TCR ENGINEERING

REDEFINING ON-TIME QUALITY

Metallurgical and Corrosion Testing Laboratory with NABL, ISO 17025 and BIS approval

COMPANY PRESENTATION

APRIL 2018

WWW.TCRENG.COM

1 ONE

TCR» ENGINEERING

WHO WE ARE

- Group Profile
- Vision, Mission & Core Values
- Legacy & Milestones
- Marquee Clients & Projects
- TCR Team and Advantage
- Certifications & Accreditations

TCR ENGINEERING

TCR: BUILDING TRUST SINCE

- 45+ Years of Experience
- Pioneers in Metallurgical Service
- Supporting 2500+ Clients Globally
- NABL, BIS, ISO 9001:2008 & ISO 17025 Certified
- End-to-end Material Testing, Inspection and NDT Services
- State of the Art Laboratory Employing the Latest Technologies

Headquartered in Mumbai, TCR Engineering Services is an ISO 17025 and NABL accredited Material, Metallurgical and Corrosion Testing and Quality Assurance Laboratory serving 2500+ customers globally. Established in 1973, TCR has a trusted legacy with a strong presence in India and internationally in countries like Saudi Arabia, Kuwait and UAE.

TCR enables organizations across the globe to develop and execute solutions for efficiently managing plant operations. TCR aims to innovate in a way that minimizes the gap between their offerings and their client needs. For almost half a century, TCR has built an enterprise that is distinctly known for its honesty, reliability, and transparency. TCR delivers unbiased results on time, every single time. From Mechanical Testing, Chemical Analysis, Non-Destructive Testing, Failure Analysis to Third Party Inspection, TCR's team is distinguished by knowledge, imagination, and experience gained across industries, which is reflected in every project they undertake. TCR, because of its global presence can rapidly assemble the right team with the right experience to help clients anywhere in the world.

For more information please visit our website:

www.tcreng.com

BETTER SOLUTIONS FOR GLOBAL LEADERS

Approved Internationally by

- USA: American Bureau of Shipping
- France: Bureau Veritas
- UK: Lloyds Register of Shipping
- Norway: Det-Norske Veritas
- India: SGS Ltd., Indian Register of Shipping, Mercantile Marine Dept., Bureau of Indian Standards among others

TCR has grown to become India's leading material testing and research laboratory, spread over 3 continents. It treats all its clients equally; whether it is Fortune 500 companies or small-medium businesses, it delivers results with the same speed and efficiency without compromising on quality. TCR recognizes the significance of developing relationships that echo their culture of unwavering ethics and mutual respect. For over five decades, TCR is focused on bringing to life great ideas and business solutions that drive growth for their clients.

TCR has a growing global presence and is rooted in behaving ethically in all their interactions with their employees, partners, and their customers

TCR ENGINEERING

TCR PROMISE

The inspiration for TCR is to extend its legacy of unbiased ethical expertise towards passionately building a better future for material testing driven by its highly credible thought leadership

BUILDING TRUST WITH ON-TIME QUALITY

OUR VISION

To be a significant transnational company by providing on-time repeatable solutions, impeccable quality and actionable results in material testing, inspection, and consulting services

OUR MISSION

To provide trusted and unbiased solutions for efficiently managing plant operations of global organizations and build a better future for material testing driven by its highly credible thought leadership

OUR CORE VALUES

#1. TRUST
#2. PASSION
#3. INTEGRITY
#4. COLLABORATION
#5. PERFORMANCE EXCELLENCE
#6. ACCOUNTABILITY

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TCR ENGINEERING

TCR LEGACY

TCR has a growing global presence and is rooted in behaving ethically in all their interactions-with their employees, partners and their customers

FOUNDING VISION: PRINCIPLES OF PRECISION, TRANSPARENCY AND RELIABILITY

TCR Engineering Services was incorporated in 1973

It was the vision of Mr. V. K. Bafna, the founder, a keen metallurgist to provide real, sustainable solutions to companies that would drive progress for them. He infused the principles of precision, transparency and reliability in all actions due to which, TCR is highly sought after by clients.

TCR today is a trusted service provider for top-notch companies across the globe and has many 'firsts' to its credit. It has become a thought leader in the industry because of its pioneering work over the last 4 decades.

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Historical Milestones

1999
Creation of in depth Positive Material Identification Facilities

1989
Installation of India´s First Image Analysis System

1987
First in India to install a High Temperature Tensile Testing System

1980
First Laboratory in India to install a Automatic Carbon/Sulphur Apparatus and Spark Emission Spectrometer

1976
First Laboratory in India to install a 100T Universal Testing Machine with Electronic extensometer

VIRENDRA KUMAR BAFNA
Founder & Visionary TCR Engineering Services Pvt. Ltd.

TCR LEGACY STRUCTURE

INDIA UNITS

- TCR ENGINEERING, MUMBAI
- METAL PROBE LABORATORY MUMBAI
- TCR ADVANCED ENGINEERING, VADODARA
- TCR PRODUCTS & SOFTWARE VADODARA
- INDUSTRIAL INSPECTION SERVICES, MUMBAI
- TCR EVOLVE INSTITUTE

GLOBAL UNITS

- TCR ARABIA LLC. DAMMAM, KINGDOM OF SAUDI ARABIA
- TCR AFRICA JOHANNESBURG, SA
- TCR ENGINEERING CONSULTING FZE DUBAI, UAE
- TCR MALAYSIA SELANGOR, MALAYSIA
- TCR KUWAIT FAHAHEEL, KUWAIT
- TCR PP SIMTECH ARABIA, DAMMAM, Kingdom of Saudi Arabia

INDUSTRY VERTICALS

SERVING DIVERSE INDUSTRIES

ONSHORE O&G PLANTS


REFINING AND CHEMICALS


ELECTRONICS


MANUFACTURING


PHARMA AND BIOTECH


OFFSHORE OIL PLANTS


POWER GENERATION


AUTOMOTIVE


SHIPPING


MINING & METALS


CONSTRUCTION


PULPING


DEFENCE


HEALTHCARE


AEROSPACE


TCR ENGINEERING

TCR CORE CLIENTS

TCR has an ever-growing list of satisfied clients that have tremendously benefitted with their engagement. TCR partners with organizations to develop solutions that deliver tangible business value.

TCR CATERS TO LEADING COMPANIES IN INDIA ACROSS INDUSTRIES

TCR ENGINEERING

TCR PERSPECTIVE

TCR has worked with more than 2500+ quality driven clients from all over the world. Its international experience brings an unique perspective to all its business engagements by ensuring rapid problem solving for all its customers

GLOBALLY, TCR FOCUSES ON WORKING WITH INTERNATIONAL CONGLOMERATES

TCR ENGINEERING

TCR TEAM ADVANTAGE

Our global team of professionals continually create impact and make a difference in the world of Engineering and Material Sciences. Our talented, dedicated and highly-skilled engineers are responsible for delivering on-time quality solutions every single time

IMPLEMENTATION TEAM

TCR ENGINEERING (MUMBAI)

Leadership

- **Managing Director** — Neelam Bafna

Supervision

- **Tech Lab In Charge** — Avinash T
- **Chief Metallurgist** — Sriram Shanbhag
- **Country Head** — Suresh Acharya

Area

- **Laboratory Manager (Metallurgy)** — S. Palav
- **Laboratory Manager (Chemical)** — Ganesh Sonawane
- **Manager NDT Services** — Shemi Bhaskaran

Division / Department / Service

- **Supervisor – Physical** — Manoj Prabhakar
- **Fatigue Projects** — Avinash T.
- **Corrosion Projects** — Manoj P.
- **Metallography** — Mukesh
- **Manager – Machining** — Ramsingh
- **Wet Chemistry Head** — Md. Israil
- **Spectroscopy** — Arvind Inamdar
- **Supervisor- Wet** — D.N. Gaichor
- **RoHS and OES** — Sunil K
- **Chemical Drafting** — R. Ghadge
- **M.D. - Consulting** — Paresh Haribhakti
- **Expert - Boilers** — Ketan U
- **Director Sourcing** — Rohit Bafna
- **QA-R&D** — Ganesh Sonawane
- **Software** — Gopul Patel
- **Supervisor-Inspection** — Shailender
- **Supervisor – PMI** — Ajit Rane
- **ToFD and Adv. NDT** — Sandeep Singh
- **Shutdown Projects** — Shemi B
- **Head - Third Party Inspection and Quality Assurance** — Shaildender
- **Conventional NDT, Radiography and Welding** — Bhaskaran S.
- **Training** — Evolve
- **Manager – Manpower** — Abdul Haq

Support / Admin

- **Shipping & Receipt** — Mahesh
- **Manager - CS** — Deepak A.
- **Asst. Manager - CS**
- **Web Support & IT** — Suresh Acharya
- **Communications** — Anita
- **Chartered Account** — Viren Khandwala
- **Director - Finance** — Neelam Bafna
- **Chief Accountant** — Lalit Surve
- **HRD Associate** — Ajit Rane
- **Director-Sales** — Rohit Bafna

TCR LEADERSHIP TEAM

V.K. Bafna

Chairman Emeritus
TCR Group of Companies

Rohit Bafna

President
TCR Global

Neelam Bafna

Managing Director
TCR Engineering

Paresh Haribhakti

Global Technical Advisor
TCR Engineering

Viren Khandwala

Director, Finance
TCR Engineering

IMPLEMENTATION TEAM PROFILE

TCR ENGINEERING

SURESH ACHARYA
Country Head, TCR Engineering

GANESH SONAWANE
Head, TCR Quality Control

LALIT SURVE
Head, Accounts & Purchase

ABDULLAH
Head, Chemical Department

ROHIT K. WAGHMARE
Associate, Fatigue & Fracture

AVINASH TAMBEWAGH
Head, Advance Testing

MANOJ SINGH
Head, Corrosion Testing

RAM SINGH
Head, Machine Department

PRAMOD
Sales Associate

SHEMI BASKARAN
ASNT Level III NDT Inspector

SRIRAM SHANBHAG
Head, Technical Lab

MUKESH
Associate, Metallurgy Division

MUKESH KUMAR
Senior Metallurgist

GAUREE S. DEOLE
Associate, Material Lab

RAMASWAMY
Senior Technician, Mechanical

TCR ENGINEERING

THE TCR EDGE

TCR believes that true success lies in empowering their clients for growth, where a report is more than just a report-it should deliver actionable insights, the foresight to help navigate challenges and provide solutions to maximize performance

Along with a global perspective, TCR provides affordable and efficient solutions to address business complexities

TCR believes that in all the services it provides, responsiveness is fundamental, reliability and transparency are its strengths and repeatability is its reward

1. COLLABORATION: This is the bedrock for TCR's service delivery approach. TCR aligns with clients, fostering engagements into long-term partnerships. No matter what the challenge is, TCR focuses on delivering practical, enduring results to equip their clients for growth

2. HIGHLY COMPETENT TEAMS: The quality of people is the cornerstone of TCR's ability to address the needs of its clients. TCR makes tremendous investments in identifying highly talented people, developing their skills and building an environment that encourages their growth. TCR can quickly assemble a team with the most appropriate expertise and experience for deployment at client sites

3. DEEP SECTORIAL EXPERTISE: TCR has gained over 45 years of expertise in the field of material testing, inspection and quality assurance while displaying a strong commitment and adherence to ISO 17025 standards. The technical teams are highly experienced having conducted over 1500 failure analysis projects. TCR is on the approved list of SABIC, Tasnee, APPC, Schlumberger and Reliance for Failure Analysis Services.

4. DIVERSIFIED PROBLEM SOLVING: TCR helps clients address their business complexities and deliver business value throughout the life cycle of any client initiative. This includes assessment, research, testing services, advisory capabilities, development and solution design, integration, deployment, inspection and support for long-term sustainability

ACCREDITATION & APPROVALS

TCR CREDIBILITY

TCR is among the few leading independent laboratories that meet the international standards of quality, and is accredited by reputed global agencies. Their stringent quality control parameters coupled with intelligent reporting systems ensure consistent, transparent, unbiased results and reports always.

2 TWO

WHAT WE DO

- Testing
- Inspection
- Consulting

TCR ENGINEERING

SERVICE OVERVIEW

- Core Services
- Material Testing
- Non Destructive Testing
- Third Party Audit & QA
- Project Consulting
- Certifications & Accreditations

VALUE PROPOSITION

TCR serves its clients at every level of their organization; in whatever capacity it can be most useful to them.

For any engagement, TCR can assemble a team with the most appropriate experience and expertise. TCR aligns itself with client needs and fosters engagements into long-term partnerships

TESTING

Material Testing
Mechanical Testing
Creep & Stress Rupture Test
Fatigue & Toughness Test
Chemical Testing
Corrosion Detection
Metallurgical Evaluation
Welder Certification
Civil Testing

Non Destructive Testing (NDT)
Conventional NDT
Advanced NDT
Tube Inspection
Boiler Inspection
Pipelines & Weld Inspection
Storage Tanks & Static Equipment Inspection

INSPECTION

Plant Shutdown Management
Manpower Deployment and On-Site Placements

Third Party Audit & Quality Assurance
Product Sourcing
Vendor Inspection
Production checks and audits for end-to-end sourcing supervision

CONSULTING

Consulting & Advisory
Engineering Advisory with Failure and Root Cause Analysis
Risk-Based Inspection
Fitness for Service
RLA and Condition Assessment of Boilers
Contract Research and Development with Technical Help For Indigenization
Selection of Materials
Quality Improvement
Solutions to Critical Weld Problems
Engineering Design and Analysis Services

COMPLETE QUALITY ASSURANCE PARTNER FOR OPTIMUM PLANT HEALTH

- Core Services
- Material Testing
- Non Destructive Testing
- Third Party Audit & QA
- Project Consulting
- Certifications & Accreditations

VALUE PROPOSITION

With over 45 years of experience, TCR has built a team that not only possess a strong engineering background but also has a track record of performing quality analysis (QA) on all engineering goods sourced from India and validate them as per ASTM, BS, GS, JS, IS and other international standards

PROCUREMENT QA

- Third Party Inspection on Sourced Material in India
- Mechanical Testing, Chemical Analysis, Fatigue Tests on Purchased pipes, Valves, Balls, Castings, Forgings, Tor Steel and Rods
- Corrosion Test for Sour Gas Applications

CONSTRUCTION QA

- Welder Qualifications, PQR, Procedure, Positive Material Identification
- Supervision by QA Inspectors with Conventional NDT, PWHT
- Baseline Plant Data Creation based NDT, Cooker Drum Inspection

IN PLANT QA

- High Temperature Phased Array and ToFD
- API Plant Inspectors for Shutdown Planning
- Corrosion Damage Evaluation Training and RBI planning

SHUTDOWN QA

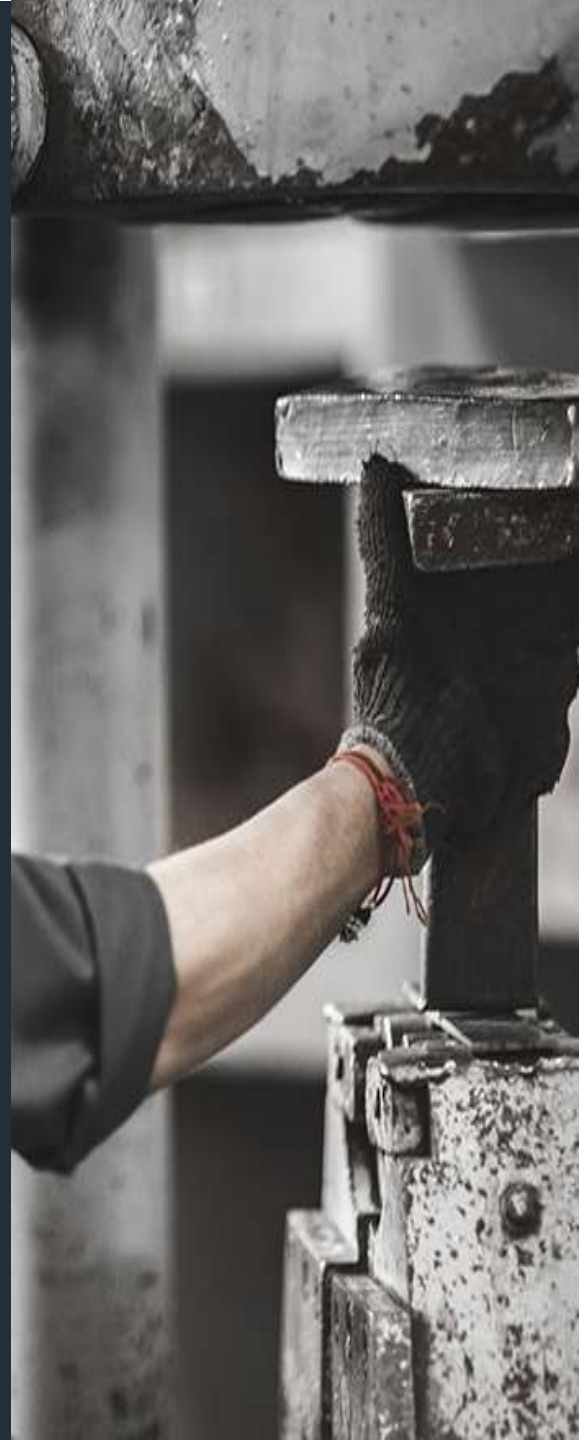
- Eddy Current, MFL, Helium Leak, Metallographic Replicas on SEM
- FFS as per API 579, Failure Analysis, Corrosion Studies, RLA

TCR ENGINEERING

MECHANICAL TESTING

Key Highlights

- Largest facility (40,000 SQFT.) in India for Mechanical Testing in commercial laboratories
- Fully equipped machine shop and testing facility for Fatigue, Stress, Creep, UTM, Impact at high and low temperatures
- All procedures are detailed and documented for each step in the process. TCR has compliance certifications from GE, Honda, Siemens, Lodha, Alstom, Halliburton, L&T and Godrej
- In-house machine shop to sample specimens to given standards
- Machines duly calibrated every two years under strict observation of external Inspectors
- Highly trained staff with extensive experience in engineering, mechanics, and materials science



KNOWLEDGE BANK

Access to a library of ASTM, ASME, API, IS and BS standards as well as 200+ man years of expertise Experienced technical heads can read new/custom standards to devise test methods

TRACEABILITY

Strong traceability of samples as it moves from machine shop to the laboratory with bar code scanning at each step. Chain of custody of samples is maintained at all times to ensure rapid turnaround at affordable cost

SUPERIOR NETWORK

Strong working relationships with authorized inspectors from TUV, BV, SGS, DNV, ABS, EIL, NPCIL who, when needed help TCR by giving quick time slots to visit and supervise testing.

1 MECHANICAL TESTING

INHOUSE EQUIPMENTS AND CORE CAPABILITIES

- Tensile Testing including Elevated Temperature Tests
- UTM of 1000 KN capacity, UTM of 400 KN capacity and UTM of 30000 lbs. capacity with Electronic Controls and Extensometers
- Charpy Impact (weld and HAZ) and I-zod Impact Test
- Weldability, Bend Test, Compression, Flaring / Flattening
- Hardness Testing (Rockwell, Brinell, Superficial Micro Hardness)
- Nick Break, Proof Load, Fasteners, Hydraulic / Pneumatic Test and Component Testing among others
- CNC Lathes, Mills, Stress-Free Grinding Equipment, Saws, Surface Grinders, and more.

2 FATIGUE TESTING (1/2)

FATIGUE TESTING FACILITY: 50 KN AND 250KN UTM

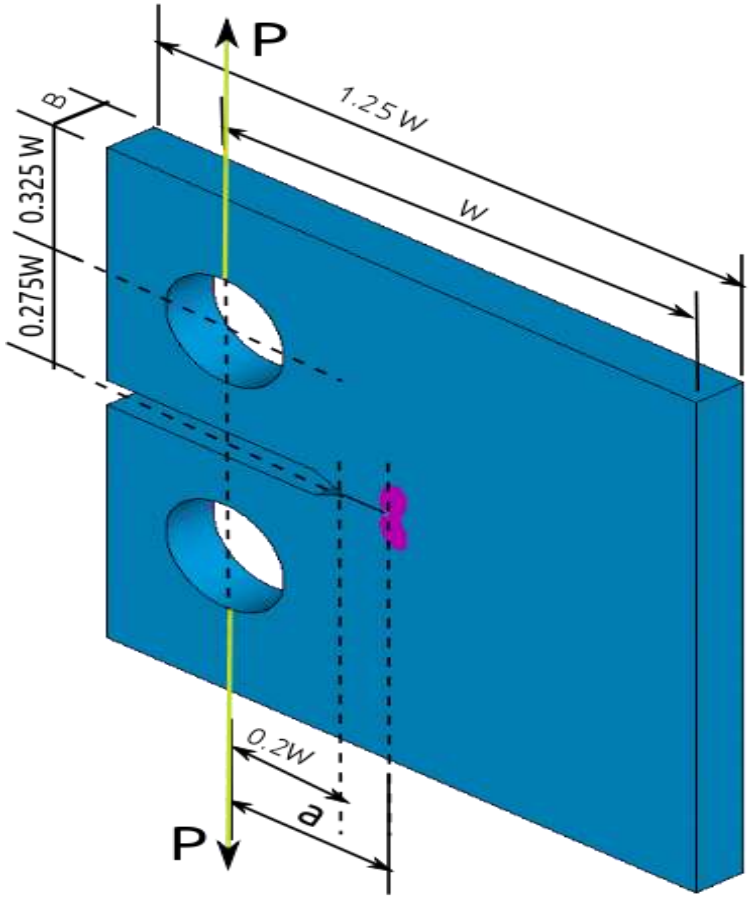
- Tensile Testing
- Compression Testing
- Fatigue Testing
- Load Unload Testing
- 3 Point Bending Testing
- High Temperature Tensile, LCF, HCF Testing [up to 1000 Degree C]
- Spring Fatigue Testing and CTOD
- High Strain Rate Testing

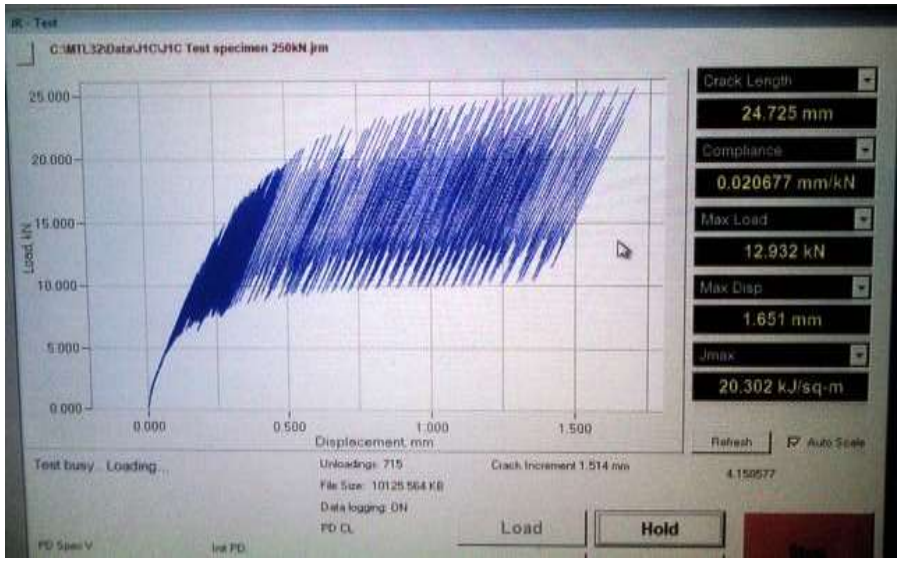
FATIGUE TESTING FACILITY (2/2)

CORE CAPABILITIES

- Advanced Fracture Mechanics Testing [K1c, J1c, CTOD Testing] as per ASTM, ISO, En Standards] for measurement of fracture toughness of the material in the presence of a sharp fatigue crack

- High Strain Rate Testing



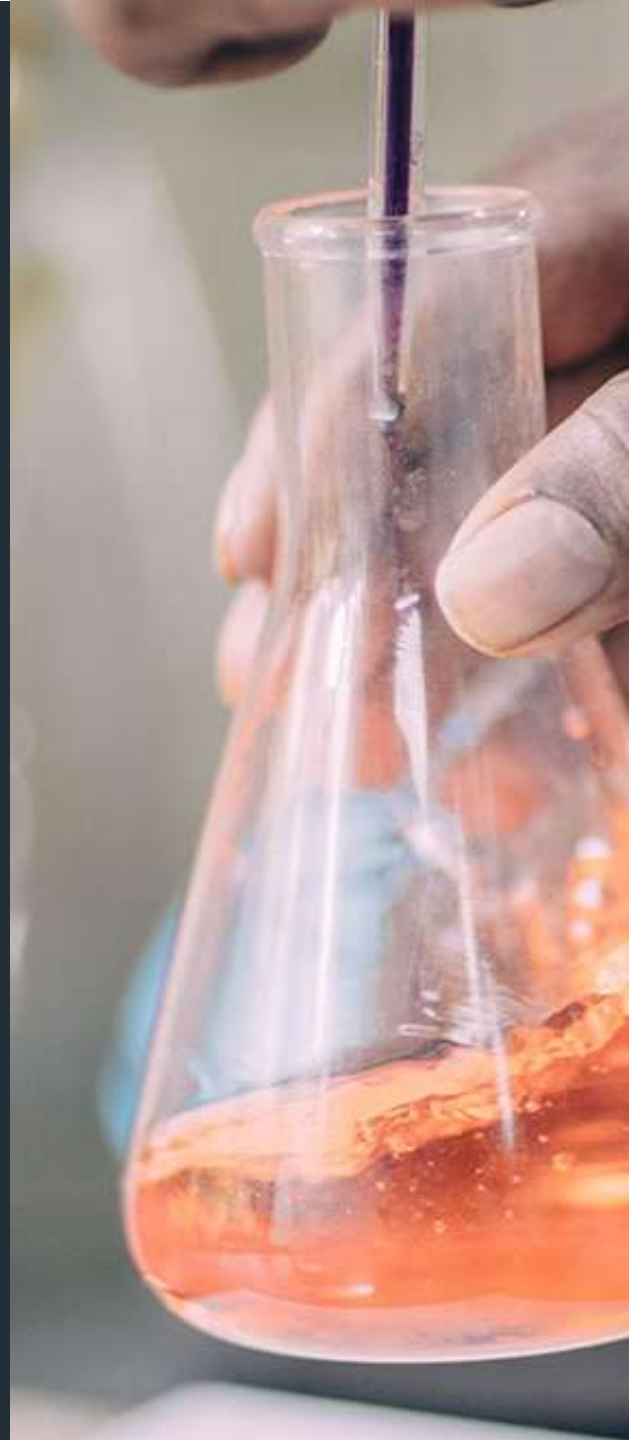


TCR ENGINEERING

CHEMICAL ANALYSIS

Key Highlights

- Expert team of chemists with over 400 man years of experience
- Leading testing provider in India for worlds' largest CRM Manufacturer - MBH Analytical
- Wet Chemical Analysis is used as a referee method for all samples that fail or are on the verge of failing spectroscopy. This method ensures highest level of accuracy for results obtained in the process
- Gravimetry and Titrimetry procedures, which are used for Wet Chemical analysis have the highest clearance from environmental agencies
- 6 spectrometers with sample polishing facilities and portable optical emission spectrometer for onsite detection of carbon are available



EXTENSIVE SCOPE

State-of-the-art Spectrometers along with Wet Chemistry lab, which has the capacity to identify minerals, ores, and other unknown materials

EXPRESS SERVICE

Rapid and accurate analysis for individual & combined chemical elements with 48-hours turnaround time for all Spectroscopy test results

IN-DEPTH REFERENCE

Over 300 certified reference materials to standardize instruments

EXTENDED STORAGE

Storage of test samples for 180 days in case of any dispute resolution

3

CHEMICAL ANALYSIS LAB

INHOUSE EQUIPMENTS AND CORE CAPABILITIES

- Conducting analytical tests for Ferrous and Non Ferrous Metals, Ceramics, Glass, Refractories, Minerals and Ferro Alloys, Aluminum Alloys, Carbon, Low Alloy & Stainless Steel, Cobalt Alloys, Copper Alloys, Jewelry and Dental Alloys, Magnesium Alloys, Nickel Alloys, Super-Alloys, Titanium Alloys, Tool Steels, Zinc Alloys, Cast Iron, Weld Metals, Gases, Industrial Water and Process Solutions

- Spectrometers: ARL Quantris, Optical Emissions, Glow Discharge, Inductively Coupled Plasma, Automatic Carbon–Sulphur Determination and Atomic Absorption

4 RoHS COMPLIANCE TESTING

CORE CAPABILITIES

- Restriction of hazardous substances: Keeping the environment safe by detecting levels of lead, mercury, cadmium, hexavalent chromium, Bromine, polybrominated biphenyls (PBBs), and polybrominated diphenyl ethers (PBDEs) in electrical and electronic components, toys etc.
- Non-destructive, in-situ screening method for PVC, PE, alloys, metals, solders, ceramics and packaging materials: Simultaneously screening in a matter of seconds for all five restricted RoHS elements Hg, Cd, Cr, Br and Pb
- Verification methods using ICP: A team of highly mobile experts can easily be deployed across any location

TCR ENGINEERING

CORROSION TESTING

Key Highlights

- Awarded as the best laboratory in India by NACE in 2007
- Advanced capability of conducting Sour Gas Corrosion Testing for HIC/SSCC as per NACE, ONGC and EIL specifications
- Continuous 24x7 physical monitoring and observation of all long duration tests by dedicated team. Photos are taken at each test interval for client records
- Flexibility to customize tests as per client's specification/needs across different solution types
- Added advantage of advisory service for interpreting tests and providing in-depth understanding of final application/usage of the tested sample

TOOL BANK

32 Vessels and Autoclaves for simultaneous HIC/SSCC testing, 50 different apparatus for IGC tests to accommodate samples and 4 different Salt Spray chambers to suit majority of sample sizes

HIGHEST SAFETY

Glass based apparatus with temperature control with stringent safety and environment measures

MINIMUM SUPERVISION

Timely test procedures to reduce the number of third party inspector visits to observe test results

REGULAR CALIBRATION

Calibration of all proof rings and furnaces is done every two years

5 CORROSION TESTING

CORE CAPABILITIES

- CORROSION TESTING FOR SOUR GAS APPLICATIONS:
  - NACE MR 0175 Testing
  - Hydrogen-Induced Cracking Test (HIC) as per NACE TM 0284
  - Sulfide Stress Corrosion Cracking Test (SSC) as per NACE TM 0177
- IN-DEPTH CORROSION TESTING FACILITIES
  1. Inter-granular Corrosion Test (IGC) ASTM A262
     - Oxalic Acid Test, ASTM A262 Practice A (Oxalic Acid Etch)
     - Ferric Sulfate - Sulfuric Acid, ASTM A262 Practice B (Streicher Test)
     - Nitric Acid, ASTM A262 Practice C (Huey Test)
     - ASTM A262 Practice D (Modified Strauss Test)
     - Copper - Copper Sulfate - 16% sulfuric acid, ASTM A262 Practice E (Strauss) & 50% sulfuric acid, ASTM A262 - Practice F
  2. Pitting Corrosion test as per ASTM G48 Specification
  3. Salt Spray Test per ASTM B117
  4. Chloride Stress Corrosion Test as per ASTM G36 Specification
  5. Corrosion test as per ASTM G35 specification
  6. Ammonia Vapor Test & Corrosion test as per ASTM A761 Specification
  7. High temperature (upto 250°c) and high pressure (upto 200psi) autoclaves

5 ADVANCED CORROSION TESTING (1/3)

TR ENGINEERING

CORE CAPABILITIES

- G31-72(2004) Standard Practice for Laboratory Immersion Corrosion Testing of Metals
  This practice describes the accepted procedures and factors that influence laboratory immersion corrosion tests, particularly mass loss tests.

- G66-99(2005)e1 Standard Test Method for Visual Assessment of Exfoliation Corrosion Susceptibility of 5XXX Series Aluminum Alloys (ASSET Test)
  This test method covers the procedure for continuous immersion exfoliation corrosion testing of 5XXX series aluminum-magnesium alloys containing 2.0 % or more magnesium. This method provides a reliable prediction for the exfoliation corrosion behaviour of Al-Mg alloys in marine environments. This particular test is useful for alloy development studies and quality control of mill products such as sheet and plate.

- G67-04 Standard Test Method for Determining the Susceptibility to Intergranular Corrosion of 5XXX Series Aluminum Alloys by Mass Loss after Exposure to Nitric Acid (NAMLT Test)
  This test method describes the procedure for constant immersion intergranular corrosion testing of 5XXX series aluminum alloys. This test method provides a quantitative measure of the susceptibility to intergranular corrosion of Al-Mg and Al-Mg-Mn alloys. The nitric acid dissolves a second phase, an aluminum-magnesium intermetallic compound (bAl-Mg), in preference to the solid solution of magnesium in the aluminum matrix. When this compound is precipitated in a relatively continuous network along grain boundaries, the effect of the preferential attack is to corrode around the grains, causing them to fall away from the specimens. Such dropping out of the grains causes relatively large mass losses.

5 ADVANCED CORROSION TESTING (2/3)

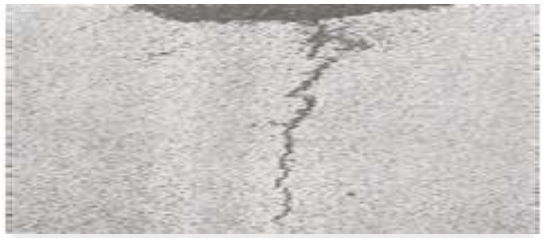
CORE CAPABILITIES

Laboratory Testing of Metals for Resistance to Sulphide Stress Cracking and Stress Corrosion Cracking in H2S Environment as per NACE Standard TM0177-2005 Method D – DCB Test

- Method D, the NACE Standard DCB Test, provides for measuring the resistance of metallic materials to propagation of EC, which is expressed in terms of a critical stress intensity factor, KISSC for SSC and KIEC for the more general case of EC, using a crack-arrest type of fracture mechanics test. Method D does not depend on the uncertainty of pitting and/or crack initiation, because a crack is always initiated in a valid test.

- For SSC testing of carbon and low alloy steels this method requires little time.

- Method D gives a direct numerical rating of crack propagation resistance and does not depend on evaluation of failure/no-failure results. The subject of fracture mechanics testing for evaluation of EC resistance is currently under consideration by NACE TG 085 and Work Group (WG) 085c, and ASTM Committees E 8.06.02 and G 1.06.04.



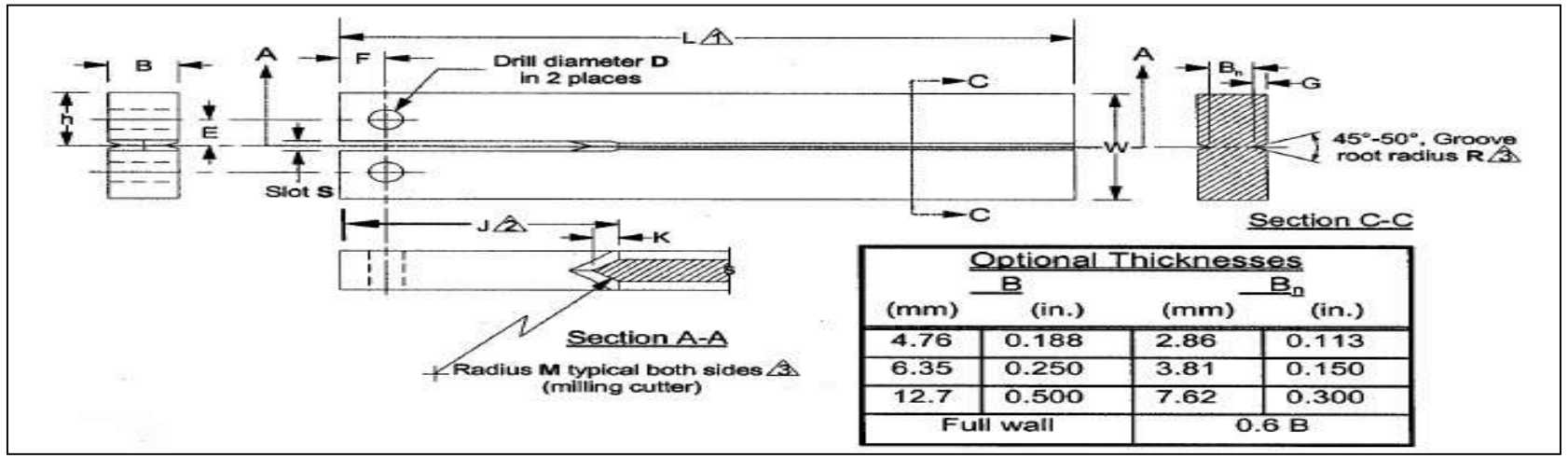
Typical SSC Crack in C Steel

SSC Tensile Test Setup with continuous H_2S Purging

DCB Testing Setup with continuous H_2S Purging

5 ADVANCED CORROSION TESTING (3/3)

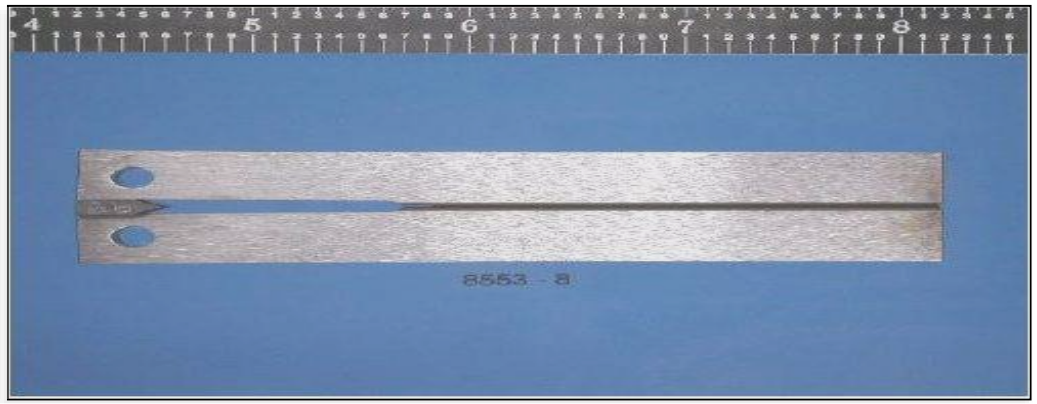
TEST SPECIMEN of Method D – DCB Test

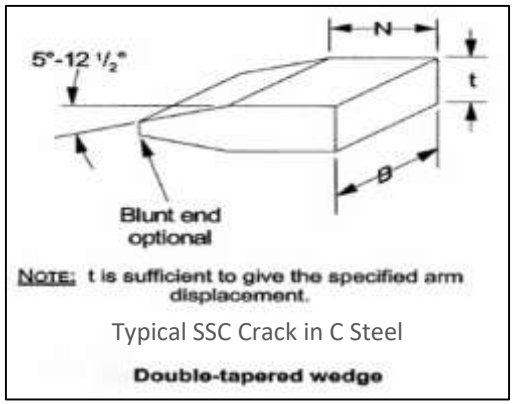


Optional Thicknesses			
B		B_n	
(mm)	(in.)	(mm)	(in.)
4.76	0.188	2.86	0.113
6.35	0.250	3.81	0.150
12.7	0.500	7.62	0.300
Full wall		0.6 B	

Dimension	Size	
	(mm)	(in.)
B	9.53 ±0.05	0.375 ±0.002
B_n	5.72 ±0.05	0.225 ±0.002
D	4.85	0.191 (No. 11 Drill)
E	6.4 +0.2/ -0.0	0.25 +0.01/-0.00
F	6.35 ±0.10	0.250 ±0.004
G	1.91 ±0.05	0.075 ±0.002
h	12.70 ±0.05	0.500 ±0.002
J	38.10 ±1.59	1.500 ±0.0630
K	3.17 ±0.77	0.125 ±0.031
L	101.60 ±1.59	4.000 ±0.0630
M	51 ±13	2.0 ±0.5
N	6.35 ±0.10	0.250 ±0.004
R	0.25 ±0.05	0.010 ±0.002
S	2.38 ±0.05	0.094 ±0.002
U	130	5
W	25.40 ±0.05	1.000 ±0.002
X	0.3	0.01
Y	41.3	1.63
Z	±0.05	±0.002

SSC Tensile Test Setup with continuous H2S Purging





Typical SSC Crack in C Steel

TCR ENGINEERING

METALLOGRAPHY STUDIES

Key Highlights

- Live image capturing using specially designed high resolution digital camera with portable microscope. These images are transferred via internet to the lab where the interpretation is provided by expert metallurgists from India's premiere institution (IIT's and other technical universities) to ensure efficiency and on-time action
- Database of over 40,000 reference microstructures gives TCR the unique ability to comment on the corrosion damage or remaining health of plant by observation of replica
- In-depth understanding of over 60 different corrosion damage mechanisms and their effect on microstructure
- State of the art SEM equipment with 20X-100000X magnification and EDS with a large detection area of 20 mm^2 and 12 portable optical microscopes with magnification of up to 50,000X

25,000+ REPLICA REPOSITORY

Damages observed include Graphitization, Degradation Of Pearlite, Decarburization, Creep, Thermal Fatigue, Oxidation, Grain Growth, Hydrogen Attack, Stress Corrosion Crack, Sigma phase detection

EXTENSIVE EVALUATION

Extensive evaluation for Heat treatment condition, microstructure, forming process, Metallographic Preparation & Examination, Macro and Micro Examination, Micro Hardness Testing, Coating / Plating Evaluation (ASTM B487, ASTM B748), Weld Examination, Case Depth and Decarburization Measurement

PROPRIETARY SOFTWARE

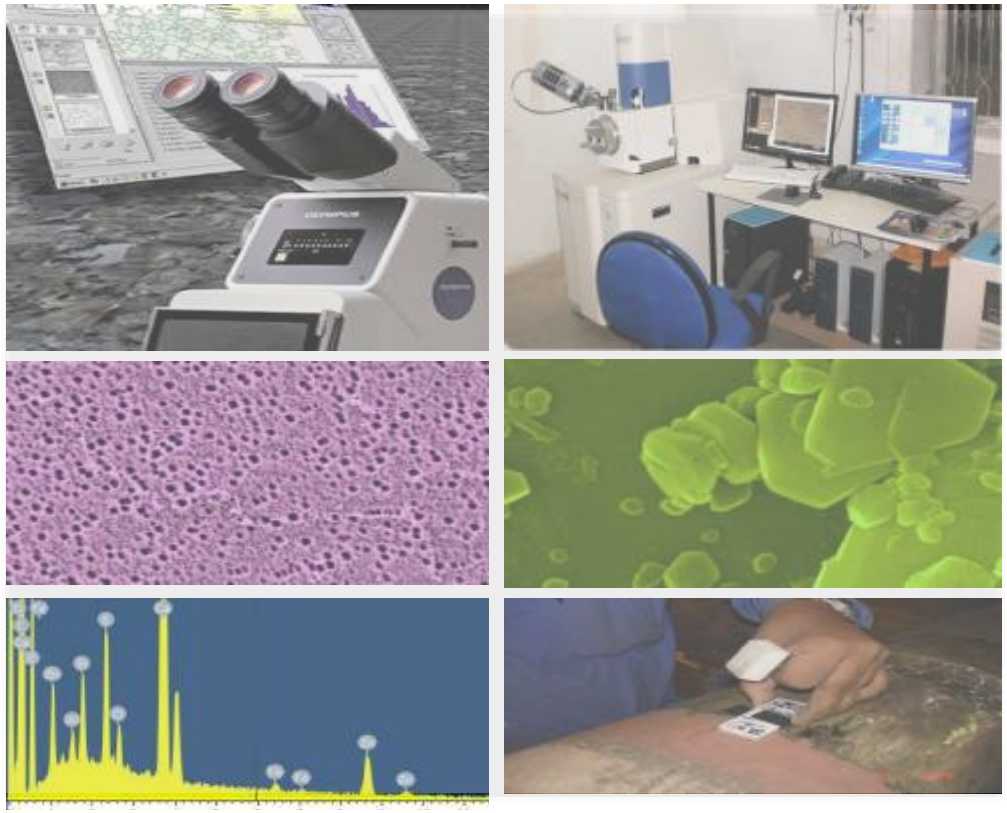
Developed an in-house Microstructure Characterizer Software 3.0, Grain Size, Nodularity, Linear Measurements and much more

6 SEM & EDS ANALYSIS

CORE CAPABILITY

TCR has the latest Scanning Electron Microscope (SEM) attached with Energy Dispersive Spectrometer (EDS) system which is a great diagnostic tool for:

- Failure Investigation
- Fractography
- Quality control
- Morphology and Identification of Localized Defects
- Identifying Corrosion Products at Microscopic Levels
- Identifying Surface Coating or Plating
- Particle Size & Shape Analysis
- Characterizing Creep in Microstructure
- Identifying Sub-Micron Features in Microstructure
- Identification of Inclusions in Metals



TCR ENGINEERING

CIVIL TESTING

Key Highlights

- 150 man years of experience in ToR Steel/Rebar Testing, Cement, Concrete, RMC, and Structural Audits
- Latest Mobile Lab facility with on-demand installation at construction site to ensure real-time testing
- Over 25 structural audits undertaken including building and water tank damage assessments for Lodha Builders They are the makers of one of the tallest towers in Mumbai and have selected TCR for all their ToR/ Rebar steel testing
- Strong relationships with insurance and disaster management companies to evaluate structures. Litigation support services also provided to construction and infrastructure development companies

7 STRUCTURAL AUDIT (1/4)

CORE CAPABILITY

A structural audit entails evaluating the overall health and performance while ensuring that the building and its premises are safe and are at no risk. An experienced and licensed consultant at TCR conducts a structural audit and recommends appropriate repairs and retrofitting measures for the buildings to perform better in its service life. As per clause No.77 of revised Bye-Laws of Cooperative Housing Societies; the Society shall cause the 'Structural Audit' of the building as follows:

- For building aging between 15 to 30 years once in 5 years
- For building aging above 30 years once in 3 years

Core Users:

- For insurance
- For bank mortgage
- For valuation
- For show distress
- For damage assessment due to earthquake, fire, blast, vibration, corrosion etc.
- For proposing additions, alterations and/or extensions in building/structure that

Key purpose of Structural Audit:

- To save human life and buildings and warn against any potential threats or failures
- To understand the condition and health of a building and to project the expected future life
- To find critical areas that need to be attended or repaired with immediate effect
- To comply with statutory requirements of municipal authorities
- To proactively assist the residents and the society to understand the seriousness of the problems and the urgency required to address these issues
- To enhance the life cycle of a building by suggesting preventive and corrective measures like repairs and retrofitting

7 STRUCTURAL AUDIT (2/4)

ADVANTAGE TCR

Our in-house structural audit team has undertaken several evaluation engagements. The TCR advantage includes:

- **Decades of Experience:** TCR Engineering has expertise built over two decades and has partnered with several developers to undertake testing, inspection and auditing services
- **Registered Service Provider:** Registered and certified by various municipal corporations, TCR has been providing services across Government and private sectors
- **In-house Capability:** TCR is a knowledgeable and customer oriented service provider with a full-fledged set up to undertake all types of structural audit activities
- **Cost Effectiveness:** With TCR's expertise, structural irregularities are identified with ease and this mitigates the cost impact resulting from the deterioration of the building
- Testing performed as per British and Indian Standards, aligned with Client's/Consultants project specification
- Sample pickup from each construction site with 48 hour report turnaround with results. Provision of online reporting to assist site personnel with quick decision-making
- Technical committee deliberates all audit reports after intensive internal debates and cross checks
- Thermography done on civil structures to save energy. Eddy Current done on chiller tubes to ensure effective air conditioning
- API 936 inspectors available for all refractory testing

7 STRUCTURAL AUDIT (3/4)

TCR ENGINEERING

AUDIT PROCESS:

Part A – Visual Inspection:

- Visual inspections of individual building / structures from inside and outside to study present status of different structural members
- Study of Architectural / RCC / Structural drawings (If available)
- Photographic Survey
- Capturing multiple details including:
  - Load transfer system,
  - Structural framing system,
  - Structural deficiencies,
  - Settlement if any,
  - Cracks in RCC members,
  - Cracks in masonry / plaster
  - Leakages,
  - Loads on structure,
  - Defects in non-structural elements etc.
- Identification of broad areas / locations in the structure requiring further detail investigation and for conducting various Non-Destructive Tests

Part B – Non Destructive Evaluation:

- In addition to visual inspection, the real strength and quality of a concrete structure needs to be checked with non-destructive tests.
- A number of non-destructive tests (NDT) for concrete are available to determine present strength and quality of concrete
- To Conduct Non-Destructive tests as required apart from detailed visual inspection

7 STRUCTURAL AUDIT (4/4)

TCR ENGINEERING

AUDIT PROCESS:

Part C – Repair & Rehabilitation Consultancy:

- Preparation of detailed report for a range of visual inspection & ND tests
- Interpretation of ND test results
- Diagnosis & Root cause analysis of the problems/ observations
- Preparation for Repair & Rehabilitation schemes to make the structure durable, healthy and have a long life
- Preparation of technical specifications & drafting of tender documents for repair and rehabilitation
- Preparation of cost estimates
- Scrutinizing tender documents
- Periodic inspection of work
- Issuing Structural Stability Certification after completion of the assignment

TCR ENGINEERING

NON-DESTRUCTIVE TESTING

Key Highlights

- TCR, in a short span of time can deploy over 100 inspection crews for shutdown or EPC projects with multiple sets of back-up equipment and probes that can limit downtime at site
- All crew members comply strictly to TCR's strong interpretation of the ASNT CP-189 guidelines. They have a minimum of 5 years of experience with ASNT or PCN Level II certification
- Radiography and RSO teams strictly comply with BARC norms and strictly adhere to safety procedures at all times
- TCR Crew members have extensive experience working with RBI and Asset integrity management projects. This ensures consistency in reporting, which can easily be inserted into a client's SAP or Meridian system

REGULAR CALIBRATION

Machines from Olympus, GE and Modsonic are duly calibrated once in every 2 years with proper storage of probes and consumables

EXTENSIVE CAPABILITY

12 PMI machines with XRF are available with a singular UT technician capable of doing 50 meters of running weld scan per day

INDUSTRY LEADING CREDIBILITY

TCR is a gold partner of ASNT. It actively provides and promotes knowledge sharing on discussion boards of NDT.NET, ASNT meets and also at the TCR Evolve training facility

END-TO-END PLANT SHUTDOWN

Qualified Inspectors with ASNT Level II and III with certifications including TKY, API, AWS/CSWIP, BGAS, ASME, AWS, NDT Project Managers provide in-depth assessments for managing plant shutdowns

8 NDT& PWHT SERVICES

CORE CAPABILITIES

ADVANCED AND CONVENTIONAL NDT SERVICES:

- In-Situ Metallography (Metallographic Replication) and Residual Life Assessment (RLA) of Boilers and Pressure Vessels
- Ultrasonic Inspection: Time of Flight Diffraction and Ultrasonic Flaw Detection and Phased Array
- Tube Inspection: Eddy Current Testing, Acoustic Eye, Automated Reformer Tube Inspection System
- Helium Leak Testing
- Leak Detection using Acoustic Emission
- Conventional NDT: Ultrasonic Examination using Pulse Echo, UT Thickness Measurement, Liquid Dye Penetrant Testing, Magnetic Particle Testing, WFMPI, Visual Examination, Portable Hardness, Ferrite Measurement, PMI
- Post Weld Heat Treatment using 70 KVA Electric Resistance

LIQUID PENETRANT TESTING

ULTRASONIC TESTING

VISUAL INSPECTION

RADIOGRAPHIC TESTING

MAGNETIC PARTICLE TESTING

9 RADIOGRAPHIC TESTING

CORE CAPABILITIES

TCR uses short wavelength electromagnetic radiation (high energy photons) to penetrate materials for finding hidden flaws and for determining thickness or composition of materials:

- SENTINELTM Model 880 Delta, 880 Elite and 880 Omega source projectors are portable, lightweight and compact industrial radiographic exposure devices. The patented device body consists of a titanium 'S' tube and cast depleted uranium (DU) shield contained within a 300 series stainless steel tube with stainless steel discs welded at each end forming a cylinder shaped housing. The discs are recessed to provide protection for the rear mounted locking mechanism and front mounted outlet port. The horizontally oriented design allows the locking mechanism, source assembly connector and outlet port to be easily operated, simplifying connection of source guide tubes and remote controls.

- EXPOSURE DEVICE: The exposure device body, containing the DU shield, locking mechanism, outlet port, protective covers and required labels*, comprises the radioactive material transport Type B(U) package

- REMOVABLE JACKET: An impact resistant plastic jacket surrounds the exposure device to protect labels and provide the means for carrying and placement during radiographic operations. The three models are identified by jacket color; yellow for the 880 Delta, blue for the 880 Elite and orange for the 880 Omega

A

PORTABLE X-RAY GENERATORS

CORE CAPABILITIES

INCREASE THE RELIABILITY OF IN HOUSE & ON-SITE X-RAY TECHNIQUES

The SITEX directional generators are equipped with an internal ‘carousel’. This contains a lead cap and 4 diaphragms that are calibrated for the films. Ensuring protection from accidental on-site losses and weighing in total a mere 1.0 kg, this very practical device replaces approximately 20 kg of fragile and space-consuming accessories. The carousel fitted on the SITEXS provides the same features and is equipped with a laser pointer. To ensure ease of handling, direct access has been arranged on the moving part

B

NDT TESTING CREW AT WORK

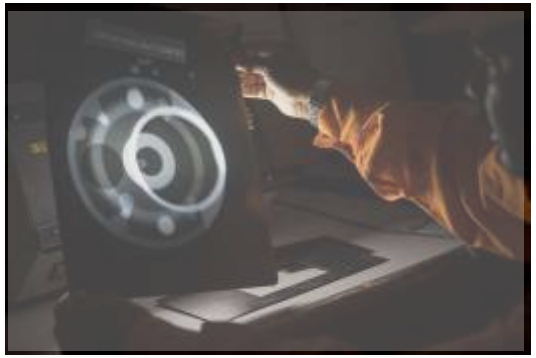
TCR ENGINEERING

FIELD IMAGES

RADIOGRAPHIC TESTING

ULTRASONIC TESTING

ULTRASONIC TESTING



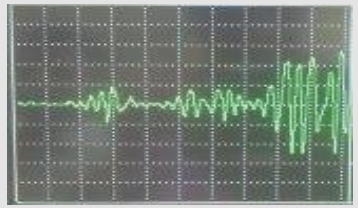
X-RAY RADIOGRAPHY

GAMMA RAY RADIOGRAPHY

ADVANCED NDT SERVICES

- TOFD: Time Of Flight Diffraction
- PAUT: Phased Array Ultrasonic Testing
- ARTIS: Automated Reformer Tube Inspection Services
- HTHA: High Temperature Hydrogen Attack Detection
- IOT: Internal Oxide Scale Thickness Measurement
- ECT: Eddy Current Testing
- RFET: Remote Field Eddy Current Testing
- APR: Acoustic Pulse Reflectometry
- HT: Helium Leak Testing
- RVI: Videoscopy

SERVING DIVERSE INDUSTRIES

PAUT/TOFD	ARTiS	HTHA	IOT
			
ECT/RFET	**APR**	**HT**	**RVI**
			

TCR ENGINEERING

PIPELINES & WELD INSPECTION

Key Highlights

- TCR Inspection teams have trained at Lavender International, USA and Eclipse Scientific, Canada for all ToFD/PA and HTHA applications
- TCR project teams can be rapidly mobilized for construction of new piping, pipelines, vessels and structural welds inspection assignments
- TCR experts have over 2000 man days of experience in ToFD/PA
- TCR specializes in High Temperature Hydrogen Attack (HTHA) detection using Phased Array
- TCR's PWHT crews are well qualified to work round the clock on project sites
- TCR ensures optimum corrosion mapping, conducts dual checks with creation of baseline data as well as ongoing thickness checks

LATEST TECHNOLOGY

TCR employs Olympus Omniscan machines for ToFD and Phased Array along with with other back-up machines to ensure zero downtime owing to machine failure at project sites

CUSTOMIZED CALIBRATION

TCR uses calibrated copper rings for LRGW for cross country and over 35 different custom probes and wedges that span all angles of inspection

FASTER TECHNIQUE

TCR uses a faster technique than radiography for piping weld join inspection

IN-DEPTH EXPERTISE

Experts at TCR can accurately size and locate defects using the field data

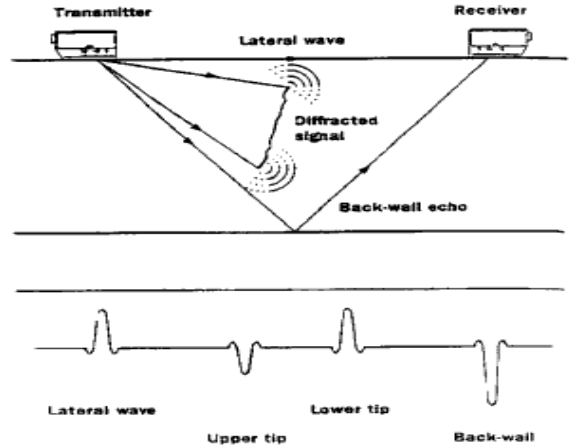
10 TOFD INSPECTION TECHNIQUE AT TCR

TCR ENGINEERING

CORE CAPABILITIES

TOFD employs two longitudinal wave (L-wave) angle beam transducers, which are arranged symmetrically opposite straddling the weld or base material under test

- One probe acts like a transmitter of ultrasonic energy while the other probe receives the ultrasound energy
- The transducer, pulser, and amplifier characteristics are selected to generate a broad distribution of energy over the material under test providing full weld coverage
- A single-axis scan (that is, along the weld), has a position encoder that records the position of the weld and enables the display of digital images in real time



TOFD waves pattern and the corresponding A-SCAN image

OmniScan MX from Olympus NDT

11

PORTABLE ULTRASONIC FLAW DETECTOR (1/3)

TCR ENGINEERING

CORE CAPABILITIES

TCR conducts quick, basic flaw detection in difficult field conditions and also in demanding production environments

TCR's works with the Olympus EPOCH LT that has:

- Display Freeze Mode that holds waveform sound path data
- Peak Memory that simultaneously displays live waveform and peak envelope of A-scan, RF display mode
- Selectable threshold positive/negative or minimum depth Alarm Modes
- Auto Transducer Calibration that calibrates for transducer zero offset and/or material velocity

Real-time data collection on the instrument allows TCR inspectors to store up to 100 calibrations/2000 thickness measurements

EPOCH LT – Ultrasonic Flaw Detection
Flaw detection in difficult field conditions or demanding production environments

11 ULTRASONIC FLAW DETECTOR (2/3)

TEST RANGE	10 mm to 5 meter (in steel) adjustable in 1mm or 10mm step
VELOCITY	1000 m/s to 9999 m/s adjustable in 1 m/s or 10 m/s step. Direct velocity setting for longitudinal and shear waves for steel
DELAY	Up to 3 meter adjustable in 0.5mm or 5mm step
GAIN	100 dB calibrated gain adjustable in 0.5,1,2,6,12 or 20dB step
REJECTION	0 to 100% FSH with LED indicator
RECTIFICATION	Full wave rectified with filtering
FREQUENCY	0.5 MHz to 10 MHz (Wideband)
TEST MODES	Pulse echo and transmit/receive
CONNECTORS	BNC and LEMO (Size 1) both are provided
MONITOR	Dual gate adjustable in 1% of Screen width with Positive/Negative logic, Gate Expand modes
GATE EXPAND	Expands Range to width of the gate
A-SCAN MEMORY*	200 Trace Patterns can be stored, recalled, printed or transferred to PC via RS-232 serial port
CALIBRATION SET-UP	50 different calibration set-ups can be Stored and Recalled
SOFTWARE*	EinSoft Interface software for transferring A-Scan from Einstein-II TFT to PC is supplied
PRINTER ATTACHMENT	Any PC Printer with serial port can be attached for instant print-out of Trace Pattern (A-Scan with Set-up data)
DISPLAY	122x92 mm (320x240 pixel) Colour LCD/TFT display for better visibility with option of eleven different color sets

11 ULTRASONIC THICKNESS GAUGE (3/3)

TCR ENGINEERING

CORE CAPABILITIES

- Memory of 2000 Readings
- Computer Connectivity
- One Step Calibration
- Pocket Sized
- Operates on Two "AA" Batteries
- Sealed Tactile Key Pad
- Built - in Calibration Block
- LCD

Display

TCR ENGINEERING

BOILER INSPECTION

Key Highlights

- TCR Boiler team has over 200 man years of domain expertise with strong visual inspection capability owing to its extensive field experience in working with power plants
- TCR conducts inspection as per API RP 573, ASME section VII/VIII/IX, API RP 577, API RP 571
- Clients are able to avoid scaffolding with TCR's advanced ARTIS system for reformer tube inspection
- With TCR’s comprehensive collection of standards and reference materials, it has completed boiler inspection in over 75 boilers till date
- Pre-packaged solutions for complete boiler assessment work including EMAT and RFET testing available for boiler water walls

END-TO-END SUPPORT

TCR has the ability to manage the complete boiler inspection project life cycle right from visual inspection, testing to final report presentation

GLOBAL BEST-PRACTICE

TCR offers the best-in class techniques for boiler inspection, which include Electro-Magnetic Acoustic Transmission (EMAT), Automated Reformer Tube Inspection System (ARTIS) and Internal Oxide Scale Boiler Measurement

NATIONAL CREDIBILITY

TCR Engineering Services is a Bureau of Indian Standards and NABL accredited laboratory. TCR Engineering is among the few organizations in India that have been recognized by Central Boilers Board as a "well-known Material Testing Laboratory as per Indian Boiler Regulations Act of 1950

12

AUTOMATED REFORMER TUBE INSPECTION SYSTEM

TCR ENGINEERING

CORE CAPABILITIES

Predict the behavior of the Reformer Tubes by creep strain, mid-wall fissure detection and bowing measurements using ARTiS

- ARTiS provides the advantage of inspecting from an external surface without needing to remove the catalyst
- Detects micro level sub surface and mid-wall creep fissures
- ARTiS has the additional benefits of creep strain and bowing angle estimate at a resolution of 0.1meter
- The biggest advantage is the electrical - motorized crawling which eliminates erection of scaffolding

13 INTERNAL OXIDE SCALE MEASURE OF BOILER TUBES

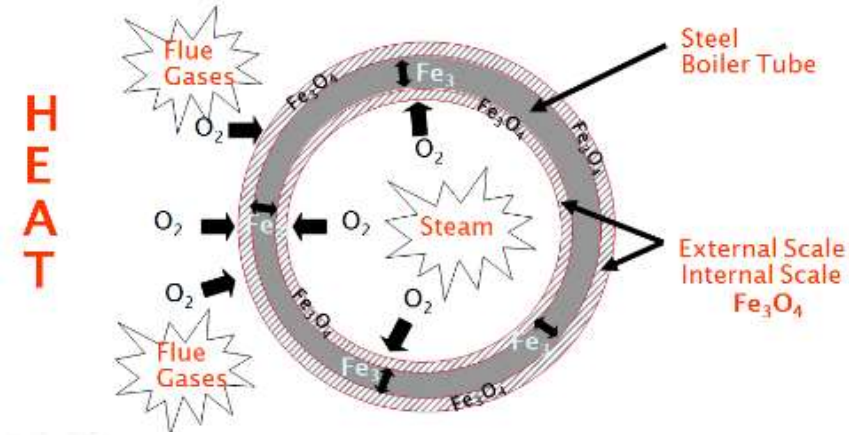
TCR ENGINEERING

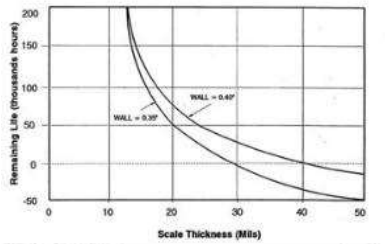
CORE CAPABILITIES

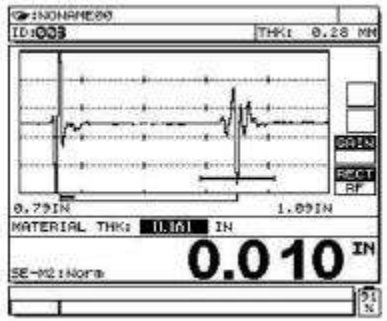
The high temperature operation of steam boilers (in excess of 1000°F or 5000°C) can cause the formation of a brittle iron oxide called magnetite on the inside surfaces of tubing

- It reduces heat transfer and increase operating tube wall temperature. This shortens the creep life of tube. If detected in time, it can help in de-scaling decisions to increase the life and efficiency
- It is possible to judge the remaining life of the boiler tube by measuring internal oxide scale with this service offering from TCR

New measurement algorithm allows the user to measure scale or oxide build up on the inside of boiler tubes with its thickness to help predict tube life







For more information, visit **www.tcreng.com**

14

HIGH TEMPERATURE HYDROGEN ATTACK (1/2)

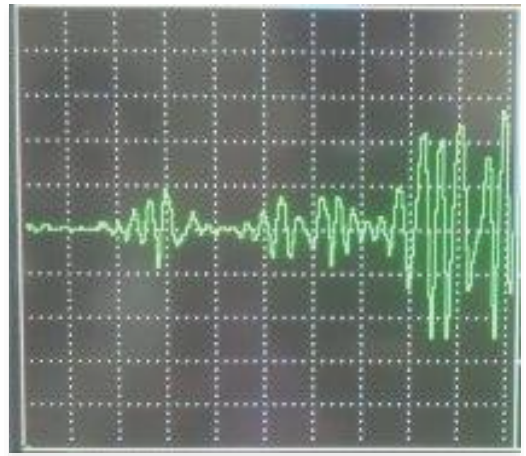
CORE CAPABILITIES

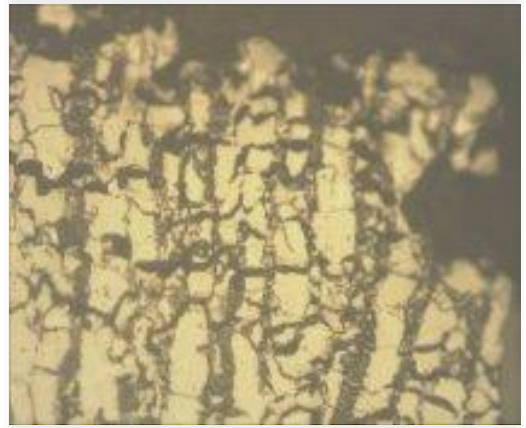
- High temperature hydrogen attack (HTHA) is observed in steel exposed to high temperature above 200 degrees. At high temperature atomic hydrogen diffuses in steel. This hydrogen reacts with the carbon of steel and forms CH4. This bubbles at grain boundary and forms voids

$$MC + 4H = M + CH4$$

- These bubbles exert pressure and also coalesce resulting in fissures. The growth of voids and fissures weakens the metal and hence the fissures develop a major crack
- AUBT (Advanced Ultrasonic Back Scattered Technique): Using API 941 guidelines, three methods are used to detect the HTHA:

  Pattern recognition | Gain drop method | Velocity ratio measurement



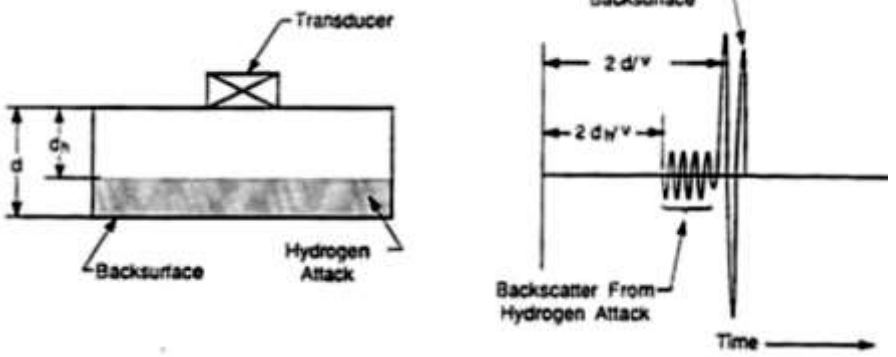


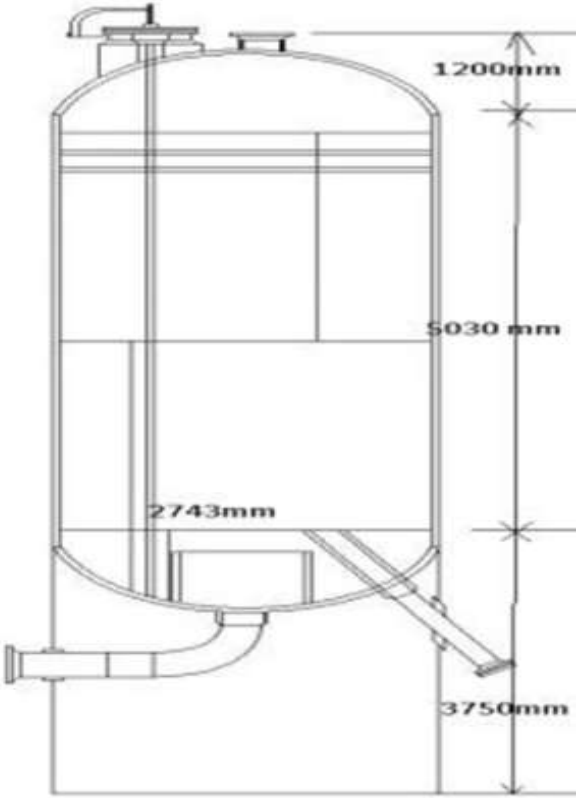
14 HIGH TEMPERATURE HYDROGEN ATTACK (2/2)

CORE CAPABILITIES

Assessment for HTHA attack on Methanator through ABUT as per the guidelines of API941

- The hydrogen attack on steels can occur through diffusion of gas molecules within the material, preferentially attacking pearlite phase at high temperature. The pearlitic phase consists of lamella of iron carbides (Fe3C) and ferrite (Fe). The hydrogen reacts with the carbides to form methane gas (CH4).
- MC + 4H = M + CH4





TCR ENGINEERING

TUBE INSPECTION

Key Highlights

- Tube inspection team at TCR is headed by an ASNT Level III in ECT professional and has the rich experience of inspecting 500+ straight tubes in a single shift by ECT
- Acoustic Eye APR can detect defect from ID of a tube in 9 seconds. It is independent of material and can inspect majority of tubes greater than one-half inch (OD) including carbon, stainless steel, copper and brass tubes
- RFET inspections can be performed with limited tube cleaning. Upto 400 bank tubes can be inspected by RFET in a shift
- TCR reports are graphically presented, which makes it easier to interpret data on heat changer/chiller/condenser/boiler tube data results

EXTENSIVE ECT CAPABILITY

5 Eddy Current Machines with over 50 different calibration tubes of common sizes, and in-house probe development for eddy current application ensures rapid deployment at client sites

UNIQUE VALUE PROPOSITION

TCR is the only service provider in India with Acoustic Eye APR machine for rapid tube inspection

INTEGRATED TECHNIQUE

Combination technique of APR with ECT results in faster completion when APR is used as a screening tool

CONTINUOS SUPPORT

TCR's global locations ensures its team can work 24x7 on shutdown projects

15

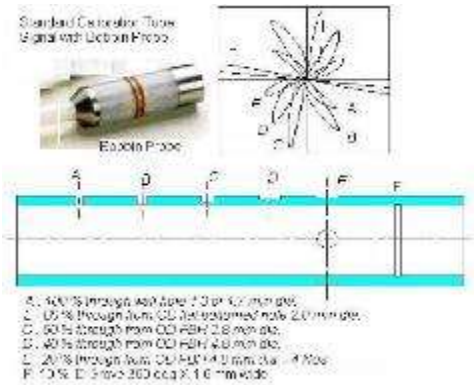
EDDY CURRENT TESTING & RFET SERVICES

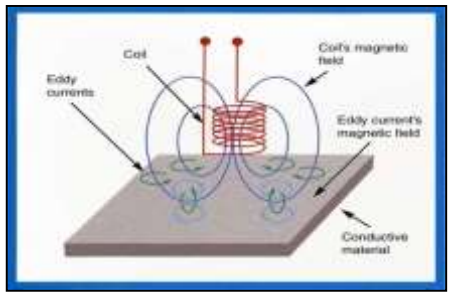
TCR ENGINEERING

CORE CAPABILITIES

Extensively used for ferrous and non-ferrous heat exchanger tubes and turbine components:

- Eddy Current can detect pitting, puncture, cracks, from ID or OD side of tube and it needs less time when compared to IRIS
- Measure or identify conditions and properties such as electrical conductivity, magnetic permeability, grain size, heat treatment condition, hardness, and physical dimensions
- Detect seams, laps, cracks, voids, and inclusions
- Sort dissimilar metals and detect differences in their composition, microstructure, and other properties
- Measure the thickness of a nonconductive coating on a conductive metal, or the thickness of a nonmagnetic metal coating on a magnetic metal



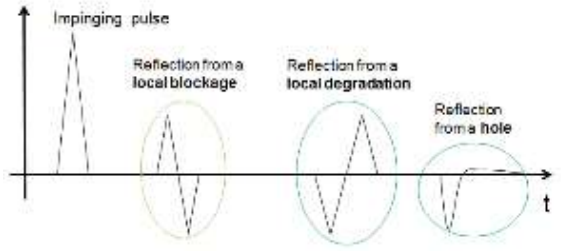


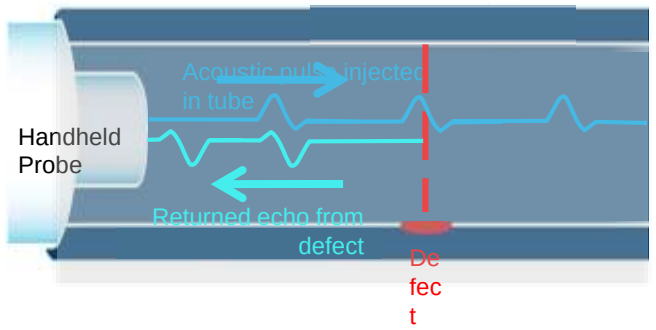
16

ACOUSTIC PULSE REFLECTOMETRY (APR)

CORE CAPABILITIES

- Fastest Tube Inspection system: 10 seconds per tube, up to 2000 tubes inspection in one shift of 12 hours. Faster turn-around of equipment contributing to faster unit/plant startup
- Rapid identification of tube faults: Pitting/wall loss, erosions, holes / leakage, blockage, bulging) in heat exchangers / condensers / boilers / chillers / reactor tubes
- It can test up to 4”inner diameter in any shape or tube material
- It can detect blockages apart from pitting or punctures- useful for detecting the extent of cleaning and can also increase efficiency of heat exchanger
- Independent of tube wall material (can be used across different type of tube materials)
- Independent of tube configuration: Fin tubes, U-tubes, multi bends, 90 degree turns





TCR ENGINEERING

STORAGE TANK & STATIC EQUIPMENT

Key Highlights

- TCR can perform visual inspection with their qualified in-house team of API 653 inspectors
- TCR uses remote inspection for tanks without emptying and ensures rapid inspection using ToFD for outer wall of storage tanks. For the tank floor scanning, it uses MFL technique to detect corrosion and loss of wall thickness
- TCR works exclusively with an international partner to offer cooker drum inspection at highly competitive rates
- TCR inspection staff have been trained by Silverwing, UK for all tank floor mapping projects
- TCR uses thermography to determine level of tank liquid and pressure vessels are inspected thoroughly with Phased Array and custom probes

DIVERSE GLOBAL EXPERTISE

TCR has performed several storage tank leak tests on-site for industries that include nuclear carriers, polymer plants, oil refineries, gas and steam turbine power plants in Kuwait, Kingdom of Saudi Arabia and India.

FLEXIBLE CHOICES

TCR uses both automated as well as manual scanners including hand held scanners

ROBOTIC INSPECTION OF TANKS

One of the salient features of this technique is the elimination of the high cost of taking down your tanks. The testing can be completed as per API 653 inspection in a few days as opposed to weeks or months. It diminishes environmental hazards and is a safe process because of minimum contact with the tank

17

HELIUM LEAK TESTING

CORE CAPABILITIES

TCR performs Helium Leak Testing with an Instrument that has a roughing capacity of 10 m3/h (7 cfm) with usable helium sensitivity in the 10-11 atm cc/s range

This has a dedicated sniffing unit based on a well-proven leak testing concept, and is also available for outboard leak testing applications.

18

Magnetic Flux Leakage (MFL) & Thermography

CORE CAPABILITIES

MFL for Storage Tanks

- The MFL machine is FloormapVS2i floor scanner
- This is a computerized MFL tank bottom scanner designed to detect and size under floor corrosion for above the ground storage tanks
- The FloormapVS2i positions defects to a +/- 3mm accuracy on an 8 meter scan and uses a dual sizing procedure enabling the FloormapVS2i's sizing accuracy to be to within +/- 5% on most corrosion types

FLIR Thermography Camera

- The use of infrared cameras has already become a standard practice in many oil and gas companies. It's a proactive way to identify sources of Volatile Organic Compound (VOC) emissions & hot spots for repair leaking components before any fatal incident

19

POSITIVE MATERIAL IDENTIFICATION (PMI)

CORE CAPABILITIES

On-site Alloy Verification

- Portable X-Ray Florescence (XRF) Spectrometers
- Portable Optical Emission Spectrometer (OES)

Time and Material or fixed-cost engagements: Highly mobile and experienced team that can complete the assignment on fixed cost

12 PMI instruments that can be deployed: Team TCR has provided PMI services to over 600 projects including major oil and petrochemical installations in India, Middle-East and Malaysia

Serviced Multiple Industry Verticals: Oil and Gas companies, Petrochemicals, Metal producers, Foundries, Metal Fabricators, Scrap yards, Scrap Traders, Electric utility companies, Fossil and Nuclear power plants, Refining and petrochemical industry, Construction engineering, and the Chemical process industry

XMet 3000TX

Niton XLT

TCR ENGINEERING

PLANT SHUTDOWN MANAGEMENT

Key Highlights

- TCR has deep expertise and has built a database based on a decade of managing plant shutdown projects across 2 continents
- TCR team has developed the right recruitment skills to interview, evaluate and hire new talent, monitor & track external talent by ensuring updated resumes for rapid recruitment reference
- TCR Logistics team takes care of all off-site requirements including visa, travel tickets and safety equipment (shoes, goggles etc.). All visa and passport copies are managed to ensure full compliance with local laws
- TCR's onsite project coordinator, is well acquainted with the team needs and deftly organizes gate passes food/ SIM etc. for the new hires

ENSURES CONSISTENT WORKFLOW

TCR identifies a backup resource for each person deployed to provide immediate replacements making sure that work remains unhindered

ON-TIME PROJECT DELIVERABLES

TCR incentivizes and keeps the team motivated always to ensure all project deliverables are met on time within the fixed budget limits

LATEST CERTIFICATIONS

All team members at TCR stay updated with the latest standards and acquire the most recent certifications

CUSTOMIZED TRAINING

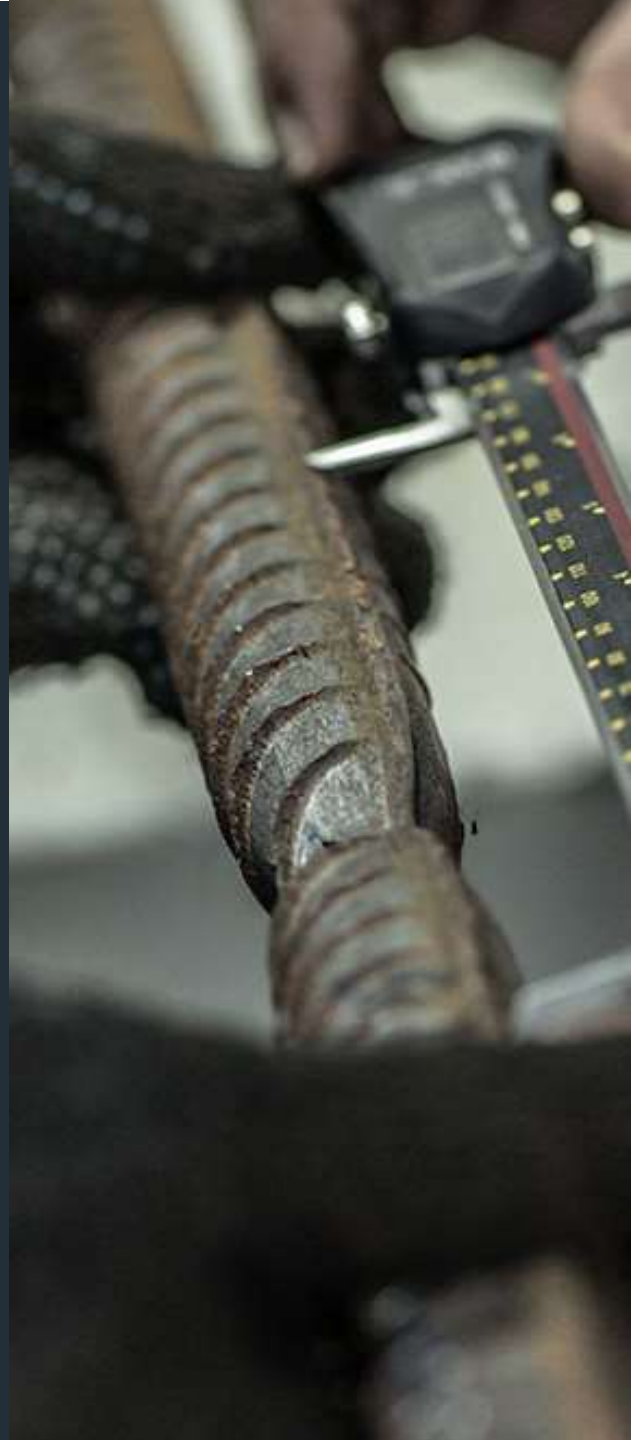
TCR teams can be custom trained in specific modules to maximize resources on a large shutdown deployment

TCR ENGINEERING

VENDOR INSPECTION & QUALITY ASSURANCE

Key Highlights

- TCR Inspectors have an average field experience of 8+ years that help them develop strong relationships with partner inspection agencies in China
- Working as "true" representatives of clients, TCR inspectors travel across India within 72 hours of receiving a notification
- TCR is one of the few companies in India that has 4 inspectors with the Saudi Aramco SAP for local inspections in India
- All sampling is done by TCR team as per ISO 2859 standards
- TCR ensures inspection cost are low by optimizing the number of visits because of its in-depth field experience



FULLY COMPLIANT

TCR has enabled environmental compliance checks as per ISO 14000 and social accountability checks especially with regards to usage of child labor as per SA 8000

REGIONAL ADAPTATION

TCR has the added advantage of understanding local laws and vendor behavior to ensure client's timelines are suitably met

SEAMLESS WORKFLOW

TCR identifies and has a backup inspector for each deployed team member onsite to ensure immediate replacements for seamless project execution

CUSTOMIZED TRAINING

TCR technicians can be trained in custom client modules to ensure alignment with inspection standards

20 THIRD PARTY INSPECTION SERVICES ACROSS INDIA

TCR ENGINEERING

CORE CAPABILITY

Independent, Third-Party Quality Assurance

- TCR provides inspection and quality assurance services to help retailers, trading partners, importers and manufacturers assess their ability to meet the contract conditions & also assist them with regulatory requirements for their specific industry vertical
- TCR assists in creating a first production prototype
- TCR facilitates improved product quality, reduction in customer complaints as well as minimization of non-compliance and other related product recalls

Inspectors can travel across India

- Defined Operations Procedure

Testing Co-ordination

- Samples picked by the inspection team are sent to TCR's Material Testing Lab for evaluation

- FACTORY AUDIT
- RAW MATERIAL INSPECTION
- SAMPLE PICK-UP FOR TESTING
- INITIAL PRODUCTION CHECK
- IN-PRODUCTION CHECK
- RANDOM INSPECTION
- LOADING SUPERVISION
- LOGISTICS MANAGEMENT

21 SCOPE OF INSPECTION SERVICE

TCR ENGINEERING

CORE CAPABILITY

- Review of suppliers internal records, test certificates for identified stages in the approved quality plan or material procurement for verifying conformance of requirements of the equipment's / systems as per Purchase Orders, agreed Technical Specifications / approved drawings / data sheets, approved Quality Plan and other documents available with the contractor
- Carry out stage wise and final inspection as per agreed documents. Inspection could be done by TCR alone or in conjunction with the customer's representatives
- Verification of calibration status of all the inspections, test and measuring instruments used by vendor/supplier for inspection
- Preparation and submission of Inspection Reports in the prescribed format along with the necessary supporting documents such as stage Inspection Reports / Test Certificates, etc. as per approved technical documentation and approved quality plans
- Identify any deviations to requirements and indicate to the supplier the proposed corrective actions.
- The Inspection reports along with all other requisite supporting documents such as stage Inspection reports / Test certificates, etc. are sent to the Client immediately

TCR ENGINEERING

PRODUCT SOURCING

Key Highlights

- TCR has extensive experience in dealing with over 3000 customers in the testing space, which ensures collaboration with leading players in the industry for sourcing of materials. TCR conducts detailed reference checks for all companies from which materials have been sourced
- TCR has in-depth domain expertise in steel, valve, castings and forgings, which gives it a distinct ability to test sourced materials and make sure it meets all standards
- TCR has the ability to locate the right material for oil and gas that adheres to NACE HIC and SSCC compliance tests
- TCR has exclusive partners in China and Malaysia to provide clients an integrated experience with end-to-end sourcing assistance

PROACTIVE SCREENING FOR SUGGESTION

TCR monitors and tracks each company that produces outstanding goods including their management details, production capacity and financial situation

LEVERAGING TCR LEGACY

By leveraging its many years of expertise, TCR offers end-to-end sourcing solutions. It covers the entire sourcing process, right from finding the suppliers to transferring design specifications. TCR also helps in setting-up the right supply chain, control logistics and ensures that the shipment meets all export guidelines.

OPTIMUM COSTING

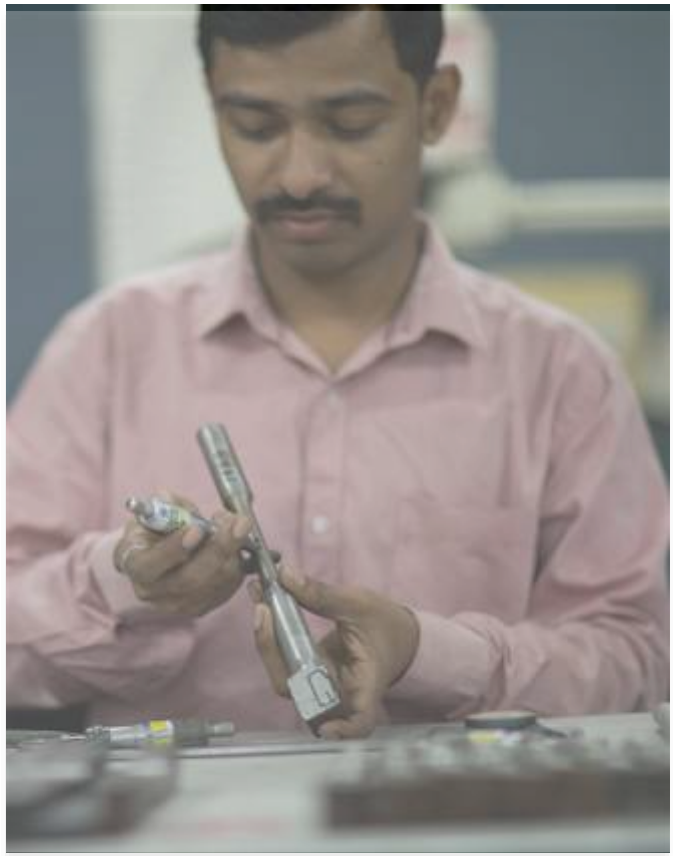
Sourcing projects are quoted on a percentage of order value with weekly reporting of sourcing progress

22 PRODUCT AND MATERIAL SOURCING

LEVERAGING RELATIONSHIPS WITH CUSTOMERS AT THE LAB

Defined Sourcing Guidelines:

- TCR initially seeks details on product type, drawing, material specifications, required amount and quality with target delivery date
- TCR visits the marketplace, contacts manufacturers, traders and steel producers, to establish production capability, availability, quality and unit price
- TCR assists in providing a FOB product price quote. It directly negotiates with the supplier and provides a competitive bid
- TCR on gaining acceptance on price and quality parameters from the client, instructs the manufacturer to produce an appropriate sample prototype for approval. This prototype is shipped to the client for approval
- TCR on receiving approved samples, places the product order with all manufacturing suppliers. It manages the logistics along with payment and shipping verification



TCR ENGINEERING

ENGINEERING CONSULTING & ADVISORY

Key Highlights

- With over 25 years of plant management experience, TCR has developed unique techniques that ensures proactive action for optimum plant health
- TCR has helped several national and global clients in increasing plant run-time with minimum disruptions and unnecessary shutdowns with its effective & result-oriented shutdown/turnaround planning
- TCR provides total sustainable asset reliability for Static and Rotating equipment
- TCR provides litigation support including assistance for/against insurance claims
- TCR has an in-depth understanding of corrosion damage mechanisms at play

GLOBAL EXPOSURE TO BEST-PRACTICES

TCR's teams have global exposure and are abreast with the latest and innovative advancements and uses the gained knowledge for client benefit

EXTENDED VALUE ADDITION

TCR has the capability to advise on selection of the right NDT and Destructive testing technique to evaluate flaws/defects for their clients

COMPREHENSIVE PERSPECTIVE

TCR's in-depth engineering consulting services ensure that clients produce the best possible product right from the initial product design to the final production.

INDUSTRY-LEADING CREDIBILITY

TCR has presented several papers at International seminars and conferences and is known for its thought leadership

23

ENGINEERING CONSULTING

LEVERAGING RELATIONSHIPS WITH CUSTOMERS AT THE LAB

TCR helps its clients resolve their challenges in the following areas:

- Metallurgical Engineering
- Corrosion Engineering
- Welding Engineering
- Castings and Forgings
- Reverse Engineering, 2D to 3D
- Mechanical Engineering
- Heat Treatment
- Forming and Casting
- Materials Selection
- Training Seminars and Workshops

24 FAILURE AND ROOT CAUSE ANALYSIS

TCR ENGINEERING

CORE CAPABILITIES

TCR's strong expertise helps clients decipher the problems surrounding parts and assembly failures and they undertake a wide range of inspections:

- Residue Analysis
- Corrosion Analyses/Studies
- On-Site Investigations
- Material Selection
- Manufacturing Processes Evaluation
- Welding Studies
- Product Design Evaluation
- Fractography

Fast Turnaround time with in-depth analysis reporting: The detailed and strong recommendations within each report are designed to avoid future failures

FAILURE CASE EXAMPLES

- Mandrel Bypass Of Equalizer Sub.
- Crank Shaft
- Cupro Nickel Tubing Of Chiller Unit
- Shaft Failures In Vertical Pumps (Cantilever)
- Volute Casing, Crane Hook / Pump
- Die Cracking In Swaging Process on 500t Press
- ESV Sleeve DN 200
- Api 5L Line Pipe Failed During Hydro Test
- Mechanical Expander Pull Rod
- Blade Of LP Rotor Stage 4A Of ESM 110MW
- Duplex Tube Failed During Hydro-Forming Expansion
- Corrosion Evaluation Of Oil Well Tubing
- Axel of a Rear Suspension of Car
- Exhaust Muffler KTPA
- Reformer Tubes
- High Density Balancing Weight
- Radiant Heater Outlet Header Cap
- Crank Shaft Of Diesel Car Engine.
- Notching Spring Of Tap Changer
- Coriolis mass flow meter sensor
- Re-Boiler of HF Recovery Plant
- Bending and seizing problem of engine valve

25

RISK BASED INSPECTION AND FFS

CORE CAPABILITIES

TCR undertakes Fitness For Service (FFS) Assessment based on Level 2 BS 7910 standards and API 579.

- TCR's fracture mechanics methodology and its application have been successfully proven worldwide across industries, including nuclear pressure vessels high consequence items in exploration, refining, petrochemical and construction industry.

BENEFITS OF FFS

- Increased safety and equipment reliability
- Fewer planned shutdowns and unplanned shutdowns
- Longer inspection intervals
- Potentially lower inspection and maintenance costs
- Evaluation of effectiveness of inspection activities
- Increased consistency of inspection planning
- Identification of potential damage mechanisms
- Identification of key process parameters affecting degradation rates
- Assessment of proposed process changes that could impact degradation rates
- Documentation of current plant configuration and materials of construction
- Improved team working and communication between all departments

PP SIMTECH ENGINEERING ADVANTAGE

RBI AssuranceSystem™

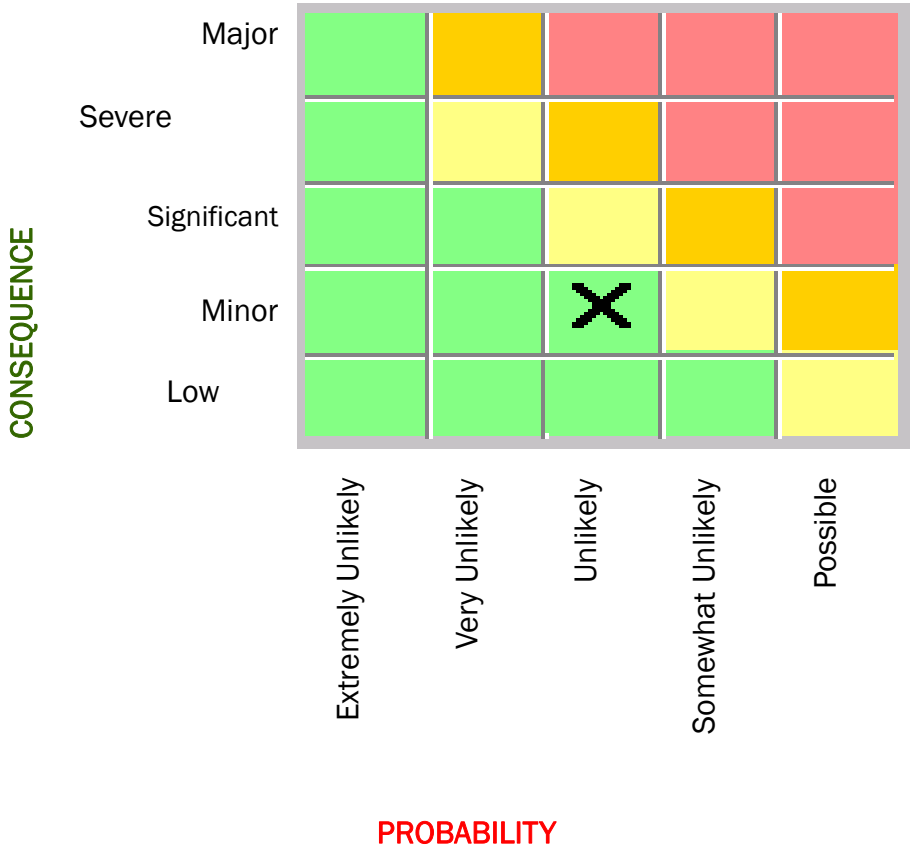
26 EVALUATING RISK CAUSED BY DM TO EACH ITEM

RISK MATRIX CREATED FOR EACH ITEM

- Displays the risk profile for each of the identified damage mechanisms applicable to an item
- Over 60 DAMAGE MECHANISMS applied to pressure vessels, piping & storage tanks

The inspection date for each of the damage mechanisms is then calculated so that the risk position is within the acceptable area of the risk matrix: This results in reliably optimized inspection intervals for each item

Study of Damage Mechanisms: Internal corrosion (general, grooving, pitting, crevice, under deposit, galvanic, biological), External corrosion (general, localized, CUI), Erosion & Erosion Corrosion, Stress Corrosion Cracking (Cl, NH3, caustic, CO/CO2, amine, methanol), High Temperature Creep, Fatigue (thermal, mechanical, pressure, vibration), H2S induced corrosion or cracking, Metal Dusting, H2 damage / cracking



27 WELDER CERTIFICATIONS AND WPQR

TCR ENGINEERING

CORE CAPABILITY

Complete Services conducted by AWS/CSWIP Inspector

- Welder qualification testing for performance and certification of welders for ASME, ANSI, AWS, API code
- Preparation of Weld Procedure Qualification as per project requirements
- Coupon Testing as per Weld Procedure Qualification: It includes visual examination, mechanical testing, metallographic examination and non destructive testing
- Documentation of the Procedure Qualification Record as per ASME, ANSI, AWS, API codes

In depth weld inspection will also include review of the applicable qualification

- Weld procedure specification, welder performance qualification and validity for process materials and consumable items, equipment, set up and other factors, including certificates of calibration and/or conformity governing the work.
- Check safety of set up and operation with respect to self, welder and other workers in the vicinity, especially for ultraviolet radiation from arc during welding

TCR ENGINEERING

RESEARCH & DEVELOPMENT

Key Highlights

- TCR's R&D team comprises of leading experts that include PhD's, professors, industry veterans and senior metallurgists, who are dedicated towards innovation and research on new materials and developing cutting edge material testing technology
- TCR undertakes highly cost-effective and time bound contract research projects for both, short-term as well as the long term
- TCR also works with an external board of consultants and professionals when conducting research for new ideas. The research undertaken is done under strict confidentiality

CUSTOMIZED TOOLS & PROBES

In addition to developing Innovative research, TCR R&D team has worked on several projects with clients where custom NDT tools and probes were developed and implemented to meet the project needs

END RESULT COMPLIANCE

TCR has the ability to truly understand project objectives and suggest appropriate test methods. It provides end-to-end plant operations support, which gives clients an added advantage

INDUSTRY-WIDE THOUGHT LEADERSHIP

TCR's 4 decades of thought leadership is highly sought after and the knowledge is expressed frequently via whitepapers, presentations and seminars

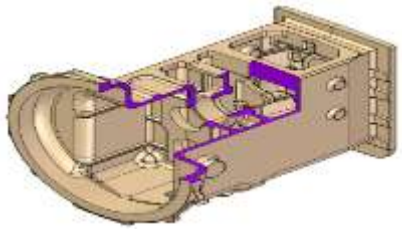
28

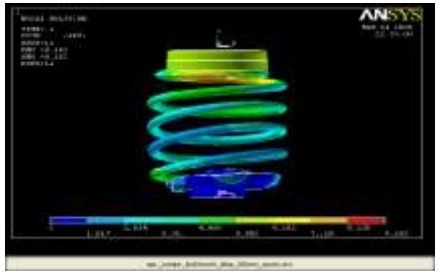
ENGINEERING DESIGN & ANALYSIS SERVICES

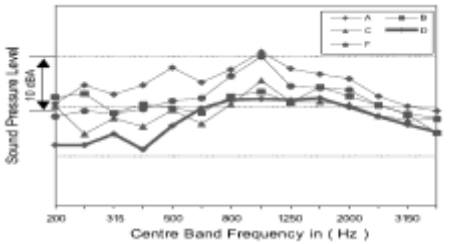
TCR ENGINEERING

CORE CAPABILITIES

- Computer Aided Designing (CAD/CAM): 2D to 3D Conversions, Solid Modeling, Surfacing for automotive, machinery and construction industries, Legacy Data Conversion for Material Handling Equipment
- Computer Aided Engineering (CAE): Finite Element Modeling using Ansys, FE stress analysis undertaken for cylinder block, cylinder head, connecting rod crankshaft & crankcase, shock absorber structure including outer tube, spring seat, knuckle etc.
- Structural Analysis & Piping Stress Analysis
- Noise, Vibration, Harshness (NVH) analysis
- Leading Software used: CATIA, Pro/ENGINEER, UniGraphics, I-DEAS, Inventor, SolidWorks, DELCAM, Ansys, LS Dyna, HyperMesh, NX Nastran, Moldflow







i-ziel
inspire . engineer . achieve
A TCR Service Partner Company

For more information, visit
www.tcreng.com

TCR EVOLVE

INSTITUTE FOR MATERIALS SCIENCE

CORE CAPABILITIES

- TCR Evolve provides training to students in material sciences with the knowledge it has gained over the last 45 years: Training facility is equipped with advanced technologies and employs the latest pedagogy approaches
- Training style is highly effective: Trainers are industry experts in technical education with vast experience in material science
- “Coaching" approach to training: Training imparted is hands-on with practical examples to promote enhanced learning
- Custom Training Available: Customizable “On-Site” classes can be conducted all over the world with minimum 4 students and a max of 10 students per class
- ASNT Level I and II Courses: Introduction to Metallography, Eddy Current Testing, Magnetic particle Testing, Liquid Penetrant Testing, Radiography, Ultrasonic Testing, Leak Testing, ToFD, Phased Array, Welder Certifications

30

MANPOWER RECRUITMENT

CORE CAPABILITIES

- Highly Experienced Professionals: TCR can provide qualified professionals in design, fabrication, construction, inspection and erection of Pressure Vessels, Heat Exchangers, Towers, Stacks, Tanks, Plant Pressure Piping, Offshore oil wells and many other such advanced projects
- Certified & Experienced Professionals: TCR can help recruit ASNT Level III personnel with of 7-15 years and ASNT Level II personnel with 5-10 years
- Fast Mobilization and Deployment: TCR can quickly deploy ASNT Level II and III (MP, UT, RT, LP, VT), AWS/CSWIP Senior Welding Inspector, API 510 and 570 Certified Inspectors, CSWIP Plant Inspector Level I (PL 11, PL 12), Welding Inspector, Electrical Inspectors, Paint Inspectors, TKY Inspectors with UT Level II, Welders with 6G experience
- TCR teams can work on projects all across the globe

3 THREE

OUR CREDENTIALS

- Appreciation Letters
- Marquee Projects
- Core Machinery & Equipment
- Next Steps
- Contact Coordinates

TCR ENGINEERING

AWARDS & RECOGNITION

RECOGNITION for TCR

NACE International, India chapter selected TCR Engineering Services as a recipient for the prestigious NIIS Award for "Excellent Laboratory." NACE has commended TCR on its contribution and achievements in the material science world

NACE INDIA SECTION

305-A, Galleria, Hiranandani Gardens, Powai, Mumbai – 400076.

NACE International India Section

Presents

CORROSION AWARENESS AWARD - 2007

(Sponsored by NIIS)

To

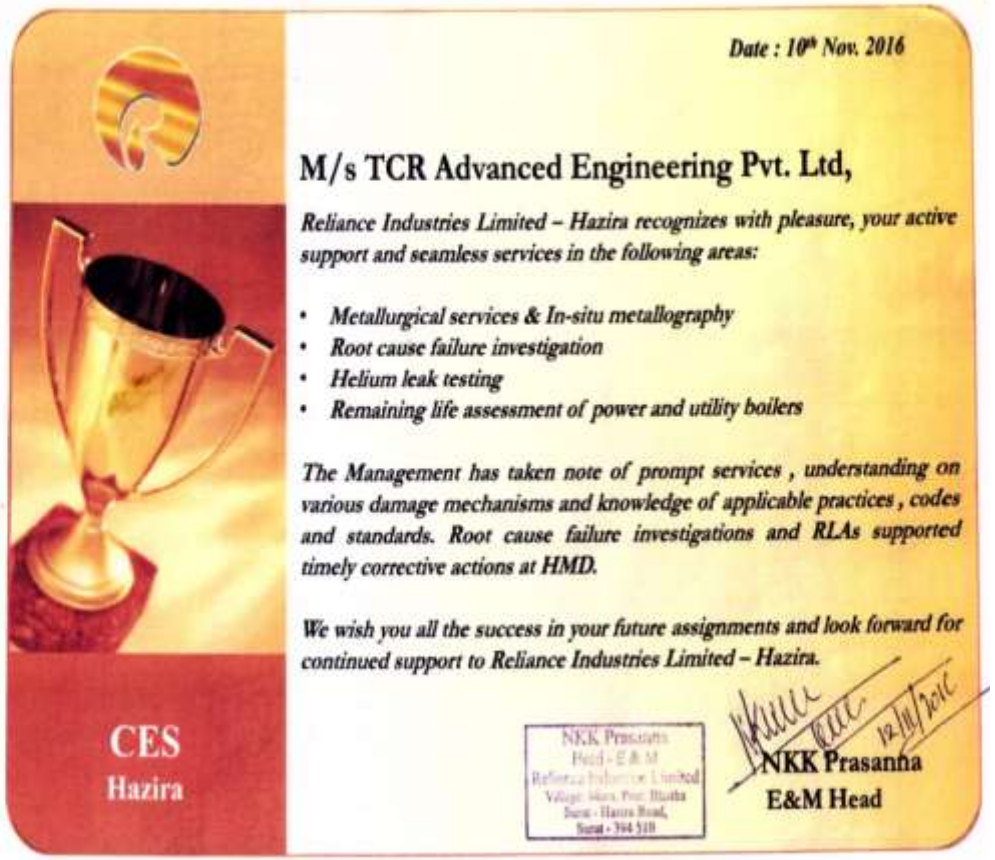
TCR Engineering Services Pvt. Ltd.

Award for excellent Laboratories in Private Sector

In recognition of their contributions in the field of Corrosion Sciences

Dr. Baldev Raj
Chairman Awards Committee

A M Uplenchwar
Chairman India Section



Date : 10th Nov. 2016

M/s TCR Advanced Engineering Pvt. Ltd,

Reliance Industries Limited – Hazira recognizes with pleasure, your active support and seamless services in the following areas:

- *Metallurgical services & In-situ metallography*
- *Root cause failure investigation*
- *Helium leak testing*
- *Remaining life assessment of power and utility boilers*

The Management has taken note of prompt services , understanding on various damage mechanisms and knowledge of applicable practices , codes and standards. Root cause failure investigations and RLAs supported timely corrective actions at HMD.

We wish you all the success in your future assignments and look forward for continued support to Reliance Industries Limited – Hazira.

CES
Hazira

NKK Prasanna
E&M Head

RELIANCE INDUSTRIES- HAZIRA for
Insitu Metallography, failure analysis,
Helium Leak Test and remaining life assessment

APPRECIATION LETTERS (1/5)

MBH®
ANALYTICAL LTD

HOLLAND HOUSE • QUEENS ROAD • BARNET • EN5 4DJ • ENGLAND • TEL: 44 (0)20 8441 2024 • FAX: 44 (0)20 8449 0810
E-mail: info@mbh.co.uk Website http://www.mbh.co.uk

TCR Engineering Services Ltd
35 Pragati Ind Est
N M Joshi Marg
Mumbai 400 011

Attn V K Bafna

11th February 2010

Dear Mr Bafna

Customer Feedback

This letter is to confirm my complete satisfaction with the service and product quality I am receiving from the laboratory at TCR Engineering Services.

As you know, your results for all my samples are compared with those from ~12 other laboratories, mostly with 17025 accreditation, from countries including India, UK, USA and China.

In all the time we have been doing business, I have found your communication and product delivery to be as required, and the quality of your results can be compared favourably with the other commercial and industry laboratories. I am delighted with our relationship, and trust we can continue with the same arrangement in the future.

Yours sincerely

Chris Eveleigh, PhD
Technical Director

NIR ISO9001

MBH Analytical for Chemical Analysis Testing Services

GE Energy

Sabiya CCGT Project Kuwait

Date: 26-June-2012

TO WHOMSOEVER IT MAY CONCERN

General Electric appreciates **TCR Engineering Services**, for their efforts, technical expertise and time spend on the On Line Helium Leak Inspection of Steam Turbine Condenser unit #20 (2701K23) to identify the Air Ingress Points in the Condenser Negative Pressure Parts at SUBIYA CCGT site, Kuwait.

Sabiya Power Project is 2000 MW combined cycle plant comprised of 06 GE 9FA Gas Turbines-Generators, 06 Heat Recovery Steam Generators (HRSG) and 03 Steam Turbines-Generators. General Electric & HHI are the main contractors and consortium partners.

The Management & Technical Team at site appreciate the valuable & prompt services provided by your technical team at site. We also expect the same from your company for our future projects.

Abdul Hannan
QA/QC Manager
General Electric
Sabiya Power Project
Kuwait

GENERAL ELECTRIC (GE) for NDT Services

LARSEN & TOUBRO LIMITED
HYDROCARBON MID & DOWNSTREAM
Ground Floor, West Block, L&T Knowledge City, SEZ (STATES)
Ajwa-Waghodia Crossing, R.H. No. 8, BARODA-390 019. India. Tel : +91-265-2410000

Date: 19 May 2010

TO WHOM SOEVER CONCERNED

Larsen & Toubro Limited, in consortium with Toyo Engineering Corporation Japan is executing the Naphtha Cracker Project (PNCP EPCC-1) on LSTK basis for Indian Oil Corporation Limited at their Panipat Refinery at Haryana.

Larsen & Toubro Limited have awarded the contract for PMI Test to M/s. TCR ENGINEERING SERVICES PVT. LTD., Navi Mumbai, Maharashtra vide P.O. Ref No. PETROCHEMICALS/44000-01449/CP dated 09/04/2009.

M/s. TCR ENGINEERING SERVICES PVT. LTD., have successfully completed the awarded job as per issued PO terms and conditions in time, fulfilling all the safety and technical requirements associated with the PMI Test job. Their approach to the project was very systematic and professional and their planning was meticulous.

They have got skilled and efficient manpower for such type of jobs and are equipped with all the required accessories equipment tools and tackles.

We wish them all the best in their future assignments.

This certificate is being issued as per their request.

Very Truly Yours,
For LARSEN & TOUBRO LIMITED
Vijaykumar Arun –Project Manager

L&T for Panipat Refinery Project of Indian Oil Corp

Reliance Industries Limited

Village Motikhavdi, P.O. Digvijaygram, Jamnagar - 361 140.

TO WHOMSOEVER IT MAY CONCERN

TCR Advanced Engineering Baroda, was awarded the job of carrying out metallograhic analysis by in-situ metallography technique of piping and piping components affected by fire in Oct 2006. M/s TCR deployed a team of engineers and technicians for taking replica's of components by in-situ metallographic technique. M/s TCR had mobilised the state of art of metallurgical microscope at site for immediate viewing of the microstructure and interpretation. The microscope had all the facilities for converting the replicas into computerised images for evaluation by experts in other parts of the world. A total of about 1200 replicas were taken in a period of about 15 days, working round the clock, which is considered a remarkable feat.

The knowledge of the crew deployed at site, the quality of the replica's and the zeal and enthusiasm with which the crew completed the work is commendable and highly satisfactory.

We wish TCR Advanced, all the very best in future assignments.

(U Anand)
Asst Vice President
Corrosion & Inspection dept.
Reliance Industries Limited
Refinery Division

MEMBER

RELIANCE Industries for Metallography

APPRECIATION LETTERS (2/5)

GODREJ INDUSTRIES LTD.

GIL/BKG/29/9/07 September 29, 2007

To Whom It May Concern

Letter of Appreciation

We had a bend failure in our hydrogen line in 2006 and we contacted TCR Advanced Engineering Pvt. Ltd., Vadodara to conduct an in- depth root cause failure analysis. The work carried out by the dedicated team of TCR helped us take necessary corrective actions for the second hand plant of 'Hydrogen Generation' procured from England. The entire plant was thoroughly assessed by NDT and metallography with Health Assessment approach by TCR. The components included Reformer section, Pigtails, SS pipelines /Carbon steel/Alloy steel pipe lines Heat exchangers etc. TCR's assessment approach is scientific by knowledge of anticipated degradation mechanism of different components with organized team work by trained and qualified man power.

TCR also provided services on Remaining life Assessment of aged components by distractive analysis. We have got benefited by the getting Repair Weld Procedures of aged Incoloy 800H header joints by TCR.

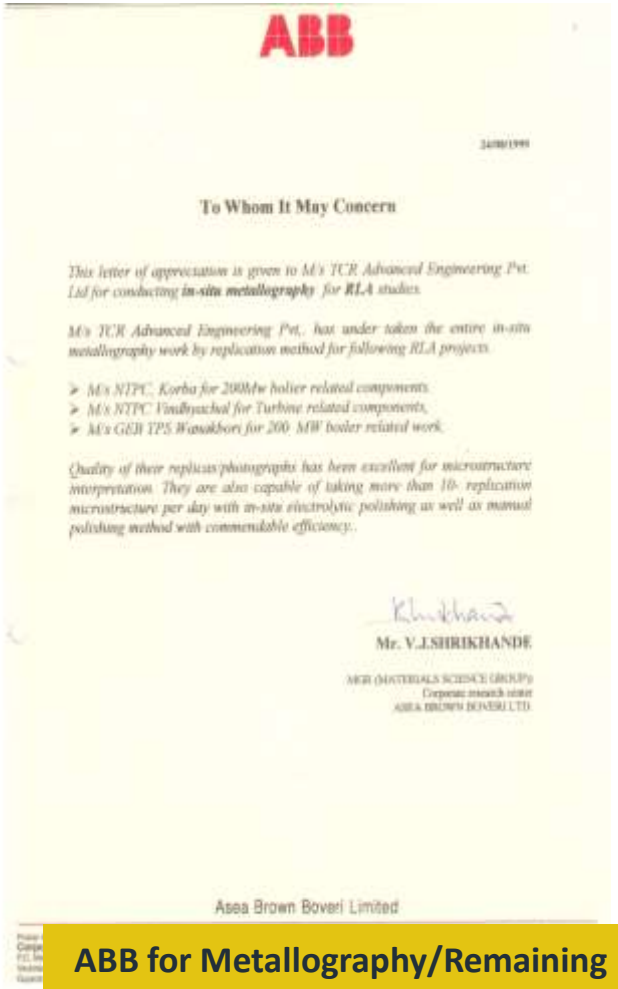
We appreciate the enthusiasm and dedication of TCR Team members towards accepting such challenging assignments and provided us satisfactory services.

For Godrej Industries Ltd-Valia

B K Gupta

Vice President- Engineering & Projects

GODREJ INDUSTRIES for Failure Analysis Project



ABB

24/08/1999

To Whom It May Concern

This letter of appreciation is given to M/s TCR Advanced Engineering Pvt. Ltd for conducting ***in-situ metallography*** *for* ***RLA*** *studies.*

M/s TCR Advanced Engineering Pvt. has under taken the entire in-situ metallography work by replication method for following RLA projects.

- *M/s NTPC, Korba for 200Mw boiler related components.*
- *M/s NTPC Vindhyachal for Turbine related components,*
- *M/s GEB TPS Wanakbori for 200 MW boiler related work.*

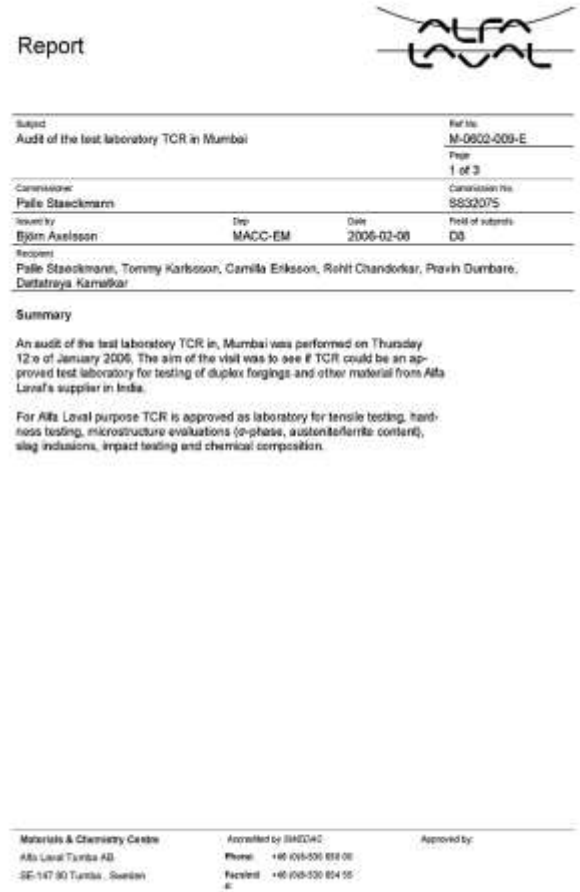
Quality of their replicas/photographs has been excellent for microstructure interpretation. They are also capable of taking more than 10- replication microstructure per day with in-situ electrolytic polishing as well as manual polishing method with commendable efficiency.

Mr. V.J.SHRIKHANDE

MGR (MATERIALS SCIENCE GROUP)
Corporate research center
ASEA BROWN BOVERI LTD

Asea Brown Boveri Limited

ABB for Metallography/Remaining Life Assessment Studies



Report

ALFA LAVAL

Subject: Audit of the test laboratory TCR in Mumbai			Ref No: M-0602-009-E
			Page: 1 of 3
Commissioner: Palle Staeckmann			Commission No: 8832075
Issued by: Björn Axelsson	Dep: MACC-EM	Date: 2006-02-08	Field of subjects: D8

Recipient: Palle Staeckmann, Tommy Karlsson, Camilla Eriksson, Rohit Chandorkar, Pravin Dumbare, Dattatraya Karnatkar

Summary

An audit of the test laboratory TCR in, Mumbai was performed on Thursday 12:e of January 2006. The aim of the visit was to see if TCR could be an approved test laboratory for testing of duplex forgings and other material from Alfa Laval's supplier in India.

For Alfa Laval purpose TCR is approved as laboratory for tensile testing, hardness testing, microstructure evaluations (σ-phase, austenite/ferrite content), slag inclusions, impact testing and chemical composition.

Materials & Chemistry Centre
Alfa Laval Tumba AB
SE-147 80 Tumba , Sweden

Accredited by SWEDAC
Phone: +46 (0)8-530 650 00
Facsimil: +46 (0)8-530 654 55

Approved by:

ALFA LAVAL's Preferred Test Lab in India

بترو رابغ
Petro Rabigh

شركة رابغ للتكرير والبتروكيماويات
Rabigh Refining & Petrochemicals Co.

28 July 2007

Mr. Rohit Bafna
Director - Global Sales
TCR Engineering Services

Mr. Bafna,

PetroRabigh Logistics & Interface Division– Directorate Quality Team would like to thank TCR for its presentation/demonstration on the 24th June, 2007 at our facilities. We believe that the presentation/ demonstration provided an excellent forum for the attendees as it provided both the theoretical background and principles behind ToFD as well as the excellent functional demonstration of your equipment and technique.

The team's NDT Level III was particularly impressed with your equipment's ability to discern the additional features he had designed into the material sample on which you performed your demonstration and has commented that he believes the technology could provide a great level of support to our contractors on the project.

We sincerely hope you and your firm is chosen to work on this project and we look forward to working with you.

Thanks and Kind Regards,

Carl Ash
Quality Assurance Engineer
PetroRabigh
Directorate Building #3, Office #7
P.O. Box 666, Rabigh 21911
Kingdom of Saudi Arabia

www.petrorabigh.com

PETRO RABIGH for Advanced NDT and ToFD

APPRECIATION LETTERS (3/5)

WORK COMPLETION CERTIFICATE

1. Refer to ASD(MB) letter DYT/PLS/05-06/SYS/DELHI/252 dated 02 Feb 06 regarding NDT test on the weld joint of firemain system and cooling water systems by M/S TCR Engineering Services Pvt Ltd, 35, Pragati Industrial Estate, Ground Floor, Nitl Joshi Marg, Mumbai-400 011.

2. It is certified that the above mentioned work has been completed satisfactory as per schedule.

INSPECTION DEPARTMENT
PANIPAT REFINERY

PR/IP/108/2007 DATE: 01.08.2007

SUB : JOB COMPLETION CERTIFICATE.

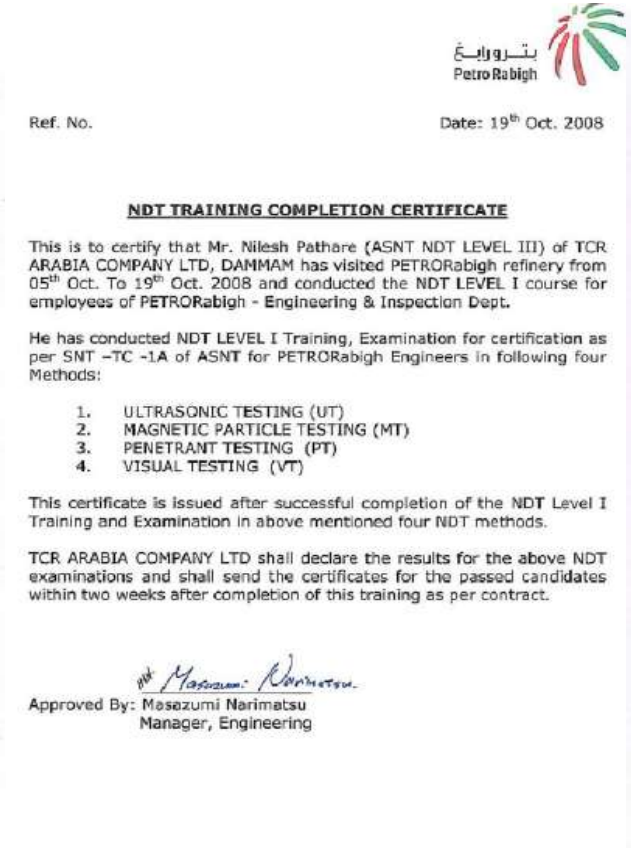
To Whom It May Concern:

This is to certify that M/S TCR Engineering Services Pvt. Ltd. Has done PMI job in AVU-I of Panipat Refinery during June -2006 shutdown against Work Order No. 17350903. The job done was up to our satisfaction.

With Best Regards,

Churaman
Sr. Inspection Manager,
Panipat Refinery,
Panipat-132140.

Ph : 01802522586 ,
E-Mail : churaman@iocl.co.in
Fax:0180-2578713



Petro Rabigh

Ref. No. Date: 19th Oct. 2008

NDT TRAINING COMPLETION CERTIFICATE

This is to certify that Mr. Nilesh Pathare (ASNT NDT LEVEL III) of TCR ARABIA COMPANY LTD, DAMMAM has visited PETRORabigh refinery from 05th Oct. To 19th Oct. 2008 and conducted the NDT LEVEL I course for employees of PETRORabigh - Engineering & Inspection Dept.

He has conducted NDT LEVEL I Training, Examination for certification as per SNT –TC -1A of ASNT for PETRORabigh Engineers in following four Methods:

1. ULTRASONIC TESTING (UT)
2. MAGNETIC PARTICLE TESTING (MT)
3. PENETRANT TESTING (PT)
4. VISUAL TESTING (VT)

This certificate is issued after successful completion of the NDT Level I Training and Examination in above mentioned four NDT methods.

TCR ARABIA COMPANY LTD shall declare the results for the above NDT examinations and shall send the certificates for the passed candidates within two weeks after completion of this training as per contract.

Approved By: Masazumi Narimatsu
Manager, Engineering

TATA

27th July, 2015

To,
Mr. Arjun Sail
General Manager
TCR Engineering Services Pvt. Ltd
Bhapa, Mumbai

Subject: Metallurgical Services

The quality of services provided by your laboratory in various Metallurgical tests and Failure analysis is appreciable. In the last two years we have been doing business, we have found your services, prompt response to queries and interactions satisfactory and we are hopeful that the same would continue in future.

Rohit Shukla
Lead Engineer (Metallurgy) - Asset Management
Core Technology and Diagnostics

TATA POWER

INDIAN NAVY (INS) for Conventional NDT Services

INDIAN OIL (IOC) for Positive Material Identification (PMI)

PETRO RABIGH for NDT Training & Certification

TATA POWER for Metallurgical Tests & Failure Analysis

APPRECIATION LETTERS (4/5)

Virgo Valves & Controls Limited

VIRGO

Work Completion Certificate

Name of Work	: PMI Test at our Pune Plant
Name of the Party	: TCR Engineering Services Pvt. Ltd.
	EL-182, TTC Industrial Area, MIDC
	Mhape, Navi Mumbai 400 710
Period of Work	: 2007 to till date
Total Value	: Approximate Rs. 15 Lakhs per year

We herewith certified that M/s. TCR Engineering Services Pvt. Ltd. is providing their PMI service on monthly basis and executing their work satisfactorily.

For Virgo Valves & Controls Ltd.,

Authorized Signatory

Virgo Valves for On-going PMI Inspection

شركة الطوخي للصناعة والتجارة والمقاولات
Al-Toukhi Company for Industry, Trading & Contracting

الطوخي Al Toukhi

To,
Mr. Faisal K. Al-Dabal,
TCR Arabia,
Dammam, KSA.

Date : 1st July, 2009

Subject : Appreciation Letter

Reference : Post Weld Heat Treatment Services – PP8 Project

Dear Sir,

This is to express our deep appreciation for the Post Weld Heat Treatment Services offered by TCR Arabia in our PP8 Project in Riyadh.

The dedication and commitment shown by TCR Arabia to meet our targeted completion date by delegating a professional team of operators played a major role in the success of our PP8 Project. We certainly look forward to work with TCR Arabia in our future projects.

Best regards,

Engr Marwan Khader
Project Manager

www.altoukhi.com E-mail : info@altoukhi.com

AL TOUKHI for Heat Treatment Services

شركة هيونداي للصناعات الثقيلة المحدودة

HYUNDAI HEAVY INDUSTRIES CO. LTD.

To,
TCR Arabia Company Limited,
Dammam, KSA

Date: 15th April, 2010

Appreciation Letter

Attention : Mr. Syed Ameen Hassan, Country Manager

We take this opportunity to thank TCR Arabia for rendering their NDT Services in our project in Jubail IWPP more specifically the Eddy Current Testing Services required on the Steam Deaerating Condenser Tubes which was called on emergency basis.

Quality of Services, response to our queries, professional approach and the experience of TCR's manpower deserves great appreciation.

We certainly look forward to avail your services in our other projects.

Best Wishes,

Y.D. Kim
Mechanical Manager
Marafiq IWPP Site

HYUNDAI for Eddy Current Testing Services

NAVAL DOCKYARD, MUMBAI

REGISTRATION CERTIFICATE

This is to certify that M/s TCR Engineering Services Pvt. Ltd., 35, Pragati Industrial Estate, Ground Floor, N.M.Joshi Marg, Mumbai – 400 011, after verification of their capacity/ capability, is registered with Naval Dockyard, Mumbai as approved Class-'E' (upto 25 Lakhs) vendor vide Registration No. Z-1045-H for the following items/ services :-

Items/Services	Registered As
(i) Survey of Hull and metal structures of ship & submarines which includes (a) Visual Inspection (b) Ultrasonic thickness / Flaw detection (c) Radiography by Gamma ray / X-ray (d) Magnetic particle testing (e) Liquid penetrant testing (f) Positive material identification (PMI) (g) Arc-met (h) In situ metallographic testing	Service Provider
(ii) Non Destructive tests which includes: (a) Radiography Testing (Gamma ray / X-ray) (b) Ultrasonic Testing (c) Magnetic particle Testing (Fluorescent & Non Fluorescent) (d) Liquid penetrate Testing (Fluorescent & Visible)	

2. This Registration Certificate is valid up to 31 Jan 2019 and is issued subject to conditions indicated overleaf.

File: DYT/QAA/0060/REG/1045

Date: 28 Jan 10

(Debesh Lahiri)
Commodore
Addl. General Manager (QA)
for Admiral Superintendent
Naval Dockyard, Mumbai

NAVAL DOCKYARD for NDT & Inspection Services

APPRECIATION LETTERS (5/5)

EMERSON
Process Management

Virgo Valves & Controls Private Limited

23rd July 2015.

SUBJECT: SPECIAL APPRECIATION TO M/S TCR ENGINEERING SERVICES PVT. LTD.

This letter is to confirm our complete satisfaction with the various testing services and product quality we are receiving from the laboratory at TCR Engineering Services Pvt. Ltd.

In all the time we have been doing business, we have found your communication and product delivery to be as required and the quality of your results can be compared favourably with the other commercial & industry laboratories.

We are delighted with our relationship and trust. We can continue with the same arrangement in the future.

Thanking You,

Authorised Signature

VIRGO

MTAR

SPECIAL APPRECIATION TO TCR ENGINEERING SERVICES PVT. LTD.

AUTHORISED SIGNATORY

VENDOR APPRECIATION LETTER

This letter is to confirm our complete satisfaction with the various testing services and product quality we are receiving from the laboratory at TCR Engineering Services Pvt. Ltd.

In all the time we have been doing business, we have found your communication and product delivery to be as required and the quality of your results can be compared favourably with the other commercial & industry laboratories.

We are delighted with our relationship and trust we can continue with the same arrangement in the future.

Lobhesh Goodane
Sr. Manager
Quality Assurance
Godrej Precision Engineering

Precision Engineering Systems

وزارة الكهرباء والماء

محطة الدوحة الشرقية لتوليد القوى الكهربائية وتقطير المياه

DOHA EAST POWER GENERATION AND WATER DESALINATION PLANT

EMERSON for Laboratory Testing Services	MTAR TECHNOLOGIES for Various Testing Services	GODREJ PRECISION ENG for Testing & Quality Assurance Services	DOHA MINISTRY OF WATER For Metallography, UT, NDT & RLA

APPRECIATION LETTERS (5/5)

emc

Standardkessel Baumgarte

Standardkessel Baumgarte Service GmbH
Duisburger Strasse 375
DE-46046 Oberhausen

LETTER OF APPRECIATION

Standardkessel Baumgarte Sercive, GmbH appreciates **TCR Engineering Services**, for their Services, efforts, technical expertise and time spend on the **Metallography, WFMPI, UT and general NDT** job to assess **Remaining life assessment and integrity of Main steam, Super Heater and Desalination pipe lines of Boilers units 1 to 7 at MEW, Doha East Power Station site (MEW-DEPS), Kuwait.**

Doha East Power Station has 7 power generating units. Four of them have the Steam generating units supplied by M/s. Fives Cail Babcock, France and the remaining three are supplied by M/s. IHI, Japan. The units are designed to generate 650 tons of steam / hour.

Their interpretation skills have helped us to the Remaining life and integrity of the pipelines and its components by quantifying the extent of damage. The Management & Technical Team at site appreciate the valuable and prompt services provided by their technical team at site. We also expect the same of TCR Engineering Services for our future projects.

Standardkessel Baumgarte
Service GmbH
Site Office - DEPS-KWT

GERHARD BRECHNER
PROJECT MANAGER
EMC/STANDARDKESSEL BAUMGARTE SERVICE, GmbH

وزارة الكهرباء والماء
محطة الدوحة الشرقية لتوليد القوى الكهربائية وتقطير المياه
DOHA EAST POWER GENERATION AND WATER DESALINATION PLANT

Ref. Date:

Letter of Appreciation

Ministry of Electricity and Water appreciates TCR Engineering Services, for their Services, efforts, technical Expertise and assessment capabilities on Metallography, WFMPI, UT , Tube analysis (creep chemical & metallurgical) and General NDT job to assess Remaining Life Assessment and Integrity of Main Steam, Super Heater and Desalination pipe lines of Boiler Units 1 to 7 as well as their work on heat damage assessment on Gas Scrubber vessels and pipelines at, Doha East Power Production & Water Desalination Station, Doha, Kuwait.

Their interpretation skills have helped us to achieve the Remaining Life and Integrity of the pipelines and its components by quantifying the extent of damage. The Management and Technical team at site appreciate the valuable and prompt services provided by their Technical Team at site.

We recommend TCR Engineering Services for our future projects.

Sinopec

فرع شركة ذا فيفث كونستركشن كومبني اوف سينوبك
Branch of The Fifth Construction Company of SINOPEC
C.R.2051033310

To,
TCR Arabia,
Dammam, KSA

Date : 15th June, 2008

Attention : Mr. Syed Ameen Hassan
Sales Supervisor.

Subject : ToFD Services in our Petrorabigh Project
Reference : 1800-RB1-SUB-MEC-005

Dear Sir:

We would like to express our sincere appreciation to the TCR Arabia team for their contribution towards the completion of our Petrorabigh Project.

The efforts & dedication shown by the TCR Arabia team was exceptional in carrying out their activities and assisting us in executing the project in time. We certainly look forward for a long term relationship with TCR Arabia by getting the wide range of NDT & Inspection Services offered by them in all our projects across the Kingdom of Saudi Arabia.

On behalf of SINOPEC, we thank you once again for your support in our project which completed in the end of May, 2008.

Best regards,

YANG SHILEI QA/QC MANAGER
The Fifth Construction Company of SINOPEC

P.O Box691 Dhahran Airport 31932 Tel: 00966-3-8575878 Fax: 00966-3-8575878

EMC for Remaining Life and Integrity of Pipelines

DOHA Ministry of Electricity for RLA and Tube Analysis of Boilers

PetroRabigh for ToFD and NDT Inspection Services

TCR ENGINEERING

Most of the projects undertaken posed a unique challenge for its teams. TCR's clients experienced significant value and were able to bring the right products/services to the market, at the right time and at the right cost

MARQUEE PROJECTS

FAILURE ANALYSIS PROJECTS (1/2)

Schlumberger Oilfield Servics
Failure Investigation (FI) of Mandrel Bypass of Equalizer Sub.

GAIL India
Root Cause Analysis at a Lpg Recovery Plant

Wartsila, Finland
Failure Investigation of Crank Shaft

Man Industries India
FI of Mechanical Expander Pull Rod

Thermax
Failure Analysis of Cupro Nickel Tubing of Chiller Unit

Siemens Ltd.
Failure Investigation of ESV Sleeve DN 200

Weir Mineral India
Root Cause Analysis of Shaft Failures in Vertical Pumps (Cantilever Design)

Hydril Jindal
Failure Investigation of Die Cracking In Swaging Process (Cold Forming Process)

Sterlite Industries India Ltd
Volute Casing, Crane Hook / Pump Failure Investigation

Welspun Gujarat Sthal Rohen Ltd
Failure Investigation of Api 5l Psl 2 X60, (Pipe No: 3612) Line Pipe Failed During Hydro Test at site

MARQUEE PROJECTS

FAILURE ANALYSIS PROJECTS (2/2)

Torrent Power Ltd.
Failure Investigation Of Blade of Lp Rotor Stage 4A Of ESM 110MW Unit

Oil India Ltd.
Corrosion Evaluation of Oil Well Tubing through Root Cause Failure Investigation

Caparo Engg P. Ltd
FI of Axel A Rear Suspension Of Car

Munjal Auto Ltd.
FI of Exhaust Muffler KTPA

Godrej Industries Ltd.
Failure Investigation of Reformer Tubes

ALSTOM Projects
Failure Investigation of High Density Balancing Weight

Hindustan Petroleum Corporation Failure Investigation Of Radiant Heater Outlet Header Cap

Avtec Ltd.
Failure Investigation Of Crank Shaft Of Diesel Car Engine.

Bombardier Transportation India
Failure Investigation Of Notching Spring Of Tap Changer

Ratnamani Metals & Tubes Ltd.
Failure Investigation Duplex R 2205 (50.8 X 2.13 Mm) Tube Failed During Hydro-Forming Expansion

MARQUEE PROJECTS

POSITIVE MATERIAL IDENTIFICATION

Kuwait Oil Company
2 crews of PMI using portable XRF and portable Optical Emission spectroscopy

Hyundai Heavy Industries
Portable XRF on Pipe Joints

Cochin Refinery
PMI for Stock sorting purposes

Reliance Industries
Detection of Carbon using portable Optical Emission Spectroscopy

Petronas, Malaysia
PMI crew on assignment on behalf of L&T, India

Indian Oil Corporation
4 PMI crews deployed for a period of 2 years using portable XRF spectrometers

Bharat Petroleum
One PMI crew for identifying incoming materials at site

Larsen & Toubro, Mumbai | Godrej & Boyce Mfg., Mumbai | Oswal Petro Chemicals | Tyco Sanmar, Tamil Nadu | Virgo valves, Pune | Hawai valves | Endress+Hauser india pvt ltd, Mumbai
Bombay Fluid / Swagelok
Ongoing on-call PMI services provided using portable XRF spectrometers

MARQUEE PROJECTS

METALLOGRAPHY ASSIGNMENTS (1/3)

Constar, USA
SEM Analysis of Plastic samples taken on 3-4 KX, 20 KV voltage magnificatio

NDT-CCS
Evaluation of Metallographic Replicas

Reliance
Over 1200 metallographic replicas created and analyzed to evaluate post fire damage

Zamil Group
Micro Hardness Testing

Alsom
SEM and EDAX Analysis

Massod John Brown, Dubai
SEM analysis to characterize the carbide morphology types in cobalt based alloys such as FXS 414

Biosync Scientific Pvt. Ltd.
Measurement of drug Coating layer on Drug coated stent used in Angioplasty

Godrej Industries Ltd.
Remaining life assessment was carried out through Insitu Metallography route

Lupin Ltd.
Remaining life assessment of fermentor vessel was carried out by Evaluating microstructure at critical locations

Gujarat Power Generation Co. Ltd. Bharuch
Microstructure evaluation at critical locations of HRSG Unit

National Thermal Power Corporation
In situ Metallography conducted on critical components of turbine.

MARQUEE PROJECTS

METALLOGRAPHY ASSIGNMENTS (2/3)

IFFCO
Insitu Metallography for evaluation degradation of microstructure of ammonia plant for remaining life assessment.

IPCL
Insitu metalloography at critical locations of naphtha plant

L & T
Insitu Metallography for microstructure evaluation after various manufacturing stages of critical components

Bharat Petroleum Corporation Ltd.
Damage assessment of Scrubber column and condenser tubes.

Gulbrandsen Limited
Damage assessment through Insitu Metallography route on ammonium chloride anhydrous vessel

Nagarjuna Fertilisers & Chemical Ltd.
Insitu Metallography of ammonia plant

United Phosphorous Ltd.
Insitu Metallography of evaporator support to assess the stress corrosion cracking

Indian Oil Corporation Ltd.
Insitu Metallography of FCC plant

Gujarat State Fertilizer Company
Insitu-metallography work on Reducer of Outlet Bottom Header of Reformer at Ammonia – IV Plant

MARQUEE PROJECTS

METALLOGRAPHY ASSIGNMENTS (3/3)

Zuari Industries Ltd.
Metallography Work Conducted On Various Critical Locations Of Process Steam Supply Heater Outlet Piping

Hindustan Petroleum Corporation Ltd.
Insitu Metallography of reformer tubes

Suzlon Windfarm Services Ltd.
Damage assessment of windmill caught in accidental fire through insitu Metallography route

Tata Power Company
Insitu Metallography work conducted on critical locations of Gas Turbine Unit -7 during outage.

Elecon Engineering Ltd.
Insitu Metallography at various locations of large size Gear

Tata Chemicals Ltd.
Various critical locations of Urea Plant

Essar Steel Ltd.
Insitu Metallography on cooling coil of furnace.

MARQUEE PROJECTS

REMAINING LIFE ASSESSMENTS (1/2)

Torrent Power
Remaining Life Assessment and Investigation of Blade failed from root for LP Rotor stage 4A of E-Station 110MW Unit

Zuari Industries
Remaining life assessment of steam pipe line and surface cracks.

Alstom Power
RLA study through Insitu-metallography work of critical components of 120MW Turbine at MSEB-KTPS; Koradi

Asha Cellulose
Health assessment work on R-1 Reactor at Mech Engineering; Valsad

Vanakbori Thermal Power station
RLA Study of various components of Boiler No.- 2

Hindustan Unilever
RLA study of critical components of MP Boiler No.- 1 (G-122) at Kundain Ind., Goa
RLA study of critical components of Boiler No.- 1 at V.D.L. at Khed, Chiplun Location
- Insitu-metallography work on various components of Boiler No.- 1 (UP – 4702) at Orai Location
- RLA study of various pressure components of Stein Mullar Boiler No.- MR 6495 at Sewri

Gujarat Fluoro-Chemicals Ltd.
- Metallurgical Assessment of CFC Reactor R-501 and Column C-513 at Formosa Plastics ompany Taiwan Roc ondition Assessment work (V.E, letallography, U.T, MPI, Hardness & Thickness Survey) on AHF Bullet: V-31B
- Health assessment work on R-201 Main Reactor CFC plant [Metallography& hardness] at Alfa-laval, Pune

MARQUEE PROJECTS

REMAINING LIFE ASSESSMENTS (2/2)

Unilever Bangladesh
RLA (Visual, MPI, DP, Metallography, Hardness & Thickness Survey) on critical locations of Package Boiler at Unilever Bangladesh Ltd; Chittagong, Bangladesh

Atul Industries Vapi, Gujarat
- RLA of Chlorine storage tank
- RLA Study (Insitu-metallography, MPI & Hardness) on Old Autoclave – G 2101

Alembic Limited, Vadodara
RLA of fermentor

Godrej, Valia, Gujarat
- Remaining Life Assessment of Used N9 Pipe for Alcohol Synthesis Plant
- Remaining Life Assessment Of Alcohol Synthesis Plant

IOCL
Health Assessment Study of C-0.5Mo Piping in Hydrogen Unit-I Plant.

Siemens Ltd
Remaining Life assessment of turbine.

Jaghadia Copper
Condition assessment of landle furnac

Aarti Industries
RLA of turbine

MARQUEE PROJECTS

CORROSION DETECTION

Caterpillar, USA
Weight loss corrosion test for over 35 sampl.

KPIOS, Kuwait
Hydrogen Induced Cracking Test as per NACE standard for over 15 plate samples

Enerflex Canada
HIC and SSC corrosion tests as per NACE TM 0177 and TM 0284 for over 20 samples

Ecolab Canada
Salt Spray test at a Coca Cola plant

GMMOS, UAE
HIC and SSC testing on over 15 samples

Larsen and Toubro (L&T)
- HIC testing as per NACE TM 0284 on an ongoing basis and Intergranular Corrosion of Aluminium Alloys by Mass Loss After Exposure to Nitric Acid As per ASTM G67

Jutal, China
SSC test based on Sinopec approved standard(closely adopted to NACE guidelines)

Xalloy, Thailand
Chloride Stress Corrosion Cracking, Intergranular Corrosion as per ASTM A262

Johnson Screens, Australia
Weigh Loss Corrosion Tests

Walchandnagar Industries
HIC and SSC Testing

Godrej , Mumbai
Stress Oriented Hydrogen Induced Corrosion as per NACE 0177 method D

Bay-Forge Pvt. Ltd. , India
Visual Assessment of Exfoliation Corrosion Susceptibility of Aluminum Alloys as per ASTM G66

MARQUEE PROJECTS

NON-DESTRUCTIVE TESTING (NDT)

ONGC, Iran
40 team member crew deployed for shutdown activity including conventional NDT, scaffolding, and shutdown project management

NPCIL, Kota
Shutdown Crew deployed for NDT including 20 NDT Level II and a NDT Level III person

Unilever Bangladesh
Ferrite Survey, UT Thickness Measurement and Hardness Checking

Indian Naval Shipping
NDT and RLA Study of LPG Tanker

Several projects for EIL and L&T
Ongoing daily callouts for UT, DP, MP, PT, Ferrite Measurement, Portable Hardness

KOC, Kuwait
Automated UT using ToFD for Storage Tanks based on API 650 Appendix U. Project undertaken with HHI as EPC contractor

Tekfen, KSA
Automated UT using ToFD based on Code Case 181 undertaken at Aramco's PetroRabigh site

Mass Construction, India
Conventional Radiography by using X-ray source based on ASME SEC VIII Div. 1 Conventional Radiography by using Gamma ray source by API 1104

NMRL, Mumbai
NDT for WPS as per ASME SEC IX

MARQUEE PROJECTS

THIRD PARTY INSPECTION SERVICES

Saudi Chemanol
Third party inspection at various locations (Kolkatta, Tarapur & Pune) as per Client provided ITP/QAP

Komline Sanderson, USA
AWS Welding Inspector as well as QA/QC Personnel deployed at a vendor site in India

EMC Sp. Z.o.o., Poland
QA/QC inspection and Pre-shipment loading audit of electric light bulbs at a vendor site in Mysore, India

Permapipe, UAE
6-Month duration project for QA/QC inspection including dimensional verification and specification compliance of insulation material used in refinery piping

Aventech, Candada
Factory Audit and Sourcing Assistance of Casting Suppliers

Flowserve, UK
QA/QC inspection at Audco in Chennai on an ongoing basis

Elliott Company, USA
Factory Audit and QA/QC inspection on behalf of the USA based company at their supplier site in western India for a 3-year duration project

Uniflex Cables, Kuwait
Inspection and Witness of Goods at a supplier site in India

Bloxwich, UK
QA/QC inspection with daily photographs and status reports advising client of vendor's progress and quality status

Metpost, UK
Inspection of fabrication and Factory Audit of casting and forgoing companies in India

American Industrial Supply, USA
Third party Inspection, Stamp Transfer and Shipment Audit

MARQUEE PROJECTS

RoHS COMPLIANCE SERVICES

Sys Concept, Canada
Detection of RoHS restricted elements using the screening and verification methods

Parveen Industries
RoHS compliance for 28 plastic samples

Birla Copper
Test of Lead content in samples

Godrej Lawkim Group
RoHS testing on an ongoing basis for over 600 samples

Emerson Climate Technologies
RoHS testing on an ongoing basis for over 500 samples

FATIGUE & FRACTURE TOUGHNESS

Naval Materials Research Laboratory, India
Crack tip opening displacement testing as per client Requirement

Amsafe Bridport, Sri Lanka
Fatigue testing of Bulk-hold baggage nuts (Belts) as per client Requirement

Jindal Steel & Power Ltd., India
Fatigue crack growth rate test as per ISO 12108

CORE MACHINERY & EQUIPMENT

MECHANICAL TESTING EQUIPMENT (1/2)

TCR invests in the latest equipment and uses cutting-edge technologies to ensure that all the products and materials they test, certify or inspect always have consistent results. All equipment is compliant with the relevant industry standards, they meet all regulations and are fit for purpose

1. **Servo Hydraulic Universal Testing Machine**
   MTS System (china) Co. Ltd.
   SHT4106/3091104 | TCR/MEC/EQP/13 | 0-1000kN/ ±1% | Mfg. Date- Nov 2009
2. **Universal Testing Machine with Electronic extensometer**
   GDR Sr. No-283/40 -1976 | Sr. No. 106/05/02 | Sr. No. 270 (Extn. Mtr) | TCR/MEC/EQP/01 | 0-1000 kN / ±1% | 0-25 mm
3. **Universal Testing Machine With Electronic extensometer**
   MCS-MP/ 156-12/06 | Sr. No. 186-0207 | TCR/MEC/EQP/02
   0-400 kN / ±1% | 0-50 mm
4. **Universal Testing Machine**
   SFM30 | Make: United | Sr. No.: 293505 | TCR/MEC/EQP/03
   0-130 KN
5. **Universal Testing Machine**
   KIC-2-1000-C | Sr. No.: 110402
   TCR/MEC/EQP/09
   0-100 KN
6. **Charpy / Impact Testing Machine**
   FIE/ IT/30 Sr. No-789 | 1975
   TCR/MEC/EQP/04 | Izod-156J
7. **Charpy Impact Testing Machine**
   IT 300 ASTM
   Sr. No. 06/12-02 | TCR/MEC/EQP/05 300J
8. **Impact Testing Machine**
   Model: ZBC2452-C/150 | Make: SANS, China
   Sr. No.: 20910025 | TCR/MEC/10
   0-450J (calibration valid upto 150J)
9. **Brinell / Vickers Hardness Tester**
   HPO 250 F.Nr-308/92, 1979 | TCR/MEC/EQP/06 | HBW 80-400 | Hv5 40-1200, Hv10- 80-1000 | ±2%
10. **Rockwell Hardness tester**
    RA/FIE | Sr. No-77/021 | 1976
    TCR/MEC/EQP/07 | HRB 30-100 | HRC 20-70, ±1%
11. **Rockwell Superficial Hardness Tester**
    RAS/FIE | Sr. No -S-7001 | 1976 | TCR/MEC/EQP/12 | HR 30T: 29-82 ±1%
12. **Wilson Wolpert Hardness Tester**
    Sr. No.: 930/250 | TCR/MEC/EQP/11
13. **Cupping machine (Scale)**
    FIE /1990 | TCR/CUPPING/SC/01
    0.20 to 3 mm

CORE MACHINERY & EQUIPMENT

MECHANICAL TESTING EQUIPMENT (2/2)

14 **Brinell / Vickers Hardness Tester**
HPO 250 F.Nr-308/27, 1981 | TCR/MEC/EQP/08 | HBW 80-400 | Hv5 40-1200 | Hv10- 80-1000 | ±2%

15 **Micro Hardness Tester**
Make: LECO USA | M-400-HI | Sr No-170765,
1996 | TCR/MET/EQP/06
0-1000gms | ±3%

16 **V Notching Machine**
Fine Marketing | 1976 | TCR/MEC/EQP/15
2 mm V Notch

17 **Hydraulic Pipe Bending Machine**
Sr. No.: 965
TCR/MEC/EQP/15

18 **Hydraulic Test Pump & Compressor**
Horizon | TSO-05 | TCR/MEC/EQP/16
600kg/cm2

19 **Digital Thermometer with sensor (New)**
MARVEL SE, Sr. No. 090901
TCR/MEC/EQP/19
-199 to 50 | Deg C

20 **Digital Thermometer with sensor (New)**
MARVEL SE, Sr. No. 113/080603
TCR/MEC/EQP/19
-199 to 100 | Deg C

21 **Digital Weighing Balance**
CONTECH | Sr. No. 01/200766 (CT 15K)
TCR/MEC/EQP/17
0 to 15 Kg

22 **Digital Weighing Balance**
Pentral Electronics | Sr. No. 01/200766 r. No. 498 Model ILW 300 | TCR/MEC/EQP/21
0 to 30 Kg

23 **Temp controller with. Indicator & sensors**
SE/TCS1&TCS2
TCR/MEC/EQP/18
0-1000 Deg C

24 **Fatigue test system**
50 KN and 250 KN
Make BISS - Bangalore

CORE MACHINERY & EQUIPMENT

CHEMICAL ANALYSIS – INSTRUMENTATION (1/2)

1. **Automatic Carbon Sulphur Determinator**
   LECO/CS244 USA 1990, Sr. NO. 2042 | TCR/INT/EQP/02
   ±0.005 C to ±0.005 S

2. **Automatic Carbon Sulphur Determinator**
   LECO/CS400 USA 1997
   Sr. No. 3153 | TCR/INT/EQP/03 |
   ±0.005 C to ±0.005 S

3. **Automatic Carbon Sulphur Determinator**
   LECO/CS230, USA APR 2009
   Sr. No. 4930 | Model No. 619-000-200 | TCR/INT/EQP/07
   ±0.005 C to ±0.005 S

4. **Automatic Oxygen, Nitrogen, Hydrogen Determinator**
   LECO ONH 836 | Model No. 632-100-400 | Sr.NO. 3006

5. **Atomic Absorption Spectrometer (AAS)**
   Perkin Elmer
   Analyst 200 | Sr. No. 20056110104 | TCR/INT/EQP/05 | ±1% of conc.

6. **Optical emission Spectrometer (OES)**
   ARL QUANTRIS/
   Switzer. JUNE 2006
   Sr. No. 15 | TCR/INT/EQP/01
   ±1% of concentration

7. **Optical emission Spectrometer (OES)**
   Thermo fisher scientific
   ARL 3460
   Switzer. year 2012
   Sr. No. 4948
   TCR/INT/EQP/

8. **ICP Spectrometer**
   Leeman Labs Inc, PRODIGY
   SPEC JUNE 2005
   Sr. No 5003 | TCR/INT/EQP/04
   ±1% of Concentration

9. **UV Spectrophotometer**
   Make:Chemito, Model 2100

10. **XRF Spectrometer**
    Rigaku Japan Model: Supermini
    Sr. No. IR 16013-3 | TCR/INT/EQP/06| ±1% of Concentration

11. **Electronic Digital Balance Mettler,**
    Model- AB 54-s | TCR/WAO/EQP/011 | 0-50 gm to ±0.1 mg

12. **Electronic Digital Balance Mettler,**
    Model- AB 204
    TCR/WAO/EQP/012
    0-210 gm
    ±0.1 mg
    Weight Box
    -0.1 mg -100gm

13. **Rough Balance**
    Make Penta model TLW Sr. No 4852 | 0.002 kg-500 gm ±0.1 gm

14. **Oven (Wet Analysis)**
    TCR/WAO/EQP-014
    Make EXPO | 0-300°C
    Oven (Wet Analysis)
    Lab Hosp Sr. No. 901115
    0-300°C

15. **Electrolytic Analyzer With Analog Ammeter & Voltmeter**
    TCR/AM/01, TCR/VM/01 | 10 A/15V to ± 1% FSD
    TCR/AM/02, TCR/VM/02 | 10A/15 V to ± 1% FSD

CHEMICAL ANALYSIS – INSTRUMENTATION (2/2)

16 Glass Thermometer
GRM INIDIA TCR/MECH/TM/02, -10 to 110 C
GRM INIDIA TCR/WAQ/EQP/22 -10 to360 C
GRM INIDIA TCR/WAQ/EQP/23, -10 to 360 C
GRM INIDIA TCR/WAQ/EQP/24, -10 to 360 C
GRM INIDIA TCR/WAQ/EQP/25, -10 to 360 C

17 Temperature and humidity meters
TCR/TEMP/02 -HTC-1 Spectro room
TCR/TEMP/03 -HTC-1 ICP Room
TCR/TEMP/04 -HTC-1 Wet Lab
TCR/TEMP/05 -HTC-1 Corrosion lab
TCR/ARB/TEMP/01 -HTC-1 SAUDI lab
TCR/ARB/TEMP/012- HTC-1 SAUDI lab

INSPECTION AND QUALITY AUDIT EQUIPMENT

1 Metric Scale
TCR/CUP/mach./01 | 0-20 mm
Technika, TCR/MS/02 | 0-1000 mm

2 Dial Vernier Caliper
Mitutoyo
Sr. No. 1096302
0-150 mm

3 External Micrometer
Mitutoyo
Sr.No.2031020 | 0-25 mm
Sr.No.099416 | 0-25 mm
Sr.No.7749020 | 25 mm

4 Tube Micrometer
Mitutoyo
Sr.No.56063638 | 25-50 mm
External Micrometer

5 Pipe Micrometer
Mitutoyo
Sr.No. 207759 | 0-15 mm

6 Dial Vernier Caliper
TESA | TCR/VC/TESA)/01
0-15 cm

7 Vernier Caliper Aero space
Sr.no. 050916033 | 0-20 mm
Sr.no. 209043 | 0-600 mm

8 Digital Vernier Caliper
TCR/DC/01 | 0-150 mm
Mitutoyo | Sr.No.07082256
0-200 mm

9 Vernier Caliper Aero space

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CORE MACHINERY & EQUIPMENT

METALLOGRAPHY TESTING EQUIPMENTS

1. **Olympus inverted microscope**
   Olympus –GX51 inverted system
   X50X- 1000X
2. **Metallurgical Microscope with image analyzer**
   LECO 500
   USA, 1989
   Mag. 50X to 2000
3. **Shadowgraph checking Metzer Biomedicaf**
   50X
4. **Insitu Metallography Kits**
   BMI 101A Microscope
   BMI 101A
   Sr.No. – 200050065
   100X-600X

INSPECTION - POSITIVE MATERIAL IDENTIFICATION (PMI), ROHS, FERITSCOPE, PORTABLE HARDNESS

1. **Niton XLT 898**
   Sr. No. 18807 | USA | ±5%
2. **Innov-X Demo**
   Sr. No. 6603 | USA | ±5%
3. **Innov-Alpha Demo**
   Sr. No. 4444 | USA | ±5%
4. **Innov-X**
   Sr. No. 10791 | USA | ±5%
5. **Innov-X system**
   Sr.No 500625 | USA | ±5%
6. **Innov-X System DS-2000**
   Sr. No 560099 | USA | ±5%
7. **Niton XL2**
   Sr. No. 73308 | USA | ±5%
8. **Niton XL2**
   Sr. No. 85754 | USA | ±5%
9. **Niton XLT 898**
   USA | ±5%
10. **ARC-MET 8000 Mobile OES analyser**
    Sr.No 800469 | USA | ±5%
11. **ARC-MET 8000 OES Analyzer**
    Sr. No 800441 | pH meter
12. **TOSHNIWAL PH-01 & 022**
    0-14 pH | pH meter
13. **Water Conductivity meter**
    Make Hanna | Model HI 2300
    Sr.NO. 08119182
14. **Electrical Conductivity Meter Technofour**

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CORE MACHINERY & EQUIPMENT

WET CHEMICAL ANALYSIS

1. **Muffle Furnace**
   TCR/WAO/EQP/09, 0-1000°C | TCR/WAO/EQP-010, 0-1000°C
2. **Oven**
   Lab Hosar/ TCR/WAO/EQP-016, 0-300°C | EXPO/TCR/WAO/EQP-014, 0-100°C | TEMPO/ Sr.no.4121O4, 0-300°C
3. **Glass Thermometer**
   KWALITY/TCR/MEC/EQP/22, -100-+50°C, ± 2°C | JRM/TCR/MEC/EQP/31, -50 - +50°C, ± 1°C | JRM/ TCR/MEC/EQP/3129, -10 - 360°C, ± 1°C
4. **Analog DC Ammeter**
   LCC/TCR/WAO/EQP/018 0-10 A, ± 1% FSD
5. **Analog DC Voltmeter**
   LEE/TCR/WAO/EQP/DCV 018, 0-15 V, ± 1% FSD | Sr. No. 861015239, 0-15v
6. **Electronic Digital Balance**
   Mettler, Model- AB 54-s TCR/wao/eqp/011 0-51 gm, ±0.1 mg
7. **Electronic Digital Balance**
   Mettler, Model- AB 204 0-200 gm, ±0.1 mg

NDT - INDUSTRIAL SAFETY AND NDT SHUTDOWN PROJECT MANAGEMENT (1/2)

1. *Ultrasonic Testing Equipment*
   Ultrasonic Flaw Detector
   Krautkramer / USK7 Sr. No- 27276-4561

   V1 Block & V2 Block
   Normal Probes
   Ultratech / SN-16 | 2MHZ ⌀24 NP
   Ultratech / SN-16 | 2MHZ ⌀10 NP
   Ultratech | 4MHZ ⌀10 NP (2 No.)
2. **Angle Probes**
   4A 8x 9-60, SN. 34 | 4A 8x 9-60, SN. 70
3. **TR Probes**
   TR4 MHZ ⌀10, SN.111
4. **Ultrasonic Thickness Gauge**
   Pulsecho system | Mp 1200-DL | Sr. No. 2151
   Modsonic | EDISON-1/Sr. No 3536-0210
5. **Probes**
   MPL 510-364 | MPL 510-365 | MPL 210-237
6. **Magnetic Particle Testing Eqpts. & Materials**
   Yoke, Y7/13 | AC/DC | PT No 518601 | Dry Powder | Magnaflux –8A | Black Water Based Powder Automeg BW-245

CORE MACHINERY & EQUIPMENT

NDT - INDUSTRIAL SAFETY AND NDT SHUTDOWN PROJECT MANAGEMENT (2/2)

7 **Magnetic Ink Black Oil Base**
Instacheak MSL 61 B
Fluorescent
Test

8 **Ultraviolet Light**
A M Trading UMV 001 I 12 V- 230 V

9 **Dry Powder Sprayer**
UPKAR

10 **D P Testing Eqpts. & Materials**
Developers: PD 31 B PMC
Penetrant: 15 B PMC
Cleaners
PMC

11 **Coating Thickness Gauges**
Positector 6000 NF-2
0- 650 Micron ± 3 Micron

12 **EPOCH LT PANAMRTRICS-NDT DIGITAL ULTRASONICDETECTOR EPOCH LT**
SR.NO 060124610
Einstein II DGS UT Machine
Modsonic Sr.No E 1502-0308
Feritscope (MP30E-S)
Sr. No. – 106-23060A
Fischer / USA

13 **Portable Hardness Tester**
TH-130/ HL- 200 I China I 5%

14 **Digital Coating thk. Machine**
Defelsko corp. model-6000-FN2
0-1500 micron

15 **Davinci Alpha UT machine**
Sr no. D 0152-4209
Modsonic

16 **Surface Roughness Tester**
TR 100
TIME
Sr. No. 10663000012

17 **Portable Magnetic permeability tester**
Model – Ferro master I Stefanmayer instruments,Germany Sr. NO 328 yr 2009

18 **Portable hardness Tester**
HL 200 I 783 H
Cu,Al conductivity meter (already mentioned above)
Technoflow I NA

19 **Fire Extinguisher**
Foam Inverted Type – B I Powder B&C I Dry Chemical Powder,
Type – B C (3 No.) I Dry Chemical Powder, Type – B C (Small)
9 KG

20 *Safety Equipments*
First Aid Kits: 3 Sets
Helmets: 2 Nos.
Boiler Suits: 10 Nos.
Hand Gloves: 50 Nos.
Safety Shoes: 10 Pairs
Safety goggles: 10 Pairs

CORROSION TESTING EQUIPMENT (1/2)

1. **Pressure Gauges**
   Pioneer I TCR/PG/07 I 0-600 Kg/Cm2
   Bourdon I TCR/PG/05 I 0-250 Kg/Cm2
   Wika/ TCR/PG/08 I 0-40 Kg/Cm2
   Hi Tech/ TCR/PG/09 I 0-70 Kg/Cm2
   Fair / TCR/PG/09 I 0-70 Kg/Cm2
   A LOT/ TCR/PG/10 I 0-42 Kg/Cm2
   A LOT/ TCR/PG/14 I 0-70 Kg/Cm2
   WIKA I 0-1000 Kg/cm2

2. **Pressure Gauges(Corrosion Lab)**
   Hi-ech/1752/TCR/PG/COR/01
   0-70 Kg/Cm2
   Hi-ech/1762/TCR/PG/COR/02
   0-70 Kg/Cm2
   Hi-ech/1753/TCR/PG/COR/03
   0-70 Kg/Cm2
   AKVALA/TCR/PG/12 I Sr.No. 510130328
   0-70 Kg/Cm2
   AKVALA/TCR/PG/13 I Sr.No. 510130331
   0-70 Kg/Cm2

3. **Thermocouple (Corrosion Lab)**
   Marvel Electronics
   Sr. No. 080220(D) I 0-800 deg. C
   Sr. No. 080220(D) I 0-800 deg. C

4. **Digital Coating Thk. Gauge with Foils**
   Defelsko corp. model-6000-FN2
   0-1500 micron

5. **Digital Thermometer with Sensor for impact test**
   Model-221P-RTD I Sr. No. 060601 I -196 To 200 Deg C
   Model-Pt-100-RTD I Sr. No. 090901 I -196 To 50 Deg C

6. **Dial gauge**
   Sr. No. 7532, 0-10 mm I Sr. No. J8037, 0-10 mm I Sr. No. 1386/1, 0-3 mm I Baker, SE/3534/3
   Sr. No. G9490, 0- 10 mm I Sr. No. 1386/1, 0-3 mm I SE/3534/5, Sr. No. 2099, 0-10 mm

7. **Dial Gauge (Impact)**
   Shock proof, Sr. No. J8037, 0-10 mm I Mitutoyo, Sr. No. 9813k7, 0-1 mm I Sr. No. 78018, 0-1"

8. **High Pressure vessel (Autoclave)**
   2T2-6175-327-0606 & 328
   Acrylic vessel
   P H Meter
   Make- Lab India

9. **HIC Vessel**
   TIC With Sensor

10. **Temp. Indicator with sensor**
    SE/TCS1&TCS2
    0-1000

11. **Temperature Controller with Sensor (6 Channel)**
    PID-8000
    Libratham
    TCR/CHEM/PID/01
    0- 150

12. **Temperature controller with sensor**
    SE/200 I SS/TC/02
    Ambient

13. **Hydrogen Sulphide Cylinder**
    Hydrogen Sulphide Controller
    Hydrogen Sulphide Detector
    MSA H2s ALTER
    H2S Mask

CORROSION TESTING EQUIPMENT (2/2)

14 **Temperature Sensors**
2K408THC1666 to 69 & Sensor 5
0-350
CR-AL SIMPLEX Thermocouple
2K7THC0001 | 2K7THC0223 |
2K7THC0222 | SENSOR 4

15 **Temperature Sensors**
Sensor 1 to 4

16 **Temperature Sensors**
(J Type) OMEGA
P05D650JIHA2 | P05D650JIHA |
P03C346JIHC2
0-250 Deg C

17 **Temperature Sensors**
(K Type)
P03C346JIHC1 | 07070/71 | TC1 |
TC2 | 0- 250 Deg C

18 **Constant temp.(Water)Bath**
INSU/TCR/CHE/EQP/WB-01 & 02
0-100

19 **Proving Rings**
Sr. No.02035, 12 kN | Sr. No.02034, 12 kN | Sr. No.02028, 12 kN | Sr. No.02026, 12 kN | Sr. No.02025, 12 kN | Sr. N. 02013, 12 KN | Sr. No.02014, 12 kN | Sr. No.02015, 0-1200 Kgs | Sr. No.97504, 0-2000 Kgs | Sr. No.97502, 0-2000 Kgs | Sr. No.97506, 0-2000 Kgs | Sr. No.97508, 20 kN | Sr. No.97505, 0-2000 Kgs | Sr. No.97507, 0-2000 Kgs | Sr. No. 3957, 20 kN | Sr. No. 3956, 20 kN | Sr. No.03001, 06 kN | Sr. No.03002, 06 kN | Sr. No.03003, 0-600 Kgs | Sr. No.03004, 0-600 Kgs | Sr. No. 02033, 12 kN | Sr. No. 97503, 0-2000Kgs

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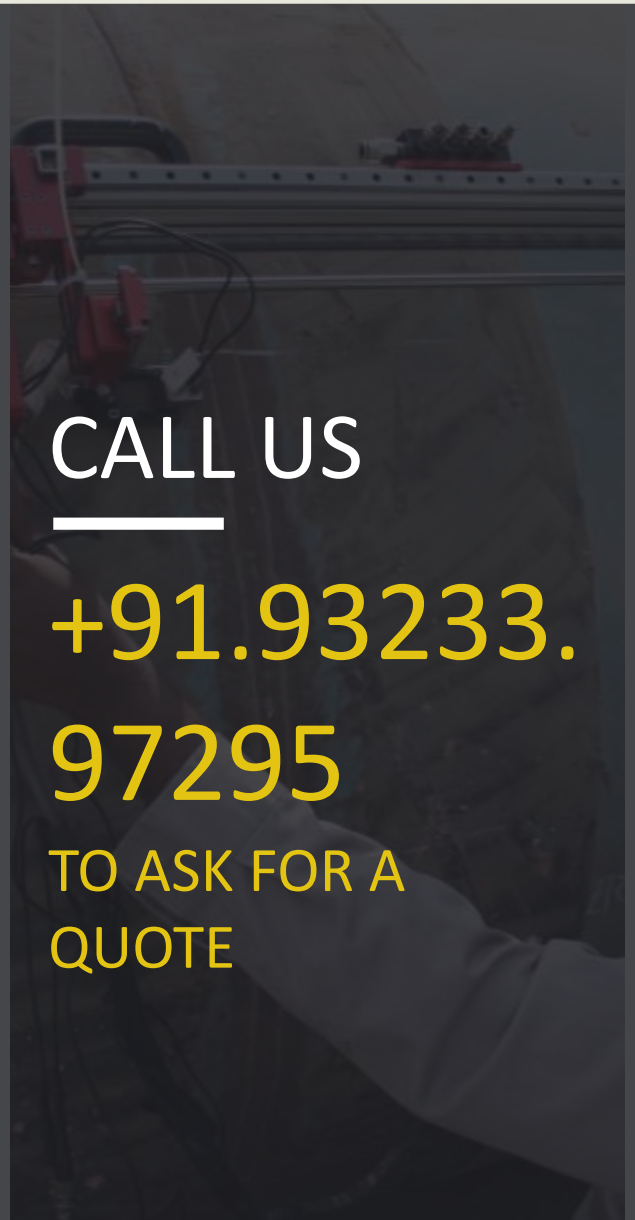

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