage tanks exist in different sizes in entire complex. Thickness measurement, Corrosion mapping & weld joints inspection are carried out by different types of advanced non-destructive methods.

The most effective and direct method is evacuate the acid in tanks and carried out the condition assessment. But it associated with interruption of the production. Due to this we choose, the advanced technology like Automatic Ultrasonic testing (AUT), Short range Ultrasonic testing (SRUT) and Phased array ultrasonic testing (PAUT). These methods are can apply in service conditions of the tanks. Thickness measurement and corrosion mapping of tank course shells carried out with automatic ultrasonic testing (AUT). Annular joints, annual plates and nozzle / piping supports corrosion mapping carried out with short range ultrasonic testing (SRUT). For checking the weld joints, we choose the Phased array ultrasonic testing (PAUT).

Keywords: Automatic Ultrasonic Testing (AUT), Short Range Ultrasonic Testing (SRUT), Phased array ultrasonic testing (PAUT).

An Improved Quality Assessment of Fuel pin End plug Welds using Digital X-ray Radiography

T. Saravanan, S. Mahadevan and C.K. Mukhopadhyay

Non Destructive Evaluation Division, Metallurgy and Materials Group

Indira Gandhi Center for Atomic Research, Kalpakkam, Tamil Nadu - 603 102

e-mail: tsara@igcar.gov.in

Abstract

In fast breeder reactors, the quality of fuel pin end plug welds is very important since presence of any weld defect can cause release of fission products in to the coolant circuit. Amongst the various defects that form during welding, a root defect at the end plug weld joint is the most prominent defect observed in fuel pins. A typical fuel pin made of alloy D9 clad tube is fused to SS 316 end plugs by pulsed TIG process. Conventional X-ray film radiography procedure for end plug welds of fuel pins would result in 80 μm IQI sensitivity.

In the present work, X-ray radiography experiments are carried out using 450 kV constant potential X-ray unit and flat panel detector with 127 μm pixel resolution. By following the standard X-ray digital radiography data acquisition procedure and the optimized radiography exposure conditions (kV, mA .sec. etc.), the normalized SNR achieved is 140 which limits the achievable radiography sensitivity to 200 μm . A study of SNR vs exposure showed that SNR could not be increased beyond a limit where the structural noise of the digital detector influences the achievable SNR. Hence, a modified digital X-ray radiography inspection procedure is proposed to assess the quality of end plug welded fuel pins using suitable X-ray detector calibration technique. The structural noise and pixel intensity variations between the flat panel pixel elements have been minimized by using this modified procedure which results in one order increase of SNR of the radiography images. After implementation of this procedure with end plug welds, X-ray images showed that the achievable radiography sensitivity is enhanced to 63 μm and micro-defects are clearly observed in the welds.

Key words: Digital X-ray radiography, Fuel pin end plug welds, SNR, Contrast sensitivity, Weld defects,

Modelling the Propagation of Partial Discharge Signals inside Gas Insulated Transmission Line Sections

Yugandhara Rao Yadam¹, R. Sarathi² and Kavitha Arunachalam^{1a}

¹Department of Engineering Design, ²Department of Electrical Engineering

Indian Institute of Technology Madras, Chennai, India

^{1a} akavitha@iitm.ac.in

Abstract

Gas insulated lines are safe alternative for overhead power lines. A gas insulated line (GIL) consists of two concentric conductors insulated by a gas mixture mainly consisting of nitrogen and sulphur hexafluoride (SF₆). Real time monitoring and detection of partial discharge (PD) inside the GIL is necessary to avoid complete breakdown of the insulation. PD signals are commonly detected using ultra high frequency (UHF) sensors operating over 0.5-3 GHz. A typical GIL runs for few km and has straight sections, bends, joints and turns, which alter the characteristics of the PD signals received by the UHF sensor. Thus, it is important to understand the influence of the GIL sections on the PD signal characteristics for sensor positioning and signal interpretation. Constructing such a large and complex system to model PD signal propagation inside the GIL is numerically expensive and time consuming. In this work, we propose a hybrid technique to model PD signal propagation inside GIL using full wave EM simulations and transmission line network analysis to minimise the computational burden. PD signal recorded for corona discharge with spectral content of 0.5-1.5 GHz inside a GIL test cell in the laboratory was coupled to the hybrid numerical model. The spectral content of the PD signal was analysed after travelling through a straight section, L bend and T joints in a GIL with 50 Ω line impedance. The simulation results of PD signal propagation using the proposed hybrid model were compared with measurements for GIL sections of the same dimensions. The spectral content of the corona discharge signal was calculated as 0.5-1.5 GHz for the straight section in agreement with the measurements. The spectral content of the corona discharge widened up to 3 GHz after travelling through L bend and T joint. Similar spectral widening was also observed in the measurements. The simulation results indicate that the proposed hybrid model can be used to study PD signal propagation inside a full scale GIL.

Keywords: gas insulated line, partial discharge, full wave analysis, transmission line model

SNT-TC-1A Edition 2016 Implementation

Diwakar Joshi¹, Prakash Tamhankar²

Insight Quality Services, Office No. 507/508, 5th Floor, Building No.1 , Siddharth Towers, Sr. No. 12/3B, Near Sangam Press, Kothrud, Pune - 411 029, Maharashtra, India

E-mail ID: prakash.tamhankar@iqs-ndt.org | E-mail ID: diwakarj@gmail.com

Abstract

SNT-TC-1A (Society for Non-Destructive Testing -Technical Council- 1A) was 1st published in 1968 and revised in 70,75,80,84,88,92,96,98 addenda, 2001, 2006, 2011 and 2016 and addenda 2018. These revisions were made to add new methods, new techniques, new processes and catering to the demands of new and challenging testing situations. While implementing the new editions a lot of preparation is needed to understand the new requirements and to implement them satisfactorily to the content and intent of the code.

ASME Section VIII Div. 1 and other code have started adopting SNT –TC-1A Edition 2016 from this year (ASME Edition 2019) and we need to gear up for implementation of SNT-TC-1A Edition 2016. Many of API codes demand latest SNT-TC-1A, therefore making SNT-TC-1A Edition 2016 (addenda 2018) are applicable to them.

This paper details the new changes in SNT-TC-1A Edition 2016 and gives guidelines how to implement these changes. Users of Section V need to necessarily consider changes to SNT-TC-1A as indicated in Mandatory Appendix III of Section V Article 1 when making the Written Practice. For the ASME certification shops these changes will become mandatorily applicable from 1st January 2020.

Keywords: SNT-TC-1A Edition 2016, Changes, ASME Section VIII Div. 1, Section V, Written Practice

NABL Certification for NDT Laboratories

Surendra Mungel¹, Diwakar Joshi²

Insight Quality Services, Office No. 507/508, 5th Floor, Building No.1, Siddharth Towers, Sr. No. 12/3B, Near Sangam Press, Kothrud, Pune - 411 029, Maharashtra, India

Email-ID : surendra.mungel@iqs-ndt.org | E-mail ID: diwakarj@gmail.com

Abstract

Qualified personnel, Calibrated equipment's and Qualified Procedure are the three essential elements of meaningful Non-Destructive Testing. The NDE service agencies play an important role in the industry and they need to take care of above three essential elements. ASTM E 1212-17 (Quality management systems for NDT Agencies) talks about detailed requirements NDT service agencies.

There are various National and International schemes for the verification of competency of NDT Personnel. However, NABL (National Accreditation Board of Laboratories) accreditation is playing an important role in giving confidence to customers on the competency of NDT service agencies. Many of the customers demand only NABL accredited service agencies shall quote for their NDT service requirements.

This paper details the requirements for NABL certification and gives guidelines for preparing and getting NABL accreditation.

Keywords: NDT Personnel, ASTM, NABL Certification, NDT Services, Accreditation requirements

Different International Certification Schemes for Welding Inspectors

Mugdha Joshi – Kale¹, Diwakar Joshi²

Insight Quality Services, Office No. 507/508, 5th Floor, Building No.1, Siddharth Towers, Sr. No. 12/3B, Near Sangam Press, Kothrud, Pune - 411 029, Maharashtra, India

E-mail ID: mugdha.joshi@iqs-ndt.org | E-mail ID: diwakarj@gmail.com

Abstract

In fabrication Industry, Welding and NDT are two faces of the same coin. Nowadays, with the latest developments in welding, 98% of joining is done with welding only. Welding Inspection is an integral part of welding technology and NDT is playing a major role in the same.

The success of any welded structure depends on the quality of weldments which is verified and certified by welding inspector. Hence role of Welding Inspector is very important in successful operation of any fabricated structure, pressure vessel, tanks and so on.

There are national and international schemes like AWS (American Welding Society) Scheme, TWI Scheme, IIW (International Institute of Welding) Schemes to qualify and certify the Welding Inspectors. Even though the aim of these schemes is same i.e. to ensure the skill and knowledge of inspector, the methodology followed is different. This paper is discussing the different schemes and the examination system for welding Inspectors. The references are taken from the applicable scheme documents.

Keywords: Welding and NDT, Skill and Knowledge, Certification schemes, AWS Scheme, IIW Scheme

ASME Section - V Edition 2019 Code Changes

Diwakar Joshi¹, Aditya Bhagwat²

Insight Quality Services, Office No. 507/508, 5th Floor, Building No.1, Siddharth Towers, Sr. No. 12/3B, Near Sangam Press, Kothrud, Pune - 411 029, Maharashtra, India

E-mail ID: aditya.bhagwat@iqs-ndt.org | E-mail ID: diwakarj@gmail.com

Abstract

ASME (American Society for Mechanical Engineers) codes revised every 2 years (generally on 1st July), and the new edition is mandatorily applicable after six months (on 1st January onward). After edition 2017 (which is applicable up to 31st December 2019) the new code are released on 1st July, 2019 which are available all over now. ASME code Section V, Nondestructive Examination, is a referenced code referred by many referencing code like ASME Section VIII Div. 1 (Pressure Vessel), ASME Section I (Power Boilers), ASME Section III (Nuclear). The manufacturer having ASME code certification, owners, users, consultants, inspectors and the fabricators need to know what are the changes in the new code and why are these changes are made to align themselves and act as per new code.

This paper is gives the summary of major changes in ASME section V 2019 from the earlier code Edition 2017, and discusses how to implement these changes.

Keywords: ASME, Manufacturer, Pressure Vessel, Non destructive Examination, Changes

Eddy Current Array for Fuel Rod Inspections and Beyond: From Manufacturing to End-of-life Management

Anne-Marie Allard¹, Mathieu Bouchard², Olivier Rousseau-Cyr³ and Jitender Yadav⁴

¹Eddyfi Technologies, 3425, Pierre-Ardouin St. Quebec, Canada

²Eddyfi Technologies, 3425, Pierre-Ardouin St. Quebec, Canada

³Eddyfi Technologies, 3425, Pierre-Ardouin St. Quebec, Canada

⁴Eddyfi Technologies, 3425, Pierre-Ardouin St. Quebec, Canada

amallard@eddyfi.com

Abstract

The fuel used in Nuclear Power Plants (NPPs) has a long lifecycle, such that it is necessary to establish short- and long-term inspection programs to ensure workers' and the general population's safety as well as optimal performance of the NPPs during its active life.

Fuel rod integrity assessment – from manufacturing to in-service inspection – is performed to ensure optimal performance of NPPs and safety. Once the rods are removed from the plants and stored, the pools, canisters, and other containment infrastructure are also inspected to ensure proper safety.

Different NDT methods are currently used to inspect fuel rods, canisters, spent fuel pools, and related assets. Each method has different advantages and disadvantages, and some are complementary. In terms of surface inspection of rods, canister walls, spent fuel pool welds and other critical parts, conventional eddy current testing (ECT) is often used to detect cracks, pits and corrosion. Unfortunately, ECT is limited in terms of flaw detection, speed, ease of analysis, and ease of deployment.

Advances in electronics has enabled the development of more modern inspection techniques like Eddy Current Array (ECA), increasing the reliability of surface inspection over traditional methods. Being able to tailor coil designs and multiplexing patterns allows users to optimize the acquisition chain to their specific application. Arrays of coils can be packaged in dedicated mechanical casing for special geometry, radioactive environments, underwater inspection and more. In addition, by multiplexing and leveraging advanced data processing capabilities, ECA solutions allow inspections to be carried out quickly, often with less surface preparation. They also provide additional benefits such as state-of-the-art imaging (e.g. 2D and 3D C-Scan displays), improved surface coverage, ease of deployment and data archiving. Finally, on top of defect detection, ECA technology also provides quantitative sizing.

This paper describes the eddy current array method along with variations on the theme, inclusive of their benefits and limitations. The deployment of actual custom ECA solutions for inspections of fuel rods and containers is also discussed.

Keywords: Non-Destructive Testing, Fuel Rods, Spent Fuel Pools, Eddy Current Array

Planar Printed E Field Sensor Array for Microwave NDE of Composites

Jayaram Kizhekke Pakkathillam¹, Nitheesh M Nair^{2,3}, Parasuraman Swaminathan² and Kavitha Arunachalam^{1a}

¹Department of Engineering Design, ²Department Metallurgical and Materials Engineering, ³Department of Electrical Engineering
Indian Institute of Technology Madras, Chennai, India | aakavitha@iitm.ac.in

Abstract

Sensor array is a group of sensors arranged in a particular fashion to sense the signal. When the array is employed, it increases the measurement dimension of the sensing parameter compared to a single element. The array improves the sensing area, spatial resolution and inspection speed. In this work, a linear 8 element array of electric field sensors is realized for non-destructive testing of dielectric composite materials. Composite materials are widely used in military, aerospace, medical and automotive fields. The chances of defects occurring in these materials are high during manufacturing stage and after field installation. Hence, NDE methods are proposed for periodic inspection and safety of the component. Among the different NDE methods, microwave based NDE technique is promising for inspecting dielectric composites.

In this work, a linear array of electric field sensors is used to detect the defect in composite samples. A dipole antenna array is printed on photo paper using silver conductive ink and transmission line is printed using polymer based resistive ink. A zero bias schottky diode is employed as RF detector output is fed to a microvolt meter. Planar dielectric composite samples of 3 mm thickness were prepared and tested. A spot focusing horn antenna operating from 8 GHz to 12 GHz with a focal length of 115 mm and focal spot diameter of 44 mm is used to illuminate the sample as shown in Figure 1. The sensor array is used to map the electric field strength in the defect free and defective regions of the sample. Measurements of the linear electric field sensor array are presented for fibre glass reinforced composites with simulated defects. Local map of the perturbation in the field distribution is obtained using the linear electric field sensor array.

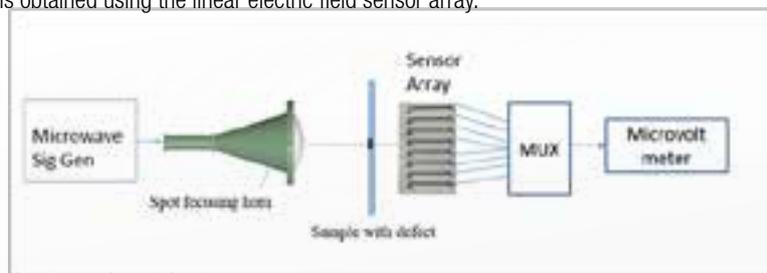


Figure 1. Schematic of experimental set up

Keywords: Composites, Electric field sensor array, Microwave NDE, Spot focusing horn antenna.

Replica Metallography (Case Study) – A NDT Technique for Life Assessment of Gas Turbine Wheel

Girish Shejale

Masaood John Brown, PO Box 11931, Dubai, UAE | gshejale@mjbi.com

Abstract

Life extension programs for rotating and non-rotating gas turbine components are popular and widely practiced in the industry. It is often possible to extend the life of the component beyond the design life through life assessment studies. The life assessment study generally includes a combination of non-destructive and destructive tests.

Considering the life assessment approach a gas turbine wheel from Frame 5002 turbine was examined non-destructively. The material of the turbine wheel is A-286, which is an iron based super alloy. This turbine wheel has accumulated over 200K service hours. The objective for non-destructive testing of this wheel was to check for any material degradation and any surface cracking in order to ensure extended service hours. The non-destructive tests included eddy current, ultrasonic flaw detection, replica metallography and portable hardness test. As such, no abnormalities were detected in eddy current test, ultrasonic flaw detection, and portable hardness testing.

Replica evaluation was done using an Optical Microscope and a Scanning Electron Microscope. The replica metallography revealed excessive carbide precipitation. Considering the microstructural transformations observed in the wheel it was recommended to retire the wheel from service. The presentation shall cover replica evaluation work, significant test result findings and conclusions.

This case study was published in ASM International Journal of Failure Analysis and Prevention (Publication date 31st August 2016).

KEYWORDS: life assessment, metallography, microstructure, replica, turbine wheel

New Methodologies for Strain Mapping at Microscale using Digital Image Correlation

Srinivasan Nagarajan^{1*}, Mukesh K. Jain², David S. Wilkinson³, Raja K. Mishra⁴

¹Department of Materials Science and Engineering, Indian Institute of Technology Kanpur, Kanpur – 208 016, India

²Department of Mechanical Engineering, McMaster University, Hamilton – L8S4L8, Canada

³Department of Materials Science and Engineering, McMaster University, Hamilton – L8S4L8, Canada

⁴General Motors Research and Development Center, Warren – 48090-9055, U.S.A

*sri@iitk.ac.in

Abstract

Development of plasticity models through experimentally informed inputs, particularly about the local phenomena at the microstructural scale, has been of keen interest in recent years. Towards this, digital image correlation (DIC) is explored as an effective tool to characterize the deformation across the microstructure. DIC is a non-destructive, non-contact method which correlates the deformed image with the undeformed (reference) image to determine the surface strain based on the gray value matching of local regions called subsets. Various small scale patterning methods such as lithography, focused ion beam milling, thin film patterning, nanoparticles drop casting, template patterning, etc., have been used in the past to attain distributed gray values. However, all these methods are time consuming and involve laborious procedures that often need specialized instruments. Another critical concern on microscale strain mapping is the loss of correlation due to evolving microstructural features during deformation which alter the local gray values, thereby making the DIC strain calculation inaccurate or impossible. In this work, we propose a simple, fast and robust speckle patterning method based on chemical etching for microstructural strain mapping in automotive nonferrous alloys. Towards this, specimens were subjected to uniaxial tension using miniature tensile stage under the vision of an optical microscope. Micrographs of the zone of interest were continuously recorded for small increments of strain and subsequently used for strain calculation using DIC. To minimize the loss of correlation due to evolving microstructural features, an incremental DIC scheme that correlates two successively recorded micrographs was employed, unlike the conventional scheme which correlates deformed micrographs to the reference micrograph. Results obtained reveal that the proposed simple and fast patterning method could characterize the inter- and intra- granular strain gradients in alloys with a wide range of grain sizes. Further, the loss of correlation is found to be relatively minimal with incremental correlation. Also, for high spatial resolution strain measurements, incremental correlation renders better accuracy and precision than the conventional scheme.

Keywords: Digital image correlation; speckle patterning; microscale strain mapping.

Characterization of Plastic Deformation using Acoustic Emission during Bending of SS 304L

S. Lavanya¹, S. Mahadevan¹, C.K. Mukhopadhyay^{1*}

¹Non Destructive Evaluation Division, Metallurgy and Materials Group, Indira Gandhi Centre for Atomic Research, Homi Bhabha National Institute, Kalpakkam- 603 102, Tamil Nadu, India

*Corresponding author: ckm@igcar.gov.in

Abstract

Sheet metal forming process utilizes the plastic deformation capability of materials to form into required geometries of various parts of big components. Bending is one such process used to fabricate angles, channels etc. which has wide applications in automobile and aircraft industries. Plastic deformation of materials generates elastic stress waves called as acoustic emission (AE), which enables online monitoring of the deformation process which in turn can be used for optimizing the process variables. The acoustic emission signals generated during this process are recorded by use of piezo electric sensors. The AE time domain parameters such as peak amplitude, counts, energy, RMS etc. are usually considered for the portrayal of AE source features. The plastic deformation of materials creates microstrain which is well characterized by the change in full width at half maxima (FWHM) of the x-ray diffraction (XRD) profiles. The present investigation aims at application of acoustic emission technique for online monitoring during bending of 3 mm thick SS 304L plates. An analysis of various parameters derived from the AE signals and their correlation with the FWHM of XRD peaks would be presented.

Bending of SS 304L steel plates was performed along the rolling direction and perpendicular to the rolling direction at various bend angles viz., 45, 60, 90, and 120 degrees. Acoustic emission that occurs during press brake bending is recorded using a wide band sensor. The AE signal parameters are analyzed and discussed in detail. XRD measurements were carried out at the bent regions of these plates and the FWHM of the peaks is analyzed for ascertaining the plastic deformation. Among the various AE parameters derived, the parameter that is most suitable to evaluate the plastic deformation corresponding to the bend region would be presented.

Keywords: Acoustic emission; Bending; SS 304L; Forming

Numerical Analysis of Partial Discharge Source Localization using Time of Arrival Measurements and Nonlinear Least Squares Search

Krishna C. Ghanakota^{#1}, Sarathi R.^{*2}, Kavitha Arunachalam^{#3}

[#]Department of Engineering Design, Indian Institute of Technology Madras, Chennai, Tamil Nadu 600036, India

¹ed18d012@smail.iitm.ac.in | ³akavitha@iitm.ac.in

^{*}Department of Electrical Engineering, Indian Institute of Technology Madras, Chennai, Tamil Nadu 600036, India

²rsarathi@iitm.ac.in

Abstract

Partial discharges (PD) are produced around various defects in dielectric or insulation mediums under high electrical stresses. Timely remedial action can be taken if these discharges are identified at an early stage thereby increasing the life span of the electrical equipment. Ultra high frequency (UHF) antennas are generally used for capturing electromagnetic (EM) emissions from PD as EM wave is insensitive to pressure and temperature variations, propagates through all dielectric medium, enables non-contact measurement and are suited for continuous real time monitoring.

In this work, an array of UHF sensors was used to detect the location of the defect in the insulation. The spectral content of PD signal generally lies in the UHF range with the dominant frequency around 1 GHz. The UHF sensors and PD source were modelled as hertzian dipoles. Swept frequency numerical simulations were converted to time domain to calculate the propagation delay in the received electromagnetic pulses from the PD source. Range of the PD source from the UHF sensor was calculated using the time of arrival measurements. A nonlinear least squares approach was used to estimate the position of the PD source. Results of the source localization algorithm were compared with the true locations of the PD source in the numerical model.

Keywords: Nonlinear Least Squares, Partial Discharge, Time of Arrival, UHF Sensor.

Non-invasive Detection Of Extent Of Corrosion In Steel Reinforcing Bars By Magnetic Force Measurement

Durgesh Tamhane¹, Sauvik Banerjee² and Siddharth Tallur¹

¹Department of Electrical Engineering, Indian Institute of Technology Bombay, Mumbai, India

²Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai, India
stallur@ee.iitb.ac.in

Abstract

We present a simple apparatus to detect extent of corrosion of steel reinforcing bars (rebars) by magnetic force measurement. The apparatus consists of a permanent magnet mounted on a free end of a cantilever beam and two pairs of strain gages attached on top and bottom surfaces at its fixed end. The strain gages are connected in a Wheatstone bridge configuration to detect deformation of the cantilever beam.

When rebars with different degrees of corrosion are scanned using this apparatus, the cantilever deforms due to the magnetic force between the rebar and the magnet. The extent of deformation varies with the magnetic force, which depends on the extent of corrosion of the rebar. While several non-destructive testing (NDT) methods for corrosion sensing exist, they produce a qualitative and probabilistic assessment and cannot be used to quantify the extent of corrosion. Our method is a step towards building a portable sensor whose voltage output directly corresponds to the extent of corrosion. Such a sensor could be used for inspection of old and new infrastructure alike by people without prior training owing to its simple detection mechanism. This technique is non-invasive, physics based (non-black box) and intuitive, requiring minimal operator training thus making it a useful utility for in-field usage by construction workers.

We have validated this apparatus to discriminate between various degrees of corrosion of a rebar of diameter 10 mm. In future we plan to investigate (by simulations and experiments) the statics of this apparatus to further improve the detection process and extend its applicability. This technique holds promise for developing a low-cost NDT technique for in-situ corrosion measurement.

Keywords: Non-destructive testing, corrosion, reinforced concrete beam, magnetic force measurement.

Study of Effect of Surface Roughness in Single Lap Joint (SLJ) of Carbon-Fiber-Reinforced-Polymer (CFRP) Composites using Radiography and Thermography

Mane Laxmikant Sarjerao¹, M R Bhat²

¹Research scholar, ²Chief Research Scientist, Department of Aerospace Engineering
Indian Institute of Science, Bengaluru-560012, India

manel@iisc.ac.in

Abstract

Composite structural components are increasingly used in the aerospace and automobile industry. These components will have joints and assemblies of different parts required to form the final product. Adhesive joints propose merits over conventional method like the riveting or fastening.

Though adhesive joint has advantages over other joining techniques, they cannot be dismantled once manufactured. Many factors affect the strength of these joints such as type of joint, geometric properties, material properties, surface preparation methods and environmental conditions like humidity and temperature. The integrity and strength of bonds need to be evaluated at regular interval without dismantling for inspection. Hence, development of an NDE tool for this purpose is inevitable.

In this study, digital radiography and infrared thermography are used for obtaining the NDE parameters related to the surface roughness that affects the bond strength. The single lap joint coupons were prepared for this study with varied surface roughness. Intensity variation in images of X-ray and the surface temperature profile with respect to roughness of adherend were measured. Details of the experimental investigations and the results obtained are presented in this paper.

Keywords: Composites, Surface roughness, Single lap joint, X-ray radiography, Thermography

Use of Acoustic Emission Technique for Leak Detection in Pressurised Carbon Steel Piping

T.K. Haneef and C.K. Mukhopadhyay

Non Destructive Evaluation Division, Metallurgy and Materials Group, Indira Gandhi Center for Atomic Research
Kalpakkam, Tamil Nadu - 603 102 | e-mail: ckm@igcar.gov.in

Abstract

Acoustic emission (AE) is an online non destructive testing technique which can be used for detection of leak at inaccessible locations of pressurised piping and storage vessels. Acoustic emission is stress wave arising from local energy release within a material such as deformation, impacts, crack initiation and propagation, fluid leakage etc. During leak, the turbulence caused by the flow of a pressurised fluid through an orifice produces stress waves and it propagates through the structure and recorded using acoustic emission sensor placed at accessible locations. This paper present the results of a mock-up study carried out using acoustic emission technique for leak detection in a pressurised pipe made of carbon steel. AE monitoring of the pressurised pipe is carried out with different leak rates. Minimum detectable leak level using AE, effect of variation of pressure on the detectable AE level and frequency analysis of leak AE signals are also addressed.

AE monitoring is carried out on the carbon steel pipe (outer diameter 90 mm and wall thickness 5 mm) with artificial flaws during pressurisation up to 20 kg/cm². For AE monitoring, two resonant sensors (150 kHz) and one wide band sensor (100 kHz to 1 Mz) are placed in the end flanges of the pipe. Threshold of all the AE channels are optimised at 30 dB. AE root mean square (RMS) voltage, cumulative AE count and dominant AE frequency are used for analysis. AE time domain signals generated during different leaks have been compared. AE RMS voltage and cumulative count increase with increase of leak rate and pressure. Frequency analysis of AE signals shows that consistent higher frequency around 590 kHz is dominant along with lower back ground frequency around 100 kHz throughout the leak. Results show that minimum detectable leak rate depend on the flaw size and applied pressure. In this study identified minimum detectable leak rate is 45 ml/min at 9 kg/cm² through 2 mm diameter hole.

Keywords: Non destructive testing, Leak monitoring, acoustic emission, frequency analysis

EMAT Phased array Inspection of Thick Austenitic Stainless Steel and Dissimilar Metal Welds

R. Dhayalan, Anish Kumar and C. K. Mukhopadhyay

Non Destructive Evaluation Division, Indira Gandhi Centre for Atomic Research, Kalpakkam-603 102, Tamil nadu

Email: dhayalanr@igcar.gov.in

Abstract

Nondestructive testing (NDT) of austenitic stainless steel and dissimilar metal welds are important for inspection of main vessel in prototype fast breeder reactor (PFBR). The strong material anisotropy and coarse grain make these welds very difficult to inspect using conventional ultrasonic techniques (UT) employed with piezoelectric transducers. It is well known that the shear horizontal (SH) wave is very well suited for this inspection, and electromagnetic acoustic transducers (EMAT) are the best for generating this wave mode. In order to overcome the low efficiency sound generation due to low conductivity and strong attenuation, an 8-channel EMAT phased array (PA) sensor has been used in tandem mode to enhance the power level and to improve the signal to noise ratio. It generates bulk SH waves with almost uniform amplitude for beam angles from 0° to 90° and can cover the entire volume of the weld including the heat affected zone by scanning from one probe position. In this paper, the EMAT PA probe was used for detection of defects in thick austenitic stainless steel and dissimilar metal mock-up weldments at 600 kHz. It has been successfully demonstrated that the EMAT PA probe can detect 3 mm deep notches and 2mm diameter side drilled hole in 30 mm and 25 mm thick weld pads. The large active aperture allows the use of highly focused beams for good defect detection and high resolution imaging of weld defects. The results obtained from the mock-up samples with artificial defects demonstrate the potential of this EMAT PA probe in laboratory settings and recommendations to transit to actual field are also explained in this paper. Though the exciting frequency of the EMAT PA probe is very low, it offers good defect detection sensitivity in thick austenitic stainless steel and dissimilar metal welds in main vessel of PFBR.

Keywords: Electromagnetic acoustic transducer, Phased array, Shear horizontal wave, Austenitic stainless steel weld, Dissimilar metal weld

Inspection of Misaligned Austenitic Stainless Steel Welds using Single Channel SH wave EMATs

R. Dhayalan¹, K. Arunmuthu¹, B. Maruthan², S. Sudhakar Naik², Anish Kumar¹ and C. K. Mukhopadhyay¹

¹Non Destructive Evaluation Division, Indira Gandhi Centre for Atomic Research

²Quality Assurance Group, Bharatiya Nabhikya Vidyut Nigam Limited, Kalpakkam-603 102, Tamil nadu

Email: dhayalanr@igcar.gov.in

Abstract

inspection of structures with austenitic welds are challenging because of strong material anisotropy and coarse grain size structure in the weld zone. Further, linear misalignment with positive or negative (high or low) weld offsets make this inspection very difficult particularly, identification and location of the defects. Shear horizontal (SH) wave has been recognized as potentially the best solution for this application which doesn't undergo mode conversion at weld boundaries and also has much smaller beam skew effect. In this paper, single channel SH wave electromagnetic acoustic transducers (EMATs) were used for detection of defects in thick austenitic welds with positive and negative offsets. The identical SH wave EMATs were developed by using spiral race coils and periodic permanent magnets with magnet periodicity (wavelength) of 6 mm. The directivity pattern was measured by using a half-cylindrical austenitic stainless steel sample and shown a maximum radiation around $\sim 30^\circ$ at 500 kHz. By utilizing the low beam angle and frequency, thick austenitic welds and misaligned weld with positive and negative offsets were tested by using pseudo pulse-echo technique. In this method, the angle beam SH wave was allowed to make multiple skips far away from the weld center line, so that it could cover the entire volume of the weld including heat affected zone (HAZ). It has been successfully demonstrated that the SH wave EMAT can detect defect of 10% of wall thickness anywhere in the weld including HAZ. The capability of detecting defects from one side of the weld makes the EMAT technique possible to be applied for the situations where there is only one side accessibility.

Keywords: Electromagnetic acoustic transducer, Shear horizontal wave, Austenitic welds, Pseudo pulse-echo technique

Ultrasonic Examination of Hard-Surfacing Overlay in Valve Body Seating Area Using Focused Beam Immersion Technique

Rohit Kumar¹, Raja Chako², Elavarasan.P²

¹Bhabha Atomic Research Centre, Mumbai, India

²L & T Valves, Coimbatore, India

rohit@barc.gov.in, Raja.Chacko@Intvalves.com, Elavarasan.P@Intvalves.com

Abstract

In valve industry, for applications involving high-pressure and high temperature, valve body and plug seating areas are 'hard-faced' to increase wear resistance against repeated cycling under service loads, thereby ensuring superior leak tightness over time. The same is important, more so for valves belonging to various systems of Nuclear Steam Supplying System (NSSS), where 'zero-leak' is the requirement because of considerations typical to a NSSS, like preventing radiation spread to environment and minimal or zero-maintenance need. Hence ensuring quality of hard-face deposit and evaluating its integrity is of utmost importance for overall plant performance and plant availability.

In general, hard-surfacing (wear resistant overlay) is applied to a new part or on a worn-out surface to restore the condition using arc welding process. Commonly used hard-surfacing materials include Cobalt based alloys, Nickel based alloys, NOREM (Fe-based); and optimum alloy selection is done based on working fluid, process parameters & other service conditions. Depending upon valve body configuration, often hard-surface deposition is done in narrow deep groove of valve body. Geometric constraints pose challenges in deposition and moreover in examination of overlay quality. Defect free deposition of hard-surfacing on valve body and plug is important to ensure reliable operation of valve throughout service-life. Lack of bonding of overlay with base material may lead to formation of leak path in manufacturing stage, functional qualification stage or during service-life and increases the maintenance frequency; resulting in plant down-time and plant unavailability.

This paper discuss the methodology developed to carryout ultrasonic examination of hard-surfacing overlay deposited in narrow deep groove of valve body and having limitation in accessibility, using focused beam immersion technique. Though the methodology is evolved for nuclear valves, the same can be adopted to valves, meant for non-nuclear applications as-well.

Key-words: Valve, Ultrasonic, Immersion, Focused beam, Hard-facing.

True 3D Tomography: New Approach for Tomographic Imaging and Evaluation of Ultrasonic Concrete Testing Data

Andrey Bulavinov¹, Roman Pinchuk¹, Andrey Samokrutov² and Viktor Shevaldykin²

¹Acoustic Control Systems – ACS Group Germany

²Acoustic Control Systems – ACS Group Russia

info@acs-international.com

Abstract

The novel technologies in ultrasound generation and data processing offer new opportunities for three-dimensional imaging of concrete structures. Especially the Full-Matrix-Capture (FMC) technique with its real-time imaging capability by Total Focusing Method (TFM) can be successfully used for quality assurance in construction industry.

Although, the available testing instruments on the market implement the principle of linear transducer array with its two-dimensional reconstruction of B-Scan images according to Synthetic Aperture Focusing Technique (SAFT) principle.

The Dry-Point-Contact transducers utilized in commercially available instruments for concrete testing with their matrix-like layout offer direct opportunity to implement three-dimensional Full-Matrix-Capture data acquisition cycle. The obtained data can be in real-time processed in 3D-SAFT reconstruction procedure (3D-TFM) using modern graphic accelerators available in table PCs. This data handling approach can be called “True 3D tomography” as distinguished from the “off-the-shelf” 2D techniques and instrumentation.

In the present contribution experimental results of 3D-FMC data processing and visualization performed on real concrete inspection objects are exemplified and the advantages of true 3D tomography in respect to improved information content and easiness of result interpretation are discussed. The novel hardware platform based on active-DPC transducers and mobile-GPU computation engine for 3D-TFM suitable for “True 3D tomography” is presented.

Keywords: Ultrasonic testing of concrete, 3D imaging, 3D tomography.

Ultrasonics in automobile industry - measuring or testing?

Andrey Bulavinov¹, Roman Pinchuk¹, Andrey Samokrutov² and Viktor Shevaldykin²

¹Acoustic Control Systems – ACS Group Germany

²Acoustic Control Systems – ACS Group Russia

info@acs-international.com

Abstract

Ultrasonics is one of the most applied techniques for the quality assurance in the automobile industry. Although, the technical application rules here differ from those in other fields of industry. Primarily they are driven by enormous high throughput requirements and high integration level of inspection machines into production lines.

In the current contribution, the most typical “facial features” of ultrasonic testing in car production are exemplified by practical application cases, e.g for testing and measuring of motor and gear box parts (pistons, liners, input shafts). Advantages and limitations of regular UT approaches are discussed in a pragmatic and nonfiction way.

Keywords: Ultrasonic testing, Automobile industry

Inspection of Concrete Lined Seawater Carrying Pipeline - A case study

K. K. Rai¹, C. Satheesh², C.G. Karhadkar³

Research Reactor Services Division, Bhabha Atomic Research Centre, Mumbai, India

E mail: kkrai@barc.gov.in, sathee@barc.gov.in, karhadka@barc.gov.in

Abstract

Nuclear Power plants located near seashore uses seawater for cooling purpose. Due to corrosive nature of seawater, concrete or rubber lined metallic pipes are used in seawater cooling system. Research reactors Cirus and Dhruva located in Bhabha Atomic Research Centre, Mumbai also use seawater for cooling purposes. Seawater to the reactors is fed by two concrete lined pipelines of carbon steel of 915 mm internal diameter and one of the lines recently shown signs of degradation. Health assessment of the pipeline and its concrete lining was necessary for planning the repair activities. This paper covers different nondestructive tests carried out on the concrete lined seawater pipe line based on which repair activities were carried out and rehabilitated the pipeline.

Keywords: Concrete lining, Ultra-Sonic Pulse Velocity (USPV) Test, Rebound Hammer Test, Chloride Analysis, Thermography, thickness measurement

Incorporation of Information Technology in The Curriculum in NDT Training to Accomplish Reliability of Automated NDT Result to Detect Key Flaws.

Sujit Chakravarty¹

ASNT NDT Level III, Velosi (M) Sdn. Bhd. No. 6-2, Jalan PJS 8/2. Mentari Business Park, Bandar Sunway, 46150, Petaling Jaya, Selangor, Malaysia. email: sujit@velosi.com

Abstract

Degree of automation in Non-Destructive Testing (NDT) is a reality of today's business. Software applications are continuously developed and applied to different field of NDT methods. This is a futuristic way of doing reliability checks using automated system. The results are key to make variety of decisions with regard to safety and quality of a product or service. Dependency on artificial intelligence, make the NDT training schemes to drive a definitive need of information technology basic knowledge in the curriculum. Human operators are basically depending on the end results of such programmable logic controls. They should know how the programs run, so that in case there is a missed detection or something detected, which is not very much detrimental to the reliability of the part. As an example a set of Alogarithm are used to create the focal laws in a phased array ultrasonic test software in space of each 1° beam steering. It has a limit of maximum up to 2nd Critical angle. Some operators try to copy the same alogarithm and set up to 89° refraction angle, which will just create creep wave with unreliable results. This topic has intended to focus on how to address the training issue related this kind of unreliability.

Key Words: Automation; Software and Artificial Intelligence; Curriculum; NDT Training; Reliability.

Finite Element Simulation of Ultrasonic Waves Interacting with a Corroding Rebar in Concrete

M. Prasanna Kumar and Abhijit Ganguli

Indian Institute of Technology Tirupati, Andhra Pradesh, India-517506 | Email: ce18d003@iittp.ac.in

Abstract

The corrosion of reinforcement has adverse effects on the strength and serviceability of the structure. Since corrosion products are expansive in nature, significant tensile stresses are generated in the concrete leading to cracking, increased chloride and moisture ingress, which results in further degradation of the reinforcement (rebars). Early detection of corrosion of rebars is very useful for taking pre-emptive corrective measures: yet it is quite a challenging task. In the present work, simulation results related to ultrasonic imaging are presented to investigate the potential of the technique for detection of rebar corrosion. A two-dimensional (2D) reinforced concrete (RC) model of size 400 mm × 100 mm is generated in a commercial Finite Element (FE) software. Coarse aggregates of random shapes and sizes are distributed randomly within the concrete model. Numerical simulations of ultrasonic wave propagation in the concrete model with a corroding rebar are conducted. The reflected waves are acquired in the form of B-scans at various corrosion levels starting from preliminary stages of corrosion to an advanced stage.

Keywords: Ultrasonics, Rebar Corrosion, Wave Propagation, Finite Element

Advanced Inspection Technology for Automated NDE Applications

Dr. Christopher Lane¹

1 Olympus Corporation of Asia Pacific, 438B Alexandra Road #03-07/12, Singapore

E: christopher.lane@olympus-ap.com

Abstract

The manufacturers of safety-critical engineering components require high-speed and high-reliability automated inspections to meet their production requirements. Whilst the end-users of these products demand the maximum sensitivity and coverage to ensure the highest safety during in-service operation.

In this talk, the utilisation of advanced NDE techniques to meet these competing demands will be presented. A number of case studies of automated inspection systems for different applications will be discussed. These include: solutions for seamless and welded pipes used in the oil & gas industry; rail track, wheel and axle inspection; and long composite components used in aerospace applications.

There will be a focus on the use of ultrasonic phased array and eddy current array technology for defect detection. Novel methods and data-processing algorithms will be presented which reduce dead-zones, detect defects at a range of orientations, and improve defect characterisation.

In addition, the use of X-ray fluorescence (XRF) technology, to ensure the correct chemical composition of engineering components at high speeds and in a fully automated way will also be presented.

Finally, a key enabler of automation is the ability to create customised software to meet the most demanding inspection requirements. Therefore, the use of software development kits (SDKs), which allow users this freedom, is discussed. It is shown how SDKs facilitates bespoke automated inspection systems; the implementation of advanced data analysis for example using artificial intelligence; and enhanced data visualisation through augmented reality.

Keywords: Industrial Automation; Ultrasonic Arrays; Eddy Current Arrays; XRF; Artificial Intelligence; Augmented Reality

Monitoring and Diagnosis of Thermal Expansion of Rails and Rail Joints Using Piezoelectric Sensor for Electro-Mechanical Impedance Technique

Tathagata Banerjee¹, Lukesh Parida² and Sumedha Moharana³

¹Postgraduate Student, Department of civil engineering, Shiv Nadar University, Dadri, India

²Research Scholar, Department of civil engineering, Shiv Nadar University, Dadri, India

³ Assistant Professor, Department of civil engineering, Shiv Nadar University, Dadri, India

sumedha.maharana@snu.edu.in

Abstract

Indian railway manages the fourth-largest railway network in the world by size, with 121,407 kilometers of total track over a 67,368-kilometre route. Most of the railway tracks in India have joined by bolted and large welded joints. Rails experience tensile stress in extreme heat from climate and friction and undergoes in excessive compressive stress while shrinkage, can even cause a buckle if the force grows too strong. It has a high chance to derailment of the railway tracks. Hence, It is very significant know the onset of thermal buckling due to excessive and fluctuate thermal stress. This paper aims to study the experimental thermal stress variation in rail and rail joints using both ESG (electrical strain gauges) and piezoelectric sensors. The electro-mechanical impedance techniques has employed to monitor the thermal stresses in bolt joints and continuous weld joints in rails. The experimental conductance signatures were plotted for incremental thermal loading and statistical interpretation of dynamic signature has computed for quantitative damage indication. The piezo coupled signature obtained from impedance based structural health monitoring shows satisfactory results in accordance elastic thermal deformation. This study also attempts to monitor the residual stresses in weld and bolt area.

Keywords: Thermal stresses, PZT patch, electro-mechanical impedance technique, rail, rail joints

Phased Array Ultrasonic Testing (PAUT) Is An Apt Tool For Reliable Integrity Assessment Of Aerospace Parts And Systems

Manu JOSEPH¹, Ankita DUBEY², Swarup POTTA³, Chuna Ram DHATERWAL², Parveen MOR¹ and M ARUMUGAM¹

¹Quality Control and Non-destructive Evaluation Group,

²Systems Reliability – Earth Storable Engines and Stages Group
Systems Reliability and Quality Assurance Entity,

Liquid Propulsion Systems Centre, Indian Space Research Organisation (ISRO),
Thiruvananthapuram-695547, Kerala, India.

³Safety, Reliability and Quality Entity, Human Space Flight Centre, Indian Space Research Organisation (ISRO),
Bangalore, India | E: m_arumugam@lpsc.gov.in

Abstract

Ultrasonic testing (UT) plays a vital role in determining the integrity of a part or a system used in Aerospace applications. Conventional UT is presently deployed due to its easiness in operation and lack of expertise at Industries. But due to its potential advantages, Phased Array Ultrasonic Testing (PAUT) is extensively replacing Conventional UT and Radiography Testing (RT) also. Conventional UT transducers uses either single or twin crystals whereas PAUT transducers consists of 16 to as many as 256 small individual elements that can each be pulsed separately. This paper explains how the enhanced reliability of Phased Array Ultrasonic Testing (PAUT) could be exploited for defect detection, analysis, and subsequent integrity assessment of raw material and welded pressure vessels used in ISRO's launch vehicle programme. The beam steering, beam focusing and electronic raster capabilities of PAUT can effectively be utilized towards this objective. In order to demonstrate this, two typical aerospace applications are chosen. Firstly, PAUT for inspection of M250 grade Maraging steel plates of 8mm thickness that are used for the manufacture of first stage solid propellant motor casings and secondly, PAUT, as a substitute for conventional UT and RT, for the inspection of TIG welds of AA2219 aluminium alloy propellant tanks used for the upper stages of Polar Satellite Launch Vehicle(PSLV) are discussed. The enhanced reliability of PAUT in both applications were demonstrated by comparing results obtained from natural defects by PAUT, conventional UT and RT.

Keywords: PAUT, Reliability, Aerospace, conventional UT, Maraging steel, Aluminium alloy AA2219

Computed Tomography (CT) Is An Asset To Ensure The Quality And Reliability Of Parts In Aerospace Applications

Manu JOSEPH¹, M ARUMUGAM¹, Regi VARGHESE¹ and G NARAYANAN²

¹Quality Control and Non-destructive Evaluation Group,

²Systems Reliability and Quality Assurance Entity,

Liquid Propulsion Systems Centre, Indian Space Research Organisation (ISRO),
Thiruvananthapuram - 695 547, Kerala, India. | E: m_arumugam@lpsc.gov.in

Abstract

The quality of parts, before they are used in space applications, are to be essentially certified for its dimensional correctness and freedom from defects. This is achieved by means of extensive Metrology Inspection and defect detection/analysis through Non-destructive Evaluation (NDE). But it is widely known that traditional Metrology and Radiography evaluation have certain limitations. Computed Tomography (CT) is best suited to overcome all limitations of the conventional techniques as it has the unique capability of performing simultaneous NDE and non-contact metrology in a single scan. Its superlative imaging capability allows for one-to-one reconstruction of the scanned object into an accurate and precise 3D model. From the reconstructed model, it is possible to extract any dimensional information of external/internal features including details of defect, its location and severity. Through CT, the quality of inspection data available for interpretation can be improved substantially, thereby increasing the reliability of existing inspection activities. Unlike Radiography, a reconstructed CT model can be viewed across any virtual plane based on requirement which further facilitates faster decision making and validation. This paper describes the novel inspection activities performed with the aid of CT on launch vehicle components and parts at ISRO. Four cases of NDE, followed by two unique cases where CT was used for failure analysis (FA) of assembled components and few cases of dimensional metrology are discussed. The merits of using CT in aerospace industry are also discussed.

Keywords: CT, Dimensional Metrology, Defect analysis, NDE, Failure analysis, Launch Vehicles

Implementation of Acoustic Emission Testing to Study the Type of Cracking in Reinforced Concrete Beams

Swarnangshu Ghosh¹, Rithik Agrawal¹ and R. Vidya Sagar²

¹Department of Civil Engineering, National Institute of Technology, Surathkal- 575 025, India

²Department of Civil Engineering, Indian Institute of Science, Bangalore 560 012, India.

swarnangshughosh.171cv146@nitk.edu.in

Abstract

In this experimental study, crack classification in reinforced concrete (RC) beams was carried out using acoustic emission (AE) testing subjected to four-point bending flexural test and monotonically increasing load was applied. Gaussian mixture modelling (GMM) of acoustic emission signals was performed. The generated AE during fracture process in the tested RC beams in laboratory was used for the analysis. A Gaussian mixture model is a type of probability model which is used to group a big data-set into numerous clusters which also follow Gaussian distribution. Two kinds of under-reinforced RC beams were tested. The first type of RC beam had shear reinforcement and the second type of RC beam had no shear reinforcement. The GMM code was developed using MATLAB programming. It was observed that the RC beam without shear reinforcement failed suddenly (brittle nature). However, the RC beam with shear reinforcement failed gradually thereby exhibiting ductile nature. In both the RC beams, considerable AE related to shear cracking appeared at 20-30% peak load. In case of the RC beam with shear reinforcement, initially tensile cracks were developed at the bottom of the beam and slowly started widening upwards. Diagonal shear cracks also started forming at the supports when the test specimen was nearing collapse. In case of the RC beam with no shear stirrups, tensile cracks originated at the bottom of the beam. But in this case the effect of shear cracks which occurred at the supports was more pronounced as it propagated rapidly. By comparing the results for different AE parameters, a steady increase in the number of hits till failure was observed in the case of the beam with shear reinforcement. But on the other hand, an abrupt increase in the number of hits was observed after 50% of peak load in the case of RC beam with no shear reinforcement. AE testing is useful to study the crack classification in RC structures.

Keywords: Acoustic emission; Fracture; Reinforced concrete; Crack type; Probability.

Prediction of Failure Process in Geo-Material Using Finite Element based Digital Image Correlation (DIC) Method

Chamanth Sai Reddy¹, Debasis Deb¹

¹Dept of Mining Engineering, IIT Kharagpur, India | chamanthsai.biit@gmail.com

Abstract

Digital Image Correlation (DIC) is a non-contact measurement technique, uses digital images and computational algorithms to measure full displacement fields on the surface of the test object. The surface should be randomly speckled to get accurate displacements. A finite element based digital image correlation (FEM-DIC) algorithm is developed by integrating finite element framework into image correlation process using law of conservation of optical flow. This algorithm is employed for monitoring the deformation process of a concrete cube under laboratory conditions using in-house developed DIC hardware. The full-field displacement plots of experiments, show that DIC can predict the location of crack formations on the surface of the cube well ahead of its visible cracks. DIC can provide new insights into crack propagation as the displacement data is collected continuously during loading and all over the surface. DIC technique have potential applications in structural health monitoring of aerospace, civil, mining structures.

Key words: - DIC (Digital Image Correlation), FEM (Finite Element Method), Crack formation, Non-contact, Structural Health Monitoring

A Non-destructive Approach of Dynamic Characterization of CFRP Composite Material Subjected to Hygrothermal Ageing

Nilesh Bagale¹ and M R Bhat²

^{1,2}Department of Aerospace Engineering, Indian Institute of Science, Bengaluru-560 012, India | mr@iisc.ac.in

Abstract

Hygrothermal ageing is known to cause serious degradation in physical and mechanical properties of composite materials; in turn, altering its dynamic properties. This alteration brings out variations in the dynamic response of composite structure. The evaluation of dynamic properties over a period of time is a vital but demanding task. In this regard, non-destructive techniques can be economic and time-saving in estimating dynamic characteristics of aged composite materials. In this study, carbon fibre reinforced polymer (CFRP) composite material was under consideration. CFRP laminates were fabricated by hand lay-up using vacuum bagging process. The HT-ageing in CFRP was induced and accelerated by immersing specimens in a hot water bath at 80°C for different durations up to 500 hours. Further, free vibration analysis and ultrasound scans were performed at different exposures of ageing to obtain a correlation between damping characteristics and the attenuation coefficient of CFRP subjected to HT-ageing. Based on the findings, ultrasound technique has shown good potential in estimating damping characteristics of CFRP composite material.

Keywords: Hygrothermal ageing, Composite, NDE

Adiabatic Guided Wave Propagation Through a Honeycomb Composite Sandwich Structure with Smoothly Varying Core Thickness

Aurovinda Kumar Mitra^{1*}, Aparna A. Aradhya² and Dhanashri M. Joglekar¹

¹Department of Mechanical and Industrial Engineering, Indian Institute of Technology Roorkee, Roorkee 247667, India.

²Structural Life Monitoring Group, Structural Technologies Division, CSIR-National Aerospace Laboratories(NAL), Bangalore-560017, Karnataka, India

*aurovindamitra9@gmail.com

Abstract

Guided wave based techniques for the non-destructive evaluation of Honeycomb composite sandwich structures (HCSS) with constant thickness have been explored by the researchers since the past couple of decades. In actual practice, the sandwich structures which find their applications in automotive, marine and aerospace industries, are complex in design and have their core thickness varying smoothly. As the knowledge of guided wave propagation in HCSS with symmetric taper is in its nascent stage, this has triggered an interest in investigating the wave propagation phenomenon and analyzing the variation of guided wave characteristics with core thickness variation.

In the present study, a finely meshed three-dimensional finite element(FE) model of a HCSS has been simulated numerically using ABAQUS/Explicit. The model constitutes a lightweight Honeycomb core made of Nomex (a synthetic fiber of Aramid class) which is sandwiched between two thin and stiff Aluminium skin panels. The concept of ideal bonding (pin-force model) has been employed for introducing the transient excitation. The loading condition of A0 mode has been ensured by employing an out of plane input force in same direction at the top and the bottom circular areas (6.35 mm diameter). For the wave propagation analysis, two central frequencies of 40 KHz and 100 KHz in three different models with taper ratios of 1, 0.5(Taper angle=0.8deg.) and 0.33(Taper angle=1.01deg.) has been modelled.

The variation of wavefield pattern has been observed when the thickness of HCSS varies from being constant to linear. Further, it has been observed that the wave characteristics such as the wavelength and wave number change with varying taper ratio ascertaining the adiabatic (A0 mode) behavior of the propagating guided wave.

Keywords: Honeycomb core sandwich, smoothly varying core thickness, adiabatic A0 mode, FE simulation

Visual Detection of Defects in Ferromagnetic Steels Using Magnetic Nano-emulsions

Manali Nandy*, B. B. Lahiri and John Philip

Smart Materials Section, Corrosion Science and Technology Division, Metallurgy and Materials Group, Indira Gandhi Centre for Atomic Research, HBNI, Kalpakkam, Tamil Nadu, PIN 603102, India

* Corresponding author email: manali@igcar.gov.in

Abstract

Magnetic flux leakage (MFL) is one of the popular non-destructive testing (NDT) for defect detection in ferromagnetic materials, machineries and components in various industries. The most widely used magnetic flux leakage sensors are Hall probes and giant magneto-resistance sensors, which are localized and raster scans are required for wide area inspections. Here, we describe a non-invasive technique for fast optical detection of defects in ferromagnetic steels, using oil-in-water magnetic nanoemulsions (MNE). The location, dimension and morphology of the defects are accurately measured using this technique, which is readily adaptable for wide area inspection. Analytical dipolar model is used to predict the leakage components of the magnetic flux. In the present study, the measurement sensitivity was improved by stabilizing the MNE droplets with 155kD PVA-Vac copolymer. Experiments were performed on mild steel specimens with rectangular and circular defects.

In the presence of an external magnetic field, the MNE droplets (size ~ 250 nm) formed linear chain like structures due to head-on aggregation along the direction of the external magnetic field, with progressively diminishing inter-droplet spacing with increasing magnetic field amplitude. Such magnetic field induced disorder-to-order transformation resulted in the use of magnetic nano-emulsion thin films as novel sensors for defect detection in ferromagnetic steels. Near the defect edges, the normal component of leaked magnetic flux was the highest, which caused the droplets to move towards the edges from the central region, thereby creating a variation in the interdroplet spacing that manifested as distinct colour patterns, which were optically discernible. The defects were accurately localized using the magnetic nano-emulsion thin films and digital images were recorded, which were then processed to obtain the intensity profiles that provided information on the size and morphology of the defects. Comparison of these profiles with those obtained from magnetic Hall probe and Uetake-Saito dipolar model showed the efficacy of magnetic nano-emulsion based thin film sensors for fast, accurate and wide area defect detection in ferromagnetic steels.

Keywords: Magnetic nano-emulsions, Superparamagnetism, Magnetic flux leakage, Optical sensors and Ferromagnetic steels

Estimation of Degree of Moisture Saturation in Cement Concrete Using Electrical Response at Low Radio Frequencies

Gopinandan Dey¹, Abhijit Ganguli² and Bishwajit Bhattacharjee³

¹National Institute of Technology Agartala, Tripura, India-799046

²Indian Institute of Technology Tirupati, Andhra Pradesh, India-517506

³Indian Institute of Technology Delhi, New Delhi, India-110016

Email: gopinita@ymail.com; abhijit.ganguli@iittp.ac.in

Abstract

Presence of moisture in the cement based materials (CBM) is the primary cause of deterioration which makes determination of the moisture content an important necessity with regard to health monitoring of concrete structures and characterization of the CBM. The moisture content in CBM is often quantified in terms of the degree of saturation (DoS) which is one of the controlling parameters of the transport phenomenon with implications on durability of the CBM. In this work, a novel electrical technique is proposed for quantification of DoS in cement concrete. Concrete samples of various water to cement ratio (w/c) and dimensions of 75 mm x 75 mm x 300 mm are embedded with electrodes for multiple measurements along the sample length. The AC voltage input are applied at radio frequencies (RF) ranging from 100 kHz to 500 kHz; the variation of the real and imaginary parts of output to input voltage ratio along the length of the sample are investigated with the DoS being homogenized along the sample through treatment in the climate chamber. The electrical responses, measured at various levels of DoS, are found to follow a systematic pattern and a geometric parameter related to the polar plot is presented as an empirical measure of the DoS.

Keywords: Cement concrete, Degree of saturation, Voltage ratio, Radio frequency, Angular parameter

Pore Evaluation and Distribution in Cement Mortar Sample Using Digital Image Processing

Sreelekha Gargepuram¹ and Sumedha Moharana

¹ Undergraduate Student, Department of civil engineering, Shiv Nadar University, Dadri, India

³ Assistant Professor, Department of civil engineering, Shiv Nadar University, Dadri, India

sumedha.maharana@snu.edu.in

Abstract

Porosity plays a significant role in concrete strength and durability. It also imparts the randomness in paste and aggregate bonding in cement concrete composite. The paper presents the optical evaluation and analysis of pores in cement mortar sample. The analysis has done by through microscopic images of a thin section of the cement mortar obtained by optical microscope. The mortar samples were prepared by varying its water-cement ratio, different batching process and substituting supplemental cementitious material. The microscopic images have processed through ImageJ software for pore size evaluation and its distribution the surface of cement mortar sample. The classification of pores has made based its size and their formation for different water cement ratio, batching process, usage of cementitious material. The overall results obtained through optical evaluation has satisfactory variation and significant in order to understand the progress of hydration and its conducive properties through non-destructive ways

Keywords: Cement mortar, pores, optical evaluation, image processing, hydration

Rapid Non-destructive Evaluation of Fireproof Coating Degradation using Terahertz Line Scanner

A. Mercy Latha¹, A. S. Nirmala Devi^{1,2}, Harikrishnan Kaimal³ and Bala Pesala^{1,2}

¹CSIR-Central Electronics Engineering Research Institute, CSIR Madras Complex, Chennai, India

²Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India

³Indian Institute of Technology Madras, Chennai, India

E: balapesala@gmail.com

Abstract

To facilitate uninterrupted operation at elevated temperatures, aero engines and gas turbine engines are coated with heat resistant or fireproof paints. Early detection of coating/paint degradation is extremely important for their efficient operation. Traditional ultrasound technique requires proximity and a coupling fluid for NDE of these materials which is cumbersome in field applications. Terahertz (THz) non-destructive evaluation (NDE) is emerging as a potential non-contact technique capable of revealing details about small defects, delamination and moisture ingress with significant contrast. However, in conventional single emitter-detector configuration, image acquisition speed is greatly limited by the speed of the mechanical stages required to perform the raster scan. Recent advances in THz detector arrays have enabled realization of rapid THz NDE systems.

In this work, rapid NDE of coatings using THz line scanner has been studied by identifying the coating degradation in terms of cracks, delamination and moisture ingress. The imaging setup consists of a high-power 100 GHz IMPATT diode source and line scanner with 256 individual GaAs based detectors. This system acquires the images rapidly as the sample is moved across the line detector yielding a maximum imaging speed of 5000 lines/second.

Multiple defects in terms of cracks separated by more than 3 mm have been successfully resolved. It has been observed that better defect resolution has been obtained when the defect is parallel to the THz source polarization for defects of size comparable to the wavelength. On the contrary, for smaller subwavelength defects, better resolution has been attained with perpendicular THz polarization. In addition, precise detection of several layers of simulated delaminations of depth $\sim 150 \mu\text{m}$ each, has been possible with the line scanner. Further, areas of moisture ingress have been identified with distinguishable contrast and low probability of false alarm with parallel THz polarization. The total image acquisition time for a coating sample of dimensions 90 x 60 x 6 mm³ is ~ 5 s, which is >1000 times faster than the conventional raster scan configuration.

Keywords: THz non-destructive evaluation, coating delamination, terahertz line scanner, moisture ingress, cracking

Study Of Ultrasonic Weld Application using Total Focusing Method (Each Word Initial Capitalized, Centered Text, Arial 14 Bold)

Anandamurugan S¹, Lalith Sai Srinivas Pillarisetti²

¹BHGE Inspection Technologies, JFWTC, 122, EPIP, Ph 2, Whitefield, Bangalore, India

²Indian Institute of Technology, Hyderabad, India

E: anandamurugan.s@bhge.com | me15btech11026@iith.ac.in

Abstract

Ultrasonic imaging has been a prominent Non-Destructive testing method that has been widely employed in industries for estimating the structural integrity of the component. Advance Ultrasonic imaging technique such as Total Focusing Method (TFM), which utilizes a Full Matrix Capture (FMC) of A-Scan data of all the phased array elements and focusses on every pixel of the region of interest is studied for weld application. Full matrix data is procured from the ultrasonic instrument and post processed the data to get TFM image.

Shear wave probe is used to study the FMC-TFM technique for different type of weld defects. The wide possibility of wave mode conversions in FMC-TFM imaging and its implications are analyzed. In this paper we have discussed in detail about the different mode combination-based weld images using total focusing method that are relevant for weld inspection and the challenges on interpretation of weld defects are discussed in detail.

Keywords: Full Matrix Capture (FMC), Total Focusing Method (TFM), Ultrasonic TFM Weld, Ultrasound Imaging, Phased Array UT

Rapid Terahertz Non-destructive Evaluation of GFRP-wood Sandwich Composite using Adaptive Sampling Technique

Harikrishnan Kaimal¹, Nirmala Devi^{2,3}, Prabhu Rajagopal¹, Krishnan Balasubramaniam¹ and Bala Pesala^{2,3}

¹Indian Institute of Technology Madras, Chennai, India

²CSIR-Central Electronics Engineering Research Institute, CSIR Madras Complex, Chennai, India

³Academy of Scientific and Innovative Research, CSIR-SERC, Chennai, India

E: balapesala@gmail.com

Abstract

Sandwich structured composite typically consists of a light-weight core sandwiched between two surfacing plates, known as skin, which is held together by a binding material such as epoxy. Glass Fiber Reinforced Polymer (GFRP) - Balsawood sand composite is widely used for renewable energy structures, such as wind turbine blades. Terahertz technology has emerged as a competent Non-destructive Evaluation (NDE) methodology because of its unique property of being transparent to non-metallic substances such as GFRP-wood composite structure. THz waves offer better spatial resolution than microwaves and unlike ultrasound do not require spatial proximity and a coupling medium for best performance.

Typical THz imaging systems employ coherent detection technique combined with raster scanning of the sample to acquire the image. Such imaging modalities significantly limit the image acquisition time. This problem can be overcome by using an array of detectors or an unconventional source array with each source element modulated at a different source frequency. In such imaging setups, the superior detector sensitivity, simplicity and spatial coherence of the point source transmitter are lost. Further, these systems are more expensive than a conventional single transmitter-detector imaging system. Thus, for time critical applications, a rapid image acquisition system becomes crucial for real time NDE.

In this paper, we employ an incoherent detection scheme using ultrafast Schottky receivers combined with a spatial adaptive sampling technique for NDE of GFRP-wood sandwich composite. In this technique, regions of interest (ROI) containing defects are extracted from an initial coarse scan by an intensity-based threshold and more sampling points are added to the ROI in the subsequent high-resolution scans. This adaptive procedure is repeated till the targeted sampling resolution is achieved. This results in the reduction of the total sampling points and hence the image acquisition time. Imaging studies are carried out using a Continuous Wave (CW) THz system in transmission mode at a frequency of 0.2 THz. Prior to imaging, the setup is characterized by evaluating the Full Width Half Maximum (FWHM) of the THz beam at the focus which is found to be 1.8 mm at 0.2 THz. The GFRP-wood sandwich composite of thickness 12 mm consists of holes of diameter 5 mm, 4 mm, 3 mm and 2 mm respectively. The adaptively sampled THz image obtained at 0.2 THz shows the smallest hole of 2 mm diameter with good contrast. Compared to the conventional raster scanning technique, a 60% reduction in image acquisition time was achieved using the adaptive sampling technique while maintaining the image quality.

Keywords: FRP Composite, Rapid THz Imaging, Adaptive sampling, Continuous Wave THz system

POD Studies of Axial and Radial type Receiver Coils in Remote Field Eddy Current Technique

T. Vijayachandrika¹, S. Thirunavukkarasu², B. Purna Chandra Rao³

¹Homi Bhabha National Institute, IGCAR, Kalpakkam. TN, India 603102

²Non Destructive Evaluation Division, Kalpakkam, TN, India 603102

³Fast Reactor Fuel Cycle Facility, IGCAR, Kalpakkam, TN, India 603102

Email: sta@igcar.gov.in

Abstract

Remote field eddy current (RFEC) technique is used for inspection of large diameter thick, ferromagnetic pipes and tubes. RFEC technique uses a send receive internal probe working at low frequency sinusoidal excitation. The manifestation of through transmitted magnetic fields (due to eddy currents in the tubes wall) interacting with the receiver coil are measured and correlated to flaws or wall-loss present in the tube. In general, an exciter-receiver separation of approximately 2-3 times of inner diameter (ID) of the tube is maintained, to attenuate the direct fields and capture the indirect fields which contains the information of both internal and external surfaces of the tubes. Traditional RFEC probe uses circumferentially wound exciter and receiver coils. This results in the poor detection of localised flaws. Localised and segmented type receiver coils are promising for improved detection sensitivity and enable imaging of flaws.

This paper reports the results probability of detection (POD) studies of radial and axial type segmented receiver coils of an RFEC probe, using CIVA software based semi-analytical modelling. Prior to the POD studies, the RFEC zone for a modified 9Cr-1Mo tube of outer diameter 17.2 mm and thickness 2.3 mm for these two receiver coil configurations has been identified. The above studies revealed that the RFEC zone for the radial and axial receiver coils are different and are found to be 30mm and 35 mm respectively. This difference is mainly due to different type of flux linkage in these coils. In order to obtain the POD estimates, the model predicted RFEC signals for flaws of different dimensions (length, width and depth) and orientation (axial and circumferential) were analysed. A threshold flaw amplitude value of 0.3mV volts was set to determine the detection of flaws. Total 272 flaws on the inner and outer wall of the tube were taken with varied dimension. The POD estimate for the radial coil was found to be 42% as against 23% for the axial coil. Detailed investigations also revealed that the axial coil exhibit better sensitivity for external flat bottom hole type flaws and the radial coil show better sensitivity for axial and radial cylindrical notch type flaws. Thus, the paper essentially proposes the use of both the axial and radial type receiver coils and also recommends a staggered arrangement of the coils taking advantage of the RFEC zones of these two coils, for enhanced detection of all possible types of flaws. This paper also reports the future studies planned to combine the collective response of both the receiver coil types using an image fusion based approach.

Keywords: Probability of detection (POD), Eddy current, Tube testing, Modelling.

Non-destructive test for Detection of Magnetite deposits in Stainless steel tube bends of Steam Generating stations

M. Janardhana¹, Arvind Kumar² and Dr. R.K.Kumar³

Materials Technology Division, Central Power Research Institute, Bengaluru-India

janrdhana@cpri.in, arvind@cpri.in & rkumar@cpri.in

Abstract

The steam generating supercritical boilers tubes like super heater, reheaters are constructed with austenitic stainless steel . These tubes are operating above 540oC temperature. At this high temperature the stainless steel tubes inner surface produce magnetite. When boilers taken shutdown, the magnetite layer dislodge from the tube surface, exfoliate and accumulate in the lower bends. The magnetite scales if not removed during shutdown will obstruct the free flow of steam, which leads to overheating and rupture of the tubes. A Nondestructive testing (NDT) method using non-contact probes helps in identifying the tube bends having magnetite deposits and quantification of percentage of blockage can be arrived to minimize the forced outage of power plants. Based on the signal pattern of wet & dry magnetite and our experience with LFET technique with non-contact probes can pin point the location of magnetite deposit and its percentage blockage are discussed in this papers.

Keywords: Super heater, Re-heater, Magnetite, Non-destructive Test (NDT), LFET, Non-contact probes.

In-situ Metallography a NDE Tool for Remaining Life Assessment of High Temperature Thick Section Boiler Components

M Venkateswara Rao¹, K T Varughese² and M Janardhana³

^{1,2,3}Central Power Research Institution, Prof. Sir C V Raman Raod, Sadashivanagar, Bangalore, India

mvrao@cpri.in

Abstract

Boiler is a key system in thermal power plants to produce the steam at required high pressure, temperature and flow for running a steam turbine to generate electric power. Boilers consist of various components such as tubes, pipes, headers, valves and they are exposed to high temperatures during operation. Different materials such as carbon steels, low alloy steels and stainless steels are used in boilers depending on the temperature exposure. Due to continuous exposure of high temperatures and pressures, the low alloy steel components undergo creep-metallurgical deformation. Accelerated stress or creep rupture tests are used to calculate the remaining life of components. These tests are limited to boiler tubes, as tube samples can only possible to draw from boiler. Whereas in thick section components like super heater headers and pipelines, sampling is not possible (impractical) due to non-availability of huge spare components. In-situ metallography is a Non Destructive Evaluation (NDE) tool to assess the metallurgical degradation in high temperature components and further it can help in calculating the remaining life by Neubauer Wedel structural cavity classification method.

In this paper, test results are discussed for in-situ metallography carried out in high temperature super heater headers of a 500 MW boiler. The operating parameters of 500MW capacity boiler are - steam flow : 1675 t/hr, pressure : 178 kg/cm² and temperature : 540 OC. In-situ metallography was carried out at different spots of base & weld metal of platen super heater inlet and outlet headers. The microstructure developed on the components was transferred to a thin film and preserved for laboratory microstructural analysis at higher magnification. Inlet header of platen super heater revealed microstructure as undamaged level of degradation and the outlet header revealed 'A' level of degradation. Remaining life was calculated based on structural cavity classification method and estimated that there is a remaining life of around 6 lakh hours and 1 lakh hours respectively for undamaged and 'A' level degradation. The recommendation given was for re-inspection by in-situ metallography after 5 years of service to monitor the level of degradation and take further preventive actions.

Keywords: In-situ metallography, Boiler components, Super heaters, Creep, Remaining life.

Uncertainty in Hardness Measurement of hard faced FBR components

Alka Kumari¹, G.Ramesh¹, S.Athmalingam¹, Dr.B.Venkatraman¹

¹Quality Assurance Division, SQ&RMG, IGCAR, Kalpakkam, India. Email : alka@igcar.gov.in

Abstract

In most of the FBR components, Nickel based hard facing of Colmonoy overlay has been selected for better wear resistance for high temperature application and to avoid the self welding of mating parts during service. Hardness Measurement is a mandatory requirement to ensure the effectiveness of the overlay during various stages of Colmonoy deposition process and also during the heat treatment as per the approved procedure. But, in case of Colmonoy deposition on large Reactor components, conventional indentation hardness test cannot be applied due to large size of component and destructive in nature and also it introduces deeper indentation mark. Hence portable hardness test using Leeb hardness measurement method is a viable option. Since Leeb hardness Testing method measures surface hardness in Leeb scale and it has to be converted in Rockwell C scale to ensure specification requirements. In most of the components, the over-layed thickness will be 1.5mm to 2mm. Error during conversion of its value may leads to reduce the accuracy of actual hardness of larger components.

In order to estimate this uncertainty, A Comparative study was conducted by measuring hardness value on a reference sample machined to various thicknesses and simulated to the same deposition and heat treatment processes. Hardness of this sample was measured using insitu and conventional hardness methods at varying thickness and compared. This paper discusses the test results of both methods and uncertainty of these measurements to ensure specification requirements of large reactor components. The study had given valid information for improving confidence and helps to standardize the test procedures for Leeb based portable hardness measurement.

Keywords: Leeb Hardness, Colmonoy overlay, Rockwell hardness, uncertainty.

Numerical Modeling of Remote Field Eddy Current Testing of Steam Generator tubes

Ranjani Jayaraman¹, J. Selva Solomon², N. Sridhar², C.V. Krishnamurthy³ and Kavitha Arunachalam¹

¹Department of Engineering Design, Indian Institute of Technology Madras, Chennai, India

²Electronics and Instrumentation Division, IIG, IGCAR, Kalpakkam

³Department of Physics, Indian Institute of Technology Madras, Chennai India

akavitha@iitm.ac.in

Abstract

Remote field eddy current (RFEC) testing is widely used for inspection of magnetic tubes. Steam generators (SGs) used in power plants have several hundreds of ferromagnetic SG tubes which are periodically inspected using non-destructive test (NDT) methods. Pre-service and in-service inspections of these magnetic tubes are carried out using RFEC technique for plant safety and structural integrity. In this work, electromagnetic properties of the SG tube are determined by comparing the experimental and the numerical results for the induced voltage in the pickup coil. SG tube of 12.6 mm inner diameter and 17.2 mm outer diameter is modeled using finite element method (FEM) based simulations for defects referred from ASTM SE – 2096 standard. The inspection frequency was set as 800 and 1100 Hz and 3D numerical model was developed for the SG tube and RFEC coil parameters to model the measurement setup in the laboratory. The material properties of the tube such as magnetic permeability and electrical conductivity were varied for the expected range and simulation results were compared with measurements for model validation. Good agreement was obtained between simulation and experimental results for SG tube electrical conductivity of 2 MS/m and relative magnetic permittivity of 30. The numerical model was carried forward to analyse the influence of surrounding SG tubes on defect detection. This is investigated for a SG tube surrounded by six neighboring SG tubes equally distributed at a distance of 15 mm from the centered SG tube. The influence of the neighboring tubes on the voltage induced in the pickup coil was studied for single SG tube and SG tube surrounded by six neighboring SG tubes in the presence of defects of varying depths. 3D numerical results indicate that the RFEC signals are perturbed in the presence of neighboring magnetic tubes and needs further investigation.

Keywords: eddy current testing, ferromagnetic tubes, magnetic field coupling, remote field eddy current, steam generator tube

Quality Assurance during Construction of Reinforced Concrete Raft Using Flowing-Concrete

G.Srinivasan, R. Magesh, P.Rajasekar, V.Venkatachalapathy, L.Davy Herbert, B.P.C Rao

Fast Reactor Fuel Cycle Facility, Indira Gandhi Centre for Atomic Research, Kalpakkam, TN – 603 102, India

e-mail: vpathy@igcar.gov.in

Abstract

Fast Reactor Fuel Cycle Facility (FRFCF) under construction at Kalpakkam, Tamil Nadu houses plant buildings for reprocessing of spent fuel discharged from PFBR, fuel fabrication as well as waste management. FRFCF being a coastal site, it is essential to ensure stringent quality assurance measures at all stages of raw material qualification, concrete mixture design, pre and post construction quality management to meet the requirements of intended strength, serviceability, radiation shielding and immunity to ground water ions diffusion. The role played by QA is vital during civil construction of these plant buildings.

Flowing Concrete (FC) with less than 500mm flow is an emerging cementitious mixture for construction of thick slabs and rafts with congested reinforcements. High flow self-consolidated mixtures (700-800mm slump flow) can spread faster during concreting of horizontally spread members and can impose cold joint risks. Therefore, rate of pouring has to be regulated to avoid formation of cold joints between the spreading fronts. During construction of rafts with congested reinforcements, restricting the mixture flow is economical than enhancing the inventory of concrete manufacturing and placing. This paper presents design and deployment of an effective quality assurance plan covering material selection, qualification, flowing concrete mixture design and pre & post construction incorporated for construction of a cementing cell unit of waste management plant (WMP) building of FRFCF.

This paper covers mixture proportion, fresh and hardened state properties, chloride permeability behaviour and field quality assessment of fly-ash blended M40 grade FC developed for construction of 750 mm thick raft of 8.5 x 35 m² size. Apart from pre-placement FC mixture qualification, effect of aggregate settlement due to applied minimal needle vibration was examined in a mock-up raft. Post construction surface finish and core samples along the depth of mock-up raft, destructively as well as non-destructively, confirm that evenly distributed density and consistent concrete strength can be achieved using very low permeable concrete. The studies confirm the adequacy of the QA plan evolved for flowing concrete for construction of rafts with congested steel reinforcement.

Keywords: Quality Assurance, Civil Construction, Flowing Concrete, Ultrasonic Pulse Velocity.

NDT IN MRO OF AERO-ENGINE COMPONENTS AT MILITARY AVIATION INDUSTRY

Abinash Behera

Manager (NDT and Inspection), Sukhoi Engine Division, HAL, KORAPUT, Working Professional

Abstract

NDT plays an important role in today's aviation industry as the requirements for quality, sustainability, serviceability, and safety are becoming more stringent and harder. Both military and civil aero-engine components are subjected to NDT in the various stages of manufacturing and overhaul as it is a vital parameter of their air worthiness. Military aero-engine parts are examined by NDT during MRO at approved firm premises. DDPMAS and AFQMS prescribe the procedure for approval of NDT facilities and personnel. Various regulatory bodies like DGAQA, CEMILAC, and DGCA are issuing time to time modification for the above requirements.

During scheduled maintenance, non-destructive testing (NDT) is one of the quickest, most economical ways to perform inspections, and the only way to discover defects that are not visible to the naked eye. NDT is used to find flaws on and under the surface, as well as to detect leaks, determine the location of structural deficiencies, and determine dimensional measurements.

Since most of the military aircraft technology in INDIA are based on TOT platform from countries like RUSSIA, USA, UK, FRANCE etc, the requirements and approval of NDT facilities and personnel are vital. The indigenously/modified NDT technology by Indian professional has to meet the TOT requirements. Even some of the NDT technique has to be introduced newly to Indian aviation industry for customize and special application.

KEY WORDS- NDT, MRO, AVIATION, MILITARY

THE PRESENTATION FOCUSES ON THE ABOVE SUBJECT AND ISSUES

Email: abinash.halkpt@gmail.com

Improvements in quality of Neutron Radiography images of pyro components used in aerospace applications using image processing tools

Girish N Namboodiri^{1,2}, Shaheer Ali V², M C Santhosh Kumar², Moideenkutty KK¹,
M Nallaperumal¹, S Umasankar¹, G Levin¹

¹Rocket Propellant Plant, Vikram Sarabhai Space Centre, Trivandrum-695022, India

²National Institute of Technology, Tiruchirappalli, Tamil Nadu-620015

Corresponding Author: santhoshmc@nitt.edu, girish_nn@vssc.gov.in

Abstract

Neutron Radiography (NR), a non-destructive evaluation method for detecting the presence of hydrogenous and other neutron absorbing compounds present inside sealed metal enclosures could be carried out using a low-flux accelerator based Deuterium–Tritium neutron source and a cooled CCD based neutron imaging camera. Suitable moderator-collimator assembly is used to thermalize the fast neutrons which are required for NR of pyro devices used in aerospace applications. Pyro devices are mission critical elements containing explosive charges whose presence could be confirmed only by NR. Since the thermal neutron flux available for NR using such sources are very low (104 n/cm²s), the quality of the neutron images are less in comparison to NR images obtained from setups that use nuclear reactor as neutron source (107 n/cm²s). Hence it becomes necessary to use suitable image processing algorithms that could reduce the noise and enhance the features in the Region Of Interest (ROI). Averaging of frames, background gamma subtraction, flat field correction applied in sequence helped in improving the quality of neutron image. The paper describes the different image processing algorithms used for images which required separate processing to extract required features from ROI. Since the required features at ROI for various types of pyro components are different, typical MATLAB algorithms are developed that suits the requirements.

Keywords: Neutron Radiography, non-destructive evaluation, image processing, ROI

Improved 3D Ultrasonic Imaging of Surface-Breaking Cracks by Linear Phased Array

Abhishek Saini, Zheng Fan

School of Mechanical and Aerospace Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 637798, Singapore | E: zfan@ntu.edu.sg , abhishek022@e.ntu.edu.sg

Abstract

The linear ultrasonic phased array has great potential to generate high-quality three-dimensional (3D) images by scanning the ultrasonic array in the direction perpendicular to array elements. However, the generated 3D images have low resolution in the elevation plane, which limits the image quality for Non-Destructive Evaluation (NDE). In this paper, an imaging procedure is proposed to improve the azimuth as well as elevation resolution by combining the half-skip total focusing method (HSTFM) and synthetic aperture focusing technique (SAFT) for imaging surface-breaking cracks. The imaging technique is applied to the full matrix capture (FMC) data gathered from the conventional array as well as with the reduced size element (i.e. reduced elevation length) array. The elevation length of the array element is reduced to widen the beam width in the elevation direction and to reduce the slice thickness for mechanical scanning. The imaging technique is analysed by simulation, point spread function (PSF) and experiments. The obtained images from reduced array elevation have better resolution compared to the large array element size.

Keywords: 3D imaging, HSTFM, SAFT, linear array, improved resolution

Bicoherence Based Study of Non-linear Intermodulation in Delaminated CFRP Plate

N. S. V. N. Hanuman¹, Subhankar Roy² and Tanmoy Bose³

Department of Mechanical Engineering, NIT Meghalaya, Shillong, India | E-mail: nsvnhanu@gmail.com

Abstract

Nowadays, non-linear wave spectroscopy (NLWS) technique is a very famous and modern technique for finding microcracks in any structural materials. One of the NLWS technique is based on local defect resonance (LDR) frequency of defects, which is developed recently for characterizing the delaminations and microcracks in composite materials. The present study discusses LDR based detection of delamination in carbon fiber reinforced plastic (CFRP) plate with single delamination, analytically as well as experimentally. Two different exciting frequencies are provided to the CFRP plate surface for generating the non-linear intermodulation peaks at the damage location. One of the exciting frequency is considered as subharmonic or superharmonic of LDR frequency while the second excitation is taken as a single periodic frequency (SPF). Subsequently, Fast Fourier transform (FFT) of the receiver signal is performed for obtaining local defect resonance intermodulation (LDRI) and single periodic frequency intermodulation (SPFI) peaks. Further, bicoherence analysis is implemented to detect intermodulation peaks due to high quadratic phase coupling. Finally, the analytical and experimental results are compared and are found to be in good agreement with each other.

Key words: non-linear wave spectroscopy (NLWS), carbon fiber reinforced plastic (CFRP), local defect resonance intermodulation (LDRI), single periodic frequency intermodulation (SPFI)

Spot Weld Examination using NDE Methods

Joel Stephen, B.E. (Mech.), MBA, ASNT L-3 (RT,UT,MT,PT), PCN L-3 (RT,UT,PT)

Engineering Quality Inspection Services, Chennai-600095 | E: stephen.joel@gmail.com

Abstract

This abstract explains the NDE methods employed to determine the weld nugget size which is the key factor in optimizing the weld current and the weld cycle in a spot welding process. Usually destructive testing is used to determine the nugget size, but since this exercise was carried out at component level, a nondestructive evaluation was required to be established and validated with the destructive findings.

This paper deals with the extensive exercise carried out at a major automobile manufacturing facility in Chennai to optimize the most efficient means of spot weld and to test its withstand-ability using NDE methods. All the findings were validated using physical methods such as shear test, chisel test, peel test, macro examination and tensile test.

The major challenges were to keep the weld current as low as possible yet retain the required shear stress; to determine the force, material, diameter, resistance and material of the electrode; to examine the weld quality non-destructively and validate the findings using destructive methods.

NDE methods helped the manufacturer finalize the optimization process without having to destroy the component after validation on trial samples. It enabled them to rely entirely on the NDE findings rather than the physical test methods. This eliminated the need to prepare test samples and test them under mechanical loads and more importantly to do away the scrap associated with it.

X-Ray Radiography and Ultrasonic Spot Check using delay line transducers were employed to estimate the nugget size. Surprisingly, 95% accuracy was achieved in the NDE methods with the actual values determined by the physical tests.

Keywords: Spot Weld, Ultrasonic Delay-Line Transducer, X-Ray Radiography.

Development of Sectored External Pipeline Inspection Gauge for health monitoring of industrial carbon steel pipelines

Shilpi Saha, D Mukherjee, Y Chandra, S C Ramrane, S K Lahiri and P P Marathe

Control Instrumentation Division, BARC | E: shilpis@barc.gov.in

Abstract

Magnetic flux leakage (MFL) based inspection gauges are widely used for full periphery inspection under non-destructive testing (NDT) of buried petroleum pipelines. These tools, known as Instrumented Pipeline Inspection Gauge (IPIG) are inserted into the pipeline, it travels along with the cargo and are retrieved at receiving barrel after travelling hundreds of kilometres. However, there are unpiggable pipelines in oil refineries, process industries and power plants (conventional and nuclear) where inline inspection is not possible. These lines are mostly inspected at few locations during in-service inspection schedule by spot thickness measurement, but full length inspection with full periphery coverage is not feasible due to unavailability of any standard inspection tool. Nevertheless, integrity management of such pipes are of paramount importance. To address this challenge, a novel inspection tool called Sectored External PIG for 10" NB carbon-steel pipeline (SEPIG-10) has been developed based on MFL technology. The tool is extremely light weight, and can be moved across the pipe (axially and circumferentially) with ease. The tool has been successfully tested at static test rigs with known calibration defects, giving encouraging results in defect detection and size (length, width, depth) estimation.

Keywords: External PIG, MFL, Wavelet, Metal-loss, Unpiggable pipeline

Quality Control of Water Couplant for Reliable Immersion Ultrasonic Testing

Dinesh Gupta¹,

¹Satyakiran Engineers Private Limited, 487-76 Peeragarhi Industrial Area Delhi, India

dinesh.gupta@satyakiran.com

Abstract

Immersion Ultrasonic testing has distinct advantages over contact testing like higher inspection speed, no wear of transducer, Ultrasound beam focusing, beam direction manipulation and easier adaptability to automation. Not enough documentation is found on properties, role and control of the water couplant. However, during his works on many recirculating contained tank immersion ultrasonic testing systems in different applications, author has observed that (i) random unacceptable drop in ultrasonic signal amplitude and (ii) corrosion of parts of test setup are two key problem areas that need more attention.

Upon careful observation and analysis, potential sources of this problem were narrowed down upon and selected for experimental studies. Experiments were conducted to determine the (i) effect of dissolved salts, Sulphur and Chlorine; (ii) effect of motion in coupling medium across sound path; (iii) effect of emulsification and contamination in recirculating systems; (iv) effect of wettability of examination surface and (v) role of galvanic corrosion in the assembly.

Test results reveal that the parameters under study have significant detrimental effects on the performance an immersion ultrasonic test system. Author has presented the benefits of control and conditioning measures implemented by him for effective control of these effects leading to direct improvement in the repeatability and reliability of test results and indirect improvement in the working life of test set up assembly. It is proposed that standard guidelines be published on this subject for the benefit of industry.

Keywords: Attenuation, Wettability, Emulsification, Repeatability, Corrosion

Design Of An Eddy Current Array Probe For Non Destructive Testing Of Thin Walled Stainless Steel Tubes

¹Mahesh Raja P., ²Thirunavukkarasu, ²Sasi B., ³Krishnamurthy C.V.
and ^{*1}Kavitha Arunachalam

¹ Department of Engineering Design, Indian Institute of Technology Madras, Chennai, India

²NDE Division, IGCAR, Kalpakkam, India

³Department of Physics, Indian Institute of Technology Madras, Chennai India

^{*}Corresponding Author : akavitha@iitm.ac.in

Abstract

Abstract: This paper presents the design of an eddy current array probe for inspection of thin walled stainless steel (SS) tubes (0.45 mm) used in nuclear industries. An array of excitation coils designed on 0.76 mm thick flexible printed circuit board (PCB) was modelled in a finite element method (FEM) based numerical simulation platform to optimize the number of coils and array parameters such as excitation frequency, excitation current and lift off for detection of machined outer diameter defects. Simulation results of the optimized EC array probe for varying defect orientations indicate the feasibility of the simulated probe for non-destructive testing (NDT) of thin walled SS tubes. Preliminary measurements from the EC array probe will be presented in this work.

Keywords: eddy current, array probe, NDT, flexible substrate

Damage Assessment for a Sandwich-like Panel using Experimental and Numerical Analysis of Guided Waves

Kaleeswaran Balasubramaniam*, Shirsendu Sikdar, Piotr Fiborek, Pawel Malinowski

Institute of Fluid Flow Machinery, Polish Academy of Sciences,
J. Fiszer 14 Street, 80-231 Gdansk, Poland. | E: kaleeswaranb@imp.gda.pl

Abstract

The presence of damage significantly affects the system's performance. Various damage detection methods are available to identify damage in engineering structures. The guided wave propagation based nondestructive evaluation (NDE) methods have proven their potential to effectively identify damage in such advanced structures due to the long-distance inspection capability and the capacity to interrogate the whole thickness of a structure. Therefore, in the present study, the scanning laser vibrometer (SLDV) and numerical simulations are used to study the guided wave propagation and their capabilities to identify different types of damage regions in a sandwich structure comprising of an aramid core and aluminum skin. The piezoelectric sensor based excitation was used. The damages involved in this study are barely visible impact damage (BVID), holes of different diameters and surface indentation.

The presence of damages causes abrupt changes to the wave field of the guided waves. Full field and elliptical based signal processing methods are used in determining the region of damage. Thus, the damage region is visualized in this comparative study.

Keywords: Lamb waves, guided waves, barely visible impact damage, laser vibrometry.

Characterization of Grain Size Distribution Using Nonlinear Ultrasonic Parameter

Saju T Abraham^{1*}, S. Shivaprasad², S. Athmalingam¹, B. Venkatraman¹,
Krishnan Balasubramaniam²

¹Homi Bhabha National Institute, Indira Gandhi Centre for Atomic Research, Kalpakkam – 603 102, Tamil Nadu, India

²Centre for Nondestructive Evaluation, Indian Institute of Technology, Chennai – 600 036, India

*Corresponding Author: sajuta@igcar.gov.in

Abstract

Mechanical properties of a polycrystalline material primarily depend on its grain size. However, heterogeneity in the grain size and its distribution has a measurable impact on the mechanical properties of engineering materials as both strength and toughness increase with a decrease in grain size. Therefore, a reliable characterization method is necessary to evaluate the usefulness of the material meets the requirements of codes and standards. Widely used microscopic characterization techniques are limited to the laboratory environments, and the replica measurements are tedious and time-consuming. Non-destructive evaluation methods like ultrasonic velocity and attenuation measurements are limited to fine grain and thin specimens owing to the scattering losses and lesser sensitivity with microstructural variations. In this context, a novel multi-frequency nonlinear ultrasonic measurement approach is introduced for the non-destructive evaluation of the grain size variations and its distributions. This methodology is applied to a set of annealed polycrystalline materials with wide variation in grain sizes. Microscopic observation reveals abnormal grain growth with higher annealing temperature, which is confirmed through high-frequency attenuation. Limitation of ultrasonic attenuation technique due to the scattering losses caused by coarse grains is overcome by frequency-dependent acoustic nonlinearity parameter. This parameter is used to discern variations in grain size in the annealed specimens more accurately than the linear counterpart. The ultrasonic nonlinearity parameter varies linearly with grain size in the Rayleigh scattering regime but deviates from linear behaviour at the Rayleigh-to-stochastic transition zone. Frequency dependence of this parameter is found to be a reliable tool for rapid screening of materials where grain size varies widely. Also, the distribution of grain size is observed to dominate the nonlinearity parameter over the mean grain size. The relative changes in the nonlinearity parameter with applied frequencies showed a good correlation with the grain size distribution.

Keywords: Nonlinear ultrasonics, prior austenite grain size, grain boundary scattering, harmonic generation

Development of Technique for Ultrasonic Testing of Small Bore Nozzle Welds

**P Chenthilkumar¹, K Murugan¹, M.V. Kuppusamy¹, N Raghu¹,
S.Athmalingam¹, B.Venkataraman¹**

Quality Assurance Division¹, Indira Gandhi Centre for Atomic Research, Kalpakkam – 603102, India
E: pckumar@igcar.gov.in

Abstract

This paper highlights the development of a guided tool to carry out ultrasonic examination of nozzle to shell welds of “set in” configuration in Fast Reactor Fuel Cycle Facility. The Code of construction such as ASME Section III Division 1 NC calls for 100% volumetric examination of all nozzle welds by suitable non-destructive technique. Radiography and ultrasonic examination are the widely used and codified NDT techniques. Due to weld joint configuration and accessibility, Volumetric NDT by radiographic examinations is precluded as it is not possible to achieve required quality requirements (optical density & Sensitivity). Conventional ultrasonic examination of such nozzle welds using pulse echo contact technique will not provide 100% inspectability and volume coverage. This aspect necessitates development of guided tool to facilitate 100% inspectability of weld joints for such a critical vessels using ultrasonic examination. The development of a dedicated tool to carry out ultrasonic inspection of nozzle welds with 100% inspectability & volume coverage using immersion normal beam technique with main focus on detecting the lack of side wall fusion on the pipe side. The tool has been successfully designed, developed, validated and implemented in shop floor. Higher productivity and inspectability coupled with meeting quality requirements were realized.

Keywords: waste tank farm, nozzle welds, lack of side wall fusion, Austenitic Stainless Steel, immersion normal beam technique.

Thermal Grading Scale for Classification of Breast Thermograms

Shobhana Periyasamy¹, Aruna.P², M.Menaka³, M.Jayashree⁴ and B.Venkatraman⁵

^{1,3,5}Indira Gandhi Centre for Atomic Research, HBNI, Kalpakkam

²Anna University, Chennai

⁴DAE Hospital, Kalpakkam

Corresponding Author: sona.smiling08@gmail.com

Abstract

Thermography is a physiological look and pictorial recording of the skin temperature which has significant contribution in detecting breast cancer, since 1957. Thermography is a potential tool to reduce breast cancer mortality by detecting at an early stage. Food and Drug Administration (FDA) approved (in the year 1982) thermography as an adjuvant screening tool for breast cancer. Accuracy of the screening to detect cancer early highly depends on interpretation of the thermograms. Progression of this technique as diagnostic tool is very less due to lack of standardization in imaging protocol worldwide and interpretation system. In this paper authors have proposed a new innovative Indian thermal grading/scoring scale based on quantitative and qualitative parameters including feature analysis, temperature difference and risk factors. The grading/scoring scale has been successfully applied to 75 cases and validated using concurrent sonography and mammography reports. This paper also provide statistically analyzes of the thermal grading/scoring scale for breast thermograms to classify normal, fibroadenoma and cancer subjects for the above mentioned cases.

KEYWORDS: Breast Thermography, Temperature Analysis, Breast Cancer, Grading/Scoring Scale

The Capabilities And Effectiveness Of Remote Visual Inspection Using UAV (Unmanned Arial Vehicle)

Peter Amin

Lloyd's Register Asia, 63-64, Kalpataru Square, 6th floor, Kondivita Lane, Off Andheri-Kurla Road, Andheri (East),
Mumbai 400 059 | E: Peter.Amin@lr.org

Abstract

Visual Inspection is a very effective inspection method, and it should be the primary method included in any effective Quality Control Program. It has been shown repeatedly that, Visual inspection (VT) conducted by properly trained inspectors using proper tools, results in the discovery of the vast majority of those defects which would only be discovered later by some more expensive non-destructive test method.

Over the past decade we have seen ground breaking advancement in Non-Destructive Examination (NDE) technology and as a result of fourth industrial revolution, technologies today offer tools that may be used to increase the efficiency and effectiveness of inspection programs at the same time keeping human factors out of harm's way.

It is only natural that we take advantage of the technology available to us to make Visual Inspection (VT) a more effective, reliable and safe NDE technique. Greater emphasis is now placed on ensuring the safety of the work force and at the same time providing evidence to show the inspection undertaken was performed and evaluated in a proper way meeting the client requirements. It is very clear that new technology can help to simplify the process and improve turnaround times, whilst also giving greater visibility, safety and a high-quality permanent record of the inspection activity.

Remote Visual Inspection (RVT) technique is the application of visual inspection of an object or area under test without the technician being in the test area, ie inspection from a remote position.

This paper addresses a similar RVT of steel structure undertaken with the aid of Unmanned Arial Vehicle (UAV) by Lloyd's Register Asia (LRA) for one of the Clients in India. The different aspects of calibration and delivery for the inspection are discussed herein along with the safety and local legislation requirements This Paper also discusses the effectiveness , advantages and limitations of Remote Visual Inspection (RVT) technique assisted by UAV (Unmanned Arial Vehicle) in wider application.

Key Words : Visual Inspection (VT) , Remote Visual Inspection (RVT), Drone, UAV, Lloyd's Register Asia (LRA)

Experimental Evaluation of X-ray Digital Radiographic and Computed Tomographic System using an Indirect FPD for Non-destructive Examination

Lakshminarayana Yenumula^{1,2*}, Anant Mitra¹, Rajesh V Acharya^{1,2}, and Umesh Kumar¹

¹Isotope and Radiation Application Division (IRAD), Bhabha Atomic Research Centre, Mumbai - 400085, India

²Homi Bhabha National Institute (HBNI), Anushaktinagar, Mumbai - 400094, India

E: laxmany@gmail.com

Abstract

Integrated high-flux X-ray based Digital Radiography and Computed Tomography (DR&CT) using two-dimensional (2D) Digital Detector Array (DDA) is one of the upcoming imaging technologies for Non-destructive Evaluation (NDE) of industrial specimen. It offers acquisition of direct digital radiographic images and facilitates generation of volume tomographic data for advanced NDE analysis. a-Si scintillator based DDAs are commercially available and are known as Flat Panel Detectors (FPDs). Due to spatial and temporal anomalies and possible degradation of the FPD performance over time, it is important to periodically evaluate its performance to ensure the image quality, level of accuracy, sensitivity and long-term stability. The present paper describes evaluation of radiographic performance of the in-house developed DR&CT system. Image quality parameters such as Image Lag (IL), Offset Level (OL), Bad Pixel distribution, Spatial Resolution (SR), Material Thickness Range (MTR), Contrast Sensitivity (CS), Signal Level (SL) and Signal-to-Noise Ratio (SNR) have been analysed. The study also includes determination of Modular Transfer Function (MTF) and Basic Spatial Resolution (SRb) of the system.

Keywords: Digital Radiography and Computed Tomography (DR&CT); Digital Detector Array (DDA); Non-destructive Evaluation (NDE); Flat Panel Detector (FPD); Material Thickness Range (MTR); Contrast Sensitivity (CS); Modular Transfer Function (MTF).

Real Time Total Focusing Method Applied To The Detection Of HTHA And HIC In Pressurized Vessels

Srinivas Kumar¹ and Hubert Voillaume²

¹Eddyfi Technologies, Dubai, United Arab Emirates

²Eddyfi Technologies, Les Ulis, France

E: skumar@eddyfi.com

Abstract

Phased Array Ultrasonic Technique (PAUT) is now widely used in oil & gas industry to assess the quality of the assets during all the life of the components. Total Focusing Method (TFM) is an advanced technique derived from PAUT. It provides powerful tool to detect and characterize hydrogen damages. It's a proven technique based on parallel electronic architecture which is available in a portable ultrasonic phased array instrument. Real time TFM provides high resolution imaging and easy characterization of small and tiny defects. The dead zone reduction is significant, and the zone coverage is increased. This paper presents some results obtained on pressurized components with TFM and highlighting real hydrogen defects, HTHA and HIC.

Keywords: TFM, HTHA, HIC.

API-650 Code Annex-U Requirements for Ultrasonic Examination in lieu of Radiography

1. Engr.Sangili Gunasekaran, 2.Miteshkumar Panchal, 3. D.M.Tripathi, 4. S.S.Murugan

1 & 2. Heavy Engineering Industries & Shipbuilding Co. K.S.C (Public) (HEISCO)-Kuwait

3. Alghanim international- Kuwait

4. Integral Services Co. (ISCO)- Kuwait

E: sangili.gunasekaran@heisco.com

Abstract

We at HEISCO constructed total 75 No's of various oil storage tanks as per API-650 Code of construction. As per API-650 code requirements all vertical weld seams of 25 mm and above shell thickness 100% RT (Radiography Testing) is required, however customer specification is asking to perform 100% RT for 19mm and above shell thickness. For all vertical weld joints having thickness 10mm and above we proposed TOFD (Time of Flight Diffraction) technique instead of RT. Radial annular joints with backing strip also 100% AUT (Automated Ultrasonic Testing) carried out instead of 100% RT.

In Kuwait only 50 Curie (Ir-192: Source) is permitted for industrial Radiography. It takes more time for RT shooting for heavy wall thickness. Radiography progress is not enough to meet the Construction schedule due to low Curie source and limited work permit time. To overcome above issues, TOFD technique (as per API-650 Annex-U Requirements) proposed and accepted by client.

This paper explains about TOFD procedure, scan plans, calibration & demonstration blocks, personal qualification and training, Interpretation and evaluation etc. TOFD shows Higher Probability of Detection (POD) and faster result compared to RT Technique.

Keywords: Non-destructive Examination (NDE), Radiography Testing (RT), Ultrasonic Testing (UT), TOFD (Time of Flight Diffraction), AUT (Automated Ultrasonic Testing), Curie, Probability of Detection (POD) etc.

Inspection of Ammonia Synthesis Converter

Ketan Amin¹, Chintan Mulchandani² and Hussain Vasadwala³

¹ Chief Manager, GNFC, Gujarat, India

² Manager, GNFC, Gujarat, India

³ Senior Mech. Engg, GNFC, Gujarat, India

Email: hevasadwala@gnfc.in

Abstract

The Ammonia Synthesis Converter is the heart of Ammonia plant and ensuring its reliable operation is of utmost importance. Normally, operating life of Ammonia Synthesis Converter with S-200 basket remains 10-15 years in plants world over. In GNFC, it was under operation since 1992 i.e. for last 26 years. GNFC, also, had faced problem of leakage from gas outlet nozzle in 2006 in this converter. Hence, with a view to increase reliability as well as production, it was decided to replace old S-200 basket with new design S-300 basket. During basket replacement project, detailed inspection of pressure shell was carried out to check its integrity for future operation.

Meticulous planning and co-ordination among various departments helped in completion of inspection in just 5 hours. Defects were found in gas outlet nozzle which was repaired and converter with new basket was put in to operation safely. Timely completion of inspection and repair activities resulted in scheduled plant start up thereby minimizing production losses.

Keywords: Ammonia Synthesis Converter, S-300 basket, NDT,

Specifying the “Specific” for Effective NDT Trainings

Navita Gupta¹

¹Satyakiran School of NDT, 487/76, Outer Ring Road, Peeragarhi, Delhi-110087, India
navita.gupta@satyakiran.com

Abstract

All NDT Personnel certification schemes in the world, irrespective of the Method, Level and Industry Sector have a mandatory Specific section as part of the examination process. Despite the fact that all certification schemes give a minimum weightage of 33% to this part of the training and certification process, this section gets the least attention in majority of the training institutes, worldwide.

The author, during her role as a Trainer and Examiner in various NDT certification schemes including ASNT SNT-TC-1A (2016), ASNT CP 189 (2016), ISO 9712 (2012), IS 13805 (2004), NAS 410 (2014), EN 4179 (2017) tried to identify reasons leading to this situation. Four basic reasons were identified which could be the source for neglect of this very important section of NDT trainings. This included non-availability of guidelines, non-existent question banks, no methodology for formulating questions and lack of understanding for handling the Specific Section. The Author identified that Specific Section in any NDT training, was actually a simulation of various customer requirements and the open book questions were administered to judge the understanding of the NDT personnel on the philosophy of that particular standard (both stated and implied).

As part of the work, Testing Standards were identified for each method (MT, PT, UT, RT, VT, and ET) & sector (casting, forging, welding and aviation) initially. A structure was created for converting these standards into meaningful multiple choice, objective type question bank. Standards defining the acceptance rejection criteria for that particular method and sector were also identified and worked upon.

These question papers were administered to more than 500 candidates in duration of six months and results evaluated. The results fortified the philosophy that Specific Section if dealt carefully and systematically can improve the effectiveness of the NDT trainings manifold times. The candidates were able to handle varied customer requirements after learning the scientific approach of demystifying any standard!

Keywords: NDT Trainings, Specific, Standards, Effectiveness

Development of a Smart Sensing System to Predict the Criticality of a Component

Hrishik Sagar¹, C. Dutta², A. Kumar², S. Palit Sagar² and A. Ghosh²

¹BITS Pilani, KK Birla Goa Campus, Goa, India

²CSIR-National Metallurgical Laboratory, Jamshedpur, India

arpita@nmlindia.org

Abstract

Inability to sense the onset of an unacceptable rise in the temperature of an industrial equipment can be a cause of catastrophic failure. Additionally, the most vulnerable areas of the component are often not accessible and the temperature sensors have to be located at distances away from those sites. In any case temperature sensing can be done at a few locations only. Based on these limited measurements, temperatures at other locations of the component need to be predicted. Mapping the temperature profile of the entire component based on a few selected measurements is not a trivial exercise. An analytic strategy employing temperature measurement from a single line of Fibe Bragg Grating (FBG) sensor on the blow pipe of an industrial blast furnace has been developed to predict the temperature at any other location. The work has been carried out by training the neural network from data generated using a validated first-principle thermal model of the component. The development of the prediction strategy is general enough to allow extension to other geometries and components easily. An alarm is activated when the sensor senses an abnormal condition and sends a message to the user using the short messaging service (SMS) or email.

Keywords: trained smart sensor, critical temperature, neural network

Proper Orthogonal Decomposition based Coating Thickness Estimation in Quadratic Frequency Modulated Thermal Wave Imaging

V. Gopi Tilak¹, G. V. P. Chandra Sekhar Yadav¹, V. S. Ghali¹ and Dr. Naik.R.Baloji²

¹ Infrared Imaging Center, Koneru Lakshmaiah Educational Foundation, Vaddeswaram, Guntur, India.

² Naval Materials Research Laboratory, Ambernath (E), Dist. Thane, Maharashtra, India 421506

gvs0raos@kluniversity.in

Abstract

Thermal barrier coatings for the objects operating at elevated temperatures require proper non- contact condition monitoring to avoid catastrophic failures. Thermal wave imaging is evolving as a reliable testing mechanism to cater to these types of industrial applications. Among various flaws, non-uniform thickness variations occur either during the manufacturing process or during the operational period. In present work, a numerical simulation is carried out to model a thermal barrier coatings sample with wedge shaped structure excited by Quadratic frequency modulated (QFM) heat flux. The quantitative and depth resolution capability of QFMTWI over thermal barrier coating is analyzed using Pulse compression and provided an empirical model for thickness estimation; further proper orthogonal decomposition (POD) is applied on pulse compressed result to reduce dimensionality of the system.

Keywords: Thermal barrier coatings, Infrared thermography, Quadratic frequency modulated thermal wave imaging (QFMTWI), Pulse compression, Proper orthogonal decomposition (POD).

Damage Assessment of Concrete Bridge Structures Using Ultrasonic Tomography Technique

Thirumalaiselvi A¹, * and Saptarshi Sasmal¹

¹CSIR-Structural Engineering Research Centre, CSIR road, Taramani, Chennai, India

*selvi@serc.res.in

Abstract

Towards maximizing the service life of civil infrastructures, timely maintenance is essential since the structural condition affects the life span. Hence, development of technique that enables the condition assessment is ever demanding. Application of stress wave propagation based non-destructive techniques to assess the structural condition is increasingly emerging. Acoustic Emission and ultrasonic pulse velocity are some of the stress wave based non-destructive techniques which are most widely used towards damage assessment of structures. Concrete structures pose the challenge in developing efficient damage assessment technique due to the inherent heterogeneity, microcracks and nonlinearities from concrete. It has been reported in earlier works that predictions from AE technique are rarely quantifiable and also not straight forward that makes it to be an insufficient tool. Detailed investigation at critical locations could be made through employing ultrasonic testing. The present work applies the ultrasonic tomography that utilizes elastic stress wave propagation for damage assessment of a typical concrete bridge.

A laboratory-scale concrete bridge model was considered for experimental investigations and static loading (through actuator) was applied to induce pre-defined level of damage. Before and after loading, elastic velocity distribution is analyzed by transmitting ultrasonic waves at multiple locations and receiving the same. Velocity distribution is determined following the algebraic iterative reconstruction technique based on Kaczmarz method. Reconstructed velocity tomography is then verified with the experimentally observed damage pattern. The results show that ultrasonic tomography reconstruction as being used in the present study is well corroborated with the damage observed from the experiment. It can be underscored that the ultrasonic tomography with proper test protocol (including the frequency range and signal type) and appropriate grid of measurement is capable of accurately depicting the damage state of in-service concrete bridge structures.

Keywords: Concrete; cracking; non-destructive technique; ultrasonic tomography.

A Thermographic System for Quantitative and Automated Subsurface Detail Visualization

A.Vijaya Lakshmi¹, G. V. P. Chandra Sekhar Yadav¹, V. S. Ghali¹ and Dr. Naik.R.Baloji²

¹ Infrared Imaging Center, Koneru Lakshmaiah Educational Foundation, Vaddeswaram, Guntur, India 522501.

² Naval Materials Research Laboratory, Ambernath (E), Dist. Thane, Maharashtra, India 421506

E: gvs0raos@kluniversity.in

Abstract

Subsurface analysis with increased reliability fascinated the post processing research in infrared imaging and non destructive testing. This paper proposes the Artificial neural network (ANN) based post processing modality to analyze subsurface anomalies in quadratic frequency modulated thermal wave imaging and validates it using the experimentation carried over a Mild steel (MS) and Carbon fiber reinforced polymers (CFRP) specimens. A novice friendly thermographic system has been developed to visualize subsurface details to quantize, detect and visualize their corresponding depths and further detection capability has been compared with the contemporary processing approaches by taking the defect signal to noise ratio and size. In this paper the region based active contour segmentation based detection was used to automatic defect detection for CFRP.

Keywords: Subsurface analysis, Infrared thermography, Quadratic frequency modulated thermal wave imaging, Pulse compression, Artificial neural networks.

Analysis of an Ambiguous Indication in Digital Radiography of Dissimilar Material Weld Joint – A Case Study

Ayaz Jhanorwala¹, Satish Tilva², Swarajya Kumar³, Asutosh Khandelwal⁴

¹²³⁴L&T MHPS Boilers Pvt. Ltd., Surat Hazira Road, Dist. Surat -394510, India

E: ayaz.jhanorwala@Intmhps.com

Abstract

This paper illustrates a case study related to Digital Radiography (DR) of a tube butt joint having two different joining materials. An unknown Indication had appeared on elliptical double wall viewing image. It seemed to be a weld defect or any non-relevant indication due to machining mark on base metal. Thorough visual examination of samples confirmed that indication was not due to any machining mark or due to any weld root and reinforcement problem. Other destructive tests and non-destructive tests were performed step by step but no any defect could be detected in weld, adjacent heat affected zone and base material. So it was confirmed that indication was not due to any defect. Finally, the root cause of the indication could be confirmed by careful study of three different series of radiography tests. These tests were conducted on tube joints as well as on their sections with different techniques and radiation energy. This paper also mentions solutions to deal with such cases.

Keywords: Ambiguous indication, dissimilar material, digital radiography

Detection of Cracks with Circumferential Magnetization in C and M Shaped Cross Sectional Parts

Ayaz Jhanorwala¹, Gaurav Zaveri² and Satish Tilva³

^{1,2,3}L&T MHPS Boilers Pvt. Ltd., Surat Hazira Road, Dist. Surat -394510, India

E: ayaz.jhanorwala@Intmhps.com

Abstract

Depending on manufacturing process, parts are susceptible to different types of defects. Two different parts had longitudinal cracks produced due to bending process. To reveal such defects, surface PT was used initially but difficulty of lower testing speed and penetrant cleaning had urged the requirement to perform MT. But for MT, there is no common central conductor technique to examine hollow parts which do not have closed metal path to provide flow of magnetic flux in circumferential direction. This paper explains how circumferential magnetic field had been produced in parts having cross section "C" shape and "M" shape. Both the cases has been illustrated with distinct set up and magnetizing current. By establishing this MT technique, longitudinal cracks had been identified and the technique had proved effective to meet productivity requirement which had testing speed three times higher than PT without affecting quality.

Keywords: Circumferential magnetization, central conductor technique, "C" shape, "M" shape

Reliability in Defect Classification and Characterization in Eddy Current Non Destructive Evaluation

Tarun K. Das*, Chandan Dutta, Alok Kumar, S. Palit Sagar

CSIR-National Metallurgical Laboratory, Jamshedpur, India.

*Corresponding Author : Email - tkdas@nmlindia.org

Abstract

Quantitative assessment of reliability of defect classification and characterization in critical engineering components plays a key role in ensuring the optimal quality control of the finished product. Classification of defect using characteristics functions and extraction of key features using the smart signal analysis tools are indispensable nowadays in order to evaluate the defects alongwith real-time defect detection. This work presents a technical review of Eddy Current (EC) NDE technique in various scope of defect detection. EC testing is widely used for NDE of metallic structures in characterizing numerous types of defects such as sliver, fin, craw-fit, weld line defect etc occurring in various locations. A framework has been developed for incorporating the Orthogonal Test Method (OTM) in order to increase the sensitivity of the EC sensor for different kind of natural and artificial defects in steel wires. Smart signal analysis and processing toolkit has applied to the EC testing data for characterizing the naturally as well as artificial defects. Furthermore, severity of defects have been identified with this developed framework. The effectiveness of the proposed technique is demonstrated on experimental data from eddy current inspection of defects in high speed drawn steel wires.

Keyword: Orthogonal Test Method (OTM), Eddy Current, Sliver, Fin, Severity of defects, Signal analysis and processing toolkit.

Non-Destructive Evaluation of Bolt-hole Components using Eddy Current Inspection Technique

Hrishikesh Dutta^{1a} and Krishnan Balasubramaniam^{1b*}

¹Centre for Non-Destructive Evaluation, Department of Mechanical Engineering,
Indian Institute of Technology Madras, Chennai-600036, India.

*Email: balas@iitm.ac.in

Abstract

Aircraft structures such as the Wing-box and Jet engine disks contain numerous stress-concentrating geometries such as dovetail slots, bolt-holes and air-holes. These features are subjected to substantial stress under operating conditions. Fatigue cracks are prone to develop at the fastener holes in these multi-layered structures. Though the progress of cracks is often slow in the initial stage, they can grow to critical size and potentially result in component failure. Non-destructive evaluation of these complex features is vital to allow the components to remain in-service safely for a longer period of time. In this paper, Eddy Current (EC) inspection technique is used for the detection of cracks within Bolt-hole components after fastener removal. For this work, Bolt-hole specimens with artificial fatigue cracks introduced in them, are studied. Finite Element (FE) modelling is employed to simulate EC inspection of fastener sites and gain physical insight into the interaction of electromagnetic fields with the defects. The EC signal response is studied at different frequencies for both absolute and differential coil configurations in order to determine the parameters which can indicate crack characteristics. The inspection of the available Bolt-hole specimen is done using an experimental setup, specifically assembled to facilitate conducting EC testing. Inspection is performed at the suitable frequency range (as obtained from FE simulation studies) using absolute and differential EC probes. The factors affecting the measurements such as probe type, frequency, and variability in lift-off are examined. In order to locate the position of the crack and its relative orientation, the Bolt-hole specimens are linearly scanned for impedance variations in the axial and circumferential directions. The results demonstrate the effectiveness of the proposed methodology for conducting fast and accurate inspection of Bolt-hole and air-hole fasteners.

Keywords: Bolt-hole, Fatigue crack, Eddy current testing, Linear scan

Automatic Visual Systems For Automotive Industry - bearings

Ondrej DOUBEK¹, Radek SALAC¹

¹ATG (Advanced Technology Group), Touzimska 771, Prague 9, 19902, Czech Republic

E: doubek@atg.cz

Abstract

Already high volume of produced cars worldwide is still increasing every year and therefore high speed testing of automotive parts is more and more important. In order to satisfy the demand, various types of automation is usually necessary. Mass visual testing by human operators still more and more expensive, slow and not reliable enough. That is why ATG develops own automatic visual testing system iVT based on neural networks, special cameras and lights. This way we can easily replace human operator and be cheaper, more sensitive if it is needed, offer repeatability and traceable. More you see in our presentation of case study from KOYO Bearings.

Keywords: automotive, automatic visual testing, neural networks

Automatic FPI Systems For Automotive Industry

Ondrej DOUBEK¹, David NOVAK¹

¹ATG (Advanced Technology Group), Touzimska 771, Prague 9, 19902, Czech Republic

E: doubek@atg.cz

Abstract

Already high volume of produced cars worldwide is still increasing every year and therefore high speed testing of automotive parts is more and more important. In order to satisfy the demand, various types of automation is usually necessary. Mass testing by immersion system usually results in excessive expenses for penetrant, reduced sensitivity of the system and complications with cleaning of parts after testing. Alternative approaches by e.g. spraying often face problem with low productivity and/or limited floor space. Specialized FPI lines developed by company ATG Ltd. for automotive industry use continuous conveyor systems with application of penetrant typically by electrostatic spraying and positions situated in several levels in order to reduce requirements on floor space. Because customer requirements may differ by type of product, testing requirements, or equipment dimensions, such systems are usually customized for customer needs. The system can be made ready for semiautomatic or fully automatic evaluation by special cameras using unique software evaluation based on neural networks.

Keywords: automotive, fluorescent penetrant testing, continuous testing, neural networks

Mixing of Lamb waves at Delamination Defect in a Unidirectional GFRP Laminate

Yamnesh Agrawal¹, Akhilendra Singh Gangwar^{1*} and Dhanashri M. Joglekar¹

¹Department of Mechanical and Industrial Engineering, Indian Institute of Technology Roorkee, Roorkee-247667, India. *agangwar@me.iitr.ac.in

Abstract

Linear interaction of Lamb waves with delamination has been explored since a couple of decades, from the perspective of NDE of composite laminates. The time domain wave signals characteristics such as reflection, mode conversion, attenuation, etc. result from the linear interactions of waves with delamination. Literature reports the use of these characteristics for detection and characterization of the delamination. In the recent past researchers have been exploring the nonlinear interaction effects for improved sensitivity in delamination detection. Most of these studies however are focusing on higher harmonics generation. The generation of higher harmonics in the frequency domain corroborates the existence of delamination and along with the temporal data, other properties of delamination can be identified.

Vibro-Acoustic Modulation method, which is one kind of a nonlinear acoustic method, has been incorporated in order to detect delamination in composite structures. In this method, the structure is subjected to a combination of frequencies that leads to the generation of higher harmonics of those input frequencies and their interaction terms in the measured spectrum. When a Dual Frequency signal is allowed to pass through a defect, it resulted into mixing of the frequencies. Although it has been discussed in case of crack using specifically bulk waves but there is a scarcity of literature pertaining to such studies in case of delamination.

A numerical investigation of the nonlinear interactions of a dual frequency signal with a delamination in a unidirectional [0]8 GFRP laminate is presented in this study. Contact Acoustic Nonlinearity (CAN) is introduced for modelling the interactions of sub-laminates at delamination. The dual frequency wave signal upon interacting with the delamination will give rise to higher harmonics and peculiar combination of those input frequencies. Resulting combination frequencies, such as: (f_1+f_2) and (f_1-f_2) are found to be dependent on the delamination location & width. This may help in devising a strategy for delamination detection & characterization.

Keywords: nonlinear frequency mixing, unidirectional GFRP laminate, delamination, contact acoustic nonlinearity

ASME ANDE-1:2020 – news related to new version 2020

Tomáš Zavadil¹

¹ATG advanced Technology Group), Ltd., Toužimská 771, Prague 9, 199 02, Czech Republic

E: zavadilt@atg.cz

Abstract

ASME ANDE-1 is a new, independent qualification standard produced by ASME that focuses on ensuring maximal proficiency of the NDE personnel, especially for inspection of pressure equipment in nuclear as well as conventional BPV industry sectors. ASME ANDE-1 went through a development process from its first release in 2015 and with version 2020 it supports qualification of all 5 conventional NDT methods for the pressure equipment industry. First provisional ANDE Level 3 were recently approved. The standard is getting ready for its industry-wide implementation that may have significant consequence on overall quality of NSE services. The article summarizes the most important ideas about the standard and provides possible ways how the standard may develop in the future.

Keywords: qualification, independent qualification, ASME, ANDE-1

Proficiency assessment of NDT suppliers for corporations via inter-laboratory proficiency testing

Tomáš Zavadil¹

¹ATG advanced Technology Group), Ltd., Toužimská 771, Prague 9, 199 02, Czech Republic

E: zavadilt@atg.cz

Abstract

Large companies and corporations are frequently outsourcing the whole processes often including the NDE special process. Because the NDE process focuses on ensuring adequate quality of the product, therefore the organizations needs to ensure that the NDE process suppliers are fully proficient. Proficiency testing of NDE labs acc. to ISO 17043 received reputation of independent assessment of proficiency. Yet the standard approach may not provide sufficient verification for the corporations that needs to make sure that the laboratory can handle the service correctly acc. to their specific requirements. Specific approach may be then established for the corporations to set their own rules how the proficiency testing should be assessed to satisfy their requirements.

Keywords: proficiency testing, ISO 17043, NDE laboratory

Detection of microstructure and stress/strain condition changes by ultrasonic testing – assessment of the detection sensitivity

Tomáš Zavadil¹

¹ATG advanced Technology Group), Ltd., Toužimská 771, Prague 9, 199 02, Czech Republic

E: zavadilt@atg.cz

Abstract

Longitudinal to transversal waves velocity ratio technique is a newly proposed technique for assessment of material degradation associated with microstructural and stress and strain changes in equipment exposed to heat and pressure for long periods of time. This article aims to demonstrate sensitivity of the technique. The experiment is performed on welded sheets with small changes in the heat-affected zone designed by precise welding process. Measurement is performed by two phased array probes running in conventional weld inspection setup. Results are compared with macro images, metallography and microhardness testing to estimate the smallest detectable changes. The technique is intended to serve as a pre-selection tool for inspectors on-site to select non-destructively and with sufficient reliability potentially critical areas (with respect to changes of microstructure or stress-strain conditions) that shall be subjected to further, more detailed (e.g. destructive) analysis.

Keywords: ultrasonic testing, phased array, microstructure, strain, welding

Parametric study on resolution achieved using FMC-TFM based phased array ultrasonic imaging

Sumana, Anish Kumar*

Non-Destructive Evaluation Division, Metallurgy and Materials Group
Indira Gandhi Centre for Atomic Research, Homi Bhabha National Institute
Kalpakkam-603102, Tamil Nadu, India

*e-mail: anish@igcar.gov.in

Abstract

Full Matrix Capture-Total Focusing Method (FMC-TFM) is an advanced mode offered by phased array technology for defect detection and characterizations. Imaging using the FMC-TFM provides simultaneous focusing at all the depths and also offers various modes of imaging by post-processing using the same acquired data. In Full matrix Capture, each element acts as a transmitter and all elements act as receivers. The TFM involves the extraction of the maximum amount of possible information from the specimen.

The defect characterizations using FMC-TFM method depend on the sound beam, which depends on the choice of some parameters such as: aperture size, transducer frequency and depth of the defect. The work aims to study the influence of these parameters on sensitivity and resolution using the FMC-TFM technique. The experimental results of FMC-TFM are compared with SFLA (Synthetic Focusing using Linear Array) technique, which is similar to the conventional SAFT in which a single element is utilized for both transmission and reception. In the present work, the FMC-TFM and SFLA methods are used for inspection of aluminum and stainless steel calibration blocks with 1 and 2 mm side drill holes (SDHs) at different depth in the range of 25 to 200 mm. To examine the effect of various parameters on resolution, the effective apertures with varying spacing of elements (1, 2, 3, 4 and 6), various frequencies (2.25, 5 and 10 MHz with 0.75, 1 and 0.5 mm pitches, respectively) and different defect depths ranging from 25-200 mm are studied. -6 dB width has been used to quantify the resolution.

The study revealed that the lateral resolution decreases with an increase in the defect depth, reduction in the frequencies and the aperture size. A unified correlation is obtained between these parameters and the -6 dB width for the SDHs. Further, focusing is also achieved by superimposition of post-processed individual B-scan images acquired from different probe locations. Resolution up to 1 mm is achieved at 175 mm depth.

Key words: FMC-TFM, SFLA, SAFT, Resolution

Experimental assessment of an RFID based wireless sensor for surface crack detection and characterization on metal

Deepak Rana, Geetha Chakaravarthi

Department of Instrumentation & Control Engineering, National Institute of Technology Trichy,
Tamil Nadu 620015, India. | E:geethac@nitt.edu

Abstract

Recent advancements in sensor technology, rapidly increases the growth of Structural Health monitoring (SHM) of engineering structures. The various structural components are fabricated using metallic materials are subjected to severe fatigue and impact load condition, reducing its strength gradually with time. In engineering structures, small cracks lead to inadequate serviceability and large cracks can result in structural failures. The periodic inspections carried out using conventional techniques are wired and difficult to use for large structures. Studies shows that RFID based wireless sensors are capable of detecting cracks and gaining significance due to passive, remote sensing and cost effective solution for NDT.

Experimental assessment of an RFID based wireless sensor is presented in this work for surface crack detection and characterization on metal. The RFID Tag antenna on metallic surface is designed at optimized using Finite element method (FEM) based 3D EM simulations in HFSS® (Ansys Software Pvt. Ltd.). The RFID tag antenna is modeled with a passive RFID chip for wireless interrogation. The fabricated sensors are tested on metal slabs of thickness 4mm. The influence of presence of crack of varying length (10-100 mm), varying width (0.5-3.0 mm), varying depth (0.5-3.0 mm) and orientations are experimentally assessed by measuring the resonance of the tag antenna. The presence of crack altered the current path and caused the shift in the resonance frequency. Experimental verification of the numerical simulations demonstrate that the proposed sensor could be used for wireless surface crack detection and characterization on metal.

Keywords: Antenna, Crack characterization, RFID, Structural health monitoring (SHM), Surface crack, tag design.

Non-destructive Evaluation of Post Weld Heat Treatment Quality of Ferromagnetic Steel (P91) Weld by Magnetic Coercive Force (MCF) Measurement

Avijit Mondal*, Anil K. Das, Satish Chand and Amit Chhabra

NETPA Energy Technology Research Alliance (NETRA), Greater NOIDA-201306, *Corresponding author
e-mail: avijitmondal@ntpc.co.in

Abstract

The modified 9Cr-1Mo (P91) steel belongs to the family of creep strength enhanced ferritic steels which are widely used for many high temperature service applications like the main steam piping, super heaters, reheaters, headers of thermal power plants. It has been reported that the most of the failures occur in the weld joint. Therefore, the evaluation of welding joint is a key factor for deciding the lifetime of the component. The strength of weld joint varies across its welding axis owing to the formation of different phases and grain size variation at the fusion zone, heat affected zone (HAZ) and the base metal regions. Additionally, the welding introduces a lot of residual stresses into the material. In this context, a suitable post-weld heat treatment (PWHT) is recommended not only to relieve residual stresses but also to temper the freshly formed martensite in fusion zone for minimizing the strength gradient. To ensure effectiveness of PWHT of modified 9Cr-1Mo welds, a suitable non-destructive evaluation technique is very much essential especially for field conditions (power plant sites). The currently known technique for evaluation of adequacy of PWHT of modified 9Cr-1Mo welds in field conditions is by way of hardness measurements taken by portable hardness testers. However, there are many uncertainties in using a portable hardness tester in field conditions.

It is understood from a series of review papers, that the magnitude of Magnetic Coercive Force (MCF) of a ferromagnetic material is a measure of magnetic hardness of the material. Ferromagnetic nature of modified 9Cr-1Mo steel opens the scope for use of micro-magnetic techniques like measurement of magnetic coercivity, which is sensitive to microstructure and stress, for assessing the effect of heat treatment on the weld joints. Hence, the present investigation was carried out with an objective of exploring the effect of different PWHT conditions on the MCF of modified 9Cr-1Mo weld. A further object of this study is to look for possible correlations between the MCF, microstructure and hardness of weld and the possible method to establish the use of MCF measurements of weld as an evaluative indicator for assessing the PWHT quality of modified 9Cr-1Mo welds.

Keywords: Welding, Coercivity, PWHT

Phased Array Ultrasonic Inspection of Dissimilar Weld Joints in Nuclear Facility by Experiment and Simulation

S.Kumar*, M.Menaka*#, and B.Venkatraman*#

*Homi Bhabha National Institute

#Safety, Quality & Resource Management Group, Indira Gandhi Centre for Atomic Research (IGCAR),
Kalpakkam 603 102, Tamil Nadu, India | Email: kumar257selvam@gmail.com

Abstract

Dissimilar metal welds (DMWs) between the main vessel pipeline and steam generators joints in nuclear power plants are commonly inspected by Phased array ultrasonic testing (PAUT). The occurrence of beam splitting and skewing in the ultrasonic inspection will affect the defect detection, localization and sizing of the defect. This paper presents the study on phased array ultrasonic method for evaluation of dissimilar welds using advanced probes such as linear array probes and dual matrix array probes. In the present study, a simulation is performed for understanding the ultrasonic beam propagation and improving the defect detectability in DMWs by a combined approach of the ray-based model and semi-analytical model. Experiments are carried out in P91 to Alloy 800 weld plates (12 mm thick plate with defects) using 16 x 2 DMA probes at 4 MHz frequency and 16 elements linear array probe at 5 MHz with 55° Shear wave & 60° Longitudinal wave wedges. Simulated results of the defect detection in the welds were validated with experimental results. The result of the simulation as well as experiments shows the dual matrix array probe gives the better defect detectability and beam propagation into the welds. The DMA probes eliminate the interface echo, dead zones due to wedge echoes & reduces the backscattering signals, thus improving the flaw detection and sizing of dissimilar welds by combining the benefits of low frequency longitudinal focused beam and transmit- receive inspection technique.

Keywords: Dissimilar welds, Ultrasonic inspection, Phased array probes, Simulation

Failure Analysis of Attemperator Nozzle in Heat Recovery Steam Generator Units

Ayush Gangwar¹, Manindra Pratap Singh², Mayank Banjare³, and B.K.Muduli⁴

¹ Inspection Engineer, Panipat Naphtha Cracker, Indian Oil Corporation Ltd.

² Inspection Manager, Panipat Naphtha Cracker, Indian Oil Corporation Ltd.

³ Inspection Manager, Panipat Naphtha Cracker, Indian Oil Corporation Ltd.

⁴ Deputy General Manager (Inspection), Panipat Naphtha Cracker, Indian Oil Corporation Ltd.

¹gangwara2@indianoil.in ²singhmanindra@indianoil.in ³banjaremayank@indianoil.in ⁴mudulibk@indianoil.in

Abstract

Superheated steam (SHP steam) plays a crucial role in the power generation facility/industry. Significant potential lies in its ability to store an incredible quantity of internal energy that is utilized as a source of kinetic energy through expansion against the turbine blade in steam turbines. The generation of SHP steam requires additional heat input after evaporation to further heat it above its saturation temperature.

Precise management of steam temperature is a critical element for safe and economical plant operation. In HRSGs, to maintain the required SHP steam temperature and pressure a special type of desuperheater plays a vital role. Rapidly varying load conditions throughout regular operations and frequent startups-shutdowns are typical for HRSG. Depending on the boiler operating characteristics and the extent of load change, the attemperator can experience high stress. Close monitoring of various operational parameters (such as the temperature of superheated steam require desuperheating, set temperature to attain final SHP steam temperature and pressure and operation of control valve regulating Injectant flow to control superheat) at different steam load conditions is necessary to avoid untimely failures of the desuperheating system.

The subject paper briefly discusses the assorted operational scenario and metallurgical factors that led to a typical failure of the desuperheating water spray nozzle. Elaborated analysis for the failure has been discussed within the paper along with adopted counter-measures to mitigate similar failures in the future.

Keywords: HRSG, Desuperheater, Temperature control, Spray Nozzle

In-Service Inspection of Fast Breeder Test Reactor Components

Govind K. Sharma^{1*}, E. Ramesh², C. K. Mukhopadhyay¹, V Alagudurai², Shaju K. Albert¹,
A. Babu² and K. V. Suresh Kumar²

¹Metallurgy and Materials Group

²Reactor Facilities Group

Indira Gandhi Centre for Atomic Research

Kalpakkam - 603 102, Tamil Nadu, India

*Corresponding author: gks@igcar.gov.in

Abstract

Ultrasonic non-destructive testing technique is most preferred for in-service inspection of components wherein access is limited from one side and higher sensitivity for detection of cracks is desired. The in-service inspection of nuclear power plant components requires special attention due to the stringent requirements imposed on flaw tolerance. The access for inspection and presence of high temperature also add complexities to the testing.

In this study, the details of in-service inspection of weld joints in steam generator and secondary sodium pipe using conventional ultrasonic testing are discussed. It has been noticed that the conventional angle beam testing cannot be used for inspection of special joints due to limited access for scanning. Under these conditions, the use of complementary Rayleigh wave inspection can be very useful.

Similarly, the weld joints close to the intermediate heat exchanger (IHX) will be at 50-150°C even during the shutdown condition. Hence calibration of the ultrasonic system at elevated temperature is essential for accurate sizing of flaws. The procedure adapted and the results of the measurements would be discussed.

Key words: Ultrasonic testing, In-service inspection, High temperature

Assessment of Performance Gamma-ray CT System Based on the Image Quality

R. Ramar¹, M. Menaka, V. Subramanian, B. Vekatraman

Radiological & Environmental Safety Division, Indira Gandhi Centre For Atomic Research, Kalpakkam-603102, India

rramar@igcar.gov.in

Abstract

Gamma-ray CT system at HSEG IGCAR is the first generation Single Source single detector CT system. A manipulator system placed in between source and detector performs the CT movement for each layer of the object. Gamma-ray CT system indigenously developed and automated system. Collimated source and detector aligned in line, move up and down for the layer-wise scan. The manipulator translates and rotates the object during the slice scan. Convolution based Filter back-projection algorithm used for image reconstruction. Visibility of the feature in the CT image depends on the difference in the attenuation between the feature and its background, size of the feature, size of the background object, number of samples collected, time of exposures and various other factors. The detectability obeys relatively simple rules that can be expressed as a function of the system noise, resolution and size and composition of feature. To assess the above parameters following physical characteristics like noise, spatial resolution, and linear attenuation coefficient sensitivity were studied. As the noise from the photon statistics is one of the main components which limits the contrast sensitivity of the CT image, photon statistics based noise were studied. Spatial Resolution on the CT image estimated using Line Spread Function (LSF) and Modulation Transfer Function (MTF) were taken to determine the resolution of the image. Linear attenuation coefficient sensitivity of the system was measured which combines both the density and effective atomic numbers of the material scanned. From the scan of objects, the sensitivity of detecting various linear attenuation coefficients are studied. In this paper we have determined the spatial resolution and contrast sensitivity of the CT images using the in-house developed CT phantom. The purpose of this study to assess the performance of the CT system based on the image quality parameters referenced in ASTM E 1441 – 00, ASTM 1695-95.

Keyword: Tomography, Image quality, Modulation Transfer Function

Need & Road Map For Getting Certified To API Specification Q2 For NDT Service Organizations in Oil & Gas

By Santosh Gupte

ICO INTERNATIONAL GROUP - Singapore | E-mail: santosh@icoasiapac.com

Affiliation of Author: Mechanical Engineer, ASNT Level III in RT,UT,MT,PT & VT (C.No. 86050)

Member of ASNT, IIW, etc. Reviewing & Contributing Member of TH Hill-USA for DS1 Standards, API Approved Trainer for API Specifications Q1 & Q2.

Abstract

MACONDO blowout was one of the worst disaster in the History of Oil & Gas, the world has witnessed.

The events of the Macondo incident reveal 13 RCAs and lack of controls within the quality management systems (QMS) of oil and gas service providers including NDT services being a critical part of any service for O&G, which heightened operational risk.

This made American Petroleum Institute (API) to come forward and set up a Task Group (TG5) to establish a new QMS Standard for Service Industries in the Upstream side of Oil & Gas.

15 Major Organizations such as ExxonMobil, Shell, BP, Total, Chevron, HESS, Halliburton, Schlumberger, Transocean, Weatherford, NOV, etc joined the Task Group to draft the 1st Edition of API Spec Q2 for QMS. Now most of the IOCs are making it mandatory for all Service providers to conform their QMS to comply to API Spec Q2 Ed 1. This paper aims to explain the criteria in a simple and easy way, allowing you to facilitate a cost-effective system to help control your operations and achieve certification of QMS for specially NDE Service Organizations.

I have tried my best to put my efforts to explain in the most possible simple way, though the path is bit harder than it appears to be.

In short statement of abstract or this article will be :

A clause-by-clause analysis of the API Specification Q2 Edition 1 criteria, what they are and what they mean, for NDT Service Providers for O&G and some guidance on their implementation.

Key Words: API Specification Q2 Ed 1 Certification.

Detection of Leakage in Pipelines using Passive Acoustic Emission Technique

Nawal Kishor Banjara, Saptarshi Sasmal and V. Srinivas

Scientist, CSIR-Structural Engineering Research Centre, Taramani, Chennai-113

Email:nawalkishor@serc.res.in/nawal1234@gmail.com

Abstract

A leak in pipeline system can cause losses in terms of financial, wastage of resources, and even some times human deaths due to the collapse of the pipelines. In past, many approaches have been introduced to identify and diagnosis the leakage in pipeline. Acoustic emission (AE)-based techniques, which is passive technique is very promising technique because AE sensors are very sensitive and can detect small leaks and growth of damage, very quick, in a pipeline system.

In this work, experimental study is carried out to detect leakage in pipeline using acoustic emission technique. Steel pipe of 2000 mm length, internal diameter of 254 mm and thickness of 5 mm is used. Wide range AE sensors of frequency upto 1000 kHz are placed at different locations. Threshold and pre-amplifier gain is set 40 dB. Analog filter of 1 kHz to 400 kHz and sampling rate of 3MSPS is used to detect the leakage in the pipe. To simulate leakage, three valves (leak 1 to leak 3) at a distance of 500 mm are provided. Before starting the actual test, to check the sensitivity pencil lead brake (PLB) test is carried out. Pipe is filled with water by applying pressure. Leakage studies are carried out by applying constant pressure of 35 kg/cm² and then release the pressure by different rate of flow of water. Flow rate used in this study is 200, 400, 800, 1600, 4800 ml/minutes. AE features are captured by sensors and further processed to evaluate the leakage of the pipe for the three leak cases. AE counts, cumulative AE energy, and signal strength etc. are prominent AE features to show the leakage in the pipe. Results of the study clearly show that AE can be effectively used for identifying and localization of damage in pipeline.

Keywords: Acoustic emission technique, leakage detection, flow rates, AE features

Eddy Current Testing for detecting Air Gaps in Sandwiched Tube Element of Reactor Shut-Off Rods

N.Ramkumar, G.Vedprakash

NPCIL-QS, Bangalore, India

npcilqa_bangalore@npcil.co.in

Abstract

Shut-Off Rods are the Prime part of Primary Shut down System of Pressurized Heavy Water Reactors. The active part of Shut-Off Rods are the Cadmium Sandwiched Element which consists of Cadmium sandwiched between two Stainless Steel tubes.

A suitable NDE method was required to be selected, developed and employed for reliably detecting any Air gaps within the sandwiched tube in a production scale with Cost effectiveness.

The Element is roughly 5m long, 100mm in diameter hollow structure with 1mm thick Cadmium element sandwiched within two thin Stainless Steel tubes. The layers have to be in intimate contact and the maximum allowable air gap between the layers is specified.

Considering the required sensitivity & configuration of product to be tested and after exploring different NDT methods, Eddy Current testing using Differential Surface coil was selected and detection of various sizes of artificially induced defects between the layers were demonstrated. As the Surface area to be inspected is large (around 16000cm² for One Element) and in production scale, the scanning was mechanized by rotating the tube and axially moving the surface probe from Outer diameter of Element creating a spiral scanning pattern. Speed of rotation and feed were experimented and overlap and system calibration carried out based on detection of artificial defects.

Multifrequency excitation of Coil reliably detected defects in- between first and second layer (ID of Outer tube and cadmium) as well as second and third layer of Element (OD of inner tube and cadmium). Non-relevant indications were identified and excluded.

All Elements were One hundred percent inspected for any Air gaps reliably by semi-automated scanning.

Keywords: Eddy Current Testing, Surface Coil

Type Approval Testing of Co-60 Based Indigenous Radiography Camera CO-CAM-120 for Industrial NDT Applications: Regulatory Perspective

S Pathak, G Bokam, G K Panda, P Tandon, and P. K. Dash Sharma

Atomic Energy Regulatory Board, Mumbai

E: spathak@aerb.gov.in

Abstract

Ionizing radiations are extensively used in non-destructive testing (NDT) to detect defects in the material and for this purpose gamma source based Ionizing Gamma Radiography Exposure Device(s) (IGREDs) are widely used worldwide. As per AE[RP]R, 2004; users in India can use AERB approved IGREDs only. Compliance to this requirement helps not only in ensuring acceptable level of safety of operators of such devices but to the public under normal and accidental conditions. For this purpose, a set of tests such as endurance test, shielding efficiency, lock breaking etc. are stipulated in AERB safety standard No. AERB/RF-IR/SS-1(Rev.1) formulated in line with ISO: 3999, needs to be performed on the device. On successful demonstration of these tests, AERB issues the Type Approval certificate. In this article, we have reported the details of tests to be performed for gamma sources based industrial radiography devices, respective tolerance limits, measurement methods and other safety features like safety interlocks etc. The regulatory experience gained from the review of first-of-a-kind Co-60 based IGRED BRIT COCAM-120 is also included in this article.

Keywords: Type Approval, NDT, Gamma source, IGREDs, AERB

Radiation Surveillance Procedure in Industrial Radiography

G Bokam, S Pathak, G K Panda, P Tandon, and P. K. Dash Sharma

Atomic Energy Regulatory Board, Mumbai

E: ganeshbokam@aerb.gov.in

Abstract

Ionizing radiation sources find wide applications from medical to industrial and agricultural purposes. One such industrial application is industrial radiography for non-destructive testing (NDT) of materials to find defects. It is of paramount importance to ensure the safety of radiation worker and general public during handling of radiation sources. Industrial radiography is a unique practice which involves frequent movement of relatively high activity radioactive sources from one site to another and therefore safety and the security of such sources requires special attention. Radiation surveillance is the measures to ensure adequate protection against these sources, such surveillance includes safety assessment, measurements and reviews performed etc. Rule 27 of AE (RP) Rules, 2004 establishes the requirement of radiation surveillance. This paper brings out a comprehensive account of the radiation surveillance procedures for planning, design, operation and decommissioning of industrial radiography facilities and inspection and maintenance of radiography devices. Radiation safety requirement of industrial radiography personnel, security of radioactive sources is also included in this paper.

Keywords: radiation surveillance, NDT, industrial radiography, safety

An Assessment of Radiographic Image Detector Technology

Vikash Behari¹, Ritwick Jana²

BHGE, JFWTC, Bangalore India

Vikash.Behari@bhge.com ; Ritwick.Jana@bhge.com

Abstract

With the advent of new technology and continuous demand of improving the detectability and also the throughput of the inspection process, it is imperative that the radiography inspection method moves from analog to digital.

Increased defect detectability, easier inspection and higher throughput are mainly provided by detector and software developments. GE detector technology in combination with software enhancement filters like the GE Flash! Filters improves image quality and changes the way of system operation.

As there is never a perfect scenario in the actual life. So, even with advancement in technologies, it is also noticeable that a majority of radiography work is still carried out by film with valid reasons under many circumstances.

The presentation will cover the brief about film to the latest digital detector technologies and it will provide the audience with basics of different detectors and the clear comparison among them along with silent features and disadvantages too.

The presentation would provide users with details and data in a simple form so that they may judiciously decide to select the technologies as per their requirement.

Keywords: Film, Computed Radiography, Digital Radiography.

Laser scan of Butterfly valve for Corrosion Damage Assessment of Hydropower Plant

Kishore kumar Gulipilli and M.Janardhana

Materials Technology Division, Central Power Research Institute, Bangalore-560080, India

E-mail :kishorekumar@cpri.in, janardhana@cpri.in

Abstract

In India the sources of power generations from hydroelectric power plants is about 22%. The butterfly valve of penstock is considered to be one of the major components in hydro power plant and it is critical in nature. The butterfly valves have been used as the guard and emergency shut-off valves to upstream of the turbines, where normal flow velocities seldom exceed about 4.5 to 6 meters per second. Corrosion of butterfly valve is a major issue to be assessed in order to eliminate the water leakage & damages. The water flow through butterfly valve becomes extremely important to ensure hydraulic efficiency and overall plant structure including inhabitations safety. Condition assessment of butterfly valve to detect corrosion and to estimate the remaining shell wall thickness is important parameter to ascertain the hoop stress. Presently conventional method such as ultrasonic thickness measurement is employed to know the exact remaining wall thickness. As this is of a spot inspection type, which needs proper surface preparation and provide only the thickness of the spot on the butterfly valve shell surface in the corroded region. Estimating the corrosion spread on the total circumferential area using conventional ultrasonic testing method is of cumbersome process, further it is difficult to measure the exact remaining wall thickness on the corroded region.

CPRI used advanced NDT method of Optical Laser scan to assess the exact quantum of external corrosion spread on the surface of butterfly valve including thickness loss and corrosion depth. In this paper discussed the evaluation of corrosion area, determining the metal loss on the butterfly valve shell, corrosion flaws spaced circumferential and evaluating the hoop stress for a safe and reliable operation.

Key words : Hydro power, Butterfly valve, Laser scan and Corrosion.

Non-Destructive Testing and Evaluation of Electrical Steels

Kishore kumar Gulipilli and M.Janardhana

Materials Technology Division, Central Power Research Institute, Bangalore-560080, India

E-mail :kishorekumar@cpri.in, janardhana@cpri.in

Abstract

Electrical steels play an important role in the generation and transmission of electrical energy. The electrical steel is used in transformers and motors as core materials, in sheet form typically 0.23 mm to 0.65 mm thickness. The physical parameters of electrical steel and technical parameters of transformers depend on composition of the electrical steel and type of insulating coating. The same grade of electrical steel sheet from different manufacturers will have different physical parameters. The non-destructive testing (NDT) method is adopted to determine the quality of the electrical steel using for the production and repair of transformers. In this study about 10 nos of different grades of electrical steel and core steel removed from transformer sample is used. The important parameters of magnetic properties are evaluated for these samples. The core steel of transformer is further evaluated using Scanning Electron Microscope (SEM) method.

The quality of electrical steel generally depends on properties of magnetization. This paper highlights the study conducted by CPRI using NDT method to characterize the suitability of electrical steel for manufacture of electrical equipment.

Keywords: NDT, Electric steel, Measurement.

3D Characterization of Ore Mineral Phases Using High Resolution Synchrotron Micro-computed Tomography (μ CT)

A. Fatima^{1*}, A. S. Venkatesh², R. Mukherjee², A. K. Agrawal¹, B. Singh¹,
Y. Kashyap¹ and T. Shripathi³

¹Technical Physics Division, Bhabha Atomic Research Center, Trombay, Mumbai, India

²Department of Applied Geology, Indian Institute of Technology (Indian School of Mines), Dhanbad, India

³UGC-DAE Consortium for Scientific Research, University Campus, Khandwa Road, Indore, India

*Email of the Corresponding Author- afatima@rrcat.gov.in, anees349@gmail.com (A. Fatima)

Abstract

Recent developments in X-ray imaging has led to the extensive application of this technique in the field of geology. Several studies like surface roughness, textural and micro-structural features of rocks have been reported. Synchrotron radiation micro-computed tomography (SR- μ CT) technique has an advantage of high flux and the coherence of synchrotron source and therefore it has been implemented for various studies of the mineral rocks.

In this study, SR- μ CT has been used for comprehensive volume characterization of ore minerals in dolomites and Graphite Mica Schist (GMS). The mineral bearing rocks were also studied by optical microscopy for identification and quantification of mineral assemblages.

Three ore mineral rocks of dolomite type and a GMS rock were obtained by mining process from region near Udaipur, Rajasthan. SR- μ CT allows the volume visualization and quantification of various mineral phases present in the host rocks. The μ CT results show the presence of sulfide minerals like galena, sphalerite and pyrite are present in the ore mineral rocks. Volume percentage of minerals has been obtained using the segmentation of tomography slices of the rocks. 3D images of SR- μ CT show the spatial distribution of the crystals of mineral and their association with the host rock. The study of interfacial area in 3D could be important for the mineral liberation processes.

Keywords: Synchrotron Radiation (SR); Micro-Computed Tomography (μ CT); ore mineral; volume visualization.

Ultrasonic Waveguide Technique for Temperature Measurement using T(0,1) Wave mode

Suresh Periyannan ¹ and Krishnan Balasubramaniam ²

¹National Institute of Technology Warangal 506004, India

²Indian Institute of Technology Madras Chennai 600036, India

Contact e-mail: sureshp@nitw.ac.in

Abstract

This paper describes a technique for measurement of temperatures at multiple locations using the multiple waveguide configurations. A single transducer has been used for transmitting and receiving the torsional wave T(0,1) mode in the waveguides. Here, a single transducer is attached to multiple waveguides of different lengths (each waveguide with a single bend). This method improve upon the earlier reported studies using straight waveguides, where the non-consideration of the temperature gradient issues. The temperature measurement range is from room temperature to maximum utility temperature of the waveguide material. The time of flight difference (Δ TOF) of reflected ultrasonic torsional guided wave modes (T(0,1)) from the bend, which is the reference signal, and another signal from the end of the waveguide is utilized to measure the corresponding temperature of the surrounding media. The T(0,1) wave mode is less dispersive as compared to L(0,1) mode in the same material from the early reported work. The wavelength of the T(0,1) mode is significantly smaller than that of L(0,1) mode and torsional velocity is also less than longitudinal velocity of ultrasonic sensor. Hence, it can be improved the sensitivity of the temperature measurements. This temperature measurement technique is more interest in several industrial applications, where involving the furnaces and melters.

Keywords: Ultrasonic transducers, Multiple bent waveguide, Elevated temperatures at different depths, Temperature measurements.

Development of Methodology for Quality Assurance and Inspection of Stainless Steel Filter Frames

Shivam Sundaram, M.V. Kuppusamy and B.P.C Rao

Fast Reactor Fuel Cycle Facility

Indira Gandhi Centre for Atomic Research, Kalpakkam, TN – 603102, India

e-mail: masakuppu@igcar.gov.in

Abstract

In nuclear facilities, HEPA filters are used to arrest undesired particles above a certain size present in exhaust/air ventilation systems, before releasing into open atmosphere. These filters are mounted on filter frames. A gasket is used to accommodate proper seating of filter over a frame. Filter frame, when assembled with HEPA filters, should allow movement of air through filter only. No observable leakage for a holding time of minimum 30 minutes qualifies the frame. Achieving close dimensional tolerances such as co-planarity, flatness, perpendicularity and surface roughness is a major requirement during the fabrication of filter frames.

This presentation describes various activities as a part of field quality assurance (QA) carried out during fabrication of SS filter frames, so as to ensure fulfillment of the design requirements. The filter frames are fabricated by welding SS304L channels of thickness 6mm using GTAW process. All the welding is carried out by using qualified welding procedure and welder as per ASME sec IX. A comprehensive field quality assurance plan has been developed and adopted during the fabrication of filter frame of different sizes to ensure the fulfillment of design and functional requirements. To achieve desired level of attributes, appropriate sequence of welding, suitable fixture and proper cooling to reduce heat to prevent distortion of the filter frames have been implemented. Meticulous QA as well as NDE inspection at shop floor have ensured flatness within 1.5mm/150mm length, co-planarity within 0.4mm, perpendicularity within 1.3 mm/m and dimensional tolerance within 2mm/ 610mm. Details of the methodology developed and implemented by the authors for QA and inspection of SS filter frames of FRFCF will be given in the presentation.

Keywords: Quality Assurance, GTAW welding, Fabrication, HEPA filters

Development of Vacuum Cup to ensure leak tightness of Terminal pipeline weld joints in Nuclear Projects

Shri. G.Kaliamoorthy¹, Shri. G.Ramesh¹, Shri. Athmalingam¹, Dr. B.Venkatraman¹

¹Quality Assurance Division, SQ&RMG, IGCAR, Kalpakkam, India.

Email:- kalia@igcar.gov.in;

Abstract

Process vessels, equipments and connected piping systems for nuclear application are mostly made up of SA 312 grade 304L and welded construction using Gas Tungsten Arc Welding (GTAW) process to achieve clean root & final welds in pipes. Stainless steel piping systems having pipe lengths of 10 to 12 meters are fabricated, inspected and erected inside concrete shielded cells. Piping systems between different concrete cells transfer service fluids through embedded SS pipes in concrete cell walls. Each pipe lines from the process tanks/equipments inside cells are terminated and connected to these embedded pipes either inside or outside of the concrete wall to integrate with the other piping systems by welding. Such critical & terminal pipe weld joints having sizes ranging from 8NB to 25NB with schedule 40 are to be ensured for soundness and leak tightness. In order to ensure stringent technical requirements, an effective QA Plan was drawn and implemented with required welding stage inspections like fit-up inspection, Root & final weld LPE, RT & final Pneumatic test and soap bubble leak tests for each pipelines.

After integration, Pneumatic leak test of these terminal joints near the walls could not be possible due to large volume of piping systems including tanks & vessels are to be pressurized. For effective operation of plant without any leaks during the planned service life of these systems, it is necessary to ensure the leak tightness of the terminal joints.

A vacuum cup was designed to suit to various combinations of terminal pipe weld joints and demonstrated a methodology for leak tests. On successful demonstration, a test procedure was developed, standardized and implemented into the actual system. This paper discusses a new approach used to ensure the effectiveness of leak tightness of the terminal joints of the piping systems.

Key words: Piping system, Terminal joints, Vacuum cup, Leak test, Welded joints.

Phase Sensitive Detection of Extent of Corrosion Using Anisotropic Magneto-resistive (AMR) sensor in Steel Reinforcing Bars (Rebars)

Indrani Mukherjee¹, Jinit Patil¹, Sauvik Banerjee^{2,*} and Siddharth Tallur^{1,**}

¹Department of Electrical Engineering, Indian Institute of Technology (IIT) Bombay, Mumbai, India

**stallur@ee.iitb.ac.in

²Department of Civil Engineering, Indian Institute of Technology (IIT) Bombay, Mumbai, India

*sauvik@civil.iitb.ac.in

Abstract

We report the development of a portable, high-sensitivity, inexpensive sensing platform based on continuous-wave eddy current detection using anisotropic magneto-resistive (AMR) sensor to measure the extent of corrosion in steel reinforcing bars (rebars). The technique uses significantly less complex instrumentation compared to pulsed eddy current sensing and assumes no technical expertise for the operator in the field. The scheme employs phase-sensitive detection, whereby the phase shift in the sensor output (proportional to surface conductivity of the rebar) measured by a lock-in amplifier is used to distinguish corroded rebars from non-corroded rebars. The proof-of-concept scanning sensor demonstration is able to resolve varying extents of rebar corrosion, and can find potential applications as an NDT tool in construction, pipelines and several other industries.

The sensing system consists of an AMR sensor located inside a 3D assembly containing two coaxial cylindrical coils (solenoids) carrying equal currents in opposite directions. This design minimizes misalignment of the AMR sensor to the axis of the coils during scanning. The currents are adjusted in circuitry such that the total magnetic field at the AMR sensor due to both coils is nullified when there is no ferromagnetic sample present. This allows the AMR sensor to selectively measure the magnetic fields due to the eddy currents in the rebar under test. The circuit consists of preamplifiers and potentiometers (for current equalization), power amplifiers (for high current drive) and lock-in amplifier (reference AC excitation of 1kHz, to detect phase shift due to sample).

The sensor is tested on a steel rebar with regions of varied levels of corrosion. Three regions on the sample are identified as un-corroded, moderately corroded and highly corroded with average diameters as 20.61mm, 19.57mm and 17.85mm respectively. Our apparatus is able to reasonably distinguish and resolve voltage and phase values with >3-sigma resolution for the different regions. While the amplitude shows a decreasing trend, the phase shift is observed to increase with the extent of corrosion. Since corrosion leads to loss of ferromagnetic material and its conversion into iron oxide, these trends are intuitively justified. Since corrosion is slow and gradual, the changes to be sensed in incipient stages of corrosion can be miniscule, hence the choice of extremely sensitive AMR sensors and lock-in detection. Our future work will focus on optimizing the sensor assembly and measurements with various lift-off levels on rebars embedded in concrete, to enable a truly portable and field-deployable sensor system.

Keywords—corrosion; reinforced concrete beam; anisotropic magneto-resistive sensor; lock-in detection; non-destructive testing

Development of Ultrasonic Waveguide Technique for Fluid Level Sensing using FEA Approach

Abhishek Kumar and Suresh Periyannan

Department of Mechanical Engineering, National Institute of Technology Warangal 506004, India

Contact e-mail: abhik@student.nitw.ac.in

Abstract

This paper reports the development of ultrasonic waveguide sensor for fluid level measurement using different types of fluids such as water, glycerin and castor oil. In this technique, a fundamental longitudinal wave mode $L(0,1)$ is transmitted and received (as a pulse-echo concept) in the aluminium waveguide. The concept of level measurement is based on the change in amplitude of reflected signals from one end of waveguide, while waveguide immersed into different depths of fluids medium. The ultrasonic waveguide sensor design is formulated by using Finite element model (FEM) approach for fluid level measurement. Here, the Abaqus 6.12 has been used as FE software to analyze the reflected signal's behaviour for level sensing of fluids. The fluid level measurement is important in manufacturing, process industries, and bio-medical field during process monitoring. This techniques can be used in hazardous and in accessible regions and also, relatively more robust and cost effective technique as compared to existing fluid's level measurements.

Keywords: Ultrasonic transducer, waveguide sensor, level sensing, FEM approach.

Automated analysis of eddy current images for crack detection using advanced machine learning techniques – A Review

Shivappa Goravar, S B Mahalakshmi

Machine Learning & Optimization, GE Global Research, India
Shivappa.goravar@ge.com, mahalakshmi.sb@ge.com

Abstract

Eddy current techniques are widely used in the non-destructive testing for surface and sub-surface cracks in metal objects, which often requires skilled operators or domain experts. The more complex the body geometry gets, the more difficult it is to differentiate crack signals from the part geometry like edges, surface profile along with signal-to-noise ratio and operator variation. To overcome some of the inherent challenges in eddy current signal acquisition like lift-off due to probe wobble, automated scanning systems are being used that produces C-scan image showing structures in a planar view. Further, careful and automated interpretation of these images are required as crack detection or characterization is still a challenging due to low spatial resolution of images. Hence, researchers today are experimenting on machine learning or deep learning techniques to help analyze and automate image processing techniques to accurately detect cracks even in the presence of noise. This paper will particularly review the current progress on automating the classification of eddy current c-scan images using advanced machine learning techniques

Keywords: Eddy Current Inspection, NDE, Machine Learning, Image Processing, Deep Learning

Scheme for Gamma and X-Ray Based Computed Tomography Scanning

Rajesh Acharya^{1, 2,*}, Anant Mitra², Umesh Kumar², V H Patankar³, S Kar⁴

¹ Homi Bhabha National Institute, Mumbai

² Isotope & Radiation Application Division, Bhabha Atomic Research Centre, Mumbai.

³ Electronics Division, Bhabha Atomic Research Centre, Mumbai.

⁴ Electronics and Instrumentation Systems Division, Bhabha Atomic Research Centre, Mumbai.

*corresponding author- email id acharyar@barc.gov.in

Abstract

Computed Tomography is a radiation imaging technique that generates a map of overall bulk density distribution across a plane or volume of sample under scan. For non-medical applications, it is challenging to device a data acquisition set-up because of the large variety in geometry, material characteristics and variations in defects among others. It usually involves use of higher energy gamma rays or X-rays for better sensitivity in CT images. It requires establishing synchronized and reliable communication among multiple hardware devices. These devices are mainly a radiation source, a multi-axis mechanical manipulator, detector(s) and associated data acquisition system. A typical scan might last for 60 to 90 minutes depending on scan parameters. Exceptions occurring during communication with these devices need to be optimally handled to prevent erroneous data acquisitions. This paper discusses a Multi input Multi output (MiMo) control based software application 'AnuViLe Yantra' developed for remote CT scanning. It controls a multi-axis mechanical manipulator which is connected to master computer using RS232 protocol, a Flat Panel Detector (FPD) which is linked through Transmission Control Protocol over Internet Protocol (TCP/IP). It is possible to set the scan parameters for the mechanical system like initial and final position of different axes, incremental angular step of turntable as well as parameters concerning data acquisition like acquisition time, number of frames to be acquired and data storage location on the drive etc through a master program. Information of X-ray voltage and current, projection geometry and other relevant information can also be entered and set in an output file along with data to support post reconstruction image analysis. Feedbacks from motor drivers, encoders and flat panel are continuously monitored to build a closed loop system and stored for debugging. Any type of direct operation intervention is prevented in the interest of radiation safety and useful data acquisition.

Keywords: Computed Tomography, Cone-beam, MiMo control, Flat Panel detector.

Software Application for Gamma Ray Computed Tomography Data Acquisition with Discrete Detectors

Rajesh Acharya^{1, 2,*}, B S Singh², Umesh Kumar², V H Patankar³, S Kar⁴

¹Homi Bhabha National Institute, Mumbai

²Isotope & Radiation Application Division, Bhabha Atomic Research Centre, Mumbai.

³Electronics Division, Bhabha Atomic Research Centre, Mumbai.

⁴Electronics and Instrumentation Systems Division, Bhabha Atomic Research Centre, Mumbai.

*-corresponding author- email id acharyar@barc.gov.in

Abstract

Computed Tomography (CT) is a radiation based cross sectional imaging technique that requires a sample to be manipulated precisely in a specific geometry to acquire analytically useful data using a relevant nucleonic data acquisition system. This data when reconstructed mathematically forms a CT image which gives the distribution of approximate linear attenuation coefficients of material under investigation. Accomplishing this task requires careful programming to devise a data acquisition strategy. This paper discusses features of control module for the hardware system used to acquire data with discrete gamma ray detectors for CT for industrial specimen. The control system facilitates position control and data acquisition in start-stop-acquire mode. The mechanical manipulator suitable for rotation of small samples up to 10 kg in weight is driven by stepper motors upon receiving programmed instruction from a master computer. Parameters like data acquisition time, number of repeated instances of acquisition, linear motion step size, rotational step size and storing data in text file on the disk at desired location. The master computer is responsible for synchronising the turntable and linear axis with data acquisition system that counts pulses received from a 1 inch NaI (Tl) scintillation detector. Feedback from limit switches is effectively utilised in minimising effect of backlash inherent in mechanical system while reversal of direction of motion. Symmetry of data acquisition offered by parallel beam CT geometry is used to reduce effective total data acquisition time by scanning the sample through 180 degree rotation. Filtered back projection algorithm is used for reconstruction of data to generate CT image. The paper will discuss design details of the prototype unit and some initial results.

Keywords: Gamma ray CT, Nucleonic Data Acquisition, Motion Control, Stepper motors, programmed motion

High Temperature Eddy Current Sensor for Real-Time Structural Health Monitoring of Critical Engineering Components

Chandan Dutta^{1*}, Tarun K. Das¹, Alok Kumar¹, Jayendra Kumar², S. Palit Sagar¹

¹ CSIR-National Metallurgical Laboratory, Jamshedpur, India.

² National Institute of Technology, Jamshedpur, India.

*Corresponding Author: dutta.chandan93@gmail.com

Abstract

Real-time structural health monitoring (SHM) of engineering components exposed to high temperature and pressure is an utmost need. The hostile operating conditions such as elevated temperatures, contraction/expansion, vibrations etc. may lead to catastrophic failure due to creep, thermo-mechanical fatigue or environmental attack (oxidation and hot corrosion). Non-availability of sensors susceptible at high temperature (HT) is a reason to handicap assessment and monitoring of such degradation during operation. Sensors using micro-fabricated sensing element are the promising, non-contact technology that have significant potential in structural health monitoring of critical engineering components operated at elevated temperatures. The present paper addresses this issue by developing application specific high-temperature sensors for real time condition monitoring of the components operated at high temperature. The goal is to provide superior performance for in-situ material condition monitoring (material degradation, flaw detection, stress relaxation, and/or creep monitoring) and through-wall temperature measurement. The sensor consists of a micro-fabricated primary (drive) winding and a secondary winding adjacent to the primary for sensing the response to a material under test. Multiple coils are cascaded / stacked together to increase the SNR and sensitivity of the sensor. The effectiveness of the proposed technique is first demonstrated on synthetic dataset from an eddy current simulation model. Further work is being underway for addressing the issues at elevated temperature.

Keywords: Eddy current, creep, micro-fabricated, glass epoxy, SNR, sensitivity

Thickness Estimation of Marine Structures Using an ROV Based Pulsed Eddy Current Technique

D Ashish Antony Jacob¹, (a), Santhosh Ravichandran¹, Vineet Upadhyay¹, Prabhu Rajagopal², Krishnan Balasubramaniam²

¹Planys Technologies Pvt. Ltd., No. 5, Balaji Nagar Main Road, Puzhuthivakam, Chennai, TN – 600091, India

²Centre for Nondestructive Evaluation, Machine Design Section, Indian Institute of Technology (IIT), Madras, Chennai, TN – 600036, India

(a)ashish.aj@planystech.com

Abstract

Jacket-type steel members are widely used in near and offshore structures wherein tubular members are welded together to either form or protect the load carrying member. Tubular joints are subject to damage as a result of fatigue, marine growth and corrosion from the environment. These structures are conventionally inspected for loss of wall thickness and pitting to prevent catastrophic damage and improve failure prediction systems using the conventional ultrasonic testing (UT). However, especially in the case of marine structures, direct access to the structure is hindered by marine growth, insulation or coating. Surface preparation is an essential step before conventional nondestructive testing modalities can be used. Marine growth is removed using powered brushes, high-pressure water jets or in some cases, manually using chisels causing the procedure to be time consuming and expensive. An alternative technology which can be used for wall thickness estimation without removing marine growth (that is thicker than 10 mm) is pulsed eddy current (PEC) which uses a stepped input signal to detect wall-thinning areas. In this paper, the authors present a methodology of rapidly estimating thickness of the steel members in the splash-zone and deeper underwater zones using PEC without removing marine growth or insulation on a remotely operated robotic vehicle (ROV). The results are compared to the conventional ultrasonic testing methodology performed both by professional divers and an ROV using a commercially available 2.25 MHz ultrasonic transducer. Key advantages and limitations of the ROV based PEC system are discussed in detail.

Keywords: pulsed eddy current, ultrasonic testing, remotely operated vehicle

Industry 4.0 and NDT

Dharmveer Singh

GE Power India Limited, Durgapur, WB, India | E: dvir_singh@yahoo.com

Abstract

Centuries ago, goods including cloths, houses, weapons gave birth to industry where those goods were manufactured by hands and later with the help of the animals. Various need based inventions started the introduction of industry which replaced house/individual owned business to organisation, focussing on the increase in the production. Water and stream based machines were invented and developed to help the workers. This industrial time of 1800s is known as industry 1.0. At the beginning of 20th century, when electricity becomes the prime source of the energy, mass production started taking place. This industry era is named as Industry 2.0 At the starting of early 1970, atomisation was the prime factor, industry were thriving for and this industrial period in called Industry 3.0. The era started from early 2010 when Industrial internet, Internet of things, digital disruption including cloud computing played a major role when machines started talking to man through internet is named as Industry 4.0.

On the other side, even though the NDT was available in the history of mankind in unstructured way since long and surface NDE was documented and structured in second half of 19th century and volumetric examination started playing a major role in the industry at early of 20th century but it was world war-I when industry started taking NDT more seriously.

This paper is an attempt to analyse the what the is future of NDE and what role NDE is going to play in the era of Industry 4.0 or later and whether current NDE industry is ready to cop up with latest industrial revolution.

Keywords: Industry 4.0, Internet of Things, NDE

TFM Imaging Of Thick Section Composite Materials

Siva Y¹, Satheesh Jeyaraman² and Sivaramanivas R²

¹BHGE, JFWTC, Bangalore, India

²GE Global Research Center, JFWTC, Bangalore, India

Siva.y@bhge.com, Satheesh.jeyaraman@ge.com, sivaramanivas.r@ge.com

Abstract

Recent developments in Ultrasonic NDT such as Full Matrix Capture (FMC)/ Total Focusing Method (TFM) are providing high resolution images. There are however few challenges in inspecting thick section composite materials using FMC/TFM. Carbon Fiber Reinforced Plastic (CFRP) materials used in aerospace industries are anisotropic by design. 3D reconstruction of defects is a challenge. This paper addresses the effect of frequency, sub-aperture size and thereby the effect of beam directivity on TFM reconstruction. TFM reconstruction of thick section composites is further complicated by the attenuation from plies. The effect of array parameters and material attenuation are simulated using CIVA software. The results are compared with experimental data from Mentor UT platform.

Keywords: Anisotropy, FMC/TFM, CFRP, Ultrasonic NDT

Study and Comparison of Different Halbach EMAT Configurations for Ultrasonic Guided Waves

Siddharth Shankar, Krishnan Balasubramaniam

Centre for Nondestructive Evaluation, Mechanical Department, IIT Madras, Chennai, India

Phone: +91 44 22575688, Email: siddharth@thebw.in

Abstract

Electromagnetic acoustic transducers (EMAT) are increasingly seen as a viable alternative to piezoelectric transducers since it does not require a coupling medium. One of the attractiveness of EMATs is that it can generate the fundamental shear horizontal (SH) wave mode, which is especially useful in ultrasonic guided wave inspections due to its non-dispersive nature. The Periodic Permanent Magnet (PPM) EMAT is a common EMAT configuration used to produce SH waves. This paper presents a similar, alternative, Lorentz force powered EMAT configuration for SH wave generation. The Halbach EMAT uses a magnet array pattern, the Linear Halbach array, which comprises of magnets arranged and oriented to augment the magnetic field on one side of the array while drastically reducing the magnetic field strength on the opposite side of the array. To assess the responses produced by various Halbach EMAT configurations, simulation models of the EMATs were developed on Aluminium plates and the results of the models are experimentally validated.

Keywords: EMAT (Electromagnetic acoustic transducer), ultrasonic guided waves, Lorentz force, Halbach array, magnet configuration.

Assessment of Sensitivity of Radioisotope based Radiometry Data during Inspection of Large sized Solid Rocket Motors

Khan Lubna S, Mali Umesh, Ghosh N K, Bhattacharyya S C, Seshadri S1

Advanced Centre for Energetic Materials, Nasik

lubna.khan@acem.drdo.in

Abstract

Conventionally Radiographic Testing (RT) is the best suited technique for inspection of SRM in terms of quality and quantitative results that are obtained. However, in case of large sized rocket motors, full inspection of the rocket motor by RT requires a huge number of exposures and equally longer duration of time. Accordingly, radiography plans are formulated with optimized number of exposures by considering maximum probability for detection of flaws and its characterization.

Present work describes the use of ^{60}Co radioisotope based radiometry technique using PMT based detector for complete inspection of propellant grain in cylindrical region in quick time. The technique is used efficiently to investigate grain defects in large sized rocket motors of web thickness (600mm-1000 mm, double wall).

The technique involves emission of gamma radiation by the radioisotope source, which after passing through the propellant grain is detected by PMT based detectors. The PMT then converts photons into electronic signal which is then processed. Finally a graph of photon counts versus length is obtained which reflects the differential absorption of gamma radiation within propellant grain. Activity of the radioisotope is analogous to the dose rate of conventional high energy X-ray generators.

As the activity of the source depletes with each passing half life, a study was undertaken to assess the sensitivity of the data generated with respect to depleting activity of the radioisotope in terms of SNR. Different sets of experiments were performed by inducing artificial defects on the surface of the SRM. Data was generated by varying scan speed, step of scanning and PMT based detector collimator opening size for good SNR values. The results were analyzed and the suitability of the use of technique with depleted activity was arrived.

Key words: Radiometry, SNR, half life, PMT, radioisotope

Making the Shift from CapEx to OpEx for Ultrasonic Flaw Detector Equipment

Mr Chris Udell

Product Manager, Proceq SA, Ringstrasse 2, CH-8603, Schwerzenbach, Switzerland
chris.udell@proceq.com

Abstract

A well-established trend from the IT industry regarding switching from upfront, outright purchases to new business models, named “as-a-service” offerings (e.g., pay-by usage or subscription models) is transferring into other industries. Instead of having high fixed costs/ CapEx, the cost of purchasing can be translated into variable costs/OpEx. What this is specifically referring to is cash flow, and specifically the timing of cash outlays.

For inspection service providers, who are typically cash-flow sensitive, the evolution from CapEx equipment purchases to Products-as-a-Service can be a powerful tool in optimising their cash flows as equipment purchase expenses consolidate into a predictable, fixed set of OpEx costs and minimise a one-time over-investment in flaw detector inventory.

This paper will model and quantify the benefits and balance between the reduction in CapEx and the increase in OpEx for inspection service organisations of various size.

Improved Nonlinear Ultrasonic Detection of Imperfect Joint using Waveguide Metamaterial Rod

Sandeep Kumar S R, Krishnadas V K, Krishnan Balasubramaniam, Prabhu Rajagopal

Center for Non-Destructive Evaluation (CNDE), Department of Mechanical Engineering, Indian Institute of Technology Madras, Chennai 600036 | E: sandeepkumariitm@gmail.com

Abstract

Nonlinear Ultrasonics Guided Waves (NLUGW) has been used for the enhanced inspection of structures by increasing the sensitivity of measurements to detect micro cracks and defects owing to their high sensitivity and long-range propagation. Measurement of higher harmonics due to material nonlinearity is crucial in characterising defects or artefacts. However, in practice the measured nonlinearity will include nonlinearity from instrumentation, transducer and couplant which may lead to false positives and inaccurate measurements. To improve the measurement of material based nonlinearity here we propose a new technique of using a waveguide metamaterial rod which creates bandgap wherein unwanted higher harmonics are suppressed. This was achieved by using a waveguide metamaterial rod made of Aluminium which consists of an array of baffles on the surface arranged periodically in axial direction. Firstly, the capability of the waveguide rod in suppressing the higher harmonics in the transmission side is demonstrated. Later, a discontinuity in the form of an imperfect joint was introduced in the sample rod and the higher harmonics due to the discontinuity was captured successfully. Thus the measurement of an imperfect joint in the cylindrical rod was recorded more accurately as it is free of unwanted nonlinearities. The proposed technique can help in improving ultrasonic measurements in potential applications such as waveguide sensors for critical Structural Health Monitoring (SHM) applications.

Keywords: Metamaterials, Waveguide, Cylindrical rods, Nonlinear Ultrasonics, Higher Harmonic Suppression, Imperfect Joint detection

Improving ultrasonic inspector productivity with modern, mobile technology

Mr Chris Udell, Product Manager,

Proceq SA, Ringstrasse 2, CH-8603, Schwerzenbach, Switzerland

E: chris.udell@proceq.com

Abstract

The processing power of today's smartphones, tablets and wearables are thousands of times greater than the computers that landed a man on the moon in 1969 and each year improve further. Using these devices can be seen to be as big a change to ultrasonic inspection systems as when the switch from analogue to digital systems occurred, because of the benefits it offers the asset owner, primarily, and the tools and aids it offers the inspectors.

Using examples from the main users of ultrasonic flaw detectors, including inspection service providers, asset owners, manufacturers and fabricators, this paper will show how mobile solutions redefine the user-interfaces and flexibility of ultrasonic flaw detectors to something that feels more natural and familiar to a new user. With this, we will show how gesture driven UI can help reduce total product costs and improve productivity. We will also reveal how digital solutions lead to more accurate, timely and consistent results with less effort and potential for errors and will be disruptive to the traditional way of performing inspections and the management of collected data.

Ultrasonic Back Projection Imaging

Calum Hoyle^{1/2}, Mark Sutcliffe¹, Peter Charlton², Stephen Mosey², Ian Cooper¹

¹ TWI Wales, Harbourside Business Park, Harbourside Road, Port Talbot, Wales, UK, SA13 1SB

² University of Wales Trinity Saint David, Technium 1, Kings Road, Swansea, Wales, UK, SA1 8PH

calum.hoyle@outlook.com

Abstract

In radiography the back projection method is used to reconstruct images of an object that has been subjected to a minimum of 180 degrees of rotation, to allow full coverage of the item. This paper explores the possibility of using the back projection method to generate images of defects within a test material specimen using two ultrasonic transducers in through transmission configuration to transmit and receive the A-scan signals. The rotation of the transmitter and receiver is not possible in this setup, therefore the reconstruction relies on the artificial generation of a limited rotation. Two probes are aligned either side of the material, and are used to gather the ultrasonic signals. These signals are processed before the reconstruction algorithm is applied to them. Various processing and imaging reconstruction algorithms are explored building on the basic back projection method to obtain better focussed images. This technique could be used within materials where the attenuation is high, such that traditional pulse echo is not feasible.

Keywords : Ultrasonics, Back Projection, Image Processing

Inspection of Friction Stir Welded Joint using EMAT Generated Fundamental Shear Horizontal Guided Wave Mode (SH0)

Nived Suresh¹, Sreedhar Puliyakote¹, Krishnan Balasubramaniam¹

¹Centre for Non-Destructive Evaluation, IIT Madras, India

Corresponding author nivedkvr@gmail.com

Abstract

Friction Stir Welding (FSW) is unique in terms of the mechanical properties and metallurgical structure of the joint. Like any other weld joints, FSW joints have some characteristic defects generated during to the joining process. These defects lead to reduction in the overall quality of the weld, thereby weakening the joint over time. Thus, there is a need for an inspection technique to evaluate the weld quality in FSW joints. The fundamental SH0 mode offers the unique advantage because of its non-dispersive nature. SH waves are very difficult to generate through conventional ultrasonic generation methods, but Electro-Magnetic Acoustic Transducers (EMAT) have proven to be very efficient in this aspect. In this paper, we present an inspection technique involving Shear Horizontal (SH) Ultrasonic waves that gives a qualitative view of FSW joint in aluminium plates. Studies were conducted on a 2.5 mm aluminium plate with a friction stir welded butt joint, with SH waves of wavelength 6.35mm wavelength generated by EMAT probes. The configuration of the EMAT transducers was in such a way that the receiver measured the specular reflection from the weld line. The method was found to be useful in detecting defects in the weld-line. Results from EMAT inspection are compared with radiographic images.

Keywords: Friction Stir Weld, EMAT, Shear Horizontal mode

Coded Excitation for Low Power Operation and Fast Acquisition in Guided Wave Ultrasonic Non-Destructive Evaluation

Shashvat Jayakrishnan¹, Dileep Koodalil², Nived Suresh², Krishnan Balasubramaniam²

¹Department of Instrumentation and Control Engineering, National Institute of Technology Tiruchirappalli, Trichy - 620015, India

²Centre for Non-destructive Evaluation, Indian Institute of Technology Madras, Chennai - 600036, India

Corresponding author 1shashvatjk@gmail.com

Abstract

Ultrasonic Non-Destructive Evaluation (NDE) techniques are widely used to ensure the integrity and strength of structures. Guided Ultrasonic Waves are typically used for inspecting inaccessible and hidden locations of complex structures. For rapid inspection, non-contact transduction methods such as Air-coupled ultrasonic transducers and Electromagnetic acoustic transducers (EMAT) are preferred. However, the major downside of these techniques is the high power requirement. To overcome this challenge, a pulse compression based coded excitation technique has been developed. By using temporally long low power transmission signals, we report results comparable in SNR to high power transmissions without compromising on the energy budget. With this technique, we have achieved 6000 fold increase in the power efficiency for EMATs; reduction from a conventional 1200Vpp to a mere 200mVpp of supply voltage.

Keywords: Coded excitation, Guided waves, Non-Destructive Evaluation

Application of Phased Array Ultrasonic Testing (PAUT) for NDT of Tungsten Flat Tile Type Plasma Facing Components

Kedar Bhope¹, Mayur Mehta¹, K. P. Singh¹, Samir Khirwadkar¹

¹Institute for Plasma Research, Bhat, Gandhinagar-382 428, India

Email: kedar@ipr.res.in

Abstract

Divertor is a Plasma Facing Component (PFC) which acts as an exhaust by extracting the heat and particle fluxes escaping from plasma for ITER like fusion device. Flat tile type divertor PFCs are actively cooled targets made as multi-layered constructions from various materials, namely Tungsten as plasma facing material, OFHC copper as an interlayer and CuCrZr as a water cooled heat sink. This component is manufactured by using various joining techniques like copper casting and brazing etc. During the manufacturing processes defects are likely to be introduced at joint interface of the bonded area. One of the quality control steps during fabrication of these components is the ultrasonic testing of bonded region between similar and dissimilar metal joints.

Divertor flat tile type mock-ups are fabricated at IPR and to access the quality of these multi-layered joints using Phased Array Ultrasonic Testing (PAUT), CIVA simulation and experimental studies are performed. Phased array parameters such as no. of elements, focal laws and probe parameters are optimized using CIVA simulation to get desire defect sensitivity of C-scan imaging for different defect scenario. The ultrasonic C-scan imaging technique for 10x10 mm and 20x20 mm tungsten flat tile targets is successfully simulated and experimentally validated using linear phased array probe. Phased array C-scan imaging utilized electronic scanning that helps to substantially reduce inspection time (from hours to seconds) compared to single crystal probe C-scan imaging. This paper presents in details the CIVA simulation and experimental test results of PAUT C-scan imaging of Tungsten Flat tile type PFC targets.

Keywords: Phased array ultrasonic testing, CIVA, Tungsten flat tile, Plasma Facing Components, Divertor.

NDT Inspection of Boiler Riffle Tubes and Laboratory Analysis

M.Janardhana, Kishore kumar Gulipilli, and R.K.Kumar

Materials Technology Division, Central Power Research Institute, Bangalore-560080, India

E-mail : janardhana@cpri.in, kishorekumar@cpri.in, rkkumr@cpri.in

Abstract

The boiler tube failures continue to be the main cause of boiler forced outages and have direct impact on structural integrity of boiler. The boiler water wall tubes are subjected to critical operating conditions such as creep, fatigue, corrosion, erosion and intend to deteriorate. Different types of damage mechanisms take place like tube metal thinning, fire side corrosion, water side corrosion and ID metal loss. Condition assessment of such boiler tubes using NDT methods for the inspection of tubing components in Boilers are UT (Thickness as well as A-Scan, B-Scan, C-Scan, Time of Flight Diffraction, and Phased Array), RT or X-Ray, and EMAT (Electromagnetic Acoustic Transducer) which are practiced regularly to minimize the forced outage of boiler to some extent. The Low Frequency Electromagnetic Technique (LFET) is one of the advanced NDT methods which are gaining importance for assessing the condition of boiler tubes. LFET is used in scanning the water wall boiler tube using non-contact type scanner to detect OD and ID metal loss, which occurs due to corrosion. The latest advancement of LFET allows for continuous metal loss mapping of boiler tubing and LFET techniques have proven their efficiency by finding and selectively replace the damaged tubes.

This paper highlights the case study conducted by CPRI for 500MW power plant boiler riffle tubes. The corrosion mapping study carried at inside furnace at the high heat flux region i.e near the burner zone and inclined tubes, base on thickness survey. During corrosion mapping study it reveals that there is ID and OD metal losses observed and result indicate that there is change in the waveform phase shift during the scanning. Further, the tubes are subjected for laboratory analysis which reveals that pearlite & ferrite matrix, the thinning of grain boundary observed, and high values of hardness noticed during the hardness test are discussed.

Key words: NDT, LFET, Boiler riffle tubes and Laboratory analysis.

Corrosion Measurement on Insulated Pipes

Rasindh K and Sheri George

Inspection Technologies, Baker Hughes, Bangalore.

Rasindh.K.k@bhge.com and George.sheri@bhge.com

Abstract

Cost effective method of detection and measurement of corrosion on insulated pipes is of prime importance to both NDE technologists and practitioners. Authors have developed a Radiography technique-based method for estimating the wall thickness and wall loss measurement on pipe. The method uses a combination of Radiography Physics and Image Processing principles to determine the wall thickness of pipe. It is possible to determine the remaining wall loss on the pipe due to corrosion. This proposed paper describes the features and results of patented technique that was developed. Two sets of experiments were performed on a pipe with different diameter holes drilled on it with and without insulation. The wall measurement and accuracy of the measurement is evaluated at the various view angles. The analysis reveals the probability of detection of the proposed method. Assumptions and possible sources of error for the technique is also discussed.

Numerical study of Phased Array ultrasonic beam parameters affecting the FMC-TFM image resolution for defect characterization

Thulsiram Gantala, Krishnan Balasubramaniam

Center for Non-Destructive Evaluation (CNDE) and Department of Mechanical Engineering,
Indian Institute of Technology Madras, Chennai 600036, India
E: thulasiramgantala04@gmail.com

Abstract

Phased array ultrasonic testing (PAUT) is used to generate varieties of ultrasound profiles (i.e. plane wave, beam steering, focusing) from a single location to produce imaging. Compared to conventional ultrasonic methods PAUT offers better inspection quality and also reduces the inspection time. In Full Matrix Capture, the transmission-reception of ultrasonic waves are performed sequentially. During one sequence, an ultrasonic wave is emitted by one single element of the array and the reception of the correspondent echoes is made by all the elements of the array. Total Focusing Method (TFM) is a post processing imaging algorithm for FMC received array data in which the array is focused every pixel point in the sample grid. The defect characterization like size and shape of defects are mostly effected by the ultrasonic beam parameters (i.e. frequency, pitch, number of the elements, attenuation coefficient). This paper reports the study of the ultrasonic parameters which are affecting the image resolution for evaluating the size and shape of the defect. A series of finite element simulations were done for acquiring the FMC raw data. Later on, this data has been used for constructing the image by using (TFM). This study shows the importance of the ultrasonic beam parameters on defect characterization FMC-TFM.

Keywords: Phased Array Ultrasonic Testing (PAUT), Full Matrix Capture (FMC), Total Focusing Method (TFM), Image Resolution

Effect of Probe Parameters on Defect Detectability Using TOFD Technique on Thin Wall Butt Weld Joints

Siva Y¹, Ezhilarasu Sengottuvelappan¹

¹BHGE, JFWTC, Bangalore, India

Siva.y@bhge.com, Ezhilarasu.sengottuvelappan@bhge.com

Abstract

Time of Flight Diffraction (TOFD) ultrasonic inspection technique is widely used in industry because of excellent probability of detection (PoD) and defect sizing capabilities. In thin wall weld TOFD inspection, scanning surface dead zone (Dds) is the biggest challenge. In scanning surface dead zone, the lateral wave masks top surface breaking and sub surface discontinuities. This can be overcome by proper selection of probe frequency, element size, wedge angle and probe separation. The aim of this work is to conduct experiments on different lower thickness weld joints to validate the effect of probe & wedge parameters on defect detectability. All the inspection experiments were conducted in compliance with BS EN ISO 10863 and BS EN ISO 16828

Keywords: TOFD, Lateral Wave, Scanning surface dead zone, Frequency, EN ISO 16828

Detecting Stress Corrosion Cracking with Eddy Current Array Technology

Dennis Chai¹

¹ Olympus Corporation of Asia Pacific, 438B Alexandra Road #03-07/12, Singapore
dennis.chai@olympus-ap.com

Abstract

The inspection world is always striving for efficiency without compromising accuracy. This paper examines the replacement of Liquid Penetrant and Magnetic Particle testing - two methods that are highly time consuming and limited in accuracy - with Eddy Current technology. Eddy Current has been long known in the aerospace industry for its accuracy in crack inspection of aluminium. Using the same technology, it is now possible to multiplex the signals to create an array of coils (Eddy Current Array). ECA not only provides accurate detection, but permits the creation of a C-Scan image of the returned signal – building a visual reference that is easy to interpret, as well as a means to evaluate depth of the indications. This presentation will discuss the multiple advantages of using Eddy Current Array over other conventional methods and will demonstrate examples of previous inspections for comparison

Keywords: Stress Corrosion Cracking; Eddy Current Array; Eddy Current Technology

Building TFM Procedures for Challenging Inspections such as ERW hook crack, Girth Welds, HTHA and others

Dennis Chai¹

¹ Olympus Corporation of Asia Pacific, 438B Alexandra Road #03-07/12, Singapore
dennis.chai@olympus-ap.com

Abstract

FMC and TFM have shown some promise for improving specific applications in the past few years. However, inspectors using this method are often subject to a lot of trial-and-error to achieve the optimal results. Many challenges are still encountered today in TFM inspection when selecting a propagation mode, for examples effectively preventing blind spots, confirming the angle of reflection, or optimizing for preferential gain direction, etc. The selection of the most appropriate mode of propagation (i.e. imaging path) is critical for an effective TFM inspection and is often problematic and still esoteric for the inspectors. Selecting the right mode of propagation requires extensive procedure development on simulation software to ensure proper detectability and perpendicularity of the beams with the reflectors (defects). This is especially the case for directional defects such as those found in ERW and some girth welds. In this paper, we will describe a wave propagation modelling technique that calculates the predicted signal response in the TFM zone created for both pulse-echo and self-tandem modes of propagation and how it can help the operator to confidently make a decision. Multiple applications will be presented demonstrating the advantages and improvements in predicting, planning and executing TFM inspections.

Keywords: FMC; TFM; HTHA; Girth Welds

Ultrasonic Phased Array Testing In lieu of Radiography Testing for Thin-Walled Heat Exchanger Welds: An In-the-Field User Case.

François-Côme Beaupré¹

¹ Olympus Corporation of Asia Pacific, 438B Alexandra Road #03-07/12, Singapore
francoiscome.beaupre@olympus-ap.com

Abstract

In this presentation, Olympus will share a user case study that demonstrates Dreifeld Materialprüftechnik GmbH successfully inspected thin-walled heat exchanger welds with phased array ultrasonic testing (PAUT) instead of industrial radiography (RT). Using a solution composed of the COBRA® scanner, the OmniScan® MX2 flaw detector, and VeriPhase® Automated Detection Technology™ (ADT) software, one operator fully inspected and analyzed the data of 1604 welds over a period of 8 days. The solution was used in lieu of radiography to help prevent missing indications such as lack of side wall fusion and to avoid complications related to safety. It was estimated that the project was performed five times faster and at a fraction of the cost of radiographic testing. This presentation will summarize the efforts to develop and validate the inspection method in accordance with ISO-20601. The ultrasonic settings, calibration process, inspection workflow as well as data analysis and reporting will be examined. It also aims to review the benefits of this solution, the challenges faced by its deployment as well as improvement perspectives.

Keywords: Ultrasonic Phased Array; Radiographic Testing; Thin-Walled Heat Exchanger Welds; Cobra; Omniscan

In-Service Corrosion Mapping—Challenges for the Industry

François-Côme Beaupré¹

¹ Olympus Corporation of Asia Pacific, 438B Alexandra Road #03-07/12, Singapore
francoiscome.beaupre@olympus-ap.com

Abstract

A typical chemical plant represents a challenge for asset condition monitoring with regards to wall thinning and corrosion. The conditions found in a chemical plant, such as elevated process temperatures, phase separations, flow dynamics, and variations in metallographic properties, make corrosion development and dynamics highly unpredictable.

Maintenance is usually performed at regular intervals within a limited time frame and includes both integrity assessment and repair. Interrupting normal activity for maintenance has huge costs to the plant operator, while the lack of predictability of the corrosion process can lead to wall thinning with consequences like vessel implosion or product leaking into the environment.

In-service inspection in these cases can help avoid accidents and minimize downtime for inspection. Industry requirements for in-service inspection include a high probability of detection (POD) of isolated pits, high sensitivity, and good near-surface resolution for the detection of severe wall-loss areas along with high-temperature capabilities. Some of these demands, including near-surface resolution and good sensitivity, can usually be accomplished by spot-testing with thickness gages while high POD can be achieved using ultrasonic phased array technology.

This paper will discuss general corrosion mapping challenges and focus on specific problems that arise during high-temperature inspection with phased array including suitable probes and wedges, coupling, and inspection methodology.

Keywords: In-Service inspection; Corrosion Mapping; High-Temperature inspection

Extending CT Applications - Large Objects, ROI Scanning and Quantitative CT

N. Shashishekar

VJ Technologies, 89 Carlough Road, Bohemia, NY – USA
shekhar@vjt.com

Abstract

Extending CT applications and the range of any fielded scanner can be a strategic asset for performing 3D CT imaging of objects and assemblies. In some cases, the detector is just too small to cover the entire extent of the object for the standard 180/360-degree scan. Alternatively, sometimes the physical extent and aspect ratio of the object does not support a standard scan at the target spatial resolution for that spot size. Lastly, scanning moderately large, low-attenuating objects is better done with lower energy techniques, but lower-energy scanners often do not accommodate the larger footprint these objects require. This paper presents techniques for performing CT imaging in these circumstances. These include region of interest (ROI) scans, half-scans (offset-scans) and tiled-scans where multiple scans are required to cover the entire object. In each case the advantages and consequences of these choices for the inspection data are covered.

High-energy scanning with LINACs is a context where CT range extension techniques are strategic. Large-area detectors for high-energy scanning can be expensive and require significant resources for fielding and operation. Camera-scintillator and amorphous silicon detectors can be easily configured for high-energy sources and include substantial spatial resolution, but the area coverage is small for the part-size that can be scanned.

Keywords: Range Extension, Industrial CT, Computed Tomography, Spatial Resolution, High Energy

Fast Inline DR & CT Solution for Light Metal Industry, with Emphasis on Automotive Applications

Satya Korlipara

VJ Technologies, 89 Carlough Road, Bohemia, NY – USA
skorlipara@vjt.com

Abstract

Inline DR and CT technology are increasingly being used in industrial applications. In the automotive industry, for example, not only safety components such as wheels, stub axles or wheel carriers are tested, but also components that contribute to energy savings due to a material and thus also a reduction in weight.

Differences between lab and inline test systems are huge, especially considering automation, uptime and speed of ADR. This presentation will cover DR and CT system optimization as it relates to processing time vs. rejection rates, and how things like burrs and casting flash can effect your results.

Data volume is a concern for many, we'll look at DR and CT applications, how to store it, for how long and how to track it. We'll also look at using a full automation mode vs. a double check by a worker, using DR and CT together and the advantages (and disadvantages) of both, as well as future inline CT solutions for fast and flexible inline inspection systems.

Keywords: Inline, DR, CT, Inspection Solutions, Automation, Data, Set-Up Time, Light Metal, Automotive

Development of Lorentz Force Flow Meter Test Setup and its Evaluation with a Moving Brass Plate

T. V. Shyam¹, S. K. Apraj¹, Nirupam Das¹ and S. K. Sinha¹

¹Reactor Engineering Division, Bhabha Atomic Research Centre, Trombay, Mumbai, India
tvshyam@barc.gov.in

Abstract

Lorentz Force flow meter has good prospects for its application in High temperature reactor applications where molten metal alloy based coolants are used. One of the salient features of this technique, is that, it can be employed as non intrusive technique which allows the sensing element to be easily maintainable.

The Lorentz force velocimetry is a non-contact technique for velocity measurement in electrically conducting fluids. It is based on exposing the fluid to a magnetic field and measuring the drag force acting upon the magnetic field lines. The force on a fixed magnet system is measured directly. The measured signal is a linear function of the flow velocity. The paper describes the development of a test setup for Lorentz force flow meter and which can be tested with a moving metal plate at room temperature conditions instead of using molten metal which necessitates the use of expensive high temperature experimental loop setup. The system comprises of a horse shoe shaped magnet system fabricated by means of a rectangular Neodymium Iron Boron (Nd-Fe-B) rare earth permanent magnet with vanadium permendur legs. The air gap in the magnet system provides the space for allowing the passage of the moving metal medium whose velocity or flow has to be determined. The breaking force experienced by the magnet system is determined by means of 'C' shaped member which houses a set of strain gauges and as well as supports the magnet system to over hang from a top mount plate. The moving metal medium is simulated by driving a metal plate through the air gap of the magnet system with the help of a linear actuator system.

Experiments were carried over by moving a brass plate at varying speeds and strain gauge readings were acquired, analyzed and correlated with speed of the moving metal.

Keywords: Lorentz force velocimetry , Vanadium Permendur, Strain gauge

Study of Tensile Instabilities Using Infrared Thermography

Jijith M¹, Sony Punnose¹, Amretendu Mukhopadhyay¹ and Gopinath K¹

¹Defence Metallurgical Research Laboratory
snbyrec@yahoo.co.in, sony@dmrl.drdo.in

Abstract

During an irreversible plastic deformation process, certain fraction of the expended energy converts into heat while the balance is retained in the material as stored energy. The heat generated due to plastic deformation during tensile deformation in turn increases the temperature of the gauge portion of test specimens. Infrared thermal imaging that captures the heat evolution due to dissipative plastic deformation has been used in the present study to analyse different forms of instability during tensile deformation of different metals. Different forms of instability depend upon the material microstructure, strain rate, testing temperature, types of testing machine etc. Infrared thermal imaging technique (IRT) is used to map the strain localization and the spatio-temporal evolution of deformation along the gauge length of the specimens during tensile tests. The study shows that the IRT data can be used as an independent set of data for analysing the complex spatio-temporal evolution of deformation process. Moreover, the results from the IRT provide information about the evolution of deformation locally that cannot be obtained from the global stress strain data. The study highlighted that instability in plastic deformation leads to strain localization in all the cases but the opposite is not always true. Entropy change and evolution of stored energy as function of global stress has been calculated for analysing the thermodynamics of the deformation process.

Detection of Cracks in Stainless Steel Structures Using Transient Eddy Current Oscillations Method

Chandra S Angani, Sudhakar J Ongole and Lokesh Andavarapu

Dept. of Electronics and Physics, GITAM Institute of Science, GITAM Deemed University, Visakhapatnam, India
chandrasekhar.angani@gitam.edu

Abstract

Continuous monitoring and in service inspection of industrial components such as pipe lines in nuclear and oil, natural gas industries is very important to maintain their integrity and failure reduction. For this purpose, there are several types of Nondestructive Testing (NDT) methods are in use, such as Eddy Current Testing (ECT), Ultrasonic Testing (UT). However, always there is a rigorous and continuous research is going on for new developments in the field of NDT. In this context, the present study uses a newly developed nondestructive testing (NDT) method called Transient Eddy Current Oscillations (TECO) to detect cracks in a stainless steel plate. EDM cracks were made having 0.5 mm width and depths of 2.5, 3, 3.5 and 4 mm on the surface of a 5 mm thick SS 304 plate. The TECO method uses an excitation coil and a capacitor connected in parallel as a probe, along with a DC power supply through a relay switch. By ON and OFF the switch, the inductor and the capacitor in the probe generates a decay of oscillations. These oscillations are used to induce the eddy currents in the test specimen which is placed beneath the probe. The resultant magnetic field is detected in the presence of cracks using hall sensor which is placed in the probe. Different time domain features are extracted from the oscillations, such as envelope, energy of the oscillations. The amplitude of oscillations was decreased with decreasing the crack depths and the oscillations decay slowly with increasing the crack depth as shown in the figures.

Keywords: Decay of oscillations, cracks, hall- sensor and stainless steel.

Optically Excited Lock-In Thermography for Evaluation of Delaminations in Basalt Fiber Reinforced Composites

Reshmina Tony A, Kalyanavalli V and Sastikumar D

National Institute of Technology, Tiruchirappalli 620015, Tamil Nadu, India
sasti@nitt.edu

Abstract

Composite materials are increasingly being used in the construction of aerospace and marine structures owing to their light weight, high specific stiffness and strength, fatigue and corrosion resistance and design flexibility. However, during manufacturing processes and maintenance, their mechanical properties may degrade severely in the presence of various types of damages. Delaminations are a common type of defect that occurs in composite structures. In this study, a nondestructive testing technique based on Lock-In Thermography is proposed to detect the delaminations in basalt fiber reinforced composite specimens.

Keywords: Lock-In Thermography, Basalt fiber reinforced composites, delaminations

Defect Quantification of Glass Fiber Reinforced Polymer Curved Composite through Pulsed Thermal Non-Destructive Evaluation

R.Gomathi¹, M.Ashok¹, M.Menaka² and B.Venkatraman²

¹National Institution of Technology, Tiruchirappalli-620015, India

²Health Safety and Environment Group, Indira Gandhi Centre for Atomic Research, Kalpakkam-603102, India

E: ashokm@nitt.edu

Abstract

Glass-fiber reinforced polymer (GFRP) curved composites are superior over the pre-existing alloy steel pipes due to their excellent corrosive resistance properties. Since, alloy steel materials get corroded by the environmental conditions such as mud deposition, exposition to oxygen and moisture (humidity, vapor and immersion), which makes alloy steel material maintenance is expensive. GFRP composite material is replacing over conventional steel materials at low temperature and pressure applications in various industries. GFRP finds wide applications in transportation of petro-chemicals (crude oil & gas), chemical storage tank, power and water treatment plants. Among the service defects in GFRP pipes, pitting or wall loss is one of the severe defects which can be internally produced in service stage due to material deterioration and the friction of small particles on the transfer fluid. The present study investigates these service discontinuities such as pit or wall loss defect on GFRP pipe by pulsed thermal NDE technique. Thermal data is affected by noise and uneven heating on the sample (curved). Hence, it is common that the signal-to-noise ratio (SNR) is low and the defect detectability of IR images is low as well. To rectify the noise thermal signal reconstruction was applied. The paper focuses on quantification of defect depth using the temperature peak contrast derivative and defect sizing by full width half maximum method and further investigates the ability of pulsed thermography to estimate the pitting or wall loss defect at various depths through simulation and experimental verification. The results of the present study are compared with well established ultrasonic C-scan results for verification purpose. The detailed preparation methodology, simulated quotient, experimental analysis and theoretical evaluation are clearly presented.

Keywords: Glass Fiber Reinforced Polymer (GFRP) pipe, Thermal Signal Reconstruction, Pulsed thermography, Finite Difference Method, Ultrasonic C-Scan.

Ultrasonic Imaging for Quality Evaluation of PHWR Fuel Bundle Endplate to Element Welds

B.V. Shiva Reddy¹, A. Vishwanath², Anish Kumar², B. Kamalesh Kumar¹, K.S.Subramanian¹, Komal Kapoor¹

¹Nuclear Fuel Complex, Hyderabad, India

²Indira Gandhi Center for Atomic Research, Kalpakkam, India

E: bvsreddy@nfc.gov.in

Abstract

Indian Pressurized Heavy Water (PHWR) fuel bundle is cluster of fuel elements welded on both sides to endplates. The coolant flows through the open cross-sectional area of the endplate. Due to swirling action of fluid on the endplates, the weld is subjected to torsional load. Hence, endplate to fuel element weld is tested for torque strength.

The bundle integrity depends on the quality of endplate to elements weld. At present, the bond quality is ensured by visual inspection and evaluation on sample basis using destructive testing. Therefore, it is required to develop a suitable non-destructive testing (NDT) technique to assess the quality of the endplate welds of fuel bundles before they go into the nuclear reactors.

The present study comprises of development of ultrasonic imaging-based methodologies for quality evaluation of endplate welds. Toward this, end plate weld samples with varying amount of heat input to weld were prepared to generate weld joints of different quality. These weld samples were subjected to ultrasonic testing (UT). The weld spot area and weld quality was assessed by using various methods viz., C-scan based on (i) 1st back wall echo amplitude from end plate (ii) Amplitude ratio (iii) Time of Flight (T.O.F) and B-scan based on (i) T.O.F (ii) amplitude drop.

The weld is then subjected to destructive testing by torque measurement for failure and a metallographic study on weld spot is done. The weld spot area calculated by different U.T methods are compared with the torque strength of the weld and weld spot area determined by stereo imaging. There is a positive correlation between area measured through U.T and torque strength of the weld. Therefore, weld qualification is done by setting a threshold value for area obtained through U.T based on threshold value of torque strength for weld to qualify.

Key words: Amplitude drop, Amplitude ratio, 1st back wall echo, Time of flight, B-scan, C-scan, Torque strength, Weld spot area, Ultrasonic imaging, Quality control.

Applications Of Thermography For Condition Monitoring Of Power Plant Equipment - CPRI Experience

T. Mallikharjuna Rao

Central Power Research Institute, Bangalore, India. E: tmrao@cpri.in

Abstract

The thermo graphic technique which is one of the versatile NDT technique is based on infrared radiation and will detect the local hot spots instantaneously without any contact. This technique can be used online that is without disturbing the intended function of the particular equipment.

The Transformers constitute vital components in Electrical power system. Most utilities and big industries use large number of transformers of various ratings in their system. There has been several reports of unforeseen, premature failures of transformers in service and there is growing need to monitor the transformer in operation. At present there is no proven and reliable technique for assessing the health condition of on line transformers. Same as the case with the switch yard equipment.

This paper describes assessment the health condition of the transformer and switch yard equipment by the "Thermo-graphic Inspection". Whenever there is any fault / abnormality in the transformer while in service like Insulation weakness, terminal disorder etc. it will reflect as temperature rise on the surface called hot spots. Similarly the switch yard equipment like busbar, CT, PT and different joints reflect their abnormality as temperature difference and can be detected as hot spots.

Similarly the paper also describes the condition assessment of another boiler insulation by this thermo-graphic technique by which good amount of energy can be saved.

Keywords : Thermography , Emissivity, Transformers, CTs, Boiler

Non Destructive Inspection of Replaceable Tooth Flank Used in Gear Rim Applications: A Failure Analysis Case Study

R. Sahoo^{1*} and T.K. Sahoo¹

1 – Advanced Materials Technology Department

CSIR-Institute of Minerals and Materials Technology, Bhubaneswar-751013

Email: raja@immt.res.in

Abstract

Tooth flanks used in gear rim applications of iron ore pelletizing plant getting failed frequently, and the failures should take place in other suspected flank. The load-carrying behavior of gears is strongly subjected by local stress concentration induced in the tooth root and by Hertzian pressure transmitted into the tooth flanks. The pressure on flank causes cracks initiation below its surface. The crack usually grows in two directions: (a) into the core of the tooth and (b) towards the surface of the flank. The objective of the study is to detect crack through Non Destructive Inspection (NDI) and ascertain the probable cause & causes of failure to occur to the part based on examination by studying its chemical, metallurgical, and mechanical properties. Ultra-sonic Inspection has been carried out on many tooth flanks fitted in the gear rim. It observed that a subsurface crack present in the core region, i.e., 43mm from the side surface of the tooth flank found. The inspected and identified tooth flank taken for failure analysis. After cleaning, Liquid Penetrant Test (LPT) was carried out and found a longitudinal centreline crack exists which propagating from core to the surface towards the trailing edge. Samples identified near the cracked region & surface for metallographic analysis through Optical, Scanning electron microscope, and Electron probe microanalyzer. The microstructural features show the presence of many isolated micro-cracks & their orientation and inclusions. The microstructure also observed under FESEM and EPMA with EDS analysis. The presence of the martensitic phase at sub surfaces and Pro-eutectoid cementite at isolated regions with the presence of high carbon concentration, amounting to an increase in hardness in comparison to tempered martensite phase at core region. It observed that micro-crack nucleated at non-metallic inclusions. The non metallic inclusions, i.e., MnS, the difference in microstructures, a variation of hardness and nucleation of the void, void growth, and void coalescence found in the grain interface leading to propagation of crack and caused the rupture of the part during service.

Keywords: Non-destructive inspection, Failure analysis, Tooth flank, Microstructure, Hardness

Hydrotreater REAC(DSS) Inspection using Advanced NDE

Akash Upadhyay, Sudhanshu Singhal, Hemant Kumar

Reliance Industries Limited Jamnagar, Gujarat, India

Akash.upadhyay@ril.com | Sudhanshu.singhal@ril.com | Hemantk.kumar@ril.com

Abstract

Hydrotreating and hydrocracking units as a part of refinery are high critical process plants due to the high pressure of operations, hydrogen and handling of hazardous chemicals like hydrogen sulphide. Reactor effluent Air Coolers, generally referred to as REAC in refineries are equipment susceptible for corrosion by NH_4Cl and NH_4HS . As more and more sour crude's are processed, the corrosion potential in REAC has seen a significant rise. Material selection for REAC has seen a constant upward trend from Carbon steel to Incoloy 825. Duplex stainless steel has been an attractive metallurgy both from prevention of corrosion and cost. However refining industry has seen some serious failures in REAC with Duplex SS in the header box.

The paper discusses the reasons for the failure in REAC with duplex SS material of construction and an experience of inspection of REAC. Some of the advanced NDT's like PAUT, AET were used for ascertaining the integrity of the REAC bundles.

Keywords: REAC, DSS, PAUT, AET, SSC

Modelling of an Electromagnetic Sensor for Material Characterization

Manju Mohan^{1*}, R. M. Kuppan Chetty¹, Abdeldjalil Bennecer², D. Dinakaran¹ and M. M. Ramya¹

¹Centre For Automation & Robotics, School Of Mechanical Sciences, Hindustan Institute Of Technology & Science, Chennai, India

²Faculty Of Arts, Science and Technology, University Of Northampton, UK

Corresponding Author: manjum@hindustanuniv.ac.in

Abstract

Mechanical, chemical and electrical properties of any polycrystalline engineering material are related to its constituent microstructure and phases. Reliable characterization of these parameters is therefore essential to ensure the desired properties of that material meeting the design requirements. Traditional electron microscopy and X-ray diffraction methods are confined to the laboratory environments, and specimen preparation is time-consuming and tedious. Also, these methods are performed on representative test coupons, and hence an accurate statistical appraisal of the overall properties of the material may not be effective. In this context, non-destructive evaluation (NDE) methods find importance. The NDE methods do not require tedious specimen preparations, and they can be directly implemented on any components during production and in-service. Most of the engineering materials are metallic in nature and hence can be characterized using its magnetic properties. The concept of hysteresis and magnetic Barkhausen noise is utilized to determine the magnetic properties and thereby identifying the phases of the material. An effort is taken towards the design of a sensor using the principles of electromagnetism. Multiple models of the sensor are simulated and optimized using the AC/DC module in COMSOL Multiphysics. This sensor is used to generate the hysteresis as well as Barkhausen noise from the material of interest. It involves the design of an electromagnet for generating the required magnetic field to drive the material into saturation and also a pick-up coil to detect the magnetic Barkhausen noise. The obtained hysteresis curve and the Barkhausen noise are correlated with the microstructural features of the material.

Keywords: Electromagnetic sensor, Barkhausen noise, Hysteresis curve, magnetic phases, polycrystalline material

Evaluation of chipless RFID sensor for wireless metal crack detection and characterization

Rinu Preethi Baskaran, Deepak Rana, Jeyashree Murugan, Geetha Chakaravarthi

Department of Instrumentation & Control Engineering, National Institute of Technology Trichy, Tamil Nadu 620015, India.

geethac@nitt.edu

Abstract

The need for life time prediction and structural health monitoring of structural components are ever growing as the currently used NDT technology for inspection are not adequate due to the various limitations of its sensing capability. Sensors based on RFIDs will have unique capability of detecting the defects non-intrusively and remotely. However, the use of chips in sensor tags limits the sensor detection capability in high temperature environment and the usage of sensors only in the narrow RFID frequency range. Evolution of chipless RFID sensor tag enables crack detection and characterization on metals for continuous health monitoring of structural components.

In this work, Ultra Wide Band (UWB) antenna that works on metal plate is designed using finite element method based simulations. The antenna designed on the metal plate of dimension (60×60×7) mm³ made of aluminium, consists of sensing part as patch antenna and ID part of the sensor as dipole resonator. The conducting ground plane is used only for ID part; whereas the monitored metal part acts as ground plane for the sensing patch antenna. Performance of the antenna is evaluated through simulations where the crack width (1-3 mm), depth (1-3 mm) and orientations are simulated on the metal plate. The presence of crack shifted the resonance frequency of the antenna with different directions based on the crack width, depth and orientation. Thus, the variation in the simulated performance of the chipless tag antenna was used for investigating wireless crack detection and characterization. The UWB chipless tag antenna simulations on aluminum specimen demonstrate that the proposed sensor could be used for wireless detection and characterization of surface cracks on metal specimen even at harsh environment.

Keywords: Antenna, chipless, crack characterization, RFID, structural health monitoring, ultra wide band

Signal Processing Approaches in Pulsed Thermography for Defect Characterization in Stainless Steel Materials

Sharath D^{1*}, Sethu Selvi¹, Sathvik Udupa¹, Tanvi Khandelwal¹, Varun Ittigi¹, Touqeer Mulla¹, M. Menaka² and B. Venkatraman²

¹Center for Imaging technologies, M S Ramaiah Institute of Technology, Bangalore 560 054, India

²Safety, Quality and Resource Management Group, Indira Gandhi Centre for Atomic Research, Kalpakkam 603 102, India

*sharathd@msrit.edu

Abstract

Pulsed Thermography (PT) is one of the advanced active thermographic Non Destructive Evaluation (NDE) techniques, which has the advantages of fast inspection rate, being non-contact in nature and output is an image which is easy to interpret. PT is widely used for defect and material characterization in various industries. In PT, a short and high energy pulse is impinged on the surface of the object under inspection, which causes instantaneous rise in its surface temperature. The temperature decay, due to diffusion of thermal waves, is recorded using an IR camera. Any intermediate interfaces within the object alter the diffusion rate causing deviation in temperature response at the surface of the object which can be detected using thermal images and which can be used to characterize the interface. Noises are associated with temperature signal in PT and it is essential to reduce these noises to get meaningful information from PT.

In this work, we report the effectiveness of various signal processing approaches in PT for enhancing the signal in AISI 316 L SS material, which is one of the important structural materials used in nuclear industries. In this study a novel deep learning method is proposed for enhancing the signal to noise ratio (SNR) in PT data and the results are compared with well-established methods like Thermal Signal Reconstruction (TSR), Principal Component Thermography (PCT) and Partial Least Square Thermography (PLST). This study showed that autoencoder based deep learning method gives much better SNR at the cost of defect detection capability.

Keywords: Pulsed Thermography, Thermal Signal Reconstruction, Principal Component Thermography, Partial Least Square Thermography, Deep Learning.

Generation of Pure Guided Wave Modes Using Comb Transduction

Dileep Koodalil, Nived Suresh, Prabhu Rajagopal, Krishnan Balasubramaniam

Centre for Non-destructive Evaluation and Department of Mechanical Engineering, Indian Institute of Technology
Madras, Chennai - 600036, India

Address for correspondence: dileepkoodalil@gmail.com

Abstract

Ultrasonic guided waves are increasingly used for inspection of large and complex structures as they facilitate rapid inspection with limited access. Existence of multiple modes together with dispersion complicates the inspection. In this work we aim to study the pure mode generation of shear horizontal (SH) guided waves. Periodic permanent magnet (PPM) electromagnetic acoustic transducers (EMATs) based comb excitation are employed to generate SH modes at a specified wavelength. By controlling input frequency bandwidth and spatial bandwidth of the magnetic field pure modes can be generated. Finite element models are developed to demonstrate this concept. Experiments are performed using PPM-EMATs to validate these findings.

Keywords: Pure mode, PPM-EMATs, SH guided waves, comb transduction

Reflection Study of Shear Horizontal Wave Modes with Beveled Plate Edges

R. Aravinth¹, Nived Suresh², N.Gopalakrishnan¹ and Krishnan Balasubramaniam²

¹Department of Physics, National Institute of Technology Tiruchirappalli, Trichy - 620015, India

²Centre for Non-destructive Evaluation, Indian Institute of Technology Madras, Chennai - 600036, India

Corresponding author 1nivedkvr@gmail.com

Abstract

The interaction of Shear Horizontal (SH) guided wave modes with beveled plate edges is investigated. This study is considered as a preliminary attempt to examine the bevel angles in Butt welds or the inclination of cracks. Reflection behaviour of SH₀, SH₁, SH₂ wave modes was used for this investigation. The dependency of bevel angles on the energy carried by the reflected SH wave modes was found out. It is found that as the bevel angle changes, the reflected SH wave amplitude changes. It is also observed that there are certain bevel angles at which the transmitted wave mode does not reflect. Finite Element Methods and Analytical solutions were used to analyse the dependency of bevel angles. Experiments were carried out to prove these results at bevel angles of 30°, 45°, 60°, 75° and 90°. SH guided waves in experiments were generated using wavelength constrained PPM-EMATs.

Keywords: Shear Horizontal waves, Bevel angle, Reflection

Application Tools for Improvements and Enhancements of 2D Radiographs and 3D Cone-Beam Computed Tomography (CBCT)

D. Shedlock, Ph.D.¹, D. Nisius, Ph.D.¹, A. Shiroma, Ph.D.¹, K. Holt, Ph.D.¹, S. Hoelzer, B. Smith¹, J. Star-Lack, Ph.D.¹

¹Varex Imaging, 1678 S. Pioneer Road, Salt Lake City, UT 84104

Abstract

Digital Radiography (DR) and the use of flat panel detectors (FPDs) for industrial imaging applications is becoming standard practice. Both 2D and 3D radiographic imaging allows for non-destruction inspection (NDI) of a variety of different parts ranging in size from microns to meters. In order to create the highest fidelity 2D radiographs and 3D volumes, tools are needed to correct for known artifacts that arise from beam hardening, scatter, lag, rings, and flux starved regions to mention a few. Presented here are demonstrations of Varex software tools that improve both 2D and 3D image fidelity for when imaging industrial-parts.

CST (Cone-Beam CT Software Tools) is a Varex software suite for users of FPDs that provides an image processing pipeline for manufacturers of 2D and 3D imaging systems. The toolkit contains a developer-friendly GUI Workbench application that enables rapid imaging calibration that directly informs the software deployment. The software is easily deployed via a library of dll's that can be used by software integrators and imaging scientists collaboratively. For 3D reconstruction, the product contains plugins that allow for CPU or GPU implementation of both Statistical Reconstruction (SR) or FDK algorithm for arbitrary geometries. The IsoCal-phantom and included IsoCal software allows for geometry calibration of repeatable geometry configurations is then used for the accurate CBCT reconstruction. For 2D imaging, the package contains a resolution enhancement algorithm (REA) that corrects the light spread from thicker scintillator screens to allow the user to take advantage of higher efficiency screens without sacrificing spatial resolution. Applicable to both 2D and 3D imaging are plugins for lag correction, scatter correction, and beam hardening correction. Scatter and beam hardening artifacts arise from the interaction of the interrogating x-ray beam with the object being imaged. The new 3D scatter correction, 3D VSHARP, plugins use physics-based models and discrete ordinates (SN) methods to rapidly solve the Linear Boltzman Transport Equation (LBTE) to correct for the resulting errors from scatter. This presentation will discuss the physical processes and methodologies for correcting these artifacts for industrial applications and provide imaging examples demonstrating the effectiveness of 3D VSHARP.

1.1 3D VSharp Example

Data was taken on an aluminium motorcycle cylinder head in our applications lab in Franklin Park, Illinois using a Varex 1620 AN3 x-ray panel. The data was reconstructed using our CST Toolkit with the 3D VSHARP algorithm to remove the impact of scattered radiation yielding higher fidelity images for both the aluminium. In the figures below, the volumetric slices of both objects are shown with and without scatter correction demonstrating the significant improvement in image quality using the 3D VSHARP. Many additional examples and parts will be presented in the presentation for different types of corrections.

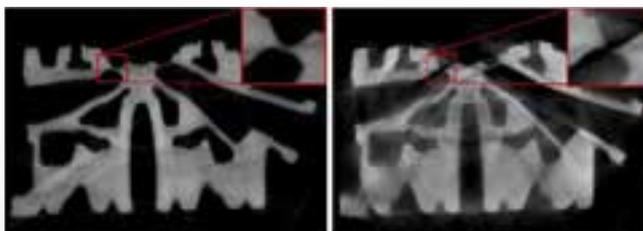


Figure 1: Aluminium motorcycle cylinder head central axial-slice from the 3D VSHARP scatter-correction (left) and with no scatter-correction (right). Zoomed-in region on the top right showing restoration of a thin aluminium wall following scatter correction. For both slices: reconstruction voxel sizes are 0.4 mm³. CT units are calibrated so that aluminium intensities are 3500 with air set to 0 (display window = 6451, level = 3226).

Keywords: Flat, Panel, Detector, Radiography, Computed, Tomography, Scatter, Beam Hardening, Lag

Crack detection real cracks in metallic sample at high temperature

Nithin Puthiyaveetil¹, Renil Thomas K¹, Mathias Ziegler², Krishnan Balasubramaniam¹

¹ | Centre of Non-Destructive Evaluation (CNDE), Indian Institute of Technology Madras, Chennai, India

² Federal Institute for Metal Research and Testing (BAM), 12200 Berlin, Germany

Address for correspondence: nithinvengara@gmail.com

Abstract

Crack detection in metallic samples at high surface temperature is one of the challenging challenging situation in manufacturing industries. Most of the present NDE methods are suitable only for lower surface temperatures, especially room temperature. In this situation, we need a fast and non-contact NDT method which can be applied in high sample surface temperature. Laser thermography is one of the techniques having a high potential in non-contact inspection. In this article, we have studied the potentiality of laser line thermography in crack detection at sample with higher surface temperature. Rail sample having roll contact fatigue cracks heated up to different surface temperature using a induction unit. A continuous wave (CW) laser is used to generate a laser line, is used to scan the metal surface. The heat distribution over the sample surface is recorded by an infrared thermal (IR) camera. A dedicated image processing algorithm was developed used for the crack detection on a piece of rail that comprises roll contact fatigue cracks and is compared using magnetic particle testing results. The experiments were repeated for different surface temperature and using different laser power. Crack detectability in increasing with increasing laser power

Key words : High temperature, NDT, Laser ,Thermography

Understanding Basic Phased Array Beam Computation and Inspection Simulation with CIVA 2020.

Amar Borawake¹, Roman Fernandez², Swapneel Rao³

¹NDTS India (P) Ltd., The Great Eastern Galleria, Nerul, Navi Mumbai, India.

²EXTENDE., 14 Avenue Carnot - 91 300 Massy – FRANCE.

³Arora Technologies (P) Limited., The Great Eastern Galleria, Nerul, Navi Mumbai, India.

amar@ndts.co.in

Abstract

In this paper, we present the understanding of phased array ultrasonic beam computation and behaviors according to the basics of ultrasonics. We will present study with linear phased array probes & appropriate wedges used commonly in industry. Study has been carried out on basic parameters and its effects on resulting phased array beam in material. Parameters under study were element pitch, element size, gap between elements, effect of dead elements, no of active elements, frequency of probe, velocity of material, grating lobes etc. CIVA has traditionally been associated with modelled simulations of inspection reliability. Sometimes in industry inspection engineers come across difficult inspection geometries. Traditionally engineers follow preparation of mock-up workpiece some with machined calibration defects, and others with realistic defects induced intentionally by artificial means. Such realistic defects are very difficult to create and have to be destructively characterized to measure their real height and location. This is not easy or cost effective way of inspection. Here comes state of the art simulation software CIVA for statistical study of inspection with the help of tools such as probability of detection (POD) and sizing accuracy curves etc.

This paper discusses use of multiple CIVA simulation and modelling tools for making inspections easier and understanding cost effective implementation in day to day inspections.

Keywords: Simulation, modeling, phased array, ultrasonic testing and probability of detection

Looking Back



Photo: Mr. P.D. Chopra MD HAL Bangalore, addressing the gathering. Sitting from L to R Mr. B. Chatterji, Senior Manager Central Lab, Dr S. Ramaseshan, Dr. Krishnadas Nair DGM Foundry & Forge Division.

The First Seminar On Non destructive Testing was organized by NDT Centre, Central laboratory , Hindustan Aeronautics Limited Bangalore on 28th and 29th January 1979, at HAL Auditorium
Conveners of the seminar - Dr. Krishnadas Nair & B. Chatterji.

Highlights

1. Key note address by Dr. S. Ramaseshan, Deputy Director National Aeronautical Laboratory, Jawaharlal Nehru Fellow, Raman Research Institute Bangalore .
2. A souvenir was released containing 24 abstracts and there were 24 advertisers
3. 32 papers were presented in 7 sessions
4. Exhibition of NDT equipments, products and technical Literature was organized on both the days
5. Total No of registered delegates participated 350 including exhibitors
6. Proceedings of the seminar containing 24 full length papers was bought out.
7. Lip smacking Lunch & savories served on both days.
8. As part of Cultural evening Bharatha Natyam organized in a city Hotel
9. The delegate fees was Rs 50/- (Fifty) only !!!

Compiled by:
P. Vijayaraghavan
Bangalore pvrvan@gmail.com

Grain Size Distribution Effects on Ultrasonic Attenuation

Sivaramanivas R

GE Global Research Center, JFWTC, Bangalore, India. | E: sivaramanivas.r@ge.com

Abstract

Grain size measurements using ultrasound are typically performed under the assumptions of Rayleigh scattering. However, samples with same mean grain size can have significantly different ultrasonic attenuations. To address these effects models for ultrasonic attenuation with frequency in polycrystalline materials have been developed considering the log-normal distribution for grain sizes.

EBSID studies for grain size distributions in nickel based super alloys Rene88 (R88) revealed Weibull distribution. In this paper a model for ultrasonic attenuation for Weibull distribution for grain sizes are developed. Comparison with experimental data for ultrasonic attenuation reveal good fit for Rayleigh and stochastic regimes. This study assumes importance since grain size distribution and the presence of large grains are known to affect the fatigue life.

Keywords: Attenuation, Scattering, Grain size distribution, Nickel based superalloys, Aerospace

Visualisation of wave propagation using Reduced Number of Samples

Jagadeeshwar TL^{1,2}, Srijith K³, Balaji Srinivasan¹ and Prabhu Rajagopal²

¹Department of Electrical Engineering, IIT Madras, Chennai, India

²Department of Mechanical Engineering, IIT Madras, Chennai, India

³Department of ECE, IIITDM Kancheepuram, Chennai, India

Abstract

Non-destructive testing based on visualisation of ultrasonic guided waves is quite popular due to its potential in identifying and localising the defect. For such imaging studies, a large group of points need to be scanned for visualizing the propagation of the wave. In this work, a wave visualisation technique using random sampling which uses less number of sampling points is proposed and the performance of the technique is evaluated. Defect identification and localisation are performed on simulated data with different sizes of canonical defects. It is observed that the performance of wave visualisation with the proposed technique is in good agreement with that of conventional sampling and it requires only 10% of total number of sensing points when compared to the latter.

Key words: Wave propagation, ultrasonic guided waves

Review of Non-Destructive Evaluation Techniques in Civil Engineering

Mr. Rohan Gurav, Assistant Professor

Water and Land Management, Department of Civil Engineering,
Center for PG Studies, VTU, Belagavi, Karnataka, India

Abstract

Non-destructive testing plays very important role in civil engineering to detect the crack, sizing material, composition and strength of individualize as well as composite material. This review paper will give overview of Different NDT techniques and methods have been used in Civil Engineering Fields so far. So it helps for the researcher to understand and chose Any one Application, Method or Technique of NDT for his or her area of research. This paper will also helps to understand the most important NDT methods, techniques and some of material strength measuring setups. This survey covers more than 15 research papers and important NDT methods with different types and combination of NDT Test and methods. Some of the important methods are ultrasonic tomography, sclerometric method, ultrasound method, pull out method, residual magnetic field, active thermography, ultrasound testing, electro-magnetic method, radar method, acoustic methods like ultrasonic and stress wave techniques, electric and resistance circuit method, the measurement method like integration method, ultrasonic pulse velocity test, rebound hammer test, half cell potential technique, infrared thermography technique and the ground penetration radar technique etc. Special character like dissimilar material composite compound, condition of wharf timber sheet wall material, moist wood, early stage concrete and so on. This review paper may help for the researcher to understand various NDT test, techniques, Method used to find out changes in the behavior of material, Understand the properties of material, early detection and also to predicts the behavior in materials properties. Also this review paper will give overview of NDT Test, Techniques used in Civil Engineering Fields with its suitable applications and limitations.

Key words : NDT - Non-destructive Testing.

Localized skin temperature measurement using two identical Ultrasound based waveguides

Guru Prakash Sahu, Ravi Kant, Krishnan Balasubramaniam

Centre for Nondestructive Evaluation, Department of Mechanical Engineering, IIT Madras, Chennai, India
gpsahu9@gmail.com

Abstract

Present work describes the application of an Ultrasound technique to measure localized skin temperature of a metal plate using two waveguides. Two identical waveguides are placed adjacent to each other and used as signal transmitter and receiver simultaneously. Change in time of flight (TOF) with temperature is the crucial parameter to measure the temperature.

Due to multiple applications and reliability of Ultrasound waveguide, it has become the leading area of research and development in the process industries. Present work consists of Finite Element based numerical simulation for the effect of depth of immersion of the waveguide inside the metallic plate for its temperature measurement. Experiments were carried out to verify the simulation results.

Keywords: Ultrasonic Transducer, Waveguide sensors, Skin temperature measurement.

Ultrasonic Beam Steering in Bulk Medium using GRIN Structures

Manjunath C.T.¹, Sai Aditya Raman Kuchibatla¹ and Prabhu Rajagopal¹

¹Centre for Nondestructive Evaluation, Machine Design Section, Department of Mechanical Engineering,
IIT Madras, Chennai, India - 600036 | E: ctmmech@gmail.com

Abstract

Controlling and directing the propagation of the ultrasonic waves in a given medium is a challenge and has attracted many researchers in recent times. Wedges and phased arrays are common practice in the industry for ultrasonic steering. We report an add-on structure based on gradient index (GRIN) to steer the ultrasonic waves in a given medium. The proposed GRIN structure is made of cells comprising of solid cylinders with circular cross section stacked together to form a brush-like structure. Steering is achieved by changing the diameter of the circular cross section, based on the dispersion behavior of waves within solid cylinders. Longitudinal waves generated by a transducer will travel through the rods with varying velocities and is steered in the bulk medium. The direction of steering angle is determined using time of arrival calculations. Numerical investigations have been carried out to explore the design and demonstrate the steering of waves. This add-on structure has important applications in the various domains such as biomedical ultrasound imaging, industrial non-destructive evaluation and underwater communications.

Keywords: Beam Steering, GRIN, Ultrasonics

GRE Pipe Manufacturing Defects, Installation and NDE Requirements

Engr.Sangili Gunasekaran

QA-QC Department, Heavy Engineering Industries & Shipbuilding Co. K.S.C (Public) Kuwait

E: sangili.gunasekaran@heisco.com

Abstract

Glass Reinforced Vinyl or Epoxy (GRV/E) is resistant, both internally and externally to corrosive effects of Water, oil and many chemicals. Cathodic Protection System (CPS) Or Coating is not required. This paper will focus the application of GRE/V Pipes in refinery construction, fabrication and erection errors and Non-destructive Examination (NDE).

If the machine setup is according to the specifications in setup sheet and raw materials are tested and approved, there are normally no problems with defects on pipes and Fittings. But sometimes process variables changes during the production and may cause defects on pipes on fittings. Defects can occur in either the GRP material or in the Lamination & adhesive bonded joints that make up a piping system. Manufacturer instructions were not followed by constructor leads to defects and delay of project completion. Leak testing failures also affect completion of project and rework required to bring to acceptable limit.

In this section will discuss the possible defects associated with the manufacturing & Installation of GRE/GRV pipes, from the point of view of human error, and or lower manufacturing skinless due to new technology introduction in the area. Also in this part will be concerning the defect types, causes, and the prevention or corrective action of such defects and NDE applications.

Keywords: Glass Reinforced Vinyl or Epoxy (GRV/GRE), Cathodic Protection System (CPS), Non-destructive Examination (NDE), Lamination & adhesive bonded joints, Defects, Leak testing failures etc.

Case Study: Leak Testing Failures at Ultrasonic Valve Pit Area: Gas Plant Piping Construction

Engr.Sangili Gunasekaran

QA-QC Department, Heavy Engineering Industries & Shipbuilding Co. K.S.C (Public), Kuwait

E: sangili.gunasekaran@heisco.com

Abstract

Underground GRE (Glass Reinforced Epoxy) two Kilometers network supply line 72 inch outside diameter and return line 52 inch outside diameter Gas Process Plant Piping erection was executed and all materials are procured as per approved manufacturer source ; client free issue materials; qualified and experienced persons are engaged on job as per contractual requirements for inspection and erection.

During installation, the manufacturer recommended installation work procedures, approved inspections and Test plans, qualified bonders, bonding specifications and approved pressure change technique used at site. It was observed failure of joint near at Ultrasonic Valve Pit area and also adjacent to joint area leaks observed at Tee section during hydro static pressure testing. The leakage of laminated /adhesive bonded joints defect work and or Tee leakage on parent metal affected the project completion delay by six month.

The detailed leak test failures investigation/preventive action step by step procedure shall be discussed in this paper. The outcome paper is in effective Visual Testing (VT) monitoring during manufacturing/ construction and also no adequate support provided with backfilling during leak testing due to large diameter hydro test load at Ultrasonic Valve Pit area.

The manufacturer's recommendation was not followed by concern project team during installation of gas plant piping. Six month delayed due to long leaded item delivery of 52" Diameter Tee. Tee failure investigated later due to manufacturing defect and valve pit area leakages identified as a point load at concrete wall design over look.

The new joints made with reinforced pad at Ultrasonic Valve Pit area and New Tee installed. Re leak testing was performed and accepted test results without any leakage and handed over the line to commissioning plant.

Keywords: Glass Reinforced Epoxy (GRE), adhesive bonded joints, Defect work, Leakage, leak test failure, Ultrasonic valve pit, Visual Testing (VT), etc.

1.000 KM WELD INSPECTION ON PIPELINES IN THE OUTBACK WITH ... CR

Steven Wissels, Phil Lewis

Baker Hughes, a GE company

Abstract

For the very first time in Australian history, large pipeline construction projects were successfully conducted with Computed Radiography (CR) technology instead of the traditional analog X-ray film. As the available Australian Standards did not yet allow this new digital inspection method, what was the main driver for going digital? With our experienced local resources, BHGE was closely supporting both the initial phase as well as the full projects. After solving some initial challenges, the awarded contracting companies could move on with their enormous inspection. Based upon the initial fruitful CR projects, more pipeline projects were awarded, again with the CRxVision scanner being the selected equipment. How were people reacting initially to CR as new technology replacing film, and how is their feedback after these successful projects?

Furthermore, we will reveal the important parameters users will need to consider while switching from industrial film to the new CR technology or when comparing available CR systems. Which factors are substantial and give the required outcome, and which features are merely kept alive by marketing?

Keywords: Computed Radiography, CR, Digital Radiography, Flash!, Pipeline Inspection, CRxVision.

On Simultaneous Generation of Dual Higher Harmonics by Single Mode Excitation in Cylindrical Structures

Shyam Sai V¹, Krishnadas VK², Krishnan Balasubramanian², A. Chandra Bose¹

¹Department of Physics, National Institute of Technology, Tiruchirappalli, India.

²Centre for Non-destructive Evaluation, Indian Institute of Technology Madras, Chennai, India.

v.shyamsai99@gmail.com

Abstract

Nonlinear ultrasonic guided wave inspection is of much interest in detecting microscopic changes at early stages of material degradation due to its high sensitivity and long range propagation. Detection of defects or artefacts in nonlinear ultrasonics is performed by measurement of higher harmonics. Although there are literatures about generation of single higher harmonics by excitation of a single mode, generation of two second harmonic modes in a single excitation is not yet reported. In this study, simultaneous generation of dual mode higher harmonics is achieved by excitation of single fundamental mode in cylindrical structure. The primary wave modes are selected, in such a way that they satisfy phase velocity matching which is an important criteria for harmonic generation. The higher harmonic modes generated have different group velocities which are independent to each other and would be sensitive to different types of material characteristics. The higher harmonics thus generated finds potential applications such as early stage damage detection due to fatigue, creep, cracks etc., and helps in material characterisation and structural health monitoring (SHM) applications.

Keywords: Ultrasonics, Guided waves, Fundamental mode, Second Harmonic, Higher Harmonics, Internal resonance.

Pre-Service Inspection of PHWRs in India

Praveen D. Bhosale, Mayank Chhapre

pbhosale@npcil.co.in, mayankchhapre@npcil.co.in

QA Section, KAPP-3&4, NPCIL

Abstract

Accidental release of any radioactive particle or radiation from any nuclear installation is a great concern because this cannot be sensed or felt by any of human senses further dose received by one can be a serious harm to the proper functioning of body or may lead to permanent damage to organs. Therefore all such probable sources of radiation leak need to be identified well in advance before the system fails & spread radioactivity. All those systems and components, which contain radioactive substance, have to be in healthy condition to ensure that release of any activity is within the internationally prescribed limits.

For this strict control measures at fabrication, startup stage of various systems and components and during operation are essential. Pre-Service (PSI) and In-Service Inspection (ISI) of power plant components have been the practice to give an assurance that any failure cannot result in endangering health and safety of the plant and personnel. To assess the healthiness of system while in service it is always preferred to have a baseline data of parameters indicating healthiness of system & components before these are put in service. At this stage no degradation of components are expected being fresh and if operated in accordance with design intent, the components will last for their intended life with assured integrity of the fluid- retaining boundary and perform this intended functions. While formulating the PSI/ISI program, limitations have been recognized with respect to instruments/equipment availability and component accessibility. It has also been kept in view that while carrying out above monitoring activities; personnel involved are exposed to radiation as low as reasonably achievable.

Thickness measurement of water-wall tube by EMAT generated shear horizontal bulk waves

B. Umesh Chandra¹, Akhil B S², Krishnan Balasubramanian², Annapureddy Venkateshwarlu¹

¹Department of Physics, National Institute of Technology, Tiruchirappalli-620015, India.

²Centre for Non-Destructive Evaluation(CNDE), Department of Mechanical Engineering, Indian Institute of Technology-Madras, Chennai-600036, India.

chandra.ssc7@gmail.com

Abstract

Water-wall tubes, a part of the boiler is the main component of a thermal power plant. These tubes carry water uninterruptedly and hence prone to corrosion frequently resulting in thickness reduction which makes this inspection vital. The conventional contact type thickness measuring methods fails when the tubes do not have a good surface finish. EMAT, an advanced ultrasonic method is one of the most reliable non-contact testing methods. Bulk waves generated by EMAT are used in the examination of thickness with the pulse echo method. In this study, the Butterfly configuration coil is used. The thickness of the tube is measured using the time of flight difference of signal received from the backwall. Any variation in this signal arrival indicates thickness reduction. This reduction in thickness can be quantified by comparing with the signal at a known thickness of the same material.

Keywords: Electro Magnetic Acoustic Transducer(EMAT), Current Carrying Coil, Butterfly Configuration, Shear Horizontal Bulk Waves(SH), Lorentz Force.

Generation of Axi-Symmetrical T (0,1) & L (0,2) Modes and Inspection of Steel Alloy Pipe Using Magnetostrictive Sensors

**Manish Reddy Papagari¹, Nishanth Raja², Krishnan Balasubramanian²,
Annapureddy Venkateshwarlu¹**

¹Department of Physics, National Institute of Technology, Tiruchirappalli, Tamilnadu, India

²Centre for Non-destructive Evaluation, Indian Institute of Technology-Madras, Chennai, India

E: manishoutlook3@gmail.com

Abstract

Ultrasonic guided waves have been successfully applied for nondestructive evaluation (NDE) and structural health monitoring (SHM) of pipelines and pressure vessels due to their advantage, such as long detection range and high inspection efficiency. In this study inspecting the defects in U-bend pipes are carried out using Magnetostrictive transducers. Magnetostriction is the change in shape of materials under the influence of an external magnetic field. The Magnetostrictive transducers have advantage over other ultrasonic guided wave actuators where the prior has simpler fabrication process, higher possible transduction efficiency and cost-effective. The aim is to inspect the defects in u-bend region of the pipes caused due to flow accelerated corrosion which takes place in systems that carry water or steam mixture at higher temperatures.

Keywords: Ultrasonic guided waves, Nondestructive evaluation (NDE), Structural health monitoring (SHM), Magnetostrictive transducers, flow-accelerated Corrosion.

Characteristics of Acoustic Emissions generated during Rebar Corrosion in Reinforced Concrete

Anjali P¹ and R. Vidya Sagar¹

¹Department of Civil Engineering, Indian Institute of Science, Bangalore-560 012, India

E: panjali@iisc.ac.in

Abstract

This experimental study reports on the characteristics of acoustic emissions (AE) generated during steel reinforcement corrosion in reinforced concrete (RC) cylindrical specimens. One of the main causes for deterioration of RC structures is corrosion of steel rebar in concrete. It is known that corrosion is of two types, one is chloride induced and another is carbonation. In this study chloride induced corrosion in RC structures is studied. A number of cylindrical specimens were monitored with 3% NaCl and 5 % NaCl solution with constant 5 Voltage in the laboratory. AE 'frequency of occurrence' and peak amplitude distribution analysis which is known as b-value analysis (Gutenberg Richter law) was performed to identify the micro cracking and macro cracking of concrete. And also, the variation of AE parameters namely signal strength, absolute energy, energy, RA and AF during the progression of corrosion was studied. It is known that AE signal strength is the area under the rectified signal envelop. It was observed that cumulative signal strength (CSS) is linearly varied during the corrosion of steel reinforcement. With the initiation of microcracking of concrete there was a very distinct change in the trend of the curve between CSS and monitoring time. AE testing is an effective corrosion monitoring NDT method for RC structures in-situ.

Keywords: Acoustic emission; corrosion, Reinforced concrete structures; microcracking; macrocracking.

Asymmetrical Analysis of Breast Thermal Images for Detection of Breast Cancer

Kavya N^{1*}, N Sriraam¹, Usha N¹, Sharath D¹, Prabha Ravi¹, Bharathi Hiremath²,
B. Venkatraman³, M. Menaka³

¹Center for Imaging Technologies, M.S Ramaiah Institute of Technology, Bengaluru, India

²Department of Surgery, M.S Ramaiah Medical College and Hospital, Bengaluru, India

³Safety, Quality and Resources Management Group, IGCAR Kalpakkam, India

*kavyan28@gmail.com

Abstract

Among women, compared to other cancers, breast cancer has high incidence rate. The appearance of cancer rises the temperature in the tumour and its surrounding region. It is well known fact that the thermal imaging method is painless, non-contact, radiation free and more sensitive to temperature variations. Thermogram provides the information associated with physiological changes which helps in detection of breast cancer. One can understand the implication by performing asymmetric analysis between the bilateral breast. Typical temperature and statistical features were extracted to recognize the asymmetry. Breast thermograms with n=300 were collected from Ramaiah Memorial Hospital, Bangalore. The raw images were pre-processed using anisotropic filter to remove the artefacts and circular masking was used as semi-automated segmentation technique. Temperature feature from thermograms and bilateral ratio from statistical features shows the importance of asymmetry. The proposed scheme needs to be validated with large datasets before introducing to the clinical screening.

Keywords: Thermal imaging, computer aided diagnostic tool, asymmetrical analysis, statistical features, temperature features, bilateral ratio.

Significance Of NDT For Monitoring Of Manufacturing Flaws In Railway Rails To Minimize Service Failures

Debdutta Mallik¹, Saroj Kumar Ojha²

¹Velosi(M) Sdn Bhd, Kulalaumpur, Malaysia

²Jindal Steel & Power Limited, Raigarh, India

debduttamallik@yahoo.co.in , d-mallik@velosi.com , saroj_jsr@rediffmail.com

Abstract

Rail safety plays an important role in our daily life. Manufacturing of good quality rail track has been a challenge since the last few decades. In the modern era of technology rail track manufacturing is an example of technological advancement in the manufacturing industry. Automatic/Online NDT plays a great role to ensure the rail is defect-free prior to putting in service. However certain discontinuity may lead to major failure in service if undetected. This paper deals with different aspects of online/automatic Ultrasonic testing of rail at the manufacturing stage and it's a limitation and also discusses how to increase detect-ability and possible failure of the NDT system which could miss the discontinuity and may lead to a service failure.

Keywords: Rail, NDT, Automatic/Online NDT, Ultrasonic.

Equipment Reliability and Energy Conservation using Ultrasound Technology.

Vinod.V

Area Product Manager – IMENA Region

UE Systems Inc.

Email: vinodv@uesystems.com | Mob: 9618647755

Abstract

The emerging trend in use of Airborne and Structure-borne ultrasound technology has reached to such a state that industries now consider it as one of the most important and cost-effective tools for their maintenance and reliability program. The below applications made the ultrasound is truly a versatile tool for today's predictive maintenance toolbox.

- » Leak Detection and Quantification-Compressed Air and other Gases.
- » Valve Internal Passing Identification.
- » Steam Trap Inspection.
- » Bearing Condition Monitoring.
- » Lubrication excellence program for greased bearings.
- » Electrical Inspection- Identifies Partial Discharges inside electrical Equipment's.

In this paper, an effort is made to present the potential of Ultrasonic instrumentation in industrial equipment upkeep, the latest related technological development, the application and user-friendliness of the gadgets and the diagnostic capability. The few classic cases of industrial applications of this technology are discussed to support the advancement of this field in realization of benefits it offers by reducing downtime, subsequent maintenance and repair costs. It is expected that this short yet informative presentation on high tech instruments in management of industry equipment would not only enrich budding fresh engineers who wish to be exposed to such industrial assignment in future, but also enlighten experienced engineers and experts from industry and academic laboratories.

Keywords: Industrial Equipment, Inspection, Ultrasound, Leak, Bearing, Partial Discharge.

Significance of Flaw Characterization & Sizing Accuracy While Testing Heavy Forgings by Ultrasonic Testing (Pulse-Echo Method)

Ashutosh Singh¹ and P. Raghavendra²

¹L&T Special Steels and Heavy Forgings, Hazira, Surat, Gujarat, India

²L&T Heavy Engineering, Hazira, Surat, Gujarat, India

E: ashutosht.singh@larsentoubro.com

Abstract

L&T Special Steels and Heavy Forgings (LTSSHF) only qualified to supply material for critical Nuclear Power Project (NPP), such as Reactor, Steam Generator, Pressurizer and End Shield.

Stringent quality norms being followed during raw material selection, process of melting, Chemistry, metallurgy, Forging, machining, physical testing and NDT on the finished component. In the life cycle of the entire forging process, NDT comes towards the ending just before customer acceptance. Any deviation found at final stage not only rejects the forgings, but also the entire life cycle journey of the process involved this impacting heavily on the survival of the company itself as well as to the customer as the project gets delayed. Ultrasonic testing is the only volumetric NDE feasible and accepted by all codes, customers. No repair/rework is allowed (repair by welding) in case of forgings. This makes the process of performing Ultrasonic testing, detection, sizing, location and evaluation very prominent/significant.

This technical paper discusses the process of Ultrasonic testing at LTSSHF being done proactively at various stages of forging process. So as to ensure the chances of rejection of final forging is minimum or almost nil.

Keywords: Heavy Forgings weight more than 10 T, critical material, Ultrasonic Testing, characterization and sizing of flaw.

Studies on using FBG Sensor as a tool for Identifying Corrosion in Pipelines

B.Arun Sundaram*, S.Parivallal and K.Kesavan

Scientists, Structural Health Monitoring Laboratory, CSIR-Structural Engineering Research Centre, Taramani, Chennai, India | *Email: arunsundaram@serc.res.in/barunsundaram@gmail.com

Abstract

Structural Health Monitoring techniques has captured much interest and attention of researchers owing to their potential in providing spatial and quantitative information regarding structural damage and the performance of a structure. Integrated health monitoring of structures with advances in sensor technology can improve structural reliability, system performance and safety. Pipelines exist for the transport of crude/refined petroleum, oil, natural gas and biofuels. Oil pipelines are made from steel which are usually buried. These pipelines are prone to natural and man-made damages. Hence monitoring of these buried pipelines becomes essential. Leakages of oil and gas from pipeline are dangerous for people and environment. Detection of leakage along the pipeline network is an essential part of the maintenance activity which is always a difficult task. The experimental studies carried out on using FBG sensors for monitoring corrosion in buried pipelines has been described in this paper. In this study the FBG sensor is used for measuring the hoop strain variation in the pipeline and from the variation of hoop strain corrosion is identified. Hence the FBG sensor technology can be adopted for monitoring corrosion in the buried oil and gas pipelines.

Keywords: Buried pipelines, FBG sensors, Health monitoring, Corrosion

Assessment of Integrity of Thin Wall Nickel Tubes for LMFBR Steam Generator Leak Detection Application

K. S. S. Reddy* , K. Sunderkrishna, R. K. Chaube, K Kapoor, D Srivastava

Nuclear Fuel Complex, Dept. of Atomic Energy, Govt. of India, Hyderabad, India.

*Corresponding author: ksreddynfc@gmail.com

Abstract

Nuclear Fuel Complex (NFC) developed Nickel thin wall tubing of 7.2mm outer diameter and 0.3 mm wall thickness for leak detection application in Liquid Metal Cooled Fast Breeder Reactor (LMFBR). Steam generator (SG) of LMFBR has sodium on the shell side transferring heat to water in the tubes. Any breach in the tube will result in the water reacting with sodium producing hydrogen and other products due to corrosive reaction. This may also lead to the damage of neighboring SG tubes. Monitoring of hydrogen concentration in sodium can indicate the initiation of a sodium water reaction (SWR). Hydrogen is detected due to the diffusion of hydrogen in sodium through nickel thin wall tubing and subsequent measurement of hydrogen concentration by a mass spectrometer which is maintained at high vacuum level (10⁻⁸ torr).

Integrity of nickel tube is of paramount importance for this critical leak detection application. Eddy current testing (ECT), Ultrasonic testing and Helium leak testing are carried out to assess the structural integrity of this nickel membrane. As nickel tubing is manufactured through cold pilgering process and exhibits ferromagnetic behavior, ECT was carried out with saturation magnetic field to suppress the noise due to dynamics of ferromagnetic domains. Ultrasonic testing was carried out with stringent 'V' notch on internal and external sides. The paper brings out the details of experimental work to detect and characterize very fine discontinuities and flaws in thin wall nickel tubing for critical leak detection application.

Keywords: Nickel Tube, Integrity, Leak detection, Ultrasonic Testing and Eddy Current Testing

Vacuum and Helium Leak Testing Techniques Used for Very Large Size Vacuum Chambers

Venkat N. Ramani¹, M. Satheesh Kumar¹, S. Sachuthan²

¹Plasma and Vacuum Technologies, GIDC Kathwada, Ahmedabad 382430

E-mail: vnramani@plavac.com

²M.Tech. Student, Rajiv Gandhi Institute of Technology, Bangalore 560032

Email : sachuthans@gmail.com

Abstract

Over the last few decades, Mass Spectrometric Helium Leak Detection Method (MSLD) has emerged as the ultimate and superior Non-destructive Leak Testing Technique useful for Vacuum as well as Pressure vessels. Very high sensitivities of leak detection (10^{-10} to 10^{-6} Pa m³/s) and very short response time for the technique (milliseconds to a few minutes) have been achieved even in very large vessels of volume larger than 10 m³. The application of MSLD has found relevance in determining and locating minute leaks from welds and joints in various systems and components of Petrochemical, Pharmaceutical, Chemical, Nuclear Plants and many R&D plants. This work describes the techniques used for determining the vacuum tightness and Integrated Helium Leak Rates of very large size vacuum chambers. Conventional Leak Testing Techniques are found to have many limitations due to poor sensitivity of detection and very large response time. In this work, typical problems that arise in the Helium leak detection of very large volume vessels (volume > 10 m³) and the methods deployed to improve the sensitivity of detection which helps to find out the location of defects and quantitatively ascertain the leak rate are described. Examples of many systems from different application areas are presented for illustration.

Key Words : NDT Leak Testing, MSLD, Vacuum Systems

Model Assisted POD for Guided Wave-Based SHM of Growing Cracks

SHARMA Sanjay, MESNIL Olivier, CHAPUIS Bastien and CALMON Pierre

CEA LIST, NDE department, Gif-sur-Yvette, France

E: sanjay.sharma@cea.fr

Abstract

Performance quantification or demonstration of new inspection technology is a necessary step towards implementation, especially in the aerospace industry. Usually, the performance of Non-Destructive Evaluation (NDE) techniques is measured by the probability of detection (POD) [1]. Structural Health Monitoring (SHM) is an emerging maintenance strategy aiming at interrogating the structure's health from embedded sensors and possibly without interrupting the regular operation of the inspected component. Elastic Guided Waves (GW) are a promising option for SHM, thanks to their capabilities to propagate on large distances and their sensitivity to different defects, which allow equipping the monitored area with a limited number of sensors.

However, the information from these waves can be quite complicated to comprehend because the waves are sensitive towards a significant number of variables, mainly environment, sensors location, damage locations/orientation, and other operational conditions [2]. Therefore, POD estimation in GW SHM through the experiment can be especially burdensome and costly because of the fixed position of the sensors. Moreover, as emphasized by various authors, [3]the option of repeated measurements on mock-ups with growing defect raises statistical issues related to the dependency of data. For these reasons, Model assisted POD (MAPOD) approach [4] is anticipated as a key element to enable the calculation of POD for GW-SHM methods.

This article illustrates the potential of this approach. We use an SFEM (Spectral Finite Element Method) code recently developed at CEA LIST and implemented in the CIVA platform. The objective was to study POD estimation through successive measurements on a growing cracked through a hole in an aluminum plate inspected by a GW-SHM system. The proposed SHM system here is straightforward and is made of two piezoelectric transducers (one exciter and one receiver). The temperature of inspection, crack length, crack orientation, and transducer positions are considered as variability in the simulation. Then, the signal response is analyzed in terms of damage index, applying a basic damage detection strategy. Two sets of data, dependent, and non-dependent, have been created by simulation [5]. From these sets of data, POD curves have been computed following different statistical analyses: Hit and Miss, length at detection, and random effect algorithms [6].

Keywords: Guided Wave, MAPOD, SHM.

Bibliography

- [1] C. Annis, "MIL-HDBK-1823A," Nondestructive Evaluation System Reliability Assessment. Department of Defense Handbook, Wright-Patterson AFB, USA, 2009.
- [2] C. Schubert Kabban, R. Uber, K. Lin, B. Lin, M. Bhuiyan and V. Giurgiutiu, "Uncertainty evaluation in the design of structural health monitoring systems for damage detection," *Aerospace*, vol. 5, p. 45, 2018.
- [3] D. S. Forsyth, "Structural health monitoring and probability of detection estimation," in *AIP Conference Proceedings*, 2016.
- [4] J. Moriot, N. Quaegebeur, A. Le Duff and P. Masson, "A model-based approach for statistical assessment of detection and localization performance of guided wave-based imaging techniques," *Structural Health Monitoring*, vol. 17, pp. 1460-1472, 2018.
- [5] C. M. Schubert Kabban, B. M. Greenwell, M. P. DeSimio and M. M. Derriso, "The probability of detection for structural health monitoring systems: Repeated measures data," *Structural Health Monitoring*, vol. 14, pp. 252-264, 2015.
- [6] W. Q. Meeker, D. Roach and S. S. Kessler, "Statistical Methods for Probability of Detection in Structural Health Monitoring," To be published-private communication, 2018.

Simulation Assisted Neural Network Model for Thermal Barrier Coating Thickness Prediction

Sruthi Krishna K P, Srinivasa Chakravarthy, Sreedhar Unnikrishnakurup and Krishnan Balasubramaniam

Indian Institute of Technology, Madras, India | E: skrishkp@gmail.com

Abstract

Thermal Barrier Coatings (TBC) are extensively used on gas turbine components that are exposed to extreme heat conditions for improving component life and engine efficiency. This paper investigates the possibilities of evaluating TBC thickness using the transient thermal imaging method. Accurate prediction of coating thickness is very important in the thermal barrier coated structure life evaluation. In this work, the pulsed thermography dataset combined with Monte-Carlo simulation to provide a large set of realistic data to train neural networks to obtain a heuristic relationship between transient thermograms and coating thickness. The transient temperature profile measured from the surface of non-uniform coating thickness is modelled with Monte-Carlo simulation. Limited experimental data on TBC coated substrates are used to provide the envelope of the input parameters to Monte-Carlo simulation. In this method, the surface temperature transient profiles are generated using Monte-Carlo simulation, and then the time derivatives of surface temperature profiles and its statistics used as input to the feed-forward neural network model. The predicted thickness and error estimates are analysed to evaluate the efficiency of this simulation assisted neural network model. Finally, this paper demonstrated a method for fast and accurate evaluation of non-uniform coating thickness.

Keywords: Thermal Barrier Coating, Transient thermal imaging, Neural networks, Monte-Carlo Simulation

Furnace tubes Intelligent Pigging in a Refinery: A Case Study

Nishank Soni¹, Dhiren Shah² and Shailesh Oza³

^{1,2 & 3} Corrosion & Inspection Department, DTA Refinery, Reliance Industries Limited, Jamnagar, India

Nishank.soni@ril.com, Dhiren.shah@ril.com, Shailesh.oza@ril.com

Abstract

Direct fired process furnaces are installed in refineries and Petrochemicals for heating fluids to desired temperatures. These furnaces handle highly flammable chemicals. The furnaces come in a variety of tube metallurgies and configuration and geometries. A leak in the tube will result in a fire resulting in significant damage to the fired heater and can potentially lead to more serious damage to assets and people around. So integrity assessment of the furnace tubes during shutdown is a very critical activity. Conventionally the integrity assessment used to be based on visual inspection and thickness measurement at select locations and where possible a hydrotest. Very little inspection could be done in the convection zone based on the construction of the equipment.

The advent of new technologies like, intelligent pigging as really brought in a step change in the methods followed for inspection of the process furnace tubes.

This paper discusses the execution challenges, reliability of data and final outcome based on an intelligent pigging carried out in a Crude unit heater.

Keywords: Piping, Pigging, Projectile, Condition Monitoring, Wall Thickness, Chocking

Adaptive Total Focusing Method for Complex Surface Geometry with Linear and Matrix Phased Arrays

Gavin Dao¹, Cyril Thibault¹, Alan Caulder¹, Nans Laroche², Ewen Carcreff²,
Dominique Braconnier²

¹Advanced OEM Solutions; Cincinnati, USA

²The Phased Array Company; West Chester, USA

Abstract

Total focusing methods such as SAFT, TFM and AFM are being used more and more in the nondestructive testing industry. They generally provide improved image quality compared with conventional phased array ultrasound. Since all TFM methods are time-based approaches they provide excellent results upon the condition the geometry and the acoustic properties of the material are well known. A real-time adaptive total focusing method (ATFM) can prove useful in applications where the surface geometry is not flat, there is some curvature, waviness or there is an unpredictable variance between the surface geometry of all the parts to be inspected. ATFM requires a single data set for a single image and does not need multiple acquisitions to detect the profile. An example will be included from the inspection of an immersed steel part and aluminum part containing various flaws, inspected with a linear phased array probe and a matrix phased array probe. Several TFM acquisition schemes are compared in terms of image quality.

Advanced NDT techniques for in Service high Temperature applications

Hari Kishore Maddi

Sievert India Pvt. Ltd. (a Bureau veritas Company), Plot no. B3/B4, TTC Inds. Area. Off Thane Belapur Road, M.I.D.C. Digha, Navi Mumbai-400708

Abstract

Non Destructive Testing (NDT/NDE) describes test methods used to examine a part, material, or system without impairing its future usefulness. For a Smooth operational of industrial assets, NDE plays a prominent role in preventive maintenance plan, to minimize the in service failures, identifying the critical locations/hotspots and assists in condition & remaining life assessments. However, due to limitations of the NDE techniques to inspect the assets during in-service such as high temperature, unable to allow hot work permits, etc. tends to asset owners to stop production and shutdown the equipment to enable to complete the life assessment analysis.

As technology advances, Industry looking for options to inspect their assets online during its service, mainly to cut down the unwanted service halts & limit the duration of planned overhauling. Recent past, Advanced NDT techniques shown a significant developments to adopt the testing environments during the equipment is still in service, would definitely a great advantage. Most of these Advanced NDT techniques are environment friendly, observe no radiation hazards, acceptable by applicable codes. In this paper, we discussed Advanced NDT techniques applied during in service inspection and the results Achieved.

Damping Estimation In Composites Structures: An Inverse Damping Modelling Technique

Eshwar Kuncham^{*}, Subhamoy Sen^b

^a Project Associate, ^b Assistant Professor

^{ab} i4S Research Group, IIT Mandi, INDIA

Emails: eshwar.research@gmail.com, subhamoy@iitmandi.ac.in

Abstract

Use of composites is increasing in various fields, such as aerospace, civil, naval etc. due to their excellent specific stiffness and strength over conventional materials and also due to the fact that their properties can be altered as required for a specific application. The mechanical properties of the composites are adversely affected due to presence of damage. Detection of damage in the composites in their service conditions, therefore, becomes important. There exist offline non-destructive evaluation (NDE) methods, such as, acoustic, ultrasonic and magnetic field based methods, radiographs, etc. which demands that the damage location should be known a priori and is also accessible and therefore vastly limits their application.

To overcome these shortcomings, vibration-based damage detection is used that provides information on the structural level. Common modes of damage in composite include matrix cracking, fiber breakage, fiber matrix debonding and delamination which induce unique changes in the vibrational properties of the composites. Typically, vibration based methods utilize the information stored in the modal domain structural response, i.e., modal frequencies, mode shapes and modal damping ratio which in turn depend on the physical properties of the structure i.e. mass, stiffness and damping. The basic strategy is that a damage that alters the physical properties of a structure will eventually lead to inducing changes in modal parameters, especially, system damping which is found to be very sensitive to damage. Ideally, the occurrence of damage should therefore be sensed through changes in damping. Further, in order to localize the damage, a support model for damping is needed to spatially isolate the origin of the changes. Of course, this model needs to be precise to ensure accuracy in damage localization. Unfortunately, damping depends on numerous known and unknown physical phenomena that makes it difficult to model or estimate. The most common approach to model damping is to assume it to be viscous. A further idealization of constant modal damping for first two modes leads to Rayleigh damping model. However, Rayleigh damping assumes existence of all possible modes in the response and therefore does not differ based on existence or absence of a particular mode. Further, the idealization of equal damping ratio for the first two modes most often does not conform to the reality.

This study, therefore, attempts to develop a mode specific damping model that takes basis on the structural stiffness, mass as well as modal participation factor using inverse estimation approach i.e. to estimate the damping model from the vibration response of the structure. Further, it has been ensured that the model is not case specific and should perform equally well for any arbitrary loading conditions. Frequency response function of the structure has been selected as target function that the model has to comply. The effectiveness of the model is tested through numerical simulations and compared with the existing damping identification methods.

Structural damage detection and localisation using 1D Convolutional Neural Network

Smriti Sharma¹ and Subhamoy Sen²

¹Research Scholar

²Assistant Professor

^{1,2}i4S Research Group, IIT Mandi, INDIA

Emails: d17007@students.iitmandi.ac.in, subhamoy@iitmandi.ac.in

Abstract

In this era of Artificial Intelligence, the structural damage detection using machine learning algorithms has been a stimulating research area in the field of Structural Health Monitoring. Machine learning techniques have been widely researched for detection and localisation of damage employing the vibrational properties of the structure. Our study involves employment of a 1D Convolutional Neural Network (CNN), which is a subset of machine learning technique for identifying the existence of damage and further localisation. The main purpose of using CNN is that it can work on real time data. CNN includes the feature extraction and classification from the data fed to it which is mapped during the training phase. Unlike, other neural networks, CNN doesn't need to be manually trained. However, for training the CNN, significant amount of data is required for proper extraction and classification.

We have performed certain validation studies on a numerical three storey steel frame. A set of experiments were performed in order to estimate the damage in the structural joints using CNN. Moreover similar study will be performed experimentally on a steel frame by collecting the real time acceleration data using accelerometers and robustness of this approach will be verified.

Keywords: Structural Health Monitoring (SHM); Damage Detection; Neural Network; Convolutional Neural Network(CNN)

Fluid Level Measurement at Higher Temperatures Using Ultrasonic Bulk Waves.

Shyam Sundar.M¹, Nishanth Raja¹ and Krishnan Balasubramaniam¹

¹Centre for Non-Destructive Evaluation, Department of Mechanical Engineering,
Indian Institute of Technology Madras, Chennai 600035, India.

shyam97murali@gmail.com

Abstract

Current ultrasonic level measuring techniques are not suitable for liquids with foam. This paper reports the method of measuring liquid level of those solutions inside a polypropylene bath at higher temperatures up to 800 C. The ultrasonic bulk waves were transmitted to the base plate of the bath using piezoelectric transducer. Based on the reflection of the ultrasonic bulk waves from the surface of the liquid, Different fluid levels can be measured from the time of flight of the received liquid signal. Finite elemental simulations have been carried out using ABAQUS 6.10. Experiments were carried out for different fluid levels till 430mm and validated using Finite element methods. An accuracy of 1mm was obtained.

Keywords: ultrasonic Bulk waves, piezoelectric, time of flight

Level Measurement at Higher Temperature Using Ultrasonic Guided Waves

Raju C¹, Nishanth Raja², Krishnan Balasubramaniam², N.V.Giridharan¹

¹Department of physics, National Institute of Technology, Tiruchirappalli, India

²Centre for Non Destructive Evaluation, Department of Mechanical Engineering, Indian Institute of Technology, Madras, India.

rajusilva1096@gmail.com

Abstract

This paper describes the non-invasive approach for measurement of liquid level inside a closed stainless steel tank at higher temperatures up to 2000 C. This involves the transmission of ultrasonic guided waves through the tank wall. It is based on the principle of attenuation of ultrasonic guided waves passing through a waveguide into the surrounding fluid. The rate of leakage depends on both the material properties of waveguide and the properties of embedding fluid medium. The energy or amplitude reduction of the guided waves due to leakage has been developed as the function of fluid level. An operating frequency of 500 kHz is found to be optimal from the dispersion curve obtained using DISPERSE software. Finite element simulations have been carried out using ABAQUS 6.12. Experiments are carried out for different fluid levels and validated with finite element trends.

Keywords: Ultrasonic, Waveguide sensor, Guided waves

SPONSORS & EXHIBITORS



Baker Hughes, a GE company
Principal Sponsor



Inspection Technologies, a business of Baker Hughes (formerly Baker Hughes, a GE company), is one of the world's leading suppliers of non-destructive testing (NDT) hardware, software and services. The company offers customers a broad spectrum of professional applications in the field of state-of-the-art 2D X-ray systems (X-Ray) and 3D computed tomography (CT) as well as ultrasonic and remote visual inspection. Today, hundreds of brands in the automotive, aerospace, consumer electronics, energy and industrial 3D printing industries trust BHIT's technologies to make their production processes easier and more efficient. Headquartered in Germany with offices globally, BHIT has more than 1,500 dedicated professionals worldwide. Find us online: www.industrial.ai/IT

Olympus
Platinum Sponsor



Olympus manufactures a large portfolio of innovative NDT instruments, Remote Visual Inspection equipment, XRF & XRD Analyzers, and Industrial Microscopes, designed with a commitment to technology and user friendliness. Our products are used for inspection and maintenance across the globe in industrial and research fields, ranging from aerospace and energy to transportation and manufacturing. We partner with our industrial customers to help them solve complex inspection challenges using our wide variety of technologies. Our products are used in a broad range of applications in markets including:

- Aerospace
- Automotive
- Power Generation
- Oil & Gas
- Chemical
- Transportation
- Welding
- Manufacturing
- Mining
- Recycling

Our commitment to designing quality products is directly linked to our customers' responsibility to ensure safety, quality and reliability by complying with the highest industry standard and regulation, making people lives healthier, safer and more fulfilling.

Company Name & Address : Olympus Medical Systems India Pvt Ltdl Ground Floor, Tower - C, SAS Tower, The Medicity Complex I Sector - 38, Gurgaon- 122001, Haryana, India.

Tel : 0124-4999191 | Fax : 0124-4999190 | Email: srinjay.gogia@olympus-ap.com

Contact Person : Mr Srinjay Gogia | Website : <https://www.olympus-ims.com/en/>

Airbus
Platinum Sponsor

AIRBUS

Airbus is a global leader in aeronautics, space and related services. In 2018 it generated revenues of €64 billion and employed a workforce of around 134,000. Airbus offers the most comprehensive range of passenger airliners. Airbus is a European leader providing tanker, combat, transport and mission aircraft and is also one of the world's leading space companies. In helicopters, Airbus provides the most efficient civil and military solutions worldwide.

Airbus has a special relationship with India for more than five decades now. During this period, it has been a partner to the growth of India's civil aviation sector and has supported the modernisation of its armed forces. The company has set-up design, engineering and research facilities in India to leverage the gifted engineering talent pool in the country. Today, it supports more than 7,000 local jobs, including 1,500 engineers. Its annual procurement from the country exceeds US\$650 million from 45+ suppliers.

In line with Indian government's 'Startup India' initiative, in 2015, Airbus established a Bizlab in Bengaluru, its third after Toulouse and Hamburg.

In early 2019, Airbus inaugurated Asia's first fully-owned flight and maintenance training centre for commercial aircraft in the National Capital Region (NCR) of Delhi. Recently, Airbus inaugurated a 500-person, nature-inspired, state-of-the-art Information Management (IM) Centre in Bengaluru to help advance the group's fast-expanding technology and digital capabilities across its global operations.

Airbus believes that 'Make in India' is a great opportunity for them to bring in their expertise of industrial collaborations worldwide and help develop a robust industry.

AIRBUS GROUP INDIA PRIVATE LIMITED, No.4, Xylem,

Plot NO. 4 & 4A, Dyavasandra Industrial Area, Mahadevapura Post, Whitefield Road, Bangalore 560048.

Tel : +91 80 66 380 380 | Fax : +91 80 66 380 118 | www.airbus.com

Fujifilm India
Diamond Sponsor

FUJIFILM

Delivering on the promise - Make Fujifilm one of Trusted Brands in India and Never Stop improving the future by building over 80 years of creating value through innovation to help, develop brighter and healthier future for all.

FUJIFILM Holdings Corporation, Tokyo, Japan, brings cutting edge solutions to a broad range of global industries by leveraging its depth of knowledge and fundamental technologies developed in its relentless pursuit of innovation. Its proprietary core technologies contribute to the various fields including healthcare, graphic systems, highly functional materials, optical devices, digital imaging and document products. These products and services are based on its extensive portfolio of chemical, mechanical, optical, electronic and imaging technologies. Fujifilm is committed to responsible environmental stewardship and good corporate citizenship.

FUJIFILM India takes this opportunity to introduce ourselves as 100% subsidiary of M/s. FUJIFILM Corporation, Tokyo, Japan. FUJIFILM Japan was established in the year 1934 as a photographic film manufacturer. FUJIFILM, Japan is known as one of the world's largest photographic and imaging Company.

FUJIFILM Corporation, Japan had earned the confidence of Indian customers by delivering high quality product performance and the service capacity since 1996 through its liaison/branch office in India. In order to meet the growing needs of Indian Market, FUJIFILM Corporation established a wholly owned subsidiary FUJIFILM India Private Limited in the year 2007 under the provisions of Indian Companies Act, 1956.

Currently, FUJIFILM India is engaged in business of Medical Equipment, Graphic Arts, Recording Media, Industrial Products and Digital Still Cameras including their accessories.

Industrial radiography is an application of Non-destructive testing (NDT) that uses X-rays to reveal defects in manufactured products or structures. Fujifilm NDT systems share digital X-ray innovations with our Fujifilm Digital Radiography Dynamix systems .

Fujifilm's imaging expertise goes far beyond photography.

It ranges from the testing equipment using digital X-ray technology to find defects, Prescale to enable visual confirmation of physical pressure, microfilm solutions for long-term archiving, to micro filters ensuring precise filtering with our proprietary microporous membranes.

Fujifilm Digital Radiography Dynamix System are system consist of technology with Advanced emulsion science, computerized and digital imagining processes that assure quality for industrial X-ray applications with Highest image quality system with efficient operation meeting to versatile needs.

The world's top class* high spatial and density resolution and Excellent signal to noise ratio (SNR) produce superb image quality. Fusion of Fujifilm's advanced technologies used in image reader, software and IP realizes images of the finest quality possible expected in digital imaging. Unique image processing and wide dynamic range bringing high accuracy to every inspection and fusion of the best of Fujifilm's technologies realizes images of the finest quality possible expected in digital imaging.

GE Research
Gold Sponsor



GE Research Centre (GRC), located in Bangalore, has a unique multi-disciplinary ecosystem that fosters innovation culture enabling GE businesses to deliver to our customers around the world with speed, scale and unmatched technology expertise. Our legacy of building world-class machines matched with our digital expertise is helping accelerate businesses into the future and turn “Research into Reality.” GRC is truly an innovation engine for GE and is at the forefront of the industry, committing to offer state-of-the-art technology solutions to its business partners. Our core offerings include

- **Testing and Measurement:** to ensure safe and smooth operation, seamless development and testing processes for various measuring devices, instruments, and equipment.
- **Research as service:** to provide state-of-the-art resource and optimize businesses' capabilities with cutting edge technology and digitally enhanced equipment.
- **Licensing Solution:** to help business, especially start-ups, realize their potential, and advance initiatives that seed the future of our business and communities.

TWI
Gold Sponsor



One of the world's foremost independent research and technology organisations, with expertise in solving problems in all aspects of manufacturing, fabrication and whole-life integrity management technologies.

Welding Inspection: CSW IP 3.0 Visual Welding Inspector - Level 1 | CSW IP 3.1 Welding Inspector - Level 2 | CSW IP 3.2 Senior Welding Inspector - Level 3 | Welding Inspection - Refresher Training / Pre-course eLearning Package

BGAS–CSW IP Painting Inspection: Painting Inspector - Grade 2 | Painting Inspector - Grade 1 | Site Coatings Inspector

CSW IP Non Destructive Testing – Levels I, II, III

Advanced NDT: Eddy Current Testing | Phased Array Ultrasonic Testing | Time of Flight Diffraction (ToFD) | Long Range Ultrasonic Testing | Automated Ultrasonic Testing (AUT) Data Interpretation Level II

SEASEP–INDIA (SOUTH EAST ASIA SKILLS ENHANCEMENT PROGRAMME): CSW IP Visual Welding Inspector (3.0) | Liquid Penetrant Testing (PT) | Magnetic Particle Testing (MT) | Ultrasonic Testing (UT) | Radiographic Interpretation of Welds | Welders Training | IOSH Managing Safely

CURRENT TRAINING VENUES - Mumbai - Pune - Kolkata - Baroda - Surat - Cochin - Trivandrum -Hyderabad - Bangalore -Chennai - Coimbatore - Trichy

TW I (India) Private Limited

78/97 Chamiers Road, Nandanam, Chennai 600-018

Tel: +91 44 43189691 Toll Free: 18001022981 E-mail: enquiries@twiindia.com

Blue Star Gold Sponsor



Blue Star Engineering & Electronics Ltd (Blue Star E&E) is a wholly owned subsidiary of Blue Star Limited (www.bluestarindia.com), a USD 681 million engineering conglomerate headquartered in India. The company has built up a strong reputation for providing advanced technology products as well as turnkey engineering solutions that cater to several industries across the country. It is the exclusive distributor in India for many globally renowned manufacturers of hi-tech electronics equipment and services, as well as industrial products and systems. Over the years, the business model changed from being a distributor of leading global manufacturers to that of a system integrator and value-added reseller, thereby moving up the value chain.

The Non-Destructive Testing business of Blue Star E&E is a leading provider of NDT equipment and systems, supporting Indian industries since 1980 with high-quality testing equipment and customised automated solutions. Blue Star E&E represents reputed companies from various countries for their non-destructive testing machines and inspection equipment. These advanced machines, with sophisticated interfaces and premium software, are capable of delivering world-class testing results.

Following the philosophy of providing world-class customer experience, the company strives hard to delight its customers, which helps in building long-term relationships. Blue Star E&E has placed itself as a premium value-adding player with a continuous supply of high-quality products, as well as successful installation and maintenance. The company's value enhancement lies in its abilities of requirement analysis, selection of the most suitable model, supply of high-performance NDT equipment, commissioning and service support.

Varex Imaging Silver Sponsor



Varex Imaging Corporation is a leading innovator, designer and manufacturer of X-ray imaging components, which include tubes, digital flat panel detectors and other image processing solutions, which are key components of X-ray imaging systems. With a 65+ year history of successful innovation, Varex's components are used in medical imaging as well as in industrial and security imaging applications. Global OEM manufacturers of X-ray imaging systems use the company's X-ray sources, digital detectors, connecting devices and imaging software as components in their systems to detect, diagnose and protect. Varex employs approximately 2,000 people located at manufacturing and service center sites in North America, Europe, and Asia. For more information about Varex, visit vareximaging.com.

Company Name & Address: HQ: 1678 S. Pioneer Road, Salt Lake City, UT 84104 | Tel: 1 800 432 4422

India Office: 838, Suyog Platinum Towers PUNE MH INDIA 411001 | Tel : 49 2154 92 49 80

Email: kirstie.mogilner@vareximaging.com

Contact Person : Kirstie Mogilner

Website : www.vareximaging.com

International Marketing Corporation Silver Sponsor



North Star Imaging is one of the leading manufacturers of Industrial 2D Digital Radiography and 3D Computed Tomography systems in the World. NSI is owned by Illinois Tools Works (ITW), and is part of their Test & Measurement Segment. Headquartered in Rogers, Minnesota USA, NSI has offices in UK, France and China. NSI's 2D DR & 3D CT systems are used by major Aerospace, Defence, Automotive etc companies all across the globe. NSI systems support features such as automated robotic scanning, precision metrology, 4D scanning, and more. With more than 750 installations NSI has proven to be the Industry best with their quality conscious and simple to use inspection systems.

NSI develops their own software which are innovative and provide in-depth inspection capabilities unlike any other.

International Marketing Corporation(IMC) is representatives for NSI in India. IMC is technology provider for all leading industrial sectors in India with over 30 years of operations. IMC provides manufacturing and inspection solutions for Aerospace, Defence, Automotive, Solar Photovoltaic etc Industries in India.

Contact : sales@imc-india.com

Company Name & Address: North Star Imaging Inc

Tel : +1.612.581.1640 | Fax : +1.763.463.5651 | Email : tlebens@4nsi.com | www.4nsi.com

Contact Person : Timothy Lebens – Global Sales Director

Company Name & Address : International Marketing Corporation

Tel : +91-22-6684 0000 | Fax : +91-22-6684 0099 | Email : prashant@imc-india.com | www.imc-india.com

Contact Person : Prashant Shah - Director

Proceq Silver Sponsor



Proceq Swiss Made since 1954- Global Leaders in NDT

Shaping the future of portable non-destructive testing (NDT) Metal / Concrete / Road safety Products, Proceq's high-tech and intuitive products solve material inspection challenges for a broad range of applications in demanding environments

Metal Testing: Equotip portable hardness testers – Leeb, Rockwell & UCI | Equotip LIVE

Ultrasonic Flaw Detectors – FD100 – UT/ PAUT / TOFD | UT8000 – Intuitive UT |

Equotip 550 Leeb U | Paper Roll Hardness Testers

Concrete Testing: GPR Live - Ground Penetrating Radar | Schmidt rebound hammers | Pundit ultrasonic | Pulse echo tomography And More

Zehntner – Road testing Products | ZDR 6020 Dynamic Retroreflectometer RL | ZRS 6060 Retroreflectometer and others

Proceq Asia Pte Lid, 1 Fusionopolis Way | #20-02 Connexis South Tower | Singapore 138632 | Tel : +65 6382 3966 | Fax +65 6382 3307 | E: logesh.raj@proceq.com | www.proceq.com

Contact Person : Mr Logesh Raj

Eddyfi Technologies Silver Sponsor



Eddyfi Technologies provides the most advanced NDT technologies in the world, helping OEMs, asset owners and service companies enhance productivity, save lives, and protect the environment. Its mission is to push the limits of advanced NDT to new heights by featuring various NDT modalities and investing massively in product advancement. Eddyfi Technologies offers a diversified portfolio of NDT sensors, instruments, and software for the inspection of critical components and assets in key industries such as aerospace, oil & gas, and power generation.

About the furniture, I would like to order a 32" TV on a floor stand but I don't see any of the exhibitor manual. Is it possible to order one?

Vector NDT Silver Sponsor



Vector NDT-ZChem Specialities Offers complete range of NDT Products in Magnetic Particle Inspection & Liquid Penetrant Inspection Techniques. Backed by unique technology, Vector-ZChem products are manufactured using world class manufacturing facility. With Vital combination of vision to grow, commitment to offer value to the customer and over 50 years of management competence, we are the unique choice for our customers. Vector-ZChem has a strong professional team capable of developing and offering customized products and solutions for various industrial applications. All Vector-ZChem products are designed to meet the most stringent requirements of the industry norms across the globe.

Corporate Philosophy of Vector-ZChem is YBWC-CWBY

YOU BE WITH CUSTOMER, CUSTOMER WILL BUY FROM YOU.

Quality Evaluation And Systems Team Silver Sponsor



QUEST is an Inspection Body providing Quality Management / allied Services to Industries, since 1984 and is accredited to ISO 9001 / 17020. With its Corporate Office in Bengaluru services are offered across India through 13 branches across various Industry Sectors.

QUEST has over 400 personnel comprising of Engineering Graduates, Post Graduates and Diploma Holders, experienced in disciplines viz. Mechanical, Electrical, Electronics, Metallurgy, Civil, Chemical, Control & Instrumentation well versed in National & International Standards with NDE. Third Party Inspection Services offered in Power, Aerospace, Defence, Railways, Health Care, Earth Moving and Automotive, Steel, Cement, Infrastructure, Petrochemical Sectors. In addition, QUEST adds Value through support on process improvement, Vendor Evaluation etc.

Engineering Services offered cover Vendor Evaluation / Audit, Industrial Health Studies, T4S Audit of City / Natural Gas Distribution (CGD) Network and Petroleum & Petroleum Product Pipelines (PPPL) & Project / Manufacturing Support Activities - QAPs, Expediting / Problem solving, Safety & Project Management Services.

Winner of the prestigious 'Rajiv Gandhi National Quality Award – 2009', 'India SME-100 Award for 2012', 'Rotary BSE-SME National Awards for Excellence' and Creative Partnership Award for 2017 from Aeronautical Development Establishment

Clients include L&T, BHEL, Adani, DRDO, ADE, Wipro, IOCL, Ambuja, JK, Jindal, BEML, Komatsu, TATA Power, Renew Power to name a few.

Topax NDT Solutions Silver Sponsor



Topax NDT Solutions provides Advanced NDT inspection equipment in various NDT methods like Radiography, Ultrasonic & Eddy Current from Global manufacturing company in India. The solution provides world class, reliable, consistent, cost-effective and built to perfection advanced NDT Inspection Solutions to a wide spectrum of industry verticals like Oil & Gas, Power, Defense, Chemicals & Fertilizers, Automotive, Aviation, Aerospace, Armed forces and Heavy Engineering Sectors including NDT Service Provider. We provide complete end to end solutions for transition from conventional to Advanced NDT in RT, UT & ET.

The solutions offered well appreciated by our customers for inspection of Welding, Forgings, Castings, Pipe lines, Boilers, Composites, Aero space components, Dis-similar Metal welding, Corrosion, Erosion CUI, SS welding for various critical applications.

We Represent:

- 1) Array Corporation for Film Digitiser: Array's 2905 Laser Film Digitizer meeting EN-14096-2, ASTM E-1936, ASME sec-V-2 & DS9 grade. Provides High Quality image suitable for storage & archival.
- 2) We also supply world class Phantom, Duplex IQI, EPS Blocks for CR/DR application. Pb screens in sheet as well as roll form and other accessories with certificate
- 3) Carestream provide World Class X-ray Films , Processor, Chemicals, Computed Radiography (CR) HPX 1 Plus & Hpx Pro & Flat panel Detector (HPX DR) with Industrex User Friendly Software, Server Solutions for archiving. The unique Reusable Laminated Imaging Plate mfg by only Company in The World.
- 4) Zetec provider for Phased Array /TOFD Ultrasonic machines like PAUT Topaz-16 (for unique Paint brush / Corrosion Monitor Solutions), Topaz-32 (for Dual Matrix Probes for Dis similar Welding & Stainless Steel Welding Solutions) & Topaz-64 (FMC & TFM with Full A scan data for various applications incl. High thickness jobs) , Weld Crawler & in Eddy Current portable MIZ-21C (Hand held Recordable, Eddy current solution replacing conventional MT & PT with Surface Array probe), MIZ 200 & various types of Probes & wedges in PAUT/TOFD as well as ET.
- 5) Sensor Network is leading probe manufacturing company & many PAUT machine mfg company source various types probes & wedges from them. We provide world class economical solutions to use any make equipment with SN Ultrasonic probes of Contact, Angle beam, Delay line, Immersion, Focused, PAUT & TOFD , DMA, etc etc & wedges).
- 6) We also provide film Digitization services using Array 2905 (DS9 grade) Film Digitiser for short terms as well as long terms (Large or small Qty) contracts.

Arora Technologies Pvt Ltd

Keeping the vision of “Make in India”, M/s. Arora Technologies (P) Limited is focusing on Manufacturing and Distribution of NDT Products & Accessories.

Our vision is to Innovate, design and manufacture NDT Products, Systems and Accessories for global markets by incorporating Quality & Excellence in our DNA. We are committed to build long-term relationships with our customers and pursue our business through innovation, latest technology & unrelenting quest for excellence.

Company Name & Address: M/s. Arora Technologies (P) Limited; 619 & 620, The Great Eastern Galleria, Plot No 20, Sector 4, Nerul (W), Navi Mumbai – 400706.

Tel: + 91 22 6138 0600 | Fax: + 91 22 2770 3903 | Email: info@arorandt.com

Contact Person: Mr. Mukesh Arora

Website: www.arorandt.com

Lucid Software Limited

Lucid provides software solutions across the entire NDT lifecycle. This includes software for the different steps involved in testing. All of Lucid's offering are geared towards enhancing productivity and effectiveness of Nondestructive Testing or Nondestructive Evaluation (NDE).

- » Preparation of test procedure - including scan plan
- » Set and testing – software integrated with instruments and also for use in an inline test set up in manufacturing
- » Data Analysis – Visualization, Assisted Defect Recognition (ADR), sharing/discussing with a remote expert, archiving the data and knowledge management
- » Reporting – support multiple report templates for different stakeholders, archival and generation of reports Products

Kovid Imaging is a decision support system in the field of NDT specially designed as world's first Multi technique and Multi-supplier NDT software. It provides the complete solution to meet the challenges of data acquisition, analysis and storage. The software can acquire the data from an instrument, process the data with application specific tools, support decision making/ make decisions, and then present or store/archive. Kovid also provides the following customizable features for the end user.

- » Ability to support different hardware
- » Customizable Graphic User Interface (GUI) as per the user's requirement
- » Easily extendable support for different image formats and databases
- » Open environment to add image processing filter algorithm
- » Customizable reports

The variants available for licensing include Kovid RT* for X ray analysis, Kovid UT for ultrasound analysis, Kovid iMaV (intelligent modelling and visualization software) for inspection planning and data and Kovid CT for 3D reconstruction of digital X ray data.

Company Name & Address :104-105, NSIC - Software Technology Parks Complex, Sector B-24, Guindy Industrial Estate, Ekkaduthangal, Chennai, Tamil Nadu 600032 | Tel :044 2225 2273 | Email : madhu@lucidindia.com, hr@lucidindia.com
Contact Person: C.P.Madhusudan | www.kovidndt.com

Technofour

TECHNOFOUR is the pioneer and leader in the field of Eddy Current Testing in India. They have been manufacturing a wide range of instruments and system based on Eddy Current technique since 1972 and command more than 90% market share in India. They have also exported several systems to Middle East, China & Latin America. Range of Eddy Current products include portable instruments like Conductivity Meter, System for Metal Segregation of various automobile components on the basis of metallurgical variation and flaw detection Systems for Tubes, Bars and Wires. Latest addition is Magnetic Leakage Flux systems for Transverse and Longitudinal defect detection and Credit-card sized Eddy Current Tester–EddyUSB with USB interface , Eddy Current Tester–EddyBLU with Bluetooth interface , Ultrasonic Tester – UTUSB and Portable Eddy Current Units with Touch screen display.

Technofour, Ndt House, 45 Dr. Ambedkar Road, Near Sangam Bridge, Pune 411001

Tel :020-26058060 | Fax :020-26058070 | Email: ndtsales@technofour.com | www.technofour.com

Contact Person: Mr. Ajit C. Gokhale

Beijing Hichance Technoloy Co., Ltd.

Beijing Hichance Technology Co., Ltd. (HICHANCE), established on 2006 and located in China, is a high-tech enterprise specializing in the research and development of construction engineering detection instruments. Our intelligent instruments series, such as concrete rebar locator, nonmetal ultrasound detector, pile integrity tester, digital concrete test hammer, floor thickness tester, crack width/depth tester, pull-off tester etc., are widely used in engineering quality inspection of construction projects such as building construction, highways, water transportation, railway networks, winning support from thousands of customers. We have a professional team with extensive engineering testing experience.

Our staffs make every effort to give every customer outstanding products and superior services. We not only supply mature products, but also provide relevant training and on-site testing services to customers and partner companies. HICHANCE has become a leader in R&D, instruments supply and technical services in the field of construction engineering detection.

Beijing Hichance Technology Co., Ltd.

Address: Room108, Building27, No.801 Changlin Road, Xisanqi, Haidian District, Beijing, PRC

Tel : +86-18611143865 | Fax : +86-01062323261 | Email : alan@hichance.cn | www.hichance.cn

Contact Person: Alan Wang

Magmatic NDT

Magmatic NDT Systems is a company based out of Bangalore engaged in the manufacture of MPI and FPI systems. The offerings include supply of Equipment, Consumables, Service and Calibration.

Magmatic has forged an alliance with Marktec Corporation Japan - which is a 60-year-old company in the NDT field. Magmatic also has joined hands with Opcoms Germany for the Ultraviolet Bulbs.

Magmatic, with a decade of presence in the NDT field, specializes in the supply of custom-built tailor-made MPI and FPI equipment to suit the needs of the Automobile and Aerospace customers. Magmatic offerings are listed below:

- » Magnetic Particle Inspection Machines - Standard and custom Built
- » 3 Phase out MPI machines
- » Fluorescent Penetrant Inspection - Tanks and Booth Systems
- » Marktec Make consumables such as - MPI powder Oil and water Base, FPI Penetrant, Developers
- » Marktec Dye Penetrant Chemicals
- » MPI accessories such as Gauss Meters, UV Intensity Meters, Shims, Ketos Ring, Flux Indicators TP4, etc
- » FPI accessories such as Tam Panels, Ni Cr Panels, Refractometer, etc
- » UV Lights for standard Application and Aerospace
- » Calibration Services
- » Cater Automobiles, Aerospace, Foundry, Forging, Casting, Metallurgical Industries
- » PAN India Presence
- » Distributor and dealer network spread over the country

Magmatic NDT Systems,

86/3, Ramachandra Reddy Buildings, Nordson Road, Bommasandra Industrial Area, Bangalore -560099

Tel - 8105983366/9342257506 | E: sales@magmaticndt.com/bopanna@magmaticndt.com

Contact Person - Guruprasad M.N. | Website - www.magmaticndt.in

Modsonic

MODSONIC is ISO 9001:2015 accredited leading Indian manufacturer, exporter and marketer of portable "Ultrasonic Testing Equipment". The product range covers various models of Ultrasonic Flaw Detectors, Ultrasonic Thickness Gauges, Various standard and custom-made probes, Reference / Calibration Blocks and other allied accessories.

Our 32,000 sq. ft. manufacturing setup includes all the facilities like Mechanical Workshop, Advance Electronic Assembly lines and Calibration units, Research and Development Cell, Application Laboratory, Administration Block, Marketing setup, Training Centre etc. are all under one roof at GIDC, Industrial Estate, Naroda, Ahmedabad, INDIA.

We have more than 1000 satisfied customers in India and Overseas. Our Customer segment includes Foundries, Forging Units, Fabrication Units, Defence, Automobile units, Oil Refineries, Railways, NDT Service companies, NDT training companies, and more. We are also RDSO approved vendor for supplying Ultrasonic Rail Testers, Ultrasonic Rail Weld Testers and Ultrasonic Rail Axle Testers to the Indian Railways.

East West Engineering Pvt Ltd

Eastwest Engineering & Electronics Pvt. Ltd., has completed 45 years of its exciting journey of manufacturing NDT equipment & Accessories. It has covered several milestones, stumbled sometimes but marched on looking at new opportunities.

Our range of products is very wide and probably unmatched. The products manufactured include equipment and accessories for Radiography, Magnetic Particle Testing, Ultrasonic calibration blocks, Vacuum Box leak detectors etc. We also manufacture a complete range of Pre & Post Weld Heat Treatment equipment. In addition to supply of NDT products we also provide innovative solutions to our esteemed customers as and when required.

A very strict quality control regime is in place with a highly qualified and strict QC manager to oversee the Quality control system. All our products strictly adhere to international standards specifications as required and we own responsibility towards the same. The delivery of our products is backed by our resolve to provide excellent after sales service.

Moving with times, a complete line of Digital Radiography system –consisting of X-ray machines, DR & CR system, CT Software, CT Scanners, CR Phantom, Manipulators, Cabinets are available.

We are also channel partners of internationally acclaimed Manufacturers like Cygnus, UK (Multi-echo Ultrasonic Thickness Gauges) Comet Switzerland & ICM, Belgium (Portable and stationary X-ray Machines), Dandong China (X-ray machines), Mitech China (Ultrasonic Thickness gauges, Hardness Testers) and few others.

Eastwest Engineering is an ISO 2015 and CE compliance company.

M/s Electromagfield Controls & SSA

We are pleased to inform you that we are one of the leading manufacturers of Magnetic Particle and Liquid Penetrant inspection equipment's and accessories in India and worldwide. We manufacture the equipment in more than 80 different models and special custom build equipment conveyors system to pick and place systems to cater our clients.

We have supplied more than 3500 machines.

- » We are the first Indian Company to Manufacture 3 FWDC machine in India.
- » First Indian company to manufacture 12000 amperes AC & FWDC supplied to HAL.
- » First Indian company to manufacture 10000 amperes AC & FWDC supplied to HAL approved by M/s. Rolls Royce UK for their engine project.
- » First Indian company to manufacture 6000 amperes AC & 3 phase FWDC machine supplied to M/s. Allison Transmission an American company in India.
- » First Indian Company to manufacture 8000 amperes AC & HWDC machine supplied to M/s. Bharath Forge Baramati for their crankshaft whose length is 4500mm & weight 2.5 tons.
- » We are pleased to inform you that we are the super stockiest and authorized distributors for M/s. Spectronics Corporation - USA for their UV range of products.
- » Distributors for M/s. Chemetall Germany for their antirust oil, cutting fluids, Phosphating chemicals, NDT chemicals which are AMS approved products.

Electro-Magfield Controls & Services

Plot no.165, Kattur Women Industrial Estate, Thirumulaivoyal, Chennai 600062.

Phone (Office): +91-44- 26366013 / 14/ 17 | E-mail: vivek@electromagfield.com / electromagfield@dataone.in

www.electromagfield.com

Carl's Zeiss

Company Profile : Carl Zeiss Industrial Metrology is a leader in CNC coordinate measuring machines and complete solutions for multidimensional metrology in the metrology lab and production. The company is a recognized partner to the automotive, aerospace, medical industries and its suppliers

ZEISS India was started as a pure sales unit in 1998 and has developed into a full scale representation.

It includes, an R&D centre, 3 production facilities, Competence centers at various cities, Global IT services, and 30 Sales & Service offices in almost all Tier I and Tier II cities in India.

The offering encompasses bridge-type, horizontal-arm and inline measuring machines, non-contact 3D Scanners, as well as form, contour and surface measuring machines. All relevant modules, such as controllers, software, measuring systems and sensors are developed and manufactured in-house.

Company Name & Address : Carl zeiss India(Bangalore)Pvt. Ltd. Plot 9, Bommasandra Industrail Estate, Jigani Link Road, Bangalore -560099

Tel : 91-80-43438020 | Email : Mahantesh.swadimath@zeiss.com | Contact Person : Mahantesh S

Website : www.zeiss.co.in

MAARG Technologies

MAARG TECHNOLOGIES is a rapidly-growing and a well established name in AUTOMOTIVE INDUSTRY with its Mitcorp, Taiwan VIDEOBOREScope . After having over a decade years of experience in promoting RVI Technologies (Videoborescope) to Aerospace ,Automobile , Petrochemical , Power & Research Industries, we are now a well known name in Indian Automotive Market.

With the growing awareness of our VIDEOBOROSCOPE application in the field of RVI (Remote Visual Inspection) we wish to expand its benefits to different Industries.

NDT Equipments that we deal in are

- » Mitcorp Industrial Videoborescope are Advanced , Economical, portable and convenient to use , that has its diverse application in examining - Tubes and Pipes for corrosion and damage check, Aeroengines, Steam & Gas Turbines , Heat Exchangers, Boilers, Generators, Condensers, Casting , Automotive Castings, Crank shafts, Cylinder-heads, Cylinder block, used in cryogenic SS tube internal welding inspection etc
- » MINISCANNER (For Spot and Projection Weld & Composite Scanning)
- » Coating Thickness Tester

MAARG TECHNOLOGIES has a prestigious Clientele' in different INDUSTRIES are : IGCAR, NPCIL,TAPS. Godrej Aerospace, Mumbai, MAN Diesel Engine (Marine Engine), Siemens, (Gas Insulated Switchgears), Mercedes Benz, Inox CVA (Inox India Pvt. Ltd.), Bosch Rexroth, Maruti Suzuki, TATA Motors, Ashok Leylands, Thermax India & many more.

Electronic & Engineering Co (I) P.Ltd

EECI is a pioneer in the field of Ultrasonic NDT. We have the unique advantage of being the largest Indian manufacturer of NDT Equipment with an infrastructure comparable to none; Government of India approved R & D department, 9 Regional Sales & Service Centers, large manufacturing facilities, qualified & experienced manpower.

Our Equipments have been found suitable for a wide range of application in diverse industries such as Aerospace, Research Lab, Defense, Railways, Ship Building, Heavy Engineering, Steel Plant, Automotives, Fabrication Shops, Foundries etc.

Our experience and reputation built over 4 decades for product quality & reliability, service and innovations has placed us an undisputable leader in the field.

With great pride, we would like to inform you that EECI has set up calibration lab, which is duly approved by AERB (Atomic Energy Regulatory Board) and NABL Accredited.

Our products are manufactured as per ASTM Standards and are well accepted in the international market. The product range manufactured by us are as under:-

a) Portable Digital Ultrasonic Flaw Detector, Thickness Gauges | b) Ultrasonic Transducers & Reference Blocks (Standard /Non Standard) | c) Automated Ultrasonic Systems | d) AC/DC Magnetic Yokes | e) Portable MPI Units and Accessories | f) MPI Bench Unit & Mobile Power Type Equipment | g) Radiation Monitoring & Detection Devices

Apart for local consumption, we are also exporting our products to China, Korea, Mongolia, Singapore, Middle-East, South Africa, Brazil, Iran, USA etc. We represent renowned Foreign Principals in India for ECT Equipments, Radiography Equipments, PC Based Single/Multi-Channel Digital Ultrasonic Solutions.

Electronic & Engineering Co. (I) P. Ltd., 8, 2nd Floor, Jyoti Wire House, Near Kolsite, Off Veera Desai Road, Andheri (W), Mumbai - 400 053. | Tel : 91-22-61503800 | Fax : 91-22 6691 9792

Email : ndtsales@eecindia.com, salesadmin@eecindia.com | Contact Person : Ms.Vaishali Joshi

Website : www.eecindia.com

Belloseal Valves Private Limited

"Bell O Seal Valves" is an ISO & PED certified company and is in the business since last 28 years in manufacturing and supplying of Manual /Actuated Bellow Seal Globe Gate and Control Valves meeting the stringent Fugitive Emission requirements as specified by EPA for Hazardous fluids, Flammable fluids and CAT M fluids. BOS is approved by Euro Chlor, Rus Chlor and is an associate member of the Chlorine Institute for supply of Chlorine Valves and have a proven track record of supplies with Chlor Alkali plants. BOS has been developing alves indigenously for hazardous applications not only for Chemical and Petrochemical industry but also for the Indian Nuclear Industries.

BOS has contributed to the nation by developing Bellow Seal bellow operated valve for BARC, Bellow sealed Isolation valve and 3Valve Manifold for NPCIL. BOS also desires to contribute to a Green Environment.

BOS has got full pledged inhouse Design department, machining centers with modern machines like CNCs, VMCs, CNC VTL, assembly centers, testing facilities including critical test facility like Helium leak test, Nitrogen test, Fire safe test and Cryogenic test facilities.

BOS is having inhouse NDT facility like DP, PMI. BOS has RT, UT, MPI at its Sister concern i.e, JRG Foundries. RT enclosure is approved by BARC.

BOS Has following major approvals: NPCIL, BARC, IGCAR, EIL, NTPC, IBR, Linde, Foster Wheeler, Chevron, TOYO, Reliance, Sabc, Thyssen Krupp, Toshiba, GNFC, GSFC, GNAL, TATA Projects, L&T, Sapreff. BOS has bagged Export Excellence award for three years from EPCC.

Pulsecho Systems

Pulsecho Systems est. in 1976 is an SSI Unit making highly reliable instruments for maintenance and upkeep of industrial units and plants. Our main products are for preventive and predictive maintenance and quality assurance.

Starting out in 1976, our first product was the digital ultrasonic thickness gauge, which was quickly and widely accepted by the industry. Empowered by this, we have slowly built our product portfolio to accommodate the industry needs. Our two brands, Pulsecho Systems and Optel, have developed more than 30 different portable products for field use with highest reliability and quality. We enjoy a wide customer acceptance and reputation. The sheer population of some of these instruments have made them an industry standard. We have earned laurels and awards of many a forum like Indian Society for Non Destructive Testing (ISNT), Chamber of Commerce and Industry, NATIONAL ASSOCIATION FOR APPLICATION OF RADIOISOTOPES AND RADIATION IN INDUSTRY (NAARRRI) etc.

We pride ourselves on the fact that we truly "Make in India", which means that we innovate, design and develop our instruments right here in Mumbai. Consequently, this allows us to focus and deliver excellent after sales service and enables us to enjoy the customer's trust, loyalty and respect. Our products are in use in more than 10 countries.

Vibrant NDT Services Pvt Ltd

We are pleased to introduce to you Vibrant NDT Services Pvt. Ltd is an adaptable NDT service provider, Leader in NDT with NABL ISO/IEC 17025:2005, capable of addressing a variety of Non-Destructive Testing demands worldwide. The Company has established itself as a high-tech firm, specializing, Research & Developments in the area of Non Destructive Testing's and Equipment's. It has the most modern Manufacturing facilities at Ambattur, Chennai, with a well-equipped application Laboratory, Training Institute with sophisticated measuring Instruments & Standards.

VIBRANT NDT SERVICES PVT LTD

Office : Module 107, SIDCO AIEMA TOWER, 1st Main Road, Ambattur Industrial Estate, Chennai - 600 058.Tamil Nadu.

Factory : SP 4&5 , 5th Lane, 1st Main Road, Ambattur Industrial Estate, Chennai - 600 058.Tamil Nadu.

Tel :9444 376 041 / 735 83 83 003 / 735 83 83 004 | Email: sales@vnsndt.com

Contact Person : Mr. Jayakandan (Managing Director) | www.vnsndt.com

Micro Lites

MICRO LITES founded in 2013 as a proprietorship firm by C.Dheerajmal.JAIN(Proprietor) has been an trading company with speciality lamps being its main product profile.

We are engaged in trading and manufacturing UV Led Lamps and equipment for NDT purpose

NDT Training Consultancy & Inspection Services Pvt.Ltd.

Manufacturer & Global Supplier of advanced NDT equipment's and inspection Service Provider.

Founded in 2008, with the ultimate goal to design, develop & manufacture the most advanced innovative NDT instruments & also to provide NDT inspection services within BUDGET & QUALITY.

Our Product Range includes various models of latest innovative Computed & Digital Radiography (CR/DR), Portable Ultrasonic Flaw Detectors, Ultrasonic Thickness Gauges, Portable Hardness Testers and Industrial Videoboroscope.

Our Inspection Services covers all major NDT inspection methods in both conventional and advanced NDT techniques serving all Industrial sectors in India and Abroad.

We are driven by VALUES, delivering with a VISION & determined to INNOVATE.

NDT TCIS Pvt.Ltd. Plot No.: FF/11, Civil Township, Rourkela – 4, Odisha. India.

Tel : 0674-2595555 / 0661-2401560 | Fax : 0674-2595555 | Email : slenka@tcis-india.com

Contact Person: Mr.Suwendu Lenka | Website : www.tcis-india.com

List of Products & Services on Display: 1. Computer Radiography (CR) | 2. Digital Radiography (DR) | 3. Videoscope | 4. ECHO : Ultrasonic Flaw Detector | 5. UTG10 : Ultrasonic Thickness Gauge. | 6. HT10 : Portable Hardness Tester.

New Products or Service Launched at NDT 2019 Exhibition: 1. Digital Radiography (DR)

Sanying Precision Instruments Co.,Ltd

Sanying Precision Instruments Co., Ltd. (stock code: 839222) is engaged in developing and manufacturing of high-resolution X-ray 3D imaging testing equipment in china. With own intellectual property, the product line includes high-precision X-ray micro CT and industrial CT, X-ray online testing equipment, X-ray 3D microscope, special-purpose 3D CT scanner for lithium battery, full core and PCB CT, 3D digital mobile testing center and so on. With own lab facility, the Company also provides nondestructive imaging testing services.

As a national high-tech enterprise, Sanying has passed ISO9001:2008 quality management system certification, has a postdoctoral working station, and has strict quality control system and strong R&D capability.

With the concept of “technique innovation, precision manufacture and quality first”, the company is dedicated to build a high-tech industrial platform centered by micro-nano nondestructive testing technology and provide professional solutions for national defense industry, new energy, new material, petroleum geology, aerospace, health and medicine, life science and agricultural technology and so on. Sanying expects to go forward hand in hand with you.

Sanying Precision Instruments Co., Ltd.

Contact person: Jian. Wu | Email: jwu_1@syipi.com.cn | Tel:0086-0-1580222209 | www.syipi.com.cn

Labino

Labino AB is the world's leading manufacturer of UV and White Light products as well as Alternative Light Sources. All Labino products are manufactured in Sweden with many first to market products in our portfolio such as explosion proof UV lights, waterproof UV lights, penetrant resistant UV lights, wireless UV meters and more. Our products are sold in over 50 countries via a wide network of distributors, service centers and calibration centers. In India we are represented exclusively by Squaremag Systems.

Over the years, Labino raised the bar with products of uncompromising quality and reliability that are in compliance with a wide range of industry standards such as ASTM E3022-18 and ISO 3059-12, as well as PRIMES requirements such as Rolls-Royce RRES 90061, Airbus AITM6-1001, USAF, The Boeing Co., Pratt & Whitney and more.

Labino AB is an ISO 9001-2015 certified company and an accredited Calibration Laboratory as per ISO/IEC 17025. Our ISO/IEC 17025 accreditation has been approved by the Swedish board SWEDAC and carries an accreditation number 10391.

LABINO AB, Fågelsångsvägen 16, 186 42 Vallentuna, SWEDEN

Tel : +46 8 83 90 70 | Email : labino@labino.com

Contact Person : Marios Athanasiadis

Website : www.labino.com

Pradeep NDT Products Pvt Ltd.

Pradeep Group of Companies , established in 1975 as manufacturing of following NDT products. Presently it has three manufacturing units at Thane and Pune in Maharashtra State in India.

1 . Dye Penetrant Testing Consumables | 2. Magnetic Particle Testing Consumables | 3. Leak Testing Consumables | 4. Accessories for Non Destructive testing .

Company has state of art manufacturing facilities and the products are manufactured under strict supervision and by ualified personnel . Company has in house testing facility and the laboratory is fully equipped with all the required equipments and personnel to test the products to confirm meeting the requirements of all the international specifications in the field of NDT. The Company is ISO 9001-2008 certified and the products and manufacturing facilities are also certified by Research esign and Standards Organisation of Indian Railways (RDSO) and Nuclear Power Corporation of India Ltd(NPCIL) for use of products in Railways and for Nuclear applications respectively. These products are well accepted all over India by Govt & Pvt Sector industries and by well known inspection authorities such as Lloyds,ABS, IRS, BV, Udhe, Jacobs, Rites, RDSO, NPCIL, EIL etc. Company has dealers network all over India and abroad for supply of the products in India and to different countries.

Company Name & Address : Tel : Pradeep NDT Products Pvt. Ltd.

Sales Office : 707, Lodha Supremus 1, Road No.22, Wagle Estate Thane 400 604

Email : sales@pradeepndt.com | Contact Person : Mr. A.G.Patil. Tel.022/2583 6001/2/3, 97570 86750

Website : www.pradeepndt.com

Sievert India Pvt Ltd

Sievert India Pvt Ltd., A Bureau Veritas Group Company is a global leader in Testing and Inspection delivering quality services to its clients to meet the growing challenges of quality, safety and social responsibility. We are renowned in NDT community in India providing NDT Services (Conventional and Advanced) & Heat Treatment Services for the Oil & Gas, Power & Utilities, Fertilizers & Nuclear field etc in Pipelines, Piping components, Petro chemical complex, Tank farms, Pressure Vessels of Onshore & Offshore construction. Sievert has enriched experience of working in Offshore Platforms & Barges for NDT of Subsea Pipelines, Risers etc.

We provide all the High Technology inspection services, such as Phased Array (PAUT), Time of Flight Diffraction (TOFD), Automated Ultrasonic Testing for pipelines (AUT), Tube Inspection like ECT, IRIS, RFET, NFT & MFL, Long Range Ultrasonic Testing, Automatic Corrosion Mapping of Storage Tanks & Pressure Vessels for maintenance and upkeep, and during annual turnarounds.

Company Name & Address: Sievert India Private Limited

Plot No.B3/B4, TTC Inds. Area, Off thane Belapur Road, M.I.D.C, Digha, Navi Mumbai-400708. Office:, Fax:+91 22 50954919, Mobile:+91 9867182747

Email : sievertindia.in@bureauveritas.com / anil.dewnani@bureauveritas.com

Contact Person: Mr. Anil Dewnani, Director (NDT)

Website : www.sievert.in

Advanced OEM Solutions

AOS offers customizable Phased Array (PA), Full Matrix Capture (FMC) and Multi-Channel Conventional UT OEM solutions with a fully documented API enabling customers to create their own high performance products for NDT applications.

AOS provides the best 'outside of the box' solution with high quality support to partner with you in your most challenging inspection projects.

Customizable | Open platform concept | Ultra Compact | Perfect for automated inspection systems | Adaptable to your needs | Easy to integrate | Fully documented API

Advanced OEM Solutions

9365 Allen Road, West Chester, OH 45069, USA

Phone: +1(844) 576-9687 | Contact Email (to publish): contact@aos-ndt.com | aos-ndt.com

Magnafield Electronics & Engineering. Pvt. Ltd

Magnafield Electronics and Engineering Pvt. Ltd. are known for manufacturing, distribution, trading and supplying quality NDT Equipment & products. The product range offered by us consists of Magnetic particle testing equipment, Ultra Violet LED Lamps, Ultrasonic flaw detectors, Ultrasonic Thickness gauges, Portable Hardness testers, Radiography Testing Film viewers, Pre & Post Weld Heat Treatment Equipment. Owing to their energy efficiency, high functionality, ease of operation, minimum maintenance, rugged & sturdy construction and longer serving life, these NDT equipment are high on demand in the market. These quality equipment and with other tools are used for the purpose of manufacturing of various range of products in accord with the industry set norms and regulation.

We are authorized distributors for NOVOTEST LTD. in India. They manufacture Ultrasonic flaw detectors, Ultrasonic Thickness gauges, Portable Hardness testers, Coating thickness gauges, rebound hammers, pulse velocity testers & other advance equipment.

NDT MASTERS INDIA is the our sister concern for services & ASNT NDT level I,II training & certification.

Insight Quality Services

Insight Quality Services is a pioneer institute in the field of Training, Consultancy, Inspection & NDT Services.

Founded in 1994, IQS is an internationally reputed organization that strives to provide services that exceed the "customers' expectations". A wide experience of many years, hands-on working style and a series of added qualifications in Inspection and Testing domains have been the focus of our team members. We are happy to announce that we are entering in the 25th year of operation.

IQS is an ISO 9001 certified company, accredited by National Certification Board of ISNT, Authorized TWI training agent for ISO 9712 Training institute approved by TUV Nord. We are in the process of getting accredited by AWS.

Our operations in UAE are under the name Insight Global FZE. We render training and consultancy services in UAE.

In our organization, our team members are qualified in different International qualification exams like ASNT, API, ISO 9712, CSWIP, AWS, IWT, ISO 9001 etc.

We are providing a one-stop solution to our customers from concept to completion for ASME certification (U, U2, S, N, PP, R). Also provide Health & Safety, ISO 9001, ISO 45001, ISO 14001, API certification.

We are also having a team of dedicated qualified engineers for Inspection & NDT Services We are in the final stage of NABL accreditation.

For more details please refer our website www.iqs-ndt.org. Or please contact us (M) +91 9689928561 / 9881244118 Phone - +91 20 25464388 / 25460894, Email id - support@iqs-ndt.org

NDT TECHNOLOGIES (P) LIMITED

NDT Technologies (P) Limited (NDTT) is a professional and a well-diversified company focused on providing advanced, application based NDT equipment and solutions right from portable and serial instruments, automated and tailor-made systems to all kinds of spares, consumables and related accessories required in non-destructive material testing application based NDT equipment and solutions..

For us at NDTT, its not just offering the right quality product that counts, but equally important to us, is to effectively render the requisite product related trainings, application assistance, after sales services and other required timely support.

Our strong, committed and customer focused approach has been the key factor in our growth to a single source house for world-class quality products and services for over 350 customers all over India. By virtue of our core competencies, a committed team of professionals, and proactive support from our Principal companies, we work very closely with our customers and contribute significantly in their production process and in quality checks.

NDTT provides solutions such as Phase Array Ultrasonic Testing System, Eddy Current Testing System, Ultrasonic Systems, Ultrasonic Thickness Gauge, Radiation Resistant Cameras, Magnetic Particle Inspection Testing, Liquid Penetrant Testing, Acoustic Emission, Hardness Tester, Coating Thickness Gauge, Wire Rope Tester, Videoscope, Robotic Cameras, Crack Depth Gauge, Immersion Ultrasonic and Magnetic Flux Leakage Testing System.

Also our company provides onsite Inspection services such as Tank Floor scanning, Remote Visual Inspection Systems, RFET Testing, Boiler Water Wall Inspection, Tubular Inspection, Bar and Insulated Piping Inspection, Leak Detection System, Utility Services and Internal UT Inspection.

Company Name & Address : NDTTECHNOLOGIES (P) LIMITED
Plot No. W-198, TTC Industrial Area, MIDC Khairane, Navi Mumbai – 400 709
Tel : 022-20874000/1/3 | Fax : 022-20874002 | Email : sales@ndttechnologies.com
Contact Person : Mrs. Sonali Salvi | Website : www.ndttechnologies.com

Square Mag

SQUAREMAG SYSTEMS manufactures complete range of MPI & FPI equipment & accessories and aerospace special process equipment to support Indian automotive, defense and aerospace companies to establish their world class Automotive & Aerospace infrastructure. We provide Turnkey Industrialization in Design, manufacturing, and installation of NDT & Special Process lines like Pre- cleaning, Anodizing, Electro Plating, Spray Painting, Air Pollution and Water Pollution control Systems. We also support our customers with post warranty services like AMC, Calibrations, onsite services etc.

SQUAREMAG is promoted by a team of manufacturing & service professionals with over 28 years of Industrial Expertise and have successfully setup facilities across the country compliant to AS9100, NADCAP, MIL and AMS, ASTM Specifications and Standards.

SQUAREMAG has 12,000 SFT state-of-the-art manufacturing facility with trained engineers for design, manufacturing, assembly, testing facilities and located in Hyderabad. Managed by professionals with sound technical knowledge and commercial expertise. The plant maintains a sustained development of safety and quality to meet the challenging business environment.

Company Name & Address: SQUAREMAG SYSTEMS,
PLOT NO. 4A/3, PHASE-1, IDA, TSIC, PATANCHERU, SANGAREDDY DIST., TELANGANA . PIN : 502319.

Tel : +91 8455 241107, +919849647107 | Email: info@squaremagsystems.com

Contact Person : Chandra sekhar | www.squaremagsystems.com

Santricals Services Inda Pvt Ltd

SSIPL is a group of SDR and it is performing in NDT Sector as a Manufacturer & Distributor of NDT Instruments and accessories – Ultrasonic Flaw Detectors, Ultrasonic Thickness Gauges | UT TEST TROLLEY | Ultrasonic Transducers | PAUT | TOFD | Scanners | Wheel Probes | Ultrasonic Couplant | Multichannel UFDs | UT Cables | Test Blocks | Videoscope | Boroscope | Crawlers | Wire Rope Testers | Conductivity Testers | Ferrite Meters | Portable Hardness Testers | LED FILM VIEWERS | UV Light | White Light | Intensity | LUX Meters | Eddy current testers | Automatic UT Inspection Systems | MPI Accessories | Magnetic Yokes | DR Radiography | Automatic Film Processors | Density Meters | Radiation Alarms | NDT INSPECTION SERVICES (UT,ECT, PT, MPI, LPT, VT)

SSIPL is doing In house Manufacturing High Intensity LED Film Viewers, Ultrasonic Probes, Repair and Calibration services for NDT Instruments as per OEM Standard procedures.

SSIPL is providing onsite NDT training for engineering professional on contract basis. We have a group of highly qualified and smart work engineers team to provide NDT Inspection services to our clients from various industries like Power, Aerospace, Oil & Gas, Fertilizer, Electricity, Steel, Automotive, Infrastructure, Aviation, Renewable energy, Chemical, Rail transport, Machine Manufacturer, Paper Industry, Education, Engineering | Raw material manufacturers. For more information you can visit our website www.sdrgroups.com; you can contact with us via support@sdrgroups.com

NDT INSTRUMENT / ACCESSORIES MANUFACTURER/DISTRIBUTOR & NDT INSPECTION , Instrument REPAIR, CALIBRATION SERVICE PROVIDER

M/s. Santricals Services India Private Limited, 4-282 Rambalaji Bhavan, Jeyam Nagar, T. Andipatti Post, NH-7, T. Vadipatti Taluk, Madurai District, Tamilnadu, India

Tel : +91 9892501239 / +91 9940870870 | Email : support@sdrgroups.com | Contact Person : Rajaprasannakumar D
www.sdrgroups.com

V.J. Imaging Technologies Pvt. Ltd.

VJ Technologies engineers, designs, and manufactures world-class imaging software and hardware products, solutions, and services for industry, academy, and government.

Founded in 1987, VJT is a leading global provider of x-ray inspection solutions with locations in the United States, UK, France, India and China to provide a true global level of service. We apply our radioscopic digital imaging expertise to government agencies and nondestructive testing (NDT) markets throughout the world.

VJT develops and manufactures a complete line of automated, manual, and turnkey X-ray inspection systems. Primary market sectors include: automotive, aerospace, electronics, remediation, nuclear, oil & gas, and pipe & weld applications. VJT x-ray inspection systems are used for radioscopic inspection of products and assemblies to detect defects or foreign matter, reducing cost and time while increasing quality and safety.

VJT delivers a competitive advantage over other companies through our network of global offices. In the 21st century, VJT continues to nurture emerging technologies and provide innovative solutions for global customers.

Visit <http://www.vjt.com> or call 631-589-8800 for more information.

VJ Imaging Technologies Private Limited

121G, Bommasandra Industrial Area, 1st Phase, Opp. Old Mahindra Reva, Hosur Road, Bangalore-560099.

Tel : +91 (80) 27836025/+91 8277585715 | Fax : +91 (80) 41328050

Email : pyaligar@vjt.com/tbajaj@vjt.com/skorlipara@vjt.com

Contact Person : Praveen Kumar Yaligar

Website : www.vjt.com

Gnat Technologies Pvt Ltd

GNAT Technologies Pvt. Ltd. is specializes in Non-Destructive Testing services in the field of Aerospace and Defence Engineering sectors comprising of following:

- » NDT NAS 410 & EN 4179 Level-III Consultancy Services
- » Training, Qualification & Certification Services of NDT personnel accordance with NAS 410 & EN 4179 with traceability to UK NANDTB and EASA
- » NADCAP accredited Independent Nondestructive Test House for leading Aerospace primes in NDT methods like Fluorescent Penetrant Inspection, Magnetic Particle Inspection and Film Radiography.

GNAT Technologies Pvt. Ltd

#16/A, Electronic City, Phase 1, Bengaluru, Karnataka, India – 560100

Tel : 080 28523337 | Email : sales@gnattechnologies.com

Contact Person : Mr. Vijay Joshi

Website : www.gnattechnologies.com

Kronix

Kronix NDT Corporation is into Marketing of NDT Products all over india, Channel Partner for BHGE Promoting Agfa Industrial X-Ray Film in India(Except Gujarat), Also deal in all Consumables, Accessories and Chemicals Required for Dark Room as well as methods of NDT.

M/s. Kronix NDT Corporation

No.1/196, Subhashree Nagar, Extn – 4, Mugalivakkam, Near Kedar Hospital, Chennai – 600 125.

Telephone / Mobile: 044 – 22520085 / 9940004299.

E Mail: info.chennai@kronix.in | Contact Person : S. Anbalagan

Website : www.kronix.in

MedeQuip Services

MedeQuip is an ISO 9001:2015 certified organization founded in 1994 by Dr. K Srinivasa Rao, an alumnus of IIT Madras with M.Tech in Instrumentation and a Ph.D. in Tomography studies.

We are glad to inform you that we are one of the leading design, manufacturer and supplier of Industrial X-Ray Systems in India for Non-destructive testing (NDT). We also design and manufacture customized manipulators for applications based on their special requirements to support Real-time radiography (RTR) and Computer Radiography.

Our key products include fully integrated NDT solutions ; Industrial X-Ray machines, Portable x-Ray Systems, RTR Systems, Linear Accelerators, CR Systems, Multi Axis Manipulators, Radiation Shielded Cabinets / Enclosures and Collimators. We also Design, Develop & Service customized Electronic Test Equipment and Electro Mechanical Sub-Assemblies for Defense and Industrial applications.

MedeQuip has partnered with industry leading organizations such as Varex, Spellman, Gulmay, X-Ray WorX, Dandong Aolong Radiative Instrument Co.,Ltd. & Volume Graphics. Clientele include SDSC SHAR, Ordnance Factories, ECIL, NFC, IGCAR, HAL, BHEL, BEL, ARDE, VSSC, BDL, DRDL, ASL, Gulf Oil & EEL.

Kappawave

KappaWave was founded in 2015 by NDT professionals who have been very active in the development of technology, applications and training of professionals.

Our objective is to build and deliver highly advanced, easy to use and affordable Ultrasonic Testing instruments meeting international standards for quality.

Kappawave's primary focus has been building quality NDT instruments with an emphasis on usability. Our machines undergo thorough testing by experienced UT professionals to ensure compliance to industry standards. Kappawave's instruments are world class units produced in the state of Kerala in India. They are economical, easy to operate, reliable, and truly state of the art. For more information please see www.kappawave.com or call John on 9447705887.

KappaWave

454, Karunkancheril, Killiroor (N) P.O., Kottayam 686020, Kerala, India.

Tel :9446426305, 9447705887 | Email :sales@kappawave.com | Contact Person : P.K. John

Website :www.kappawave.com

Hi Tech Imaging Pvt Ltd

Hi Tech Imaging Private Limited is Mumbai based company headed by Mr. Samir K. Choksi providing a myriad of NDT and Nuclear related solutions.

» We are sole distributors and service providers for complete range of Oserix products i.e. Gamma Radiography Equipment, Accessories and Isotopes. We have adequate persons trained by OSERIX to provide service support and maintenance of IGRED.

EXERTUS CIRCA 80 is the world's no.1 device for close proximity radiography.

» Recently we have tied up with "SPEC", Source Production & Equipment Co., Inc. USA for service, sales and maintenance of all devices manufactured by SPEC i.e. SPEC-150 (Ir-192 / Se-75), SPEC-300 (Co-60), related accessories and replacement of source.

» We also represent Teledyne ICM who have more than 20 years of expertise that has been fully dedicated to the development, manufacturing and marketing of highly innovative portable X-Ray Generators.

» We are sole agent for Silflex Shielding material in India and Middle East.

Silflex provides silicon flexible shielding solution for Radiography, Nuclear Gamma and Neutron shielding.

» We also supply:

- LASER Industrial X-Ray Film & Chemical
- RADAC Lead Intensifying Screen
- All accessories related to NDT

Contact: choksindt@gmail.com / 98703 56789 / 93228 94243 / www.ndti.co.in

Teledyne ICM

Our mission, at Teledyne ICM, is to facilitate professionals' life by providing innovative, user-friendly, and safe x-ray solutions, while accompanying them throughout the use of our products.

For more than 20 years, Teledyne ICM has been a worldwide-active company specializing in developing and manufacturing portable x-ray generators and detectors for Non Destructing Testing. Today, our x-ray solutions, CP SERIES, SITEX and GO-SCAN, have permitted safe, accurate and easy testing for countless inspections around the globe.

Regardless of your application and budget, you can rest assured that we will find the right x-ray product to fit your needs. From pipeline inspections to shipbuilding projects, to military applications, to aerospace innovations... Teledyne ICM will always provide the lightest and most robust portable X-Ray solutions out there. Since making your life the easiest possible is our top priority, we make a point in developing inspection solutions that exceed your expectations in design, power and accuracy.

As we want to make sure that our products can be serviced anywhere in record time, we have now ten officially licensed after-sales service centers scattered around the world, including one located in Mumbai known as Hi Tech Imaging Private Limited. You can sure to always receive a 5 star service ... wherever you are.

OSERIX SA

As one of the leading global players, OSERIX S.A. offers a complete range of world-class Gamma-ray Projectors and Sources serving the Non-Destructive Testing industry sectors such as Oil & Gas, Power Generating and Ship Building

Our policy is to combine Safety, Reliability and Performance constantly strive to improve our Core Competencies and Value Innovation to be the best in our class to always offer unparalleled services to our Customers worldwide.

Backed by Hi Tech Imaging Private Limited in India, OSERIX S.A. continues to grow by exploring new opportunities.

RiM LaS Private Limited

RiM LaS is a young organisation and the front runner in introduction of advanced technological products and new innovations in its category. At RiM LaS we aim at providing our customers with superior quality products that completely satisfies their need. RiM LaS, offers an array of value added products & solutions, aiming at simplifying customer needs, improving efficiency & optimizing the value proposition offered.

We are committed to be the leading solution provider in the Indian region to provide the most reliable yet cost effective NDT inspection, quality assurance and control related equipments and solutions to our valuable customers.

Principle Partners and Products:

RiM LaS has been chosen as exclusive National Sales Partner for India from the world's best global technology leaders, to compliment their offerings, to the Customers. We are partnering with technology innovators for Indian Territory who repose their confidence in RiM LaS.

Q NET Engineering GmbH, Germany – Hardness Case Depth Tester by NDT Method

Mashproject LLC, Russia – Leeb Hardness Tester, UCI Hardness Tester, Crack Depth Gauge and Detector

NDT1 KRAFT Ltd, Czech Republic – Ultrasonic Thickness Gauge and Coating Thickness Gauge

Mubatec GmbH, Germany – Mubatech HU-1 (Portable Universal Tester Machine)

LLC "Construction", Russia –Ultrasonic Flaw Detector

RiM LaS Private Limited

G-32, Sector-3, Gautam Buddha Nagar, Noida- 201301, Uttar Pradesh.

Tel : 0120- 4348088, 9137398070 | Email : pradeep@rimlas.co.in

Contact Person : Pradeep Kumar | Website : www.rimlas.co.in

ANSA Training & Quality Assurance Pvt. Ltd.

ANSA TRAINING & QUALITY ASSURANCE PRIVATE LTD (ANSATQAPL) is established in October 2017 in Chennai mainly to cater for ISO 9712 NDT CERTIFICATION TRAINING with utmost quality and integrity.

ANSA TRAINING & QUALITY ASSURANCE PRIVATE LIMITED is a group company of ANSA HOLDINGS PTE LTD, SINGAPORE.

Our primary pioneer founder Mr.G. Babu set up the NDT company since 1983 as a smallscale industrial testing laboratory in Chennai, India. In 2004 it is renamed as WENS QUALITY ASSURANCE PRIVATE LIMITED and continue its service and successfully completed various projects to the satisfaction of the clients. Following Mr.G. Babu's humble foot step, his successor continues to grow and expand services in overseas countries and developed ANSA HOLDINGS PTE LTD & its group of associated companies ANSATQAPL presently operates as Authorized Training and Examination Centre in Chennai. Our Training centre is Certified to ISO 9001:2015.

ANSA Wens Quality Assurance (S) Pte Ltd is an Authorized Qualifying Body (AQB) of RTC Testing & Diagnostics, a Certification body based in Moscow accredited by UKAS under Personnel Certification to ISO/IEC 17024:2012.

RTC Testing & Diagnostic's ISO 9712 scheme is one among 3 certification body at UKAS on NDT Personnel certification.

Our Certification is widely accepted globally as RTC is part of ICNDT and EFNDT MRA Schedule.

Presently we do Training and Certification for Level 1, 2 and Level 3 in various Methods (RT, UT, MT, PT, VT, PAUT, TOFD, ET) in different Sectors (Welds/Casting/Forging/Pre-and Inservice including Manufacturing) except TOFD and ET. TOFD is provided in Welds only. ET is provided for Welds and Tubes.

SG Marketing Pvt. Ltd.

SG Marketing Pvt. Ltd. is a sales and service company that represents manufacturers of Hi-tech equipment from all over the world. Based in Delhi and Secunderabad, we have an enviable list of clients all over the country. Founded in 1981, our many years of experience has enabled us to become well placed in India, to market new technology, systems and solutions. Dedicated to getting the best solutions for our customers, we work with some of the best manufacturers in their field. Our principal's equipment, is used across research and development organizations, security forces, PSU's, ordinance factories, Armed forces and space research institutions. We provide solutions to customers in the fields of Ballistics, forensics, cleanrooms, Non-destructive testing (including Linear Accelerators), Weapons & ammunition testing, Gun Barrel Inspection and repair and manufacture of aircraft engines.

SG Marketing Pvt. Ltd.

15, Birbal Road, Jangpura Extension, New Delhi – 110014 | Tel : +91 - 11 - 41823118 / 119 / 120

Fax : +91 - 11 – 24317369 | Email : shaanthadhani@ssgrouponline.com | www.ssgrouponline.com

Contact Person : Mr. Shaan Thadhani – CEO

List the Products & Services on Display

RVI Equipment – Videoscope – a) viZaar's Vuman X0, Vuman E3, Revolver80 | b) Schölly's – HD Endoscope FV100

Linear Accelerators – Only catalogue display

New Products or Services launched at NDE 2018 Exhibition

viZaar's Vucam D Portable Videoscope with interchangeable Probe.

Spellman

Spellman High Voltage Electronics Corp is the world's leading independent supplier of precision DC high voltage power supplies, X-Ray generators and Monoblock® X-Ray sources for medical, industrial and scientific applications. For Non-Destructive Testing we provide power generators for in-line and offline Inspection of low to high density materials, low ripple, high stability platforms improving image and throughput in film & digital imaging. Reliable, cost effective high voltage power supplies and X-Ray sources, with industry leading warranty, add value to NDT applications. CE/UL compliant, superior performance, flexible standard products, low cost of ownership and ease of integration.

Spellman High Voltage Electronics Corp.

10/2, Hungerford Street, Kolkata 700017 | Phone (Office): +91-9811404406 | E-mail: abose@spellmanhv.com

Website: www.spellmanhv.com

Contact Person: Arindam Bose

Far Asia

Founded in 1992, Dandong Flaw Detection Instrument Factory (DanFDIF) is qualified with ISO 9001:2008 and mainly manufactures:

- a.) Real Time Industrial Imaging System which can analyze flaw, defects of workpiece and can be used in various industries such as inspection of pressure vessel, wheel hub, Welded tube, cast parts, refractory material etc.
- b.) Wireless X-ray Flaw Detector which can connect and show results on PC.
- c.) Pipeline Crawler, for inspection pipes ranging between 219mm to 1200mm.

All instruments have certificates of GB/T19001-2008 (Chinese National Standard) and various patents.

Manufacturer: Web: www.ddNDT.com Email: sale@ddNDT.com Tel: +86-451-6191950

Sales Agent: www.farAsia.com.cn Email: info@farAsia.com.cn Tel: +86-10-87709858

Fill GmbH

Fill is a leading international machine and plant manufacturing company serving diverse branches of industry. The family-owned business excels in the use of the latest technology and methods in management, communication, and production. Business operations encompass the fields of metal, plastics and wood for the automotive, aircraft, wind energy, sport and building industries. The company is the global market and innovation leader in aluminum core removal technology, casting technology, in wood bandsaw technology, as well as in ski and snowboard production machines.

In the field of aerospace several manufacturing machines have been developed, i.e. hot drape forming, drilling, countersinking, riveting, and sealing based on accurate robots. Since 2009 Fill has developed high end NDT machines by integrating UT or X-ray components from known suppliers into these systems. Recent developments are basing on articulated high precision robots for UT, X-ray and metrology (CMM) applications. The robots have a unique performance in positioning and inspection speed.

Andreas Fill and Wolfgang Rathner are joint CEOs of the company founded in 1966 that is still completely family-owned and now has about 900 employees. In 2018, the company recorded sales of around 160 million euros.

More information can be found at: www.fill.co.at

FILL GESELLSCHAFT M.B.H.

Fillstraße 1, 4942 Gurten, Austria

Tel : +43 (0) 7757/7010 | Fax : no longer available

Contact Person : Mr. Wolfgang Haase

Website : <http://www.fill.co.at>

c/mos processors

c/mos processors - Chennai, name synonymous with excellent support and services, is 32 year old organization. Company is involved in Industrial Automation and NDT Equipment.

The key to success is dedicated service support. Vast Knowledge of Application Engineering & Innovative Solutions made it possible to give satisfactory support to all clients.

We are in the field of Non Destructive Testing Equipment for 20 years. We are Authorized Channel Partner of Baker Hughes, GE in South India.

We have offices in Chennai, Coimbatore, Hyderabad and Bangalore.

Our esteemed clients include Hindustan Aeronautics Ltd, LPSC Bangalore, VSSC, LPSC Trivandrum, IPRC, Lucas TVS Ltd., Brakes India Pvt. Ltd., Sundaram Clayton Ltd., Renault Nissan Automotive India Pvt. Ltd., LMW Ltd, L & T Valves Ltd., Rane Engine Valves, Turbo Energy Pvt. Ltd., BGR Energy Systems Ltd, Vestas, LM Wind Power, ZF Wind Power, Cochin Shipyard Ltd., BHEL Trichy, BHEL Ranipet, BHEL Chennai, DMRL, Naval Armament, Tata Sikorsky Aerospace Ltd. to name a few

C/MOS Processors

SP-152, 1st Floor, 4th Lane, 1st Main Road, Ambattur Industrial Estate, Chennai - 600058

Tel : 044-48535622, 044-42327656 | Fax : 044-26247655

Email : support@cmos.in, das.ndt@cmos.in

Contact Person : Mr. A C Krishnadas, +91-7358032323

Website : <http://www.cmos-ndt.in/>

CHIR-AYU Controls Pvt Ltd

Chir-Ayu Controls Pvt Ltd manufactures and supplier of complete range of Testing Equipment for the Construction industry such as Concrete, Cement, Soil, Asphalt and Steel confirming to EN, ASTM and Indian Standards.

We exclusively represents CONTROLS group Italy, Wykeham Farrance UK, IPC Global Australia, ACS-Solutions Germany and Capstone Capping Gypsum Taiwan.

Our major products includes complete range of compression, flexural and universal testing machines, NDT equipment, Dynamic UTMs and AMPT, CBR and Marshal testers, Static and Dynamic Triaxial Testing Machines, Automatic Vicat apparatus etc.

We also provide NABL Calibration Service under our brand FORCE MEASUREMENT as per ISO-17025.

CHIR-AYU CONTROLS PVT LTD

An ISO 9001:2015 Certified Company

4, Golden Apartment, Subhanpura, Vadodara: 390023, Gujarat, INDIA

Contact Person : Nikunj, E: nikunj@chirayugroup.in, M: 97255 68606

Website : chirayugroup.in

MFE Middle East

MFE Middle East is a part of MFE Group, a USA based firm with more than 25 years of solid presence in the NDT market. MFE Middle East is dedicated to providing NDT technicians with access to the most advanced NDT and RVI equipment available.

MFE Enterprises is a North America's leading Manufacturer of MFL Tank Floor scanners, MFE manufacture and sells specialized storage tank and pipeline MFL inspection tools using modern MFL detection technology.

MFE MIDDLE EAST

65, District No. 2, Fifth Settlement, New Cairo, Egypt. HQ: 150 Holder Lane Dripping Springs, TX 78620, USA.

Tel : 002 - 010 000 66 508 | Fax : 002 - 02 25 6434 85 | Email : Mgamal@mfemiddleeast.com

Contact Person : Mohamed Gamal - Director

www.mfeenterprises.com

UE Systems INC

The Most Trusted Source in Ultrasonic Plant Reliability & Energy Conservation Manufacturers of famous Ultraprobe® ultrasonic detection instruments since 1973

For over 40 years, UE Systems has produced thousands of ergonomically designed portable, and incredibly accurate airborne/structure borne ultrasonic instruments. Used primarily for leak detection, mechanical analysis and electrical inspection, these instruments have saved our clients tens of thousands of dollars in premature failure detection, elimination of downtime, increased productivity, and overall replacement costs. UE System's digital Ultraprobe® instruments are supported by Ultratrend DMS, a powerful data management software that fully integrates all inspections for effective plant-wide reliability and energy conservation. In fact, this patented software is the first of its kind to report both cost and carbon footprint reduction while enabling users to analyze, repair and report their savings.

So, whether you require instrumentation for a simple or robust predictive maintenance program, need safe, reliable equipment for hazardous areas, or want assurance that your reliability program is working around the world, UE Systems can help you become more productive and profitable.

Why Choose UE Systems?

We understand the need to keep production consistent and ongoing. | We know equipment failure costs time, money, and resources. | We recognize energy waste is a true threat to plant economics and productivity. | We believe Condition Monitoring is key to ensuring a safe, reliable, and profitable plant.

Ultrasound can help eliminate most of your challenges, and every day we strive to make our products more and more robust – enabling inspectors to truly have an entire Condition Monitoring lab in the palm of their hand.

Since our inception in 1973, UE Systems Inc., has been recognized as the worldwide leader in the technology of airborne ultrasound. Allow us to support your Condition Monitoring/predictive maintenance program with the tools, techniques, training, and resources you require to satisfy all of your plant maintenance goals.

UE Systems IMENA Pvt Ltd, Hyderabad are having factory trained engineers to support all our esteemed customers on Technology, Applications and Products.

UE Systems IMENA Pvt Ltd, 401, Sai Krupa Arcade, Kavuri Hills, Madhapur, Hyderabad – 500032, Telangana State

Tel: +91 9491073736 | Email: ManoharC@UESystems.com | Contact Person: Manohar Chidurala

Website: www.uesystems.com

Zhongke NDT Technologies (P) Ltd

ZHONGKE NDT TECHNOLOGIES (P) LTD. (abbreviated as ZHONGKE) is a professional manufacturer of NDT equipment with independent intellectual property rights. ZHONGKE is a scientific and technological enterprise held by Chinese Academy of Sciences. ZHONGKE has been working on R&D of Ultrasonic technology for over 30 years from 1988.

ZHONGKE has different series of NDT products, such as X-ray Detector, Phased Array Detector, TOFD Detector, Conventional Ultrasonic Flaw Detector, EMAT Detector and Online Automatic Inspection Systems for Pipe, Tube, Plate, Bars, Vessel, Automobile Parts and etc.

ZHONGKE has been committed to providing the market users with various kinds of all-round, efficient, steady, reliable, safe and environment-friendly nondestructive testing solutions and products, and providing special market users with customized personalized services to help the industries continuously improve technology process, enhance product quality and continue to increase enterprise benefits.

ZHONGKE continues to move towards the ideal. The new Ultrasonic Inspection Technology Industrial Park which is invested in and built by the company has been officially put into use. The Park establishes modernized research & development bases and test equipment such as acoustical experiment center, electronic technology experiment center, mechanical design center, Inspection instrument research & development center, mechanical processing center, assembly debugging center and quality Inspection center, etc. The use of Ultrasonic Inspection Technology Industrial Park will certainly lay a solid foundation for ZHONGKE to improve technical innovation capacity, optimize product quality and continue to lead the technology of Chinese ultrasonic nondestructive testing technology.

Zhongke NDT Technologies Private Limited. PAP-R-133, Near Sai Prasad Hotel, TTC MIDC, Rabale, Navi Mumbai, Maharashtra, India, Post Code: 400708. (Next to Vista Inn Hotel)

Tel :0091 81044 37339 | Fax :0086-311-85235689 | Email :hr.ma@zkcx.com.cn | Contact Person :Edward Ma
www.zkcx.com.cn

FLIR Systems India Pvt. Ltd.

Flir is the world leader in the design, manufacture and marketing of thermal imaging cameras for a wide variety of applications in commercial, industrial and government markets. Flir is a pioneer in the commercial infrared camera industry, has been supplying thermography equipment to science and other industries for over 50 years. From predictive maintenance, condition monitoring, non-destructive testing, r&d, medical science, temperature measurement and thermal testing to law enforcement, surveillance, security and manufacturing process control.

Flir r&d thermal cameras with lock-in, transient, and pulse capability possess the ability to perform advanced inspections such as non-destructive testing (ndt) or stress mapping that resolves temperature differences as low as 1 mk. Ndt is a widely used method to evaluate the properties of a material, component or, system without causing damage. Thermal imaging cameras can detect internal defects through target excitation and the observation of thermal differences on a target's surface. It is a valuable tool for detecting defects and points of failure in composites, solar cells, bridges, and electronics. It is also a great tool for thermal mapping of stress when performing materials testing. That's why flir r&d thermal cameras are widely used around the world for applications as diverse as micro-electronics, paper processing, automotive, plastics, injection molding, consumer appliance design, telecommunications, target heat signatures, mechanical testing, r&d and much more.

FLIR Systems India Pvt Limited

1111, D- Mall, Netaji Subhash Place, Pitampura, New Delhi-110034

Tel: +91-11-45603555 | Fax: +91-11-47212006 | Email: flirindia@flir.com.hk | Web: www.flir.in

Sonatest

Founded in 1958, Sonatest is the leading manufacturer of Ultrasonic inspection equipment. We are recognised and respected around the world for the quality of our rugged portable products which can be found in every industry and application.

Whether it is conventional ultrasonics or advanced cutting edge phased array with FMC-TFM, Sonatest is your partner for Non-Destructive Testing solutions whatever your industry or application.

Our products are used by the world's biggest and most innovative companies. Shell, Airbus, Siemens and Arcelor Mittal are amongst the thousands of customers who use Sonatest instruments to ensure that their products and processes are safe and reliable.

Sonatest have a range of products and solutions on display at NDE 2019 and are proud to introduce WAVE. Next generation technology at your fingertips.

The WAVE ultrasonic flaw detector is an innovative solution, where all the useful parameters are pre-set and available in less than two clicks and is suitable for a wide range of industrial applications from manufacturing to service engineering.

Additionally, there will be demonstrations of our Sitescan and Masterscan range of robust, technician focused flaw detectors. Veo+ and Prisma ultrasonic flaw detectors will also be on show offering the full range of Sonatest's innovative, phased array instruments.

To see our impressive range of solutions and to arrange a demonstration visit us on Stand E59/60.

Sonatest

Dickens Road, Old Wolverton, Milton Keynes, MK12 5 QQ | Tel: +44 (0)1908 316345 | Email: sales@sonatest.com

Website: www.sonatest.com

First Source Impex

First Source Impex has expanded their sales & service activities from Nuclear Products into NDT Instruments / Systems such as Thickness Gauges , Coating Thickness Gauges (Non-Contact) ,Ultrasonic (Sensors / Transducers ,Flaw Detectors , Ultrasonic Imaging & Test Systems, etc), Phased Array Ultrasonic Spotweld Detector Eddy Current Transducers & Instruments / Systems ,Acoustic Emission Monitoring Systems, Structural Health Monitoring Sensors (Dielectric) Monitors/ Software, Thermal Imaging Cameras & Solutions , NDT Measurement of Material Characteristics based on Impulse Excitation Technique , Digital X-Ray Instruments , X-Ray Inspection System & 3DX-Ray Inspection Systems , LINACS for NDT applications, Video Extensometer , DIC - Digital Correlation StrobeCam Vibration Analysis , Carbon Fibre Fabrics Testing Instruments , Roughness Testers , Roundness Testers, Surface Profilometers, Optical Profilometers Ultrasonic Technique & Equipment for Residual Stress Measurement , FBG Sensors , FBG Arrays & Interrogators , Fiber Optic Sensors & Monitoring Systems for Temperature / Pressure/ Strain/ Displacement measurements , Portable & Benchtop Hardness Testers , Terahertz Spectrometers , Terahertz Cameras , Terahertz Imaging System, Terahertz Components , Free space Terahertz Detector , TeraHertz radiation measurement , 2D/3D Imaging, thickness measurement and spectrometry.

For more details on the above please contact us at info@fsimpex.in

FIRST SOURCE IMPEX PRIVATE LTD

600, 1st B Main Road, Domlur Layout, BANGALORE- 560 071. INDIA

Tel : +91 98451 58797 | Mobile : 9886125777 / 9845158797

Planys Technology Pvt Ltd

Planys Technologies is an Indian deep tech startup specialising in smart underwater inspection solutions. Planys envisions to steer a new course in the maintenance and inspection industry with its disruptive innovations in the field of marine robotics, novel underwater NDT methods and AI enabled post-inspection analytical digital reporting dashboard. Planys' technology solutions helps asset owners take data driven decision for efficient planning of maintenance and repair.

Planys' capabilities include underwater HD videography, GPS mapping, ultrasonic thickness inspection, bio-fouling spot cleaning & acoustic surveys. Planys' robots are highly customisable wherein a host of sensors can be incorporated basis the on-field site conditions and inspection requirement from asset owner.

Over the last 4 years, Planys has launched 6 products, is a strong team of 60+ members and completed 65+ projects across various sectors like ports/terminals/shipping, oil & gas, desalination plants, power plants, dams and bridges. Planys is currently scaling up operations to the Middle East, Europe and South-East Asia. More recently, Planys started operations in the Netherlands and has executed projects for marquee customers like Vopak and Port of Rotterdam.

The company has received much acclaim and recognition, to name a few:

- » NATIONAL ENTREPRENEURSHIP AWARD 2019 (Engineering Category) from the Hon'ble Minister of Skill Development and Entrepreneurship, Dr. Mahendra Nath Pandey
- » FEATURED STARTUP - MAHARASHTRA STARTUP WEEK 2019 (Maharashtra State Innovation Society)
- » WINNER – DAM SAFETY AWARD FOR EXCELLENCE IN DEVELOPMENT OF TECHNOLOGY (Aqua Foundation, in association with World Bank and Central Board of Association)
- » WINNER – RISING STAR AWARD FOR BEST START-UP IN HYDROCARBON SECTOR, PETRO TECH 2016 under the aegis of Ministry of Petroleum and Natural Gas
- » WINNER – TAKEDA YOUNG ENTREPRENEURSHIP AWARD (The Takeda Foundation, University of Tokyo)

Planys Technologies, No. 5 Jaya Nagar extension, Balaji Nagar Main road G.K. Avenue, Puzhuthivakkam, Chennai, Tamil Nadu 600091 | Tel : +91 84481 88507 | Email : info@planystech.com | www.planystech.com

CyX Plus

CyXplus designs, manufactures and integrates industrial automatic NDT equipment and software for the manufacturing industries. 30 years of experience in X-ray, vision and laser technologies, let CyXplus to develop multiple inspection applications for various industries: automotive, tire industry aerospace & defense, pharmaceuticals, nuclear, oil&gas...

A comprehensive know-how in the field of X-ray technologies associated with a large experience in process automation systems allow CyXplus to provide in-line customized integrated solutions. Our systems integrate different X-ray detectors such as linear, multi-energy or digital detector array with wide range shooting energy from a few kV to 15 MeV.

For this purpose, CyXplus has multidisciplinary human resources with expertise in automation, robotics and highly specialized technical services (mechanical and electrical engineering, optics/vision, control-command and X-ray).

CyXplus has also a solid expertise in image processing and software development used to improve the image analysis and defect recognition. CyXplus has developed standard proprietary software

solutions for

- X-ray chain setting & automatic management,
- PLC management,
- X-ray images transmission & synchronization and data exportation
- Automatic Defect Recognition or 2D expertise
- Computed Tomography

CyXplus SAS

20 Avenue de Lamartine, 13170 Les Pennes-Mirabeau, France

Tel : +33 4 42 07 42 22 | Fax : +33 4 42 07 42 36 | Email : info@cyxplus.fr | Contact Person : Mrs Samia BRAHIMI

www.cyxplus.fr

Aimil Ltd

Aimil Ltd. a leading ISO 9001:2015 company, having All-India network of 14 offices, staffed and managed by over 850+ professionals with rich and varied experience in the instrumentation industry, is a complete solution provider under one roof for all your needs of NDT applications, whether it is X ray, Terahertz , Ultrasonic or fiber sensors based system.

Our Partner Teraview Ltd., is at the leading edge of applications of terahertz pulses to industrial applications. It has undertaken groundbreaking developments in the following areas:

- Product development within the pharmaceutical industry
- Quality control of paint on cars
- Failure analysis of semiconductor devices moving towards QC
- Developments of the application of terahertz pulses in the field of medical imaging

Teraview TeraCota 2000 sensor, a Non-Contact, Multi-Layer Coating & Paint Thickness Sensor with Scanning Capability can determine the individual thickness of multiple paint layers on both metallic and non-metallic substrates and offers significant benefits over existing techniques.

The X Ray NDT Specialist RX Solutions designs, manufactures and support one of the broadest range of high performance CT systems, from micro to nano scale analyses. This product portfolio covers all the industrial applications such as R&D, failure analysis, quality control, dimensional measurements, metrology and more. .

The Elcometer range of Bolt Tension Monitors accurately and ultrasonically measures the elongation, time, load, stress, and %strain of a bolt under load.

Elcometer Ultrasonic Thickness Gauges is ideal for measuring and recording material thickness and sound-velocity on a variety of substrates, in a wide range of industrial applications.

Surabi Biomedical Instrumentation

We are an indigenous medical ultrasound company with more than 2000 installation world-wide. We were the industry first to leverage the developments in PC and the USB to market a colour Doppler ultrasound scanner based on these technologies.

Being centered in the industrial city of Coimbatore we received requests for solution of problems faced by the foundry and fabrication industry using ultrasound. We indeed solved many problems using our medical probes with modified software on the scanner. Thus was born the inspiration to develop a PAUT scanner.

Weld joint inspection was a frequent requirement from the industry and thus was born the "Welder's Ultrasound Scanner". It is cost effective machine with a simple user interface to enable the welder to catch his defect at the source. To realize this we have developed the integrated wedge transducer, the touch friendly user interface apart from the 48 channel Phased array instrument.

We expect to sell the first instrument in NDE2019

Surabi Biomedical Instrumentation

22 Govinda Swamy Layout, Sivananda Colony, Coimbatore

Tel : 9944934352 | Email : tech@surabi.com | surabi.com

Contact Person : Gomathi

Pallakki NDT Excellence Ceter

Pallakki NDT Excellence Centre Pvt Ltd is accredited by NABL-2017 and ISO 9001 -2015 Certified in NDE Testing and Training Center.

Pallakki NDT Excellence Center Pvt.Ltd was established in the year 2001, provides quality and reliable NDT services to various Industrial sectors like Aerospace, Earth moving, Petrochemicals, Process piping, etc...

It is the Fact that Pallakki NDT Excellence Centre Pvt Ltd has earned the Name & Fame form all its Customers starting from Entrepreneurs to Public & Government sectors by catering our Quality Services, Competitive price & Delivering in time for the varieties of jobs starting from simple washer, Large & Huge Fabricated Items & highly critical welding areas involved high pressures.

Pallakki NDT Excellence Center Pvt Ltd feels proud to offer Services and Training through a team of highly qualified, certified and devoted professionals having substantial experience with vast multi disciplinary background. We cater to the needs, demanded by the ever increasing complexity of industry today.

Pallakki NDT Excellence Centre Pvt Ltd has been catering quality NDT services more than 250 reputed customers like HAL, NAL,ISRO, BEML, NPCIL, South Western Railway, DRDO, RAIL WHEEL Factory ,L&T, Shell, etc., through dedicated professional approach.

PALLAKKI NDT EXCELLENCE CENTER PVT LTD

No. 411/A, 11th cross, 4th phase, Peenya Industrial area, Bangalore - 560058

Contact Person : Shashidhar P Pallakki

Mob : 9448060717

ICO Asiapacific Group

ICO Asiapacific Group has been providing inspection services in the Asia Pacific Region for over 25 years. With almost 500 employees in 12 Countries and 21 office locations, not including offshore work. ICO has yard facilities in eight of these countries for Inspection of Tubulars, Drilling Tools, and Lifting Equipment.

ICO Asiapacific Group is an API Q-1 Certified Company. ICO is a full Member Company of API with ICO Managing Director appointed as a Board Member of API.

Under the name of ICO International Group, we also provide API-U Training for API Spec Q1, Spec Q2 and Lead Auditing.

- » Singapore (Corporate Office)
- » Indonesia: Jakarta, Batam, Balikpapan Surabaya and Duri
- » Malaysia: Kemaman, Labuan
- » Thailand: Songkhla, Sattahip
- » Vietnam: Vung Tau
- » Australia: Perth, Queensland
- » China: Tianjin and Huizhou
- » Brunei: Kuala Belait
- » Philippines: Manila
- » India: Mumbai
- » New Zealand: New Plymouth
- » Papua New Guinea: Port Moresby

ICO Asiapacific Group.

Head Office Address: Loyang Offshore Supply Base, Block 103, Unit 01-02 Loyang Crescent, Singapore 508988

ICO Inspection Services India Pvt Ltd. (A part of "ICO Asiapacific Group")

Address in India: F 204, Kapil Abhijat, Dahanukar Colony, Kothrud, Pune - 411038 | Tel : +6596374150 / +919850990989 | Fax : +6565427378 | Email : santosh@icoasiapac.com | www.inspection.icoasiapac.com

Contact Person : Dr. Santosh Gupte

Universal Precision Screws

Manufacturer and Exporter of High Tensile fasteners and machined components, having state of art manufacturing facilities and in-house R & D for Defense and Aerospace, Automobile, Renewable Energy, Medical, Power Transmission and Distribution, Construction equipment, Tool & Die etc.

We have global customers presence in all the 5 continents of the world in 35 countries and have been serving the best of the distributors and OEMs across the world. The company has the highest number of quality certifications and quality management systems in place and the manufacturing running in line of Industry 4.0 with SAP (ERP).

Universal Precision Screws. NH-10, Delhi-Rohtak Road, Kharawar Bye Pass, Rohtak (Haryana), INDIA | Phone (Office): +91-1262-305102, 113 | Fax (Office): + 91-1262-305111,112 | E-mail: customer@upsind.com | www.upsind.com

Chief Executive: Mr. Rajesh Jain, Managing Director

Quality Certification: ISO 9001, ISO 14001, IATF 16949, ISO45001, AS 9100D, ISO 17025, NADCAP and NABL certified quality lab

Shet NDT Services

We would like to introduce our company, Shet NDT Services, which has been in the business of providing NAS 410 level-3 Consultancy services to Aerospace and Non-Aerospace customer's in India, Thailand, Indonesia and China since 2011.

Our services include end to end contract from facility installation consultancy to NADCAP documentation and Audit support for prime customers like AIRBUS, BOEING, GOODRICH, ROLLS ROYCE , HONEYWELL .. etc

We have been recognized by many of the aerospace primes for NAS410 Level-3 services, NAS410 Level-2 and Level-3 certification for Penetrant testing and Magnetic Particle testing.

Our goal is customer satisfaction, and we offer you great service at very competitive prices. We do not compromise on the quality of our service

Shet NDT Services

NAS410 Level-3, Bangalore

ADVERTISEMENTS



FUJIFILM DIGITAL RADIOGRAPHY
DYNAMIX™ SYSTEM

MAKING THE INVISIBLE VISIBLE



DYNAMIX™ FXR Pad



DYNAMIX™ FXR



DYNAMIX™ HR²



DYNAMIX™ VU



UR-1

ST-VI

- Superb imaging from the full range of low to high dosage exposures
- High sensitivity, high sharpness and low noise
- Durability for a long expected lifetime

Industrial X-Ray Film **IX**



- Complaint with Film System Classification In Standard (ISO11699-1, ASTM E1815, EN 584-1)
- Brilliant Image Quality to Exhibit High Defect Recognition
- Stable Density Throughout Development Time/ Temperature Ranges
- Constant Performance Increasing Batch to Batch Productivity
- Less Density Unevenness – Uniform Emulsion Coating

+ Ecology

Fujifilm India Private Limited

Unitech Cyber Park, Unit No. - 801 to 807, 8th Floor, Tower C, Sector 39, Gurugram - 122001, Tel : 0124-4325500

Mumbai Office: 022-42364000 | Bengaluru Office: 080-49332000 | Chennai Office: 044-43994000 | Kolkata Office: 033-40268500

Email: ip@fujifilm.com | Web: www.fujifilm.in



GE Research

Your Innovation Partner to turn **Research into Reality**

Our offerings in



Research
as a service



Testing &
Measurement
as a service



Licensing
as a service



Together, let's partner to unleash limitless possibilities

To know more about how we can help you solve your toughest problems,
please email us at geresearch.externals@ge.com



www.twiindia.com

**World Leaders in Welding,
Painting and NDT Training and Certification**

Thinking of improving your career Prospects?

Welding Inspection

- CSWIP 3.0 Visual Welding Inspector - Level 1
- CSWIP 3.1 Welding Inspector - Level 2
- CSWIP 3.2 Senior Welding Inspector - Level 3
- Welding Inspection - Refresher Training / Pre-course eLearning Packages

BGAS-CSWIP Painting Inspection

- Painting Inspector - Grade 2
- Painting Inspector - Grade 1
- Site Coatings Inspector

CSWIP Non Destructive Testing - Levels I, II, III

Advanced NDT

- Eddy Current Testing
- Phased Array Ultrasonic Testing
- Time of Flight Diffraction (ToFD)
- Long Range Ultrasonic Testing
- Automated Ultrasonic Testing (AUT) Data Interpretation Level II

SEASEP-INDIA (SOUTH EAST ASIA SKILLS ENHANCEMENT PROGRAMME)

- CSWIP Visual Welding Inspector (3.0)
- Liquid Penetrant Testing (PT)
- Magnetic Particle Testing (MT)
- Ultrasonic Testing (UT)
- Radiographic Interpretation of Welds
- Welders Training
- IOSH Managing Safely



About TWI

One of the world's foremost independent research and technology organisations, with expertise in solving problems in all aspects of manufacturing, fabrication and whole-life integrity management technologies.

Blended Learning Package available for CSWIP PAUT and TOFD level 2 courses

More courses and venues planned - check our website for up-to-date information

CURRENT TRAINING VENUES - Mumbai - Pune - KolKata - Baroda - Surat - Cochin - Trivandrum - Hyderabad - Bangalore - Chennai - Coimbatore - Trichy

TWI (India) Private Limited
78/97 Chamiers Road, Nandanam, Chennai 600-018

Tel: +91 44 43189691 Toll Free: 18001022981 E-mail: enquiries@twiindia.com



NDT Products & Systems



- Conventional Ultrasonic
- Phased Array Ultrasonic
- Eddy Current
- Eddy Current Array
- Remote Visual Inspection
- Acoustic Emission

**Superior
Technology
Solutions**

- X-Ray
- Computed Tomography
- Computed Radiography
- Digital Radiography
- Metrology
- Magnetic Particle Inspection

For over 35 years, Blue Star E&E is a leading player in the NDT market by offering high performance equipment and has designed and delivered NDT Products and Systems as per requirements. The value addition lies in precise need identification, solution configuration, design & engineering, pre-installation support, installation and commissioning as well as reliable after-sales service.



Ultrasonic Thickness Gauge



Ultrasonic Flaw Detector



Phased Array Flaw Detector



Industrial Scanner



Eddy Current Flaw Detector



Remote Visual Inspection



Computed Radiography



Digital Radiography



Portable X-Ray



X-Ray Cabinet Inspection System



3D Scanners (Metrology)



Ultrasonic Immersion Inspection System



Ultrasonic Rail Axle & Wheel Inspection System



Ultrasonic Plate Inspection System



Ultrasonic Bar Inspection System



ENGINEERED SOLUTIONS

Varex Imaging portfolio of industrial imaging components enable exceptional image quality within NonDestructive Testing (NDT) and Quality Control X-ray systems.

Our industrial components - linear accelerators, rad hard detectors, X-ray tubes, CBCT software, betatrons and accessories enable outstanding image quality and a clear view in all your applications.

Varex Imaging providing crucial core components for Industrial NDT and Quality Control.



For more information visit www.vareximaging.com

Customized Film Digitization Services



CR HPX - 1 PLUS



CR HPX PRO



FILM DIGITIZER ARRAY - 2905 HD



DUPLEX IQI



IMAGING PLATE



DR FLAT PANEL



CR PHANTOM



All India Channel Partner



TOPAX NDT Solutions LLP
Solutions Built To Perfection
 Sales Office : B-61/114, Veena Ind. Estate,
 Opp. Monginis Cake Factory, Off Andheri Link
 Road, Andheri (W), Mumbai - 400053, INDIA
 Mob : +91 22 26394823 / 26394826 /
 +91 9920129375
 Email : reply@topaxndtsolutions.com
 Website : www.topaxndtsolutions.com

Radiographic Testing

Film Digitization Services

Ultrasonic Testing

Eddy Current Testing



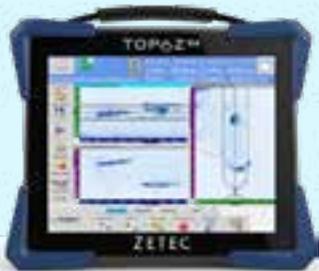
TOPAZ 16 / 128 with PAINT BRUSH



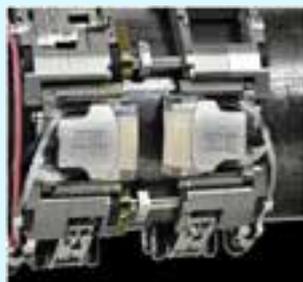
WELD CRAWLER



TOPAZ 32 / 128



TOPAZ 64 / 128



CIRCIT SCANNER



MIZ - 21C



MIZ 200



SURFACE ARRAY PROBE

See beyond the surface



CT Scan of a Turbine Blade

We build World class Industrial Digital X-ray and 3D Computed Tomography Systems so you can develop the world's best products.



+91-22-6684 0000 +91-98200 31959 prashant@imc-india.com
418 Swastik Chambers, S.T Road, Chembur, Mumbai - 400 071, INDIA



Flaw Detector Live

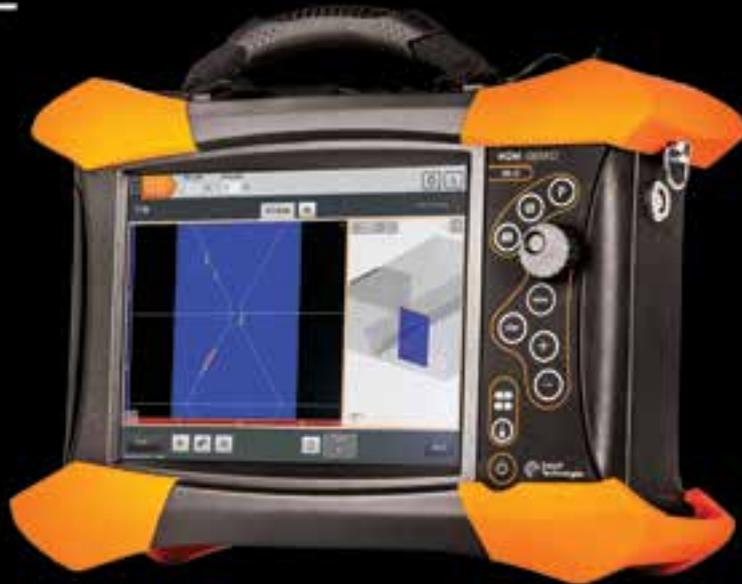


UT8000



Local Partners www.sasthascientific.com

BE THE BEST INSPECTOR
YOU CAN BE



M2M GEKKO



NDT
MPI | LPI PRODUCTS



Red Dye Penetrants
&
MPI Powders



Fluorescent Penetrants
&
Accessories



UT, Eddy Current
Systems





A NABCB Accredited Company
for Third Party Inspection

On-site Field Quality Assurance Services

(Power incl Nuclear / Defense / Aerospace / Healthcare / Steel
/ Construction & Earth Moving Machinery / Petroleum
/ Cement / Transportation & other major Sectors)

Contact:

Quality Evaluation And Systems Team Pvt Ltd, Bangalore

Web: www.questxl.co.in; Tel: +91-80-2657 2819 / 2830;

Email: mktg@questxl.co.in

Best Compliments & Seasons' Greetings
From.



OVERVIEW OF SERVICES:

- API-U APPROVED TRAINING: API SPEC Q1; Spec Q2 & Lead Auditing;
- VARIOUS API MONGRAM TRAINING & CONSULTANCY;
- NDT AND OCTG INSPECTION SERVICES;
- MAINTENANCE SERVICES FOR TUBULARS AND DRILLING TOOLS;
- QA/QC & THIRD PARTY INSPECTION;
- ASSET INTERGRITY MANAGEMENT SERVICES IN UPSTREAM SEGMENT;
- LIFTING EQUIPMENT INSPECTION.



Contact: Dr. Santosh Gupte
santosh@icoasiapac.com

ICO ASIAPACIFIC GROUP
ICO INTERNATIONAL GROUP

Website: www.icoasiapacific.com

UNiverse of PRECISION Fasteners



UNIVERSAL PRECISION SCREWS

NH-10, V.P.O. Kharawar Bypass, Delhi Road,
Rohtak-124001 Haryana (India)

Tel: +91-1262-305262 Fax: +91-1262-305111,112
india@upsind.com www.upsind.com

An ISO 9001, ISO 14001, IATF 16949, ISO45001, AS 9100D
ISO 17025, NADCAP and NABL certified company



Sciencetech Services

Non Destructive Testing Engineers



ISO 9001:2015 certified and NABL Accredited as per ISO/IEC 17025:2017

RDSO Approved for USFD Testing of AT & FB Weld

Offices at: Bengaluru, Shivamogga, Hubballi,
Udupi and Coimbatore.

Approved by: AERB and other statutory bodies
All major Third Party Agencies

Head Office:

No. 15, Singasandra, 14th KM,
Hosur Road, Bangalore – 560 068
Ph: 080 25730691, 080 25730719

Services Offered

- ✓ Industrial Radiography By X-Rays & Gamma Rays (Ir192 & Co 60)
- ✓ Casting Upgradation
- ✓ Ultrasonic Flaw Detection & Thickness Gauging
- ✓ Magnetic Particle Inspection
- ✓ Dye Penetrant Inspection
- ✓ Hardness Testing
- ✓ NDT Consultation, Training & Certification



Expertise in Castings

Website: www.sciencetechservices.com email: contact@sciencetechservices.com

PALLAKKI NDT EXCELLENCE CENTER PVT LTD.

Your Product Our Assurance



NABL - 2017 & ISO 9007-2015 Certified Company



OUR SERVICES :

- ❖ ASME "U" & "U2" Stamp NDE Consultation.
- ❖ Ultrasonic Examination Both Contact and Immersion.
- ❖ Radiographic Examination both Gamma & X-Ray.
- ❖ Magnetic Particle Examination both Visible & Fluorescent.
- ❖ Penetrant Examination both Visible & Fluorescent / Booth Type & Can Type.
- ❖ NDT Training & Certification Course in ASNT SNT TC 1A : Level-I & II.
- ❖ Consultations in NDT to Various industries.
- ❖ Procedure Preparation as per Code, Std, Requirements.

No. 411/A, 11th Cross, 4th Phase, Peenya Industrial Area,
Bangalore - 560 058 (Karnataka, India), Phone : 080-28360717, 41270949, 41147312
Mobile : +91 94480 60717, +91 94483 70954, +91 80889 38938
Email : pallakki@pallakkindt.com, pnec@pallakkindt.com, smurthy@pallakkindt.com

With Best Equipment

MALNAD M/S **Malnad Group of Companies - Shimoga** **MALNAD**

Experts in : Fully Machined Valve; Pump; Steam Turbine Components; General Engineering; Nuclear Power & Defense Sector Components in Sand & Investment Castings

<p>Malnad Alloy Castings Pvt Ltd</p> <p>Manufacturers of: Alloy Steel; Stainless Steel; Nickel Alloy; Cobalt Alloy Castings for all International Standards</p> <p>Certified For: ISO 9001:2015; ISO 14001:2015; OHSAS 18001:2007; IBR; PED; AD-MERKBLATT</p> <p>Foundry Approvals By: BUREAU VERITAS; DNV-GL; Lloyd's Register</p> <p>Since 1985</p>	<p>Shimoga Precision Castings Pvt Ltd</p> <p>Manufacturers of: Alloy Steel, Stainless Steel, Nickel Alloy Steel, Cast Iron and Cobalt Alloy Steel Castings by Investment Casting and Sand Casting Process</p> <p>Certified For: ISO 9001:2015</p> <p>Since 1996</p>
<p>Malnad Prime Machining Technologies</p> <p>Manufacturers of: Precision Machined Components</p> <p>Certified For: ISO 9001:2015</p> <p>Since 2010</p>	<p>Malnad Alloy Castings Pvt Ltd (Laboratory Division)</p> <p>NABL Accredited Mechanical and Chemical Testing Lab</p> <p>Certified For: ISO 17025:2005</p> <p>Since 2017</p>

Factory & Office :
36-A, Shimoga- Bhadravathi Indl. Area, Machenahalli, Nidige Post, Shimoga-577222 Karnataka, INDIA
Phone: 08182-246 141 / 43 Mobile: +91 - 88616 99975
Website: www.malnadalloycastings.com; www.shimogaprecisioncastings.com

Manufacturing of NDT Products & Accessories



Electromagnetic Yokes



LED Film Viewers



Digital Densitometer



LED UV Lamps



MPT/LPT Chemicals



Ultrasonic Testing Accessories

Distribution of NDT Solutions



Ultrasonic Flaw Detector



RTR/CT Systems



Tube Testing Solutions
(ECT/RFT/NFT/MFL/ECA)



Pulsed Eddy Current Machine



Wire Ropes Tester

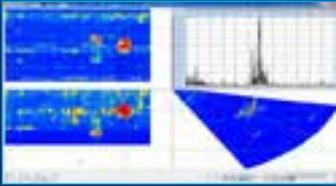


Portable Hardness Testers

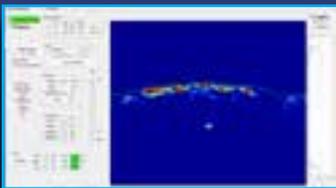
Arora Technologies (P) Limited

619 & 620 The Great Eastern Galleria, Plot No. 20, Sector 4, Nerul, Navi Mumbai 400 706, Maharashtra, India
T: +91-22 6138 0600, 2770 3913 | E: info@arorandf.com | W: www.arorandf.com

Experts in
Phased Array
Ultrasound



Prelude Software:
• PAUT Acquisition and Analysis



ARIA Software:
• Advanced TFM
• Adaptive FMC/TFM

www.tpac-ndt.com
info@tpac-ndt.com

Field Ready Real-Time Adaptive TFM



Explor 64/128
Phased Array Including FMC/TFM
Option:
• Adaptive FMC/TFM
• Advanced FMC/TFM



Adaptive TFM
Scan from top of the weld!
Real-Time Geometry
Correction



Instrumentation • Software • Solutions • Facilitation • Customization



HIGH PERFORMANCE PHASED ARRAY ULTRASONICS



OEM
Brand custom solutions with an open platform



COMPACT
Integrate our small lightweight instruments almost anywhere



ADVANCED
Ultra fast data speeds of **3 GB/s**
Up to **8192** Channels!

Cutting Edge Technology
Full Matrix Capture (FMC) & Total Focusing Method (TFM)

www.aos-ndt.com • contact@aos-ndt.com



KappaWave®

ULTRASONIC FLAW DETECTOR K1 & K8

Large display. Less eye strain
See everything in detail

State-of-the art Gate movements

Scientific calculator for UT work

Convenient dB steps
0.3, 2, 1.2.6 & 12

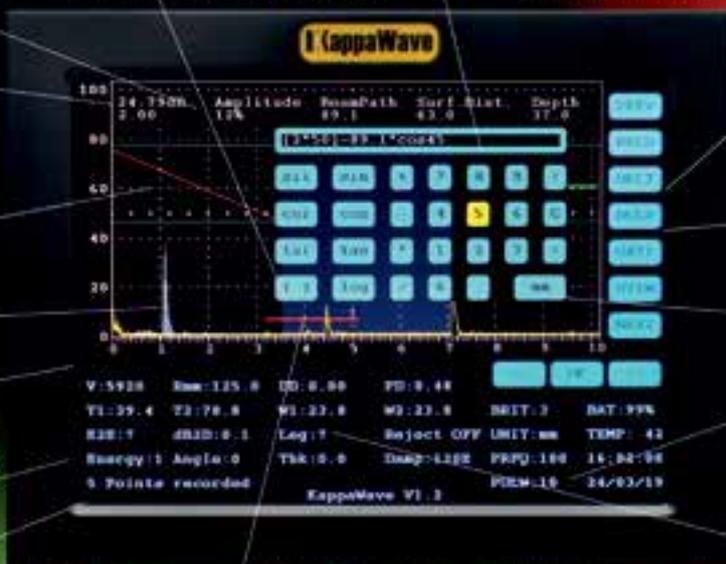
Beam plot in an Angle
beam test helps you interpret signals with ease

Echo store control.
Ideal for transfer correction and corrosion monitoring work

7 Colour options

High Penetrative Power.
2 Energy Steps

Grease & Oil Friendly
Durable Touchscreen for industrial use.



Create test records!
Save several thousands of test files easily.
Review any file in the instrument or computer with relevant info

Easy to construct
14 point **DAC** and **TCG**
with dB to DAC by default

Direct mm to inch
conversion

Better near surface resolution with
Pulse width control

Log info in an Angle beam work

Model K1AL with 26.4cm (10.4") touchscreen display

Add your logo and address for your reports



Single Gate provides **Echo to Echo** distance.
Measures through coatings or use a Normal probe for
Low thickness measurement.

Multiple waveforms
in a **B-Scan**



100 small divisions for ranges from 20mm to 1000mm

Two Point
Auto
Calibration

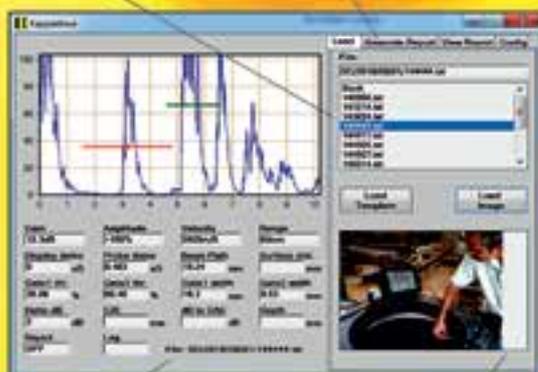
AWS D1.1
Weld evaluation

Easy to access
functions

16 Hrs
Li-Ion Battery
16GB Memory
1.2Kg

Select any file and prepare custom reports in few minutes
Enter data for report

Model K8E with 17.7cm (7") touchscreen display



Add photos or drawings to report
Test File information will be printed with report

Additional Features in K1AL & K8E ● B-Scan ● Angle Beam Plot ● RF Wave ● AWS D1.1 Weld evaluation tool ● DGS (Provides ERS value)
● Echo Store for comparisons, corrosion monitoring & transfer corrections

KAPPAWAVE

454, Karukancheri Buildings, Killoor (IN) P.O., Kottayam 686020, Kerala. Tel: Sales: 9447705887. E: sales@kappawave.com



HEALTH CARE FOR INDUSTRY



Baker Hughes

**THICKNESS GAUGE
CORROSION**



**FLAW DETECTION
INTERNAL FLAWS**



**EDDY CURRENT
SURFACE CRACKS**



NEW

NEW



**Advanced Mid Range
VideoProbe**



**Reimaging PAUT Inspection
with Mentor UT**

**RELIABLE & PROVEN
PERFORMANCE, PORTABLE,
STATIONARY & CABIN
REAL TIME INDUSTRIAL
RADIOGRAPHY SYSTEMS**



**DIGITAL RADIOGRAPHY &
COMPUTED RADIOGRAPHY
WITH INNOVATIVE
TECHNOLOGY**



C/MOS PROCESSORS, A NAME SYNONYMOUS WITH EXCELLENT SUPPORT & SERVICES ARE INVOLVED IN INDUSTRIAL AUTOMATION & NDT. WE ARE THE CHANNEL PARTNER FOR BAKER HUGHES FOR ENTIRE SOUTH INDIA HAVING MARKETING RESOURCES IN TAMILNADU, KERALA, ANDHRA PRADESH, TELANGANA, KARNATAKA & PONDICHERRY

WE ARE DEALING WITH ULTRASONIC EQUIPMENTS, INDUSTRIAL X-RAYS & REMOTE VISUAL INSPECTION PRODUCTS FOR MORE THAT 15 YEARS. WITH AN EXPERIENCE OF OVER 30 YEARS, OUR KEY TO SUCCESS IS VAST KNOWLEDGE OF APPLICATION ENGINEERING & INNOVATIVE SOLUTIONS TO PROVIDE SERVICE SUPPORT TO OUR ESTEEMED CLIENTS



SP-152, First Floor, 4th Avenue, 1st Main Road, Ambattur Industrial Estate, Chennai - 600 058, Tamilnadu, INDIA

Phone : +91 44 4853 5622, 2624 7653 / 54 Fa

E-Mail : support@cmos.in Website : WWW.CMOS-NDT.IN

Contact : A.C.K.DAS, Senior Manager - Marketing ; Mobile : +91 73580 32323; E-Mail : das.ndt@cmos.in

Avasarala Technologies Limited

Established to deliver Innovative, Well Engineered, Quality Product & Services On par with International Standards to Nuclear, Defence, Space, R&D and Other Sectors.

Critical Execution - Nuclear Sector/DAE



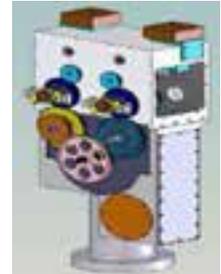
Fueling Machine Head



Radiation Shielding Window



Self Elevating Platform



Reactivity Mechanism



Sodium Purification cold trap



Storage Module & Alignment Mechanism



Maintenance Vehicle

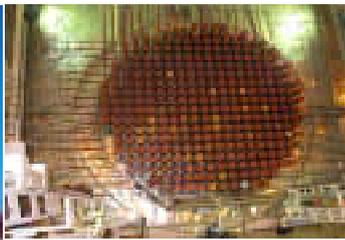
Site Services - Nuclear Sector/DAE



End shield & Calandria installation at RAPP



Coolant Channel Assembly



Fuel Handling Equipment



Avasarala Technologies Limited

Manufacturing Unit:

60, K Choodahalli, Somanahalli Gate, 26th KM, Kanakapura Road, Bangalore – 560082.

Tel. Ph: 96866 82581 /82. Fax : 080 - 2668 3935. Email: rangaraj@avasarala.com



PAUT FLAW DETECTOR



Phascan II



Flexscan

- 32/128PR Model
- 128G SSD fast data storage
- Single data file up to 4GB
- 2D Matrix Array, 3D simulation
- CAD Module Import
- TFM,FMC
- SDK
- Fast & Reliable
- Incredibly Easy To Use
- INCLUDING: Robust PAUT Instrument 18/64 32/64PR; Premium Quality PAUT Probes; Versatile Scanners And Crawlers



Doppler International : Mike (Sales director) - email id : mike@cndoppler.cn - Contact number: +8618664732627
 Doppler India : Hemal Patel - hemal.patel@cndoppler.cn - +91-9016000508 www.cndoppler.com

25
YEARS OF EXCELLENCE

Manufacturing Hydraulic Equipment

Worldwide Industries



Hydraulic Press



Hydraulic Cylinders



Hydraulic Coil Curing Press



Hydraulic 4 Pillar Hot Moulding Press



Hot & Cold Hydraulic (Coil Curing) Press



Hydraulic Closed Frame Press



Hydraulic Jacks & Power Packs

- Hydraulic Presses
- Hydraulic Cylinders
- Hydraulic Power Packs
- Hydraulic Remote Controlled jacks for Bridge's



hydropack (India) pvt. ltd.

Regd. Office & Unit I: Plot No.19, Sy. No.323, Majgaon Indl. Area, G.I.T. College Road, Udyambag, Belgaum - 590 008

Unit II : Plot No.54(Part), Sy.No.536, Honaga Industrial Area, Belgaum-590 010

Tel : (0831) 2442559, 2442857 Fax : (0831) 2442658 E-mail : snd@hydropackindia.com Web : www.hydropackindia.com



Johari Engineering



JOHARI ENGINEERING
1213 Kailashpur
Saharanpur UP India 247001
M +917417060180,
info@johariengineering.in
www.johariengineering.in



Akhil Johari

NDT & POWER TOOLS INSTRUMENTS We are MSME,ISO 9001-2018 , ISNT ,IIA Member.



Coating Thickness Gauge JE CT 650 Johari Engg India



Ultrasonic Thickness Gauge JE TG2 Johari Engg India



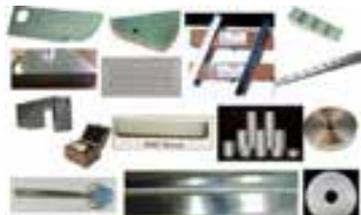
MPI Yoke JEMPY27, Johari Engg India



UCI Hardness Tester ,BAQ Germany



Belt Sander Makita



NDT Blocks ,Johari Engg India



UT probes ,Johari Engg India



Angle Grinder 4,5,7 & 9 Inches, Makita



355mm Cut Off Machine, Makita



Die Grinder Makita



Cutter Makita



Drill Makita



Chain Saw



Our Principals



Authorised Dealer

Makita Power Tools, Japan



BAQ Germany



Inspection Solutions with Vision
XIRIS Canada



Few Our valuable Customers



Universal Heavy Engineering Company





NABL ISO/IEC-17025:2005 ACCREDITED &
ISO 9001: 2015 CERTIFIED LABORATORY
(Inspection & NDT Engineers)

TC-7141, TC-6749 C.No. 688359

**WE INDUSTRIAL RADIOGRAPHIC INSPECTION CO. (IRICO) GROUP OF COMPANIES
PROVIDE FOLLOWING SERVICES**



LINEAR ACCELERATOR RADIOGRAPHY 6Mev



BETATRON RADIOGRAPHY 7.5 Mev



X-Ray 300 KV, 10 mA



GAMMA RAY RADIOGRAPHY (Ir-192, 3.7 TBq / 100 Ci)



GAMMA RAY RADIOGRAPHY (Co-60, 3.7 TBq / 100 Ci)

**ULTRASONIC FLAW DETECTION
CONVENTIONAL, TO FD & PHASED ARRAY**



**MAGNETIC PARTICLE TESTING
(PROD & YOKE)**

**LIQUID PENETRANT TESTING
(VISIBLE & FLUORESCENT)**

THIRD PARTY INSPECTION

CASTING UP-GRADATION

SP11, Ambattur Industrial Estate, Chennai- 600 058
Tel: 044-26880235 / 702/ 790
E-mail: iricochennai@gmail.com
Contact No. +91 9444418045

Old No. 69, New No. 61, Natesan Nagar, Vivekananda Street, Athipet, Chennai- 600095
E-mail: iricoplantb@gmail.com
ContactNo. +919444418048

477/9, Sipcot Industrial Estate, Ranipet- 632 403
E-mail: iricoranipet@yahoo.com
Contact No. +919944577880

75, Sidco Industrial Estate Kurichi Coimbatore- 641 021
Tel: 0422-2677726 / 25
E-mail: iricocbe@yahoo.co.in
Contact No. +91 9444954614

233/2B& 2C, Masagoundan Chetti Palayam Village, Telungupalayam Road, Near Annur, Coimbatore-641 653
E-mail: view_ndt@yahoo.com
Contact No: +91 9444954613

1152/A, Kainankarai, Mathur Post, Pudukottai Road, Trichy- 622 515
E-mail: view_trichy@yahoo.com
Contact No. +919444418047

Website: www.iricondt.com



Simplifying NDT

30 Years' of Focused Leadership in Portable **ULTRASONIC TESTING EQUIPMENT**

<p>NEW! Arjun Series</p>  <p>Ultrasonic Flaw Detector</p> <ul style="list-style-type: none"> • Palmtop • One Hand Operation • Ultra-light (Weights 800 grams with the battery) • High Resolution Display (800 x 480 Pixels) • 1GB Disk and Micro SD card slot • Dynamic DAC, TCG, DGS, AVG • Dynamic wave pulse • Measurement Resolution: 0.01MM • Built-in Continuous Data Recording and Colour Wave Plotting 	<p>da Vinci Delta</p>  <p>IMAGING Ultrasonic Flaw Detector</p> <ul style="list-style-type: none"> • B-scan and C-scan for corrosion survey • TOFD for weld inspection • High performance flaw detector • Guide Scale thickness measurement • Test range: 2.5mm to 10 meters • Measurement Resolution: 0.01MM 	<p>INDIA'S #1 Einstein-II DGS</p>  <p>Ultrasonic Flaw Detector</p> <ul style="list-style-type: none"> • Most popular user friendly series • More than 5000 units sold worldwide • Exported to thirty plus countries • Dynamic DAC • DGS/AVG • AVG • TCG 	<p>Arya Series</p>  <p>MULTICHANNEL Ultrasonic Flaw Detector</p> <ul style="list-style-type: none"> • 8 or 16 channels with different colours of A-Scan traces • Handy design • 7" Display • Weighs only 2Kgs • ideal for integrators of Automatic Ultrasonic Testing Systems
<p>Edison Series</p>  <p>Ultrasonic Thickness Gauges and Velocity Meter</p> <ul style="list-style-type: none"> • Different variants and special probes to full various applications • Supplied more than 8000 units • Precision type • With memory storage facility • High temperature application • Through coating measurement • EL-backlight for indoor use 	<p>Products for Railways</p>  <p>Axle Tester and Rail Testers</p> <ul style="list-style-type: none"> • RDSO approved Railway Products • Axle Tester • Rail Weld Tester • Rail Testers • Sold more than 1000 units to Indian Railways and also exported 	<p>Ultrasonic Probes</p>  <p>Standard and Custom Probes</p> <ul style="list-style-type: none"> • Wide range of high quality standard and custom probes with Test Certificates • Customized probes for various applications 	<p>Allied Accessories</p>  <p>Blocks, Cables and Attachments</p> <ul style="list-style-type: none"> • Various probe cables • Standard Reference and Calibration Blocks • Special Probe wedges and other attachments • Various types of UT couplants
<p>Scanners and Encoders</p>  <p>EzeoScan-1 and MagMan</p> <ul style="list-style-type: none"> • Single and Dual axis scanners • TOFD and Phased Array Scanners • String Encoder for B-Scan • TOFD Scanners upto 8 inch probes 	<p>MUX-8</p>  <p>8 Channel Multiplexer</p> <ul style="list-style-type: none"> • 8 separate channels with individual adjustments • 16x2 alphanumeric display • Rechargeable Li-ion battery • Weighs 1.8Kgs with battery 	<p>Support Services</p>  <p>Repairs, Calibration and AMC Services</p> <ul style="list-style-type: none"> • Quick turnaround service • Component level repairs for cost effectiveness • Calibration of flaw detectors as per ASTM E317-11 and EN 12668-1 • AMC for all products 	<p>Application Lab</p>  <ul style="list-style-type: none"> • Full-fledged application lab • Against your sample we provide free "Evaluation Report" for best solution by Ultrasonic NDT.

All Products Conceived, Designed, Developed and Manufactured in India by:

MODSONIC INSTRUMENTS MFG. CO. (P) LTD

Plot No.33,Phase III, GIDC Industrial Estate, Naroda, Ahmedabad-382 330, INDIA,

Tele: +91 (079) 2281 1217, 2281 3131 E-mail: modsonic@modsonic.com

www.modsonic.com

40 Years of Impeccable Performance in Precision, Reliability & Innovation

Since 1976, Pulsecho Systems & Optel have been making highly reliable and portable instruments for preventive and predictive maintenance and quality assurance.



Radiation Detectors,
Monitors & Alarms



Sound Level Meter
& Calibrator



Vibration Meter



Ultrasonic Thickness Gauges



Coating Thickness Gauge



Optical
Densitometer



UV - Meter



Smart Radiation Detectors



Leak Detectors



Hardness Tester & Block



Film Viewer

Awarded by: ISNT | Chambers of Commerce & Industry | & More...



WE MAKE IN INDIA



Varied Range
of Products



High Reliability
& Quality



Wide Customer
Acceptance



Industry Standard
Instruments



Used In More Than
10 Countries



Excellent After
Sales Service

Website: www.pulsecho.com / www.optel.in | Email: sales@pulsecho.com / optel@pulsecho.com



PULSECHO SYSTEMS (BOMBAY) PVT. LTD.

Unit 110, Nirmal Industrial Estate, Near Sion Fort, Sion (E), Mumbai - 400022.
Fax : +91 22 2407 4244 | Phone : +91 2407 1055, +91 2409 2087

optel



Every Degree Matters

therelek engineers private limited Furnace Manufacturing & Heat Treatment Services

Manufacturers of:

- ♦ Industrial Furnaces ♦ Ovens ♦ Kilns ♦ Vacuum Furnaces ♦ Incinerators ♦ Gas Nitriding
- ♦ High Temperature Sintering Furnaces at Nuclear Fuel Process Plant
- ♦ Precipitation Hardening Oven ♦ Ladle Furnaces ♦ Carburising & Lab Furnaces
- ♦ Rotary Calcination Furnace, etc.

HEAT TREATMENT FACILITY

An AS9100:2016 (Rev.D) & ISO 9001: 2015 Certified Company & NABL approved calibration facility.

SPECIALISED IN GAS NITRIDING, VACUUM HEAT TREATMENT, VACUUM BRAZING, HYDROGEN ANNEALING, SEALED QUENCH FURNACE OPERATIONS, GAS NITRIDING OF PH & S.S. STEELS FOR NPCIL.

ALUMINIUM ALLOY HEAT TREATMENT IN DROP BOTTOM QUENCH FURNACE

HEAT TREATMENT OF INCONEL, NIMONICS, PH STEELS, AUSTENITIC, MARTENSITIC AND FERRITIC STEELS, CASE HARDENING, ETC.

ANNEALING OF MAGNETIC MATERIALS.

APPROVED BY PRIMES - SNECMA, SAFRAN, TURBO MECA, MOOG, GOODRICH, NAL, ROLLS ROYCE, PRATT & WHITNEY- CANADA & USA, HONEYWELL, BOEING, AVIO, RAFAEL ISRAEL, TATA SIKORSKY, THALES, DOWTY & GE AEROSPACE INDUSTRIES FOR HEAT TREATING AEROSPACE COMPONENTS

APPROVED HEAT TREATERS OF NPCIL, AEQUS, ACE DESIGNERS, BONFIGLIOLI, HICAL TECHNOLOGIES, TITAN INDUSTRIES, TRIVENI HI-TECH, TAL, SIDER FORGE AND MAINI PRECISION PRODUCTS



For further details, contact:

therelek engineers private limited

70-71, III Phase, Peenya Industrial Area, Bangalore – 560 058
Tel: +91-80-28395101/102, 64503726 ♦ Fax: +91 (80) 28395103
E-mail: info@therelek.com ♦ web: www.therelek.com



ACCREDITED BY NATIONAL CERTIFICATION BOARD OF ISNT

Insight Quality Services

Office 507, 508, 5th Floor, Building No.1, Siddharth Towers, S.No.12 / 3B, Near Sangam Press, Kothrud, Pune 411 029. Maharashtra (INDIA)

Ph.: + 91 - 20 - 2546 4388 / 2546 0894 Mb.: 09689928561 / 09881244118

Email : support@iqs-ndt.org Website : www.iqs-ndt.org / www.igf-ndt.org



TRAINING COURSES

- TWI approved for CSWIP 3.0, 3.1, 3.2, Bgas Training
- TUV Nord approved for ISO 9712 Training (PT,MT,UT,RT,VT)
- Internal Auditor, ISO 9001 Awareness
- ASME codes Awareness, NDT Awareness
- NDT Level I / II Certification Training for (PT,MT,VT,UT,RT,ET,LT)
- Preparatory for API (510, 570, 653, 580, 936,577, TES,571, 1169, SIFE)
- Preparatory training for NDT Level III (Basic, PT,MT,UT,RT,VT,LT,ET)
- Welding inspectors / Welders, QC managers' certification
- The IQS Bridge (Training Program in Welding & NDT)
- Online Training for API & NDT & Mock-Up Exams Modules
- Computerized mockup exams for API, AWS and ASNT Level III modules
- AWS / CWI, AWS / SCWI preparatory, Fabrication Inspector

INSPECTION SERVICES

- Pressure vessels, Heat exchangers, Storage tanks, Castings, Forgings, Static & rotary Equipments
- Pumps & Valves, Equipment of nuclear projects

SHUTDOWN INSPECTIONS

- Team of Authorized Inspectors
- Engineers for Shutdown Inspections

CONSULTANCY SERVICES

- ASME Certification (U, R, U2, S, N, PP Stamps) Preparatory work
- ISO 9001, ISO 14001, OHSAS 18001 Certification preparatory work
- Quality & Safety audits (HSE)
- Setting up NDT labs
- Welding procedures & Welders' review / approval
- Vendors assessment & development
- Developing QA / QC systems
- Setting up internal quality systems
- Liaison with third party / statutory inspection agencies
- Procedures as per ASME and EN ISO 9712
- Work Instructions & Company written practice
- ISO 3834 & ISO 15085 Certification Consultancy Services

NDT SERVICES

- NDT services for VT, PT, MT, UT and RT film interpretation as per ASME or EN ISO 9712 qualified Level 2.

WELDING TRAINING AND TESTING CENTER

- Basic and Advanced Level Programs in SMAW, GTAW

"It is good to have Education, It is Better to have Experience, but it is essential to have Training!"



Small Angle – Beam Transducers TOFD



Small Angle – Beam Wedges



Phased Array Transducers



Dual Element Transducers For UTG



Delay-Line Contact Transducers : DFR



Small Integral Angle – Beam Transducers



Immersion & Focused Transducers



Contact Transducers



Advanced NDT Solution Provider
TOPAX NDT Solutions LLP
Solutions Built To Perfection

Address : B 61, 114, Veena Ind. Estate, Near City Mall, Opp. Monginis Cake Factory, Off. Andheri Link Road, Andheri (West), Mumbai - 400 053, India.

Tel : (+91) 2226394823 / 26394826 / (+91) 9920129375 Website : www.topaxndtsolutions.com

E-mail : reply@topaxndtsolutions.com / info@topaxndtsolutions.com

PTC INDUSTRIES LIMITED

Manufacturer of

- 1) Titanium Castings
- 2) Nickel Super Alloys Castings
- 3) Hot Isostatic Pressurised Parts
- 4) 5 Axis CNC Machining

Components of Aero Engines, Rocket, Missiles, Submarines and Land based Defence equipments.



Advanced Manufacturing and Technology Centre
NH-25A, Sarai Sahjadi, Lucknow – 227101
E-mail – marketing1@ptcil.com ; Ph no. 0522 -7111017 ; Fax no. 011-66173715



**NEW GENERATION
LED FILM VIEWERS & DENSITOMETERS**



**CALDEN PORTABLE
DENSITOMETER CD - 1**



**LUMINUX LED FILM VIEWER LH-P1-D
WITH BUILT-IN DENSITOMETER**



**RADAX
SURVEY METER**



**RADAX
AREA ZONE MONITOR**



**CYGNUS MULTI-ECHO
THICKNESS GAUGE**



**RADIO-ACTIVITY
WARNING LIGHT**



**PORTABLE
CP X-RAY UNIT**



**PIPELINE CRAWLERS
REGULAR & DR TYPE**



**DOUBLE WALL
DIGITAL RADIOGRAPHY**



**STATIONARY
CP X-RAY UNIT**



**MAXIFLUX MAGNETIC
CRACK DETECTORS**



**VACUUM BOX
LEAK DETECTORS**



**Eastwest
Engineering &
Electronics Pvt. Ltd.**

Works : D - 191, MIDC Shirwane, Nerul, Navi Mumbai - 400 706.
Phone : (022) 2768 6241 to 44 • Fax : (022) 2768 6245
E-mail : info@eastwestndt.com • Website : www.eastwestndt.com

With Best Compliments



NABL

MADRAS RADIOGRAPHY ENGINEERS

ISO 9001:2015 Certified

Nation Wide NDT Services

Since 1987

NABL Accredited Lab

Well Known IBR Certified for RLA of Boilers

Facilities Available:

1. Radiography
2. Ultrasonic
3. Magnetic Particle
4. Dye Penetrant
5. Local SR
6. Metallography
7. Using Co-60 & Ir-192 with Casting upgradation facilities at Tamil Nadu (Ranipet)



Registered Office:

705, 3rd Cross
1st Block, HRBR,
Kalyan Nagar,
Bangalore: 560043.
PH: 080-25453228 / 9448040882
Email: mre.ndt@gmail.com
Website: www.mrendt.com

Gujarat Office:

B1103 Kalpvan
Rajkot – Gondal Road
Rajkot 360022
PH: 9099123424 / 9944033446
Email: mre.india@gmail.com

Corporate Office and Works:

Chinna Ramnathaouram Road,
Eranthangal Village and Post,
Thiruvallur, Vellore District,
Tamil Nadu : 632519.
Tel.: 9448040882 / 9944033446
Email: mre.india@gmail.com
Website: www.mrendt.com



A2Z NDT SERVICES

104, 'Infant Paradise', S M LAYOUT, Channasandra Main Road,
KADUGODI Post, BANGALORE - 560 067

IN - SITU NON DESTRUCTIVE TESTING & EVALUATION IN MINING INDUSTRIES (UNDER GROUND & SURFACE OPEN CAST MINING)

- Structural Audit on the Head gear structure
- NDT on Mine machinery components to determine in-service defects on critical components
- Stability assessment on Heavy Earth Moving machineries
- NDT on Ventilation panels
- NDT on rotary, static and mining equipments
- NDT on winders/winchies
- Concrete testing on civil structure
- Stability test on Belt Conveyor Structures
- Stress analysis and failure analysis
- NDT on wire rope using Defectography
- Vibration analysis on winders
- NDT on EOT Cranes, Crane wheels, Air receivers etc.,
- NDT on Smelter-plant components
- Identification of electrical faults in power transmission lines, sub-station, control panels, mis-alignment etc., using Infra-red thermography
- Laser alignment on Winder shaft with gear shaft/motor shaft
- NDT on heat exchanger tubes using Eddy-current tubes



Mobile : 94 82 84 54 67, 90 35 19 03 57.

GSTIN : 29AGZPV4083D1ZK

Mail Id: a2zndtservices2016@gmail.com

ATOS

ATOSCOPE



 **Automation Technology**
Vision Sensors and Systems

Infrared NDT Systems & Solutions



Kymera Multimodal Spectroscopy
Platform - Adaptive Focus - True Res - Quad
Grating Turret - μ Manager



Cooled & Uncooled IR cameras
Portable and fixed cameras



Solar cell QE measurement, photobiological
safety, light/display characterisation &
spectroradiometers



Hyperspectral Imaging cameras for field, lab
and airborne applications



Precision Gas Mixers
Mix 2-6 gases with precise stoichiometric
ratios without usage of multiple MFCs



THz Imaging with Cooled Infrared Cameras



ATOS Instruments Marketing Services

ATOSCOPE Instruments Pvt. Ltd.

www.atosindia.com

atos@atosindia.com

Only one is perfect inside.



Don't guess. X-ray it.

ZEISS X-Ray Series. Make the Invisible Visible.

ZEISS X-Ray Series non-destructively reveals what would otherwise remain hidden from even the most watchful eyes. From sub-micron imaging to scanning of large parts, from high-precision measurements to fast, automated inspections: ZEISS X-Ray Series offers X-ray solutions for every application. Find out more and contact us for your free demo appointment.







ORGANIZING COMMITTEE



Organizing Team

Dr. Shyamsunder Mandayam
Chairmen, NDE 2019

Mr. Shashidhar Pallakki
Convenor, NDE 2019

Mr. Sreelal Sreedhar
Co-Convenor, NDE 2019

Advisors

Mr. K Viswanathan

Mr. DJ Varde

Mr. V Pari

Mr. Dilip Takbhate

Dr. P Kalyanasundaram

National Steering Committee

Mr. R.J. Pardikar
Chairmen

Mr. P Mohan
Co-Chairmen

Members

Mr. Diwakar Joshi

Mr. Jaiteerth Joshi

Dr. B Venkatraman

Prof. Krishnan Balasubramanian

Mr. Rajul Parikh

Mr. Anil Jain

Mr. Mukesh Arora

Dr. Paritosh Nanekar

Mr. Samir Choksi

Mr. G Levin

Dr. Debasish Mishra

Mr. G Ramachandran

Mr. RVS Mani

Mr. B Pangare

Mr. MS Shendkar

Mr. T Kamaraj

Mr. D Gautam

Mr. Deepak Parikh

Mr. RG Ganesan

Dr. Sarmishtha Palit Sagar

Mr. Dharmveer Singh

Dr. MR Bhat

Prof. Sastikumar

International Relationship Committee

Dr. B. Venkatraman
Chairmen

Prof. Krishnan Balasubramanian
Chairmen

Mr. Mottito Togo
Co-Chairmen

Industrial Relationship Committee

Mr. Sreelal Sridhar
Chairmen

Mr. Prakash Balasubramanian
Co-Chairmen

Advisors

Mr. Diwakar Joshi

Dr. Jaiteerth Joshi

Mr. Deepak Parikh

Technical Committee

Mr. Bikash Ghose
Chairmen (Scientific)

Mr. U Anand
Chairmen (Industry)

Mr. Tushar Mukherjee
Chairmen (Industry)

Advisors

Dr. Paritosh Nanekar

Prof. Prabhu Rajagopal

Exhibition Committee

Mr. Ravikumar T
Chairmen

Mr. Ved Prakash
Co-Chairmen

Mr. Vijay Joshi
Co-Chairmen

Advisors

Mr. Mukesh Arora

Mr. Vivek Rajamani

Mrs. Navita Gupta

Finance Committee

Mr. Durga Naik
Chairmen

Mr. Kalesh Nerurkar
Co-Chairmen

Advisors

Mr. Samir Choksi

Mr. S Subramanian

Registration Committee

Mr. Prasad Thapa
Chairmen

Mr. Prasad Thapa
Chairmen

Advisors

Prof. S Mohan

Mr. VN Misale

Marketing & Publicity Committee

Mr. Suresh Subramanya
Chairmen

Mr. S Kalyanasundaram
Co-Chairmen

Advisors

Mr. Rajul Parikh

Mr. Suryaprakash G

Event Management Committee

Ms. Danielle D'Costa
Chairmen

Mr. Vamshi Kommareddy
Co-Chairmen

Mr. Siva Y
Co-Chairmen

Advisors

Dr. MR Bhat

Mr. Ved Prakash

Pre-Conference Tutorials

Mr. V Manoharan
Chairmen

Mrs. Vijayalakshmi MR
Co-Chairmen

Advisors

Mr. P Vijayaraghavan

Dr. Ravibabu M

Professional Conference Organisers



Elbon Conferences & Events Pvt. Ltd.

Praveen Kumar Kokne

Senior Manager – Meetings & Conferences

E: praveenkokne@elbonmeetings.com | www.elbonmeetings.com







AIRBUS

Looking Back



Photo: Mr. P.D. Chopra MD HAL Bangalore, addressing the gathering. Sitting from L to R Mr. B. Chatterji, Senior Manager Central Lab, Dr S. Ramaseshan, Dr. Krishnadas Nair DGM Foundry & Forge Division.

The First Seminar On Non destructive Testing was organized by NDT Centre, Central laboratory , Hindustan Aeronautics Limited Bangalore on 28th and 29th January 1979, at HAL Auditorium
Conveners of the seminar - Dr. Krishnadas Nair & B. Chatterji.

Highlights

1. Key note address by Dr. S. Ramaseshan, Deputy Director National Aeronautical Laboratory, Jawaharlal Nehru Fellow, Raman Research Institute Bangalore .
2. A souvenir was released containing 24 abstracts and there were 24 advertisers
3. 32 papers were presented in 7 sessions
4. Exhibition of NDT equipments, products and technical Literature was organized on both the days
5. Total No of registered delegates participated 350 including exhibitors
6. Proceedings of the seminar containing 24 full length papers was bought out.
7. Lip smacking Lunch & savories served on both days.
8. As part of Cultural evening Bharatha Natyam organized in a city Hotel
9. The delegate fees was Rs 50/- (Fifty) only !!!

Compiled by:
P. Vijayaraghavan
Bangalore pvrvan@gmail.com



See what 1228k pixels of detection can do.

Mentor Visual iQ VideoProbe™ is the first HD 3D measurement-enabled video borescope on the market. Now with cutting-edge TrueSight™ visuals, you can enhance POD in all engine stages, reduce AOG, improve shop and flightline inspection processes, and detect more than ever before.

Learn more about our leading NDT solutions for major industries here:
www.industrial.ai/IT



Mentor
Visual iQ HD

Join us at

NDE 2019

DECEMBER 5-7, 2019 • BENGALURU

December 5-7
Bengaluru, India
Booth A1

Baker Hughes 
Inspection Technologies