REDEFINING ON-TIME QUALITY

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

COMPANY PRESENTATION

APRIL 2018

WWW.TCRENG.COM
TCR: BUILDING TRUST SINCE 1973

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
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.
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

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.

For more information please visit our website: www.tcreng.com
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.

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.

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 an Automatic Carbon/Sulphur Apparatus and Spark Emission Spectrometer

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

INDIA UNITS

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

GLOBAL UNITS

- TCR ARABIA LLC. DAMMAM, KINGDOM OF SAUDI ARABIA
- TCR ENGINEERING CONSULTING FZE DUBAI, UAE
- TCR KUWAIT FAHAHEEL, KUWAIT
- TCR AFRICA JOHANNESBURG, SA
- TCR MALAYSIA SELANGOR, MALAYSIA
- 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 CATER TO LEADING COMPANIES IN INDIA ACROSS INDUSTRIES

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.

For more information please visit our website: www.tcreng.com

For more information, visit www.tcreng.com
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.
# IMPLEMENTATION TEAM

## TCR ENGINEERING (MUMBAI)

<table>
<thead>
<tr>
<th>Leadership</th>
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<tbody>
<tr>
<td>Managing Director</td>
<td>Neelam Bafna</td>
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<tr>
<td>Country Head</td>
<td>Suresh Acharya</td>
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<tr>
<td>Tech Lab In Charge</td>
<td>Avinash T</td>
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<tr>
<td>Chief Metallurgist</td>
<td>Sriram Shanbhag</td>
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<tr>
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<tbody>
<tr>
<td>Laboratory Manager (Metallurgy)</td>
<td>S. Palav</td>
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<tr>
<td>Laboratory Manager (Chemical)</td>
<td>Ganesh Sonawane</td>
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<tr>
<td>M.D. - Consulting</td>
<td>Paresh Haribhakti</td>
</tr>
<tr>
<td>Expert - Boilers</td>
<td>Ketan U</td>
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<tr>
<td>Supervisor-Inspection</td>
<td>Shailender</td>
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<tr>
<td>Head - Third Party Inspection and Quality Assurance</td>
<td>Shailender</td>
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<tr>
<td>Supervisor – PMI</td>
<td>Ajit Rane</td>
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<tr>
<td>ToFD and Adv. NDT</td>
<td>Sandeep Singh</td>
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<tr>
<td>Conventional NDT, Radiography and Welding</td>
<td>Bhaskaran S.</td>
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<tr>
<td>Software</td>
<td>Ganesh Sonawane</td>
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<td>QA-R&amp;D</td>
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<td>Support / Admin</td>
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<tr>
<td>Shipping &amp; Receipt</td>
<td>Mahesh</td>
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<tr>
<td>Manager - CS</td>
<td>Deepak A</td>
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<tr>
<td>Asst. Manager - CS</td>
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<tr>
<td>Web Support &amp; IT</td>
<td>Suresh Acharya</td>
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<tr>
<td>Communications</td>
<td>Anita</td>
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<tr>
<td>Chartered Account</td>
<td>Viren Khandwala</td>
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<tr>
<td>Director - Finance</td>
<td>Neelam Bafna</td>
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<tr>
<td>HRD Associate</td>
<td>Ajit Rane</td>
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<tr>
<td>Director-Sales</td>
<td>Rohit Bafna</td>
</tr>
<tr>
<td>Manager NDT Services</td>
<td>Shemi Bhaskaran</td>
</tr>
<tr>
<td>Country Head</td>
<td>Suresh Acharya</td>
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## 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.
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
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.
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.
SERVICE OVERVIEW

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

For more information, visit our website: www.tcreng.com
COMPLETE QUALITY ASSURANCE PARTNER FOR OPTIMUM PLANT HEALTH

**Core Services**
- Project Consulting
- 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

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

**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

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

For more information please visit our website: www.tcreng.com
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

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Highly trained staff with extensive experience in engineering, mechanics, and materials science
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.
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
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
CHEMICAL ANALYSIS LAB

INHOUSE EQUIPMENTS AND CORE CAPABILITIES


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

For more information, visit www.tcreng.com
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
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
CORE CAPABILITIES

  This practice describes the accepted procedures and factors that influence laboratory immersion corrosion tests, particularly mass loss tests.

  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.
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.
ADVANCED CORROSION TESTING (3/3)

TEST SPECIMEN of Method D – DCB Test

SSC Tensile Test Setup with continuous H2S Purging

Typical SSC Crack in C Steel
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 mm² and 12 portable optical microscopes with magnification of up to 50,000X.

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

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.

25,000+ Replica Repository
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

For more information, visit www.tcreng.com
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
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 extensions in building/structure

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
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.
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
STRUCTURAL AUDIT (4/4)

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
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.
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
- Post Weld Heat Treatment using 70 KVA Electric Resistance
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.

For more information, visit www.tcreng.com
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 SITEX 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.
NDT TESTING CREW AT WORK

FIELD IMAGES

RADIOGRAPHIC TESTING

ULTRASONIC TESTING

X-RAY RADIOGRAPHY

ULTRASONIC TESTING

GAMMA RAY RADIOGRAPHY

For more information, visit www.tcreng.com
## ADVANCED NDT SERVICES

### SERVING DIVERSE INDUSTRIES

<table>
<thead>
<tr>
<th>PAUT/TOFD</th>
<th>ARTiS</th>
<th>HTHA</th>
<th>IOT</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="paut-tofd.png" alt="Image" /></td>
<td><img src="artis.png" alt="Image" /></td>
<td><img src="htha.png" alt="Image" /></td>
<td><img src="iot.png" alt="Image" /></td>
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<th>ECT/RFET</th>
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</tr>
</tbody>
</table>

- **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
PIPRINES & 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 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
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.
11

PORTABLE ULTRASONIC FLAW DETECTOR (1/3)

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.
### ULTRASONIC FLAW DETECTOR (2/3)

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

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

For more information, visit www.tcreng.com
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.
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 0.1 meter
- The biggest advantage is the electrical - motorized crawling which eliminates erection of scaffolding
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.
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
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).

- $MC + 4H = M + CH4$
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. Up to 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.
EDDY CURRENT TESTING & RFET SERVICES

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
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
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.

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.

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

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.
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.
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
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
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.

TCR ENGINEERING

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.

For more information, visit www.tcreng.com
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.

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.

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

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

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

For more information, visit www.tcreng.com
THIRD PARTY INSPECTION SERVICES ACROSS INDIA

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
SCOPE OF INSPECTION SERVICE

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 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.
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 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.

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

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

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.

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

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


- TCR teams can work on projects all across the globe
OUR CREDENTIALS

- Appreciation Letters
- Marquee Projects
- Core Machinery & Equipment
- Next Steps
- Contact Coordinates
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 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. Upadhyaya
Chairman India Section

RELIANCE INDUSTRIES- HAZIRA for In situ Metallography, failure analysis, Helium Leak Test and remaining life assessment
**MBH Analytical for Chemical Analysis Testing Services**

**GENERAL ELECTRIC (GE) for NDT Services**

**L&T for Panipat Refinery Project of Indian Oil Corp**

**RELIANCE Industries for Metallography**

APPRECIATION LETTERS (1/5)

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**MBH Analytical**

General Electric appreciate TCR Engineering Services for their efforts, their technical expertise and the promptness in the completion of the service with inspection of theCritical Components of the Project.

Date: 26th June 2017

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**GENERAL ELECTRIC**

Salutes COST Project, Kolwezi.

---

**LARSEN & TOUBRO LIMITED**

Larsen & Toubro Limited, in association with TCR Engineering Corporation are executing the Bahriara Grand Project for Panipat Refinery Project of Indian Oil Corporation Limited at Panipat. We are happy to inform you that we have received the Most Satisfactory Award.

---

**RELIANCE Industrides**

Reliance Industries Limited, for Metallography Project.
APPRECIATION LETTERS (2/5)

GODREJ INDUSTRIES for Failure Analysis Project

ABB for Metallography/Remaining Life Assessment Studies

ALFA LAVAL’s Preferred Test Lab in India

PETRO RABIGH for Advanced NDT and ToFD
APPRECIATION LETTERS (3/5)

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 for On-going PMI Inspection

AL TOUKHI for Heat Treatment Services

HYUNDAI for Eddy Current Testing Services

NAVAL DOCKYARD for NDT & Inspection Services
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
LETTER OF APPRECIATION

Standard Ressell Bauwarte Service GmbH appreciates TCR Engineering Services for their Services, effort, technical expertise and knowhow on the Metallurgy, WHPFL, UT and General NDT job to assess Remaining Life assessment and integrity of main headers, Super heater and Condensation pipe Lines of Boiler units 1 to 7 of NECB, Doha East Power Station of MDA-DEPA, Qatar.

Doha East Power Station has 7 power generating units. Four of them have the steam generating units supplied by MA, France and Boeckman. France and the remaining three are supplied by MA, EPE, Japan. The units are designed to generate 920 Mw of Steam/ hour.

Their interpretation skills have led us to the Remaining Life and integrity of these pipelines and its component by qualifying the status of damage. The Management & Technical Team at site appreciate the valuable and prompt services provided by their technical team at site. We also appreciate the efforts of TCR Engineering Services for our future projects.

Mr. Mohammed Ali Al Bapti, MD

Senior Project Manager

DOHA Ministry of Electricity for RLA and Tube Analysis of Boilers

EMC for Remaining Life and Integrity of Pipelines

PetroRabigh for ToFD and NDT Inspection Services
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 (2/2)

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

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

- Godrej Industries Ltd.
  Failure Investigation of Reformer Tubes

- Hindustan Petroleum Corporation
  Failure Investigation Of Radiant Heater Outlet Header Cap

- Bombardier Transportation India
  Failure Investigation Of Notching Spring Of Tap Changer

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

- Munjal Auto Ltd.
  Fl of Exhaust Muffler KTPA

- ALSTOM Projects
  Failure Investigation of High Density Balancing Weight

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

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

For more information, please visit our website: www.tcreng.com
MARQUEE PROJECTS

POSITIVE MATERIAL IDENTIFICATION

- **Kuwait Oil Company**: 2 crews of PMI using portable XRF and portable Optical Emission Spectroscopy
- **Indian Oil Corporation**: 4 PMI crews deployed for a period of 2 years using portable XRF spectrometers
- **Hyundai Heavy Industries**: Portable XRF on Pipe Joints
- **Bharat Petroleum**: One PMI crew for identifying incoming materials at site
- **Cochin Refinery**: PMI for Stock sorting purposes
- **Reliance Industries**: Detection of Carbon using portable Optical Emission Spectroscopy
- **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
- **Larsen & Toubro**: Bombay Fluid / Swagelok
- **Petronas, Malaysia**: PMI crew on assignment on behalf of L&T, India

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MARQUEE PROJECTS

METALLOGRAPHY ASSIGNMENTS (1/3)

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

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

Godroj Industries Ltd.
Remaining life assessment was carried out through In situ Metallography route

Lupin Ltd.
Remaining life assessment of formentor 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 metallography 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 Metallurgy 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 Urca 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 pipeline and surface cracks.

Alstom Power
RLA study through In-situ-metallurgy work of critical components of 120MW Turbine at MSEDCL-KTPS; Koradi

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

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, Chipruri Location
- Insitu-metallurgy 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 company Taiwan Roc
- Ionisation Assessment work (V.E., Ietallography, U.T, MPI, Hardness & Thickness Survey) on AHF Bullet: V-31B
- Health assessment work on R-201 Main Reactor CFC plant (Metallurgy & hardness) at Alla-laval, Pune
MARQUEE PROJECTS

REMAINING LIFE ASSESSMENTS (2/2)

Unilever Bangladesh
- RLA 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, Valla, 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 Limited
- RLA of turbine
MARQUEE PROJECTS

CORROSION DETECTION

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

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.

JUTA, 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
Weight Loss Corrosion Testing.

Walchandnagar Industries
HIC and SSC Testing.

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

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

For more information, visit our website: www.tcreng.com
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

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MARQUEE PROJECTS

THIRD PARTY INSPECTION SERVICES

- **Saudi Chemanol**: Third party inspection at various locations (Kolkata, 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
- **American Industrial Supply, USA**: Third party Inspection, Stamp Transfer and Shipment Audit
- **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 forging companies in India

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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
- Jindal Steel & Power Ltd., India
  Fatigue crack growth rate test as per ISO 12108
- Amsafe Bridport, Sri Lanka
  Fatigue testing of Bulk-hold baggage nuts (BELTS) as per client Requirement
**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.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Servo Hydraulic Universal Testing Machine</td>
<td>MTS System (china) Co. Ltd. SHT4106/3091104</td>
</tr>
<tr>
<td>2</td>
<td>Universal Testing Machine with Electronic extensometer</td>
<td>GDR Sr. No-283/40-1976</td>
</tr>
<tr>
<td>3</td>
<td>Universal Testing Machine With Electronic extensometer</td>
<td>MCS-MP/ 156-12/06</td>
</tr>
<tr>
<td>4</td>
<td>Universal Testing Machine</td>
<td>SFM30</td>
</tr>
<tr>
<td>5</td>
<td>Universal Testing Machine</td>
<td>KIC-2-1000-C</td>
</tr>
<tr>
<td>7</td>
<td>Charpy Impact Testing Machine</td>
<td>IT 300 ASTM</td>
</tr>
<tr>
<td>8</td>
<td>Impact Testing Machine</td>
<td>Model: ZBC2452-C/150</td>
</tr>
<tr>
<td>9</td>
<td>Brinell / Vickers Hardness Tester</td>
<td>HPO 250 F.N-308/92</td>
</tr>
<tr>
<td>10</td>
<td>Rockwell Hardness tester</td>
<td>RA/FIE</td>
</tr>
<tr>
<td>11</td>
<td>Rockwell Superficial Hardness Tester</td>
<td>RAS/FIE</td>
</tr>
<tr>
<td>12</td>
<td>Wilson Wolpert Hardness Tester</td>
<td>Sr. No.: 930/250</td>
</tr>
<tr>
<td>13</td>
<td>C cupping machine (Scale)</td>
<td>FIE/1990</td>
</tr>
</tbody>
</table>
MECHANICAL TESTING EQUIPMENT (2/2)

14. Brinell / Vickers Hardness Tester
   Make: TCS, Model: ABC-123
   Purchase in 2021

15. Micro Hardness Tester
   Make: LECO USA, Model: 400-HIL, Serial No: 1707565
   Calibration in 1996

16. V Notching Machine
   Fine Marketing, Model: 1976, TCR/MEC/EPQ/15
   Calibration in 2015

17. Hydraulic Pipe Bending Machine
   Make: TCS, Model: ABC-123, Serial No: 965
   Calibration in 2015

18. Hydraulic Test Pump & Compressor
   Make: TCS, Model: ABC-123, Serial No: 600kg/cm²
   Calibration in 2015

19. Digital Thermometer with sensor (New)
   Make: TCS, Model: ABC-123, Serial No: 090901
   Calibration in 2015

20. Digital Thermometer with sensor (New)
    Make: TCS, Model: ABC-123, Serial No: 090901
    Calibration in 2015

21. Digital Weighing Balance
    Make: TCS, Model: ABC-123, Serial No: 01/020766
    Calibration in 2015

22. Digital Weighing Balance
    Make: TCS, Model: ABC-123, Serial No: 01/020766
    Calibration in 2015

23. Temp controller with Indicator & sensors
    Make: TCS, Model: ABC-123, Serial No: 01/020766
    Calibration in 2015

24. Fatigue test system
    50 KN and 250 KN
    Make: BISS - Bangalore
### CHEMICAL ANALYSIS – INSTRUMENTATION

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/03 | ±1% of conc.

6. **Optical emission Spectrometer (OES)**  
   ARL QUANTXRIS/  
   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/01 | 0-50 g 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

For more information, please visit our website: www.tcreng.com
## CHEMICAL ANALYSIS – INSTRUMENTATION (2/2)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass Thermometer</td>
<td>GRM INIDIA TCR/MECH/TM/02, -10 to 110°C</td>
</tr>
<tr>
<td>Temperature and humidity meters</td>
<td>TCR/TEMP/02 - HTC-1 Spectro room</td>
</tr>
</tbody>
</table>

### INSPECTION AND QUALITY AUDIT EQUIPMENT

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metric Scale</td>
<td>TCR/CUP/mach./01</td>
</tr>
<tr>
<td>TESA</td>
<td>TCR/VC/TESA/01</td>
</tr>
<tr>
<td>External Micrometer</td>
<td>TCR/DC/01</td>
</tr>
<tr>
<td>Digital Vernier Caliper</td>
<td>TCR/DC/01</td>
</tr>
<tr>
<td>Tube Micrometer</td>
<td>TCR/DC/01</td>
</tr>
<tr>
<td>Pipe Micrometer</td>
<td>TCR/DC/01</td>
</tr>
<tr>
<td>DIN Vernier Caliper</td>
<td>TCR/DC/01</td>
</tr>
<tr>
<td>Vernier Caliper Aero space</td>
<td>TCR/DC/01</td>
</tr>
</tbody>
</table>

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**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. – 20005065
   - 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%

   - 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
## CORE MACHINERY & EQUIPMENT

### WET CHEMICAL ANALYSIS

1. Oven
   - Lab Heat: TCRWAO/EO/09, -0.10°C
   - EOR: TCRMAO/EO/01, -0.10°C
2. Glass Thermometer
   - KWAULT/TCR/MEC/EOP/22
   - 1°C URM/TO/MEC/EOP/1
3. Ultrasonic Testing Equipment
   - Normal Probes: Ultratech / SN: 16 / 2 MHZ / 24 NP
   - V1 Block & V2 Block: Ultratech / SN: 16 / 2 MHZ / 10 NP
4. Ultrasonic Testing Equipment
   - Ultratech / 14 MHZ / 10 NP (2 No.)
5. Chart Recorder
   - Type: GEC1
   - Model: TCRMAO/EO/01
6. Electronic Digital Balance
   - Mettler Model: A8-S-A
   - Range: 0.1 mg to 1 mg
7. Magnetic Particle Testing Equip.
   - Yoko Y1/13 AC/DC L1 No. 8960 / 1 D
   - Powder: Magnaflux 8A / Black Water Based Powder
8. Magnetic Particle Testing Equip.
   - Automeg BW-245

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

<table>
<thead>
<tr>
<th>Core Machinery &amp; Equipment</th>
<th>Contact Details</th>
<th>Marquee Projects</th>
<th>Core Machinery &amp; Equipment</th>
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<td>Appreciation Letters</td>
<td>Next Steps</td>
<td>Core Machinery &amp; Equipment</td>
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</tr>
</tbody>
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For more information please visit our website: [www.tcreng.com](http://www.tcreng.com)
### NDT - INDUSTRIAL SAFETY AND NDT SHUTDOWN PROJECT MANAGEMENT (2/2)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>7</td>
<td>Magnetic Ink Black Oil Base Instachek MSL 61 B Fluorescent Test</td>
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<tr>
<td>8</td>
<td>Ultraviolet Light A M Trading UMW 001</td>
</tr>
<tr>
<td>9</td>
<td>Dry Powder Sprayer UPKAR</td>
</tr>
<tr>
<td>10</td>
<td>D P Testing Eqpts. &amp; Materials Developers: PD 31 B PMC Penetrant: 15 B PMC Cleaners PCM</td>
</tr>
<tr>
<td>11</td>
<td>Coating Thickness Gauges Positector 6000 NF-2 0-650 Micron ± 3 Micron</td>
</tr>
<tr>
<td>12</td>
<td>EPOCH LT PANAMTRICS-NDT DIGITAL ULTRASONIC DETECTOR 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</td>
</tr>
<tr>
<td>13</td>
<td>Portable Hardness Tester TH-130 / HL- 200</td>
</tr>
<tr>
<td>14</td>
<td>Digital Coating thk. Machine Defelsko corp. model-6000-FN2 0-1500 micron</td>
</tr>
<tr>
<td>15</td>
<td>Davinci Alpha UT machine Sr no. D 0152-4209 Modsonic</td>
</tr>
<tr>
<td>16</td>
<td>Surface Roughness Tester TR 100 TIME Sr. No. 10663000012</td>
</tr>
<tr>
<td>17</td>
<td>Portable Magnetic permeability tester Model – Ferroman master</td>
</tr>
<tr>
<td>18</td>
<td>Portable hardness Tester HL 200</td>
</tr>
<tr>
<td>19</td>
<td>Fire Extinguisher Foam Inverted Type – B Powder B&amp;C</td>
</tr>
</tbody>
</table>
### Core Machinery & Equipment

#### Appreciation Letters

#### Marquee Projects

#### Core Machinery & Equipment

#### Next Steps

#### Contact Details

---

### Corrosion Testing Equipment (1/2)

<table>
<thead>
<tr>
<th>No.</th>
<th>Equipment</th>
<th>Manufacturer/Model</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pressure Gauges</td>
<td>Pioneer TCR/PG/07</td>
<td>0-600 Kg/Cm²</td>
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<tr>
<td></td>
<td></td>
<td>Bourdon TCR/PG/05</td>
<td>0-250 Kg/Cm²</td>
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<tr>
<td></td>
<td></td>
<td>Wika/TCR/PG/08</td>
<td>0-40 Kg/Cm²</td>
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<tr>
<td></td>
<td></td>
<td>Hi-Teck TCR/PG/09</td>
<td>0-70 Kg/Cm²</td>
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<tr>
<td></td>
<td></td>
<td>Fair/TCR/PG/09</td>
<td>0-70 Kg/Cm²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A LOT/ TCR/PG/10</td>
<td>0-42 Kg/Cm²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A LOT/ TCR/PG/14</td>
<td>0-70 Kg/Cm²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wika I 0-1000 Kg/cm²</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Pressure Gauges (Corrosion Lab)</td>
<td>Hi-tech/1752/TCR/PG/COR/01</td>
<td>0-70 Kg/Cm²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hi-tech/1762/TCR/PG/COR/02</td>
<td>0-70 Kg/Cm²</td>
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<tr>
<td></td>
<td></td>
<td>Hi-tech/1753/TCR/PG/COR/03</td>
<td>0-70 Kg/Cm²</td>
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<tr>
<td></td>
<td></td>
<td>AKVALA/ TCR/PG/12</td>
<td>Sr.No. 51030328</td>
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<td></td>
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<td>0-70 Kg/Cm²</td>
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<td></td>
<td></td>
<td>AKVALA/ TCR/PG/13</td>
<td>Sr.No. 51030331</td>
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<td></td>
<td></td>
<td>0-70 Kg/Cm²</td>
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<tr>
<td>3</td>
<td>Thermocouple (Corrosion Lab)</td>
<td>Marvel Electronics</td>
<td>Sr. No. 080220(D) 0-800 deg. C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sr. No. 080220(D) 0-800 deg. C</td>
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<tr>
<td>4</td>
<td>Digital Coating Thk. Gauge with Foils</td>
<td>Defelsko corp. model-6000-FN2</td>
<td>0-1500 micron</td>
</tr>
<tr>
<td>5</td>
<td>Digital Thermometer with Sensor for Impact test</td>
<td>Model-221P-RTD</td>
<td>Sr. No. 060601</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-196 To 200 Deg C</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Model-Pt-100-RTD</td>
<td>Sr. No. 090901</td>
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<tr>
<td></td>
<td></td>
<td>-196 To 50 Deg C</td>
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<tr>
<td>6</td>
<td>Dial gauge</td>
<td>Sr. No. 7532, 0-10 mm</td>
<td>Sr. No. J8037, 0-10 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sr. No. 1386/1, 0-3 mm</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Sr. No. G9490, 0-10 mm</td>
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<td></td>
<td></td>
<td>Sr. No. 1386/1, 0-3 mm</td>
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<tr>
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<td></td>
<td>Sr. No. 2099, 0-10 mm</td>
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<tr>
<td>7</td>
<td>Dial Gauge (Impact)</td>
<td>Shock proof, Sr. No. J8037, 0-10 mm</td>
<td>Mitutoyo, Sr. No. 9813K7, 0-1 mm</td>
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<td>Sr. No. 78018, 0-1</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>High Pressure Vessel (Autoclave)</td>
<td>272-6175-327-0606 &amp; 328 Acrylic vessel</td>
<td>P H Meter</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Make-Lab India</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>HIC Vessel</td>
<td>TIC With Sensor</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Temp. Indicator with sensor</td>
<td>SE/TC1S &amp; TCS2</td>
<td>0-1000</td>
</tr>
<tr>
<td>11</td>
<td>Temperature Controller with Sensor (6 Channel)</td>
<td>PID-8000 Libratham TCR/CHM/PID/01</td>
<td>0-150</td>
</tr>
<tr>
<td>12</td>
<td>Temperature Controller with Sensor</td>
<td>SE/200 I SS/TC/02 Ambient</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Hydrogen Sulphide Cylinder</td>
<td>Hydrogen Sulphide Controller Hydrogen Sulphide Detector MSA H2s ALTER H2S Mask</td>
<td></td>
</tr>
</tbody>
</table>
CORROSION TESTING EQUIPMENT (2/2)

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

15. Temperature Sensors
   Sensor 1 to 4

16. Temperature Sensors
   (J Type) OMEGA
   P05D650JIHA2 I P05D650JIHA I
   P03C346JIIHC2
   0-250 Deg C

17. Temperature Sensors
   (K Type)
   P03C346JIHC1 I 07070/71 I TC1 I
   TC2 I 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 I Sr. No.02034, 12 kN
   I Sr. No.02028, 12 kN I Sr. No.02026, 12 kN
   I Sr. No.02025, 12 kN I Sr. No.02013, 12 kN
   I Sr. No.02014, 12 kN I Sr. No.02015, 12 kN
   Kgs I Sr. No.97504, 0-2000 Kgs
   Sr. No.97502, 0-2000 Kgs
   Sr. No.97506, 0-2000 Kgs
   Sr. No.97508, 20 kN I Sr. No.97505, 20 kN
   I Sr. No.97507, 0-2000 Kgs
   Sr. No.97509, 20 kN
   Sr. No. 3957, 20 kN
   Sr. No. 3956, 20 kN I Sr. No.03001
   06 kN I Sr. No.03002, 06 kN
   Sr. No.03003, 0-600 Kgs I Sr. No.03004
   0-600 Kgs I Sr. No.02033, 12 kN I Sr. No.97503,
   0-2000 Kgs
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