Company Profile
Material Testing Lab, Risk Based Inspection, Engineering Consulting, NDT Services and Training

Founded in 1973 | ISO 17025, BIS and NABL Accreditation | Multi-National Locations

www.tcreng.com
India | Middle-East | Africa | Asia-Pacific
Document Version: Public Release under Copyright held by TCR
Version Date: 14.0
Date Printed: March 1, 2014
File Name: TCR-Engineering-Services-Profile-2014.doc
Contributors: Sales and Marketing
Contact: Rohit Bafna

### Document History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date Delivered</th>
<th>Description of Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.0</td>
<td>March 1, 2014</td>
<td>Revised and released on TCR Website</td>
</tr>
<tr>
<td>11.0</td>
<td>September 09, 2012</td>
<td>Revised and released on TCR Website</td>
</tr>
<tr>
<td>10.0</td>
<td>March 06, 2011</td>
<td>Revised and released on TCR Website</td>
</tr>
<tr>
<td>9.0</td>
<td>February 06, 2010</td>
<td>Released on TCR Website</td>
</tr>
<tr>
<td>9.0</td>
<td>March 06, 2009</td>
<td>Revision 9.0</td>
</tr>
</tbody>
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1. About TCR Engineering Services

Founded in 1973, TCR Engineering Services (TCR) is India's most reputed and established, NABL and ISO 17025 accredited independent Material Testing Laboratory, Third Party Inspection and Quality Assurance Company. TCR Engineering Consulting FZE, based in Dubai, UAE controls the overseas operations and has a strong Middle Eastern presence with offices in Kuwait and Dammam, Saudi Arabia as well as representative offices in Malaysia, Nigeria and Qatar.

The services TCR provides include Mechanical Testing, Fatigue, Metallography and Mircoscopic Studies (SEM, Optical Microscope, EDS, EDAX, XRD, TEM), Chemical Analysis, Positive Material Identification (PMI including onsite carbon detection), Non Destructive Testing (UT, DP, MP, PT, Automated UT using ToFD and Phased Array, Helium Leak Detection, Ferrite Measurement, Portable Hardness, MFL, Thermography, Eddy Current Testing), Welder Qualification (as per ASTM, ASME and API), RoHS Compliance Testing, In-situ Metallography (with SEM and EDAX), Corrosion Testing (HIC and SSC, Salt Spray, Inter-granular Corrosion), Risk Based Inspection as per API 581, Failure Analysis, Fitness for Service as per API 579, Finite Element Analysis, Vendor Evaluation, Factory Audits, Third Party Inspection, Metallurgical Product Evaluation, Post Weld Heat Treatment, Manpower Deployment, Training, Engineering Design and Analysis (CAD, CAM, CAE), Engineering Research, Reverse Engineering and Consultancy using NDT Level III and AWS/CSWIP inspectors.

TCR Engineering Services undertakes material testing as per international standards and specifications as defined by ASTM, NACE, DIN, AWS, API, ASME, BIS, IS, ISO and others. Testing can also be done as per client-supplied specifications.

Customers worldwide use TCR’s services to dramatically improve and certify their products, validate material quality, ensure innovation in the marketplace, and to achieve significant competitive advantages. As a result, these companies are bringing the right products to market, at the right time, at the right cost.

Till date, TCR has worked with more than 2000+ quality driven clients (from India and rest of the world) in Aerospace, Automotive, Oil Refineries, Petrochemical plants, Chemical Processing, Defense, Electronics, Nuclear Power and Capital Goods manufacturing industries to determine material properties, improve product's performance, assist to develop new and better products or materials, evaluate remaining life of an industrial equipment, determine why a component's performance expectations were not met, or to identify why a product may have failed.

The multi-disciplinary certified and experienced personnel team of professionals at TCR includes: metallurgical, mechanical, electrical, and chemical engineers; materials scientists; chemists; physicists; NDT inspectors and computer scientists who have the qualifications, the education and the experience to meet rigorous standards in the testing field, whether serving the Private and Public Sector, Government or the Military.

Customer Service Representatives, at TCR, provide clients with up-to-the-minute information on the status of a sample through the in-house laboratory information management software. The need for responsiveness is something understood by everyone in the company. Turnaround time has been improved without sacrificing quality by operating 12 hours a day in the lab, 16 hours a day in the machine shop.

TCR Advanced Services, a TCR Engineering service partner company, has its laboratory in Baroda. TCR Advanced, also accredited to ISO 17025 standards offers specialized services in the field of Metallography, including Failure Investigations, In-situ Metallography for process related equipment's in-service degradation, Indigenization of the components, Selection of materials of constructions, Weld repair solution etc.

In recent years, TCR has been recognized as one of the most innovative, successful, and fast-growing private companies in India. The company won the prestigious award from NACE International for “Excellent Laboratory in Private Sector” in September 2007.

A. Laboratory Accreditation

TCR Engineering Services is a Bureau of Indian Standards and NABL accredited laboratory. NABL approval is from National Accreditation Board for Testing and Calibration Laboratories, Department of Science and Technology, Government of India. NABL provides laboratory accreditation services to laboratories that are performing tests / calibrations in accordance with ISO 17025.
ISO/IEC 17025 includes the quality system requirements of ISO 9001 and additional requirements to demonstrate that the laboratory is technically competent and able to produce technically valid data and results.

TCR is one of the select few test houses, in India, to be on the approved list of such organization as Bharat Heavy Electrical Ltd., Nuclear Power Corporation of India Ltd. (NPCIL), Larsen & Toubro Ltd. (L&T), Engineers India Ltd. (EIL), Toyo Engineering India Ltd., Oil & Natural Gas Commission (ONGC), Bhabha Atomic Research Centre (BARC), Vikram Sarabhai Space Centre (VSSC), Dept. of Defense, DGS&D, Indian Railways, Mumbai Municipal Corporation, Dept. of Telecommunications, Electronic Corporation of India Ltd and others.

TCR is also approved by international recognition bodies including Halliburton, Schlumberger, Wartsila, American Bureau of Shipping (USA), Bureau Veritas (France), Lloyds Register of Shipping (UK), Det-Norske Veritas (Norway), SGS (India) Ltd. Indian Register of Shipping, Mercantile Marine Dept, Bureau of Indian Standards, and others.

TCR’s in-house quality system (accredited to ISO 17025 for Mechanical, PMI, RoHS and Chemical testing) assures that all sample specimens are properly handled, machined, tested, examined, and inspected in accordance with test requirements.

The mission of the Quality Assurance Department is to maintain the ISO 17025 established standards of quality, and for the development and application of the systems and procedures necessary to meet or exceed the quality requirements of all customers.

The Quality Assurance Department conducts frequent and vigorous internal audits to ensure the highest possible level of quality in support of the TCR service offering.
In the year 2014, TCR Engineering Services received an approval of “Well known Material Testing Laboratory” by Central Boilers Board (CBB), Government of India, Ministry of Commerce and Industries. With this approval TCR’s can now carry out life assessment jobs and certify the fitness of boiler components as per Indian Boiler Regulation (IBR).

B. Company History

Growth and downturn. Boom and bust. High and low. Economic and business cycles are in constant flux, driving change and have a lasting impact on industry structures, the role of technology, customer behavior, the creation, and the destruction of markets. It is a tall order for any firm to deal with this paradigm as it strives to maintain its survival. Organizations need a trusted partner who will help them navigate through these ever changing conditions. TCR Engineering Services has not only survived these cycles in the last three decades but has also remained true to its customers and helped them weather these economic uncertainties.
C. Why TCR

- TCR Engineering Services is registered with all major companies in India and abroad
- TCR brings its experience gained over the last 40 years in the field of material testing, inspection and quality assurance with its strong commitment and adherence to the ISO 17025 standards.
- Experienced by conducting over 1800 failure analysis projects. TCR is on the approved list of SABIC, Tasnee, APPC, Schlumberger, Saudi Aramco, QAFCO, SuezSteel, HPCL and Reliance for Failure Analysis Services. The company has access to Scanning Electron Microscopy with EDAX and Optical Inverted Metallurgical Microscopes. In-house corrosion testing facility as well as ability to test for Fatigue and Fracture Toughness.
- Conducted major projects on fitness for service and routinely undertake remaining life assessment and integrity assessment projects.
- Technical Training Courses conducted by TCR Engineering aims to provide in-depth knowledge and expertise to all plant operations and inspection personnel in India and other countries. Experts teaching this class each have over 15 years of industry experience.
- Use of Advanced NDT techniques including ToFD and Phased Array, Infrared Thermography, Eddy Current, Acoustic Eye Tube Inspection, Automated Reformer Tube Inspection System, Helium Leak Testing and more. Automated UT using ToFD is fast replacing Radiography as a preferred method for faster scanning of weld joints. TCR compliments this service with a range of conventional NDT services.
- Assisting RLA studies by conducting in-situ metallography (Metallographic Replication) by a talented and experienced team
- Access to a pool of resource talents, ability to undertake faster mobilization and committed to work under good safety, health and environment principles.
2. Material Testing Services

TCR Engineering Services’ ability to provide value to our metal testing customers is based on organizing multiple talents into a focused set of technological capabilities. TCR provides several testing services, but, no matter which discipline you choose, one thing is certain. When you send a sample to TCR, you can have confidence in the results, because you are working with a company that has a reputation for being meticulous.

A. Mechanical and Physical Testing

TCR provides a comprehensive range of Mechanical Testing services with a dedicated machine shop to assist in sample preparation.

The Mechanical Testing Facility at TCR conducts tensile tests for understanding the strength characteristics of a material and provides precise determination of Proof Stress by the attachment of various electronic controls and extensometers. Testing temperatures range from 50°C to 850°C and beyond for particularly high temperature applications. The Mechanical Testing department at TCR performs a range of Impact tests, including Izod and Charpy testing from 100°C to -196°C. Highly specialized pressure test facilities are also available.

TCR is well equipped to determine mechanical properties of materials and solve a wide variety of technical problems for industry. Mechanical Testing Facilities available at TCR in India include:

- Universal Testing Machine of Capacity 100 T with Electronic Extensometer
- Universal Testing Machine of Capacity 40T
- Universal Testing Machine with Extensometer of capacity 0 - 13T
- Fatigue Testing and CTO
- Charpy Izod Impact Tester, Charpy Impact Tester (ASTM E 23)
- Brinell / Vickers Hardness Tester and Rockwell Hardness Tester
- Rockwell Superficial Hardness Tester, Micro Hardness Tester
- Hydraulic Test Pump
- Shadowgraph
- Erichsen Cupping Machine
The following are also available: Welder Qualification, Bend Tests, Compression Tests, Flaring and Flattening Tests, Hardness Testing (Rockwell, Brinell, and Superficial Micro Hardness), Nick Break, Drop Weight, Proof Load, Hydraulic / Pneumatic Test, Component Testing, and more.

Superior technology, responsive versatility, and quality performance ensures reliable and fast turnaround on all test results. A dedicated in-house sample machine shop ensures that all test samples are machined onsite. Experts in the Machine shop are capable of low stress grinding and machining sub-size specimens to very close tolerances. Professionals in the machine shop can custom design fixtures, mount specimens for metallography examinations, and custom fabricate TOFD weld blocks for NDT operators.

Equipment at the machine shop includes CNC wire cut machine, milling and lathe machines, hacksaw, drilling machine, stress-free grinding equipment, saws, surface grinders, and other tools.

Complete List of Mechanical Testing services at TCR include:

Tensile / Transverse/Compression test
Tensile test with 0.2% proof stress, stress / strain diagram with electronic extensometer inclusive of sample machining charges
Tensile test at an elevated temperature upto 850 Deg C with Extensometer and without Extensometer upto elevated Temperature of 400 Deg C
Tensile (n.k.r. value) / composite / plastic / fabric
Tensile test for fine wires/foils
Tensile test for steel bar up to 20mm and up to 36 mm dia
Ball Test
Bend test / Reverse bend / Rebend / Root / Face / side bend test
Flattening / Flaring Test
Re-bend test including ageing
Proof load test on Nut up to 40000kg
Proof load test on Nut over 40000kg
Full size breaking of bolt
Wedge load test / Head soundness test
Compression test of springs (upto 3 readings)
Tensile test for fine wires/foils
Charpy V notch Impact Test (a) R. T. inclusive of sample machining charges as per ASTM E23 (for a total set of 3 specimens and 3 readings)
Impact Test upto – 60 ºC and bellow – 60 ºC
Hardness test Rockwell A, B, C
Vickers hardness test
Brinell hardness test
Jominy end quench test (without normalizing heat treatment)
Sectional weight of CTD bars
Surface Characteristics of CTD Bars
Hydraulic / Pneumatic Test inclusive of sample preparation charges
Shear Test
Proof Load / Slip Test on fabricated items such as clamps and assemblies
Load test up to 40 Ton
Peel test
Residual Stress Measurement
B. Metallography Tests

Qualified metallurgists at TCR are experts in Metallographic preparation & examination to evaluate the characteristics of metals. They can access a material’s heat treatment condition, microstructure, and forming process. The team undertakes Macro and Micro examination including Weld Examination, Case Depth and Decarburization Measurement. Micro Hardness Testing and Coating/Plating evaluation is also undertaken.

The Metallography department has the state-of-the-art Inverted Metallurgical Microscope Olympus GX51 and the Leco 500 Microscope with an Image Analysis System. The company also has an SEM. The team has in-house developed microstructure characterizer software that assists with the analysis of images to determine the micro structural degradation due to creep. The software can also calculate the graphitization, depth or width of decarburization, phase/volume percentage, grain growth, inclusion rating, particle size, volume percentage, particle count, porosity and coating thickness.

TCR can undertake metallurgical evaluation using SEM, EDAX, XRD and TEM as well. The range of services in metallography at TCR include:

- Microstructure Examination (Routine) with two photographs
- NDT microstructure with two photographs
- Microstructure with Comment on Heat Treatment
- Microstructure examination for failure related study
- Grain size distribution chart on Image Analysis (With print out)
- Prior austenite grain size measurement (including heat treatment charges)
- Prior austenite grain size measurement by Mc Quid Ehn method (including carburizing)
- Oxide-scale/Nitriding/Carburizing/Decarburizing/Coating – Measurements. (Avg. of 3 readings), over and above microstructure examination charge
- Grain size Measurement as per ASTM E112 with photograph
- Linear measurement, up to 3 measurements, over and above macrostructure/microstructure examination charge
- Each Additional linear measurement
- Inclusion Rating as per ASTM E45 Method A with photograph
- Inclusion rating as per ASTM E454 with photograph
- Color Metallography (With two Photos)
- Delta ferrite from SS weld microstructure, Sigma phase, volume fraction by microstructure examination (Avg. 5 frames)
- % Nodularity, Nodule Count as per ASTM A247
- Porosity Analysis as per ASTM 276
- Decarbization level as per ASTM E 1077
- Phase Distribution as per ASTM E 562 / 1245
- Powder particle size measurement (Avg. 5 frames)
- Coating Thickness Measurement as per ASTM B 487
- Retained Austenite measurement with electro polish and copper deposition method, and calculation on image analysis software from microstructure examination. (Avg. 5 frames)
- Micro-Hardness Testing
- Micro hadness profile for case depth measurement (max. 10 readings)
- Macro Etch Test up to 100 mm (Including Photo & Comments)
- Macro Etch Test Between 100 to 200 mm (Including Photo & Comments)
- Macro Etch Test Over 200 mm (Including Photo & Comments)
- Fractography by Stereo Microscope or by SEM
- Coating thickness by SEM
- Microstructure Examination Test With Photographs, Grain Size Comment on Carbide Precipitation, Nitrides & Intermetallic Phases In Haz, Parent, Weld As Per A-262,E-112 for Inclusion Rating
- Hydrogen Embrittlement on Copper
- Ferrite as per ASTM E562 per phase per sample
- Intermetallic Phase (Chi, Sigma, Laves Nitrate Carbide) per phase per sample
- Intermetallic Phases in Weld, Parent Material (PM), Heat Affected Zone (HAZ) per phase per sample
- Microstructure test with photograph (for Sigma Phase)
Microstructure test with photograph (for Ferrite content)
Analysis of a given SEM Image for particle size and particle size distribution (max/min, size/frequency information) of the dispersed phase in a continuous phase matrix.
Cost to prepare the sample for placement in SEM sample chamber
SEM Analysis with single image
Delta Ferrite Measurement by Ferritscope
Pit Dimension Measurement
EDAX / EDS Analysis
XRD Analysis
Structural Examination (As per 6.1)
Structural Examination (Each Addition measurement)
Inclusion rating as ASTM E15 – Method D (Set of six specimen)
Volume Fraction measurement (30 Frames) as per phase
Sodium hydroxide etch as per A 923 Method A
Microstructure carbide network as per SEP 52100 chart (Heat Treatment charges are extra)

Insitu Metallography
Step Macro without photograph
Step Macro with photograph
Macro Measurement (MLP/Penetration... etc.)
Depth of Attack
Banding Index
Intermetallic Phases
Coating/Plating Thickness/Mesh Size
Austenitic Grain Size with photographs (up to 3 samples)

C. Chemical Analysis
An inherent strength of TCR Engineering Services is the ability to successfully undertake analytical chemistry assignments. With an ever-expanding senior staffed team of highly qualified Analytical Chemists experienced in using the full range of analytical instruments which include state-of-the-art Spectrometers and Wet Chemistry lab facilities, TCR can cater to all analytical requirements for Ferrous, Non-Ferrous Metals, Ceramics, Glass, Refractory, Minerals and Ferro Alloys. The chemical department can analyze samples in all forms including drillings or turnings, solid samples and liquids.

State-of-the-art equipment available at TCR includes:
- Optical Emissions Spectrometer (OES)
- Inductively Coupled Plasma (ICP) Spectrometer
- Glow Discharge spectrometer (GDS)
- Atomic Absorption Spectrometer
- Automatic Carbon Sulphur Determinators
- Xray Fluorence (XRF) Spectrometer

The Classical Wet Chemistry (bench chemistry) department uses Gravimetry and Titrimetry procedures to analyze chemical composition of materials, and assists in the identification of unknown materials and gaining an understanding of their chemical composition, structure and function. Most classical wet chemical methods can accommodate comparatively small amounts of a sample in diverse shapes or forms. Fully compliant to environmental standards of India, the wet chemistry department at TCR is sought by leading companies all over the world for trace chemical analysis to very low detection levels.

The complete range of Chemical Analysis Services at TCR includes:

**Chemical Analysis by Classical Wet Method**
Ferrous metals (including) C, S, P, Mn, Cr, Mo, Ni
Non Ferrous
Refractory, Ceramics and Minerals, Ferro alloys (Fe-Mn, Fe-Si, Fe-Mn-Si, Fe-Mg-Si, Low C Fe-Cr, Fe-Mo)
Non Ferrous metals (each additional element)
Elements such as Co, Al, W, Cu, Sn, Ti, Mg, V in steel
Nitrogen / Boron / Palladium (each element)
Purity of Cu
Purity of Al, Zn, Pb, Ni, Bi, Cd, Sn, Mg, W, Ti
Oxygen Analysis and Hydrogen Analysis

Chemical Analysis by Spectrometers
EDAX analysis, Complete Chemical Analysis up to 8 elements
Impurities in PPM Level using AAS or ICP

Chemical Analysis by LECO
Oxygen by LECO
Nitrogen by LECO
Hydrogen by LECO

Steel and Cast Iron
Determination of any one element (%C)
Determination of any one element (Mn, Si)
Determination of any one element (Ni, Cr, S, P)
Determination of C, Mn, Si, S, P
Complete analysis of Low Alloy Steel up to 8 elements including C, S, P, Si, Mn, Ni, Cr, Mo
Determination of any one element in Stainless Steel
Complete Analysis of Stainless Steel up to 8 elements
Determination of High Alloy element (Cr, Ni, Mn)
Determination of some special element (Cu, Ti, Co, V, W, Al) per element
Complete analysis of High Speed Steel (8 elements) per element
Determination of Mo%
Determination of V%
Nitrogen in steel

Non Ferrous Material
Copper Base Alloys
Determination of any one element
Complete Analysis of 6 elements
Purity Test of Cu
Purity test of other non ferrous element

Tin, Aluminum, Lead Base
Determination of any one element
Complete Analysis of up to 8 elements
Purity Test
Only Aluminum %

Ferro Alloys
Analysis of Main Element
Each Subsequent element

Other Tests
pH Value Determination
Sand Content (as SiO2)
Acid Insolubles
Sulphates, Chlorides, Silicates, Carbonates, Oxides of Iron per element
Elemental analysis – Calcium, Magnesium, Potassium, Sodium, Iron per element
Moisture Content
Analysis by XRF per element
Ash Content
D. Oil Analysis - Ferrography

Ferrography (Oil analysis) is a series of laboratory tests to determine the condition of used Lubricants and equipment components, over a period. A trend of Wear Particle Concentration typically presents the opportunity for Maintenance programs from breakdown to be more proactive.

There are six basics wear particle types generated through the wear process. These include metallic particles that comprise of Normal Rubbing Wear, Cutting Wear Particles, Spherical Particles, Severe Sliding particles, Bearing Wear Particle (Fatigue Spall Particles, Laminar Particles) and Gear Wear (Pitch Line Fatigue Particles, Scuffing or Scoring Particles). There do also exist sand and dirt particles responsible to generate wear particles in the system.

Benefits of Ferrography
• Reduction in unscheduled downtime due to wear of rotary components like bearings and gears
• Effective maintenance scheduling
• Improved equipment reliability and safety
• Reduction in maintenance costs
• Maximization of oil change-out intervals that indirectly conserves environmental cleanliness aspect
• Reduction in machine power consumption over a period

E. RoHS Compliance Testing

TCR Engineering Services undertakes RoHS and WEEE related compliance testing for electronic products and accessories using both the Non Destructive Screening Method using XRay Fluorescence Spectroscopy (XRF) as well as the Verification Method using Inductively Coupled Plasma (ICP) Spectrometer. The RoHS Testing Team at TCR analyzes concentrations of lead, mercury, cadmium, chromium, polybrominated biphenyls (PBBs), and polybrominated diphenyl ethers (PBDEs) in electrical and electronic components to the required limits to ensure that products meet requirements but more importantly, that products retain their full functionality.

F. Lead Inspection and Detection

As awareness continues to increase on the ill-effects of Lead (Pb) in day-to-day products in India and overseas, TCR Engineering Services undertakes classification of definitive positive/negative results for Pb using the portable XRF instruments. The XRF instrument of TCR can detect of lead in Paints & Coatings, Oils & Liquids. The tests are done in-situ and it can help in establishing area contamination boundaries and depth profiles including assisting in site investigations, delineation and contamination patterns.

The lead inspection service from TCR allows manufactures in India to create lead-free landfills, hazardous clean-up sites, consumer electronic materials, children's toys and jewelry, cooking or eating materials, packaging, and several other materials.

G. Fatigue Testing

TCR Engineering has expanded its capabilities include fatigue, fracture toughness, CTOD, and high temperature tensile testing with the addition of two new Fatigue System Universal Testing Machine in capacity of 50KN and 250KN. The versatile servo-hydraulic systems allow the mechanical testing lab of TCR in Mumbai to perform numerous types of fatigue tests on many different sample sizes and orientations in temperature range from Ambient – 1000°C. TCR has the capability of applying linear displacements utilizing linear and hydraulic actuators. Comparison fatigue testing of OEM and alternate source parts can also be performed to demonstrate equivalency of fatigue life. Fatigue testing can be thought of as simply applying cyclic loading to a test specimen to understand how it will perform under similar conditions in actual use. The load application can either be a repeated application of a fixed load or simulation of in-service loads. The load application may be repeated millions of times and up to several hundred times per second.

Fracture Toughness Tests are conducted as per ASTM / British Standards etc. The ASTM 1290 method to determine CTOD was withdrawn in January 2013 and it is now incorporated into ASTM E1820 for measurement of KIC CTOD and JIC from a single test. TCR undertakes tests on materials of your choice using SENB, CTS and ARC shaped bend specimens and others that are based on the availability of the product form, and the dimensions of the specimens are as stipulated in the
Fracture Toughness determines the amount of stress required to propagate an existing flaw or defect in specific materials. Since traditional methods of destructive testing cannot always predict how a material will behave with a defect, fracture toughness is very important in the design stage.

Crack-Tip Opening Displacement (CTOD) is used as a type of fracture toughness testing to determine if a material is appropriate for strenuous working conditions. CTOD testing is the measure of deformation prior to failure in a pre-cracked sample. This type of test is a variation of fatigue testing that has load rates more representative of in-service conditions. TCR Can conduct fatigue testing as per ASTM E606 [Low cycle fatigue-Strain controlled Fatigue Testing], and ASTM E466 [Load Controlled Fatigue Testing – High / or Low cycle fatigue testing].

TCR undertake the following ASTM/BS/ISO Specification Capabilities:

- ASTM E8 / E8M Tension Testing of Metallic Materials
- ASTM E21 Elevated Temperature Tension Tests of Metallic Materials
- ASTM E399 Linear-Elastic Plane-Strain Fracture Toughness (KIC) of Metallic Materials
- ASTM E1290 Crack-Tip Opening Displacement (CTOD) Fracture Toughness Measurement
- ASTM E1820 Measurement of Fracture Toughness (JIC-CTOD Measurement)
- ASTM E466 Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials
- ASTM E606 Strain-Controlled Fatigue Testing
- ASTM E647 Measurement of Fatigue Crack Growth Rates
- BS 7448 Fracture mechanics toughness tests. Method for determination of Kic, critical CTOD and critical J values of welds in metallic materials
- ISO 12135 Metallic materials – Unified method of test for the determination of quasi-static fracture toughness
- ASTM E9 – Room Temperature Compression Testing of Metallic Materials,

Testing applications done at the TCR Engineering Fatigue Test Lab in Mumbai are:

- Fatigue crack propagation [da/dN vs ∆K Studies]
- Fracture mechanics [K1c, J1c, CTOD] Testing
- 3 – point bend testing of materials
- Spring Fatigue Testing
- Room temperature and high temperature tests [up to 1000C]
- Tension/compression
- Low/High cycle fatigue (LCF/HCF) Testing
- High temperature tensile tests [up to 1000C]
- High strain rate testing [300mm/sec on 50KN and 100mm/sec on 250KN UTM]
- Slow strain rate testing [10-7 mm/sec on 100kN UTM]
H. Corrosion Detection

TCR Engineering Services (TCR), a NABL and ISO 17025 accredited independent material testing laboratory in Mumbai, India undertakes a wide range of corrosion and stress corrosion test per ASTM, NACE or as per an individual client’s requirements. Senior staff members are available to provide corrosion consulting, advice on corrosion prevention and corrosion control services including materials selection in laboratory or on-site inspection.

TCR’s staff with specific industry expertise covers a variety of corrosion problems that are encountered in industries such as oil and gas production, oil and gas transmission, energy conversion systems, and nuclear power systems. The objective of the corrosion detection department at TCR is to provide quality service at a reasonable price and work with all clients as an extension of their QA team.

A wide variety of corrosion related tests can be undertaken at TCR Engineering Services to determine weight loss corrosion, inter-granular attack, pitting corrosion, corrosion fatigue, stress corrosion cracking, sulfide stress cracking, and hydrogen-induced cracking.

TCR’s Sour Service Corrosion Testing department undertakes Small Scale Tests and Full Ring Testing for SSCC (NACE TM 0177, EFC 16 and 17) and HIC (NACE TM 0284). The range of instruments available to perform these tests in unrivalled in our operating regions. Highly experienced and qualified engineers within the group routinely undertake corrosion studies to include all observations as per NACE MR 0175. We can also carry out the tests listed above under 3rd party inspection of LRS, TUV, DNV, ABS, BV and other inspection agencies.

TCR offers comprehensive material testing of corrosion problems, including:

- Pitting Corrosion test as per ASTM G48 Specification
- Salt Spray Test
- Corrosion test as per ASTM G35 specification
- Inter granular Corrosion Test (IGC) per ASTM A-262 Practice A B C D E & F
- Hydrogen-Induced Cracking Test (HIC) as per NACE TM0284
- Sulfide Stress Corrosion Cracking Test (SSCC) as per NACE TM0177
- Hydrogen Disbonding Test as per ASTM G146 Specification
- Chloride Stress Corrosion Test as per ASTM G36 Specification
- Ammonia Vapor Test
- Corrosion test as per ASTM A761 Specification
- Customized Corrosion Testing
- Inspection as per NACE MR0175

Inter-granular corrosion

Inter-granular corrosion attack in stainless steels may result from precipitation of carbides, nitrides or inter-metallic phases. To conduct these tests as per ASTM A262, the corrosion team at TCR carefully chooses a method which is suitable for the steel grade and grain boundary composition to be tested.

Salt Spray (Neutral / Fog), ASTM B117

A number of samples can be tested at once at TCR for Salt Spray depending upon their size for salt spray corrosion testing of inorganic and organic coatings, especially where such tests are used for material or product specifications.

Pitting Corrosion Test

TCR can undertake Pitting Corrosion as per ASTM G48 Method B, Ferric Chloride Test which involves exposing a specimen to a highly oxidizing acid chloride environment, to determine the extent of pitting. We can also undertake Pitting Corrosion test as per ASTM A923 Method C.

Hydrogen-Induced Cracking (HIC) Test, NACE TM0284

HIC Test by TCR evaluates the resistance of pipeline and pressure vessel plate steels to Hydrogen Induced Cracking caused by hydrogen absorption from aqueous sulfide corrosion.

Sulfide Stress Corrosion Cracking (SSCC), NACE TM0177, EFC 16 and 17
Sulfide stress corrosion cracking (SSCC) test by TCR is done when a susceptible material is exposed to a corrosive environment containing water and H2S at a critical level of applied or residual tensile stress.

**Complete list of Corrosion Testing Services at TCR include:**

- Inter-Granular Corrosion Test as per ASTM 262 Practice A with photograph also called as Oxalic Acid Etch test
- Inter-Granular Corrosion Test as per ASTM 262 Practice B (Streicher Test)
- Inter-Granular Corrosion Test as per ASTM 262 Practice C (Huey Test)
- Inter-Granular Corrosion Test as per ASTM 262 Practice D
- Inter-Granular Corrosion Test as per ASTM 262 Practice E (Strauss Test)
- Inter-Granular Corrosion Test as per ASTM 262 Practice E for 72 hours
- Inter-Granular Corrosion Test as per ASTM 262 Practice F
- Stress Corrosion test as per ASTM G 36 First day (24 hours)
- Stress Corrosion test as per ASTM G 36 each additional day
- Huey Test with microstructure examination including Inclusion rating, Oxalic acid etch test, Sodium cyanide etching
- IGC test as per DIN EN ISO 3651 – 2, method A
- IGC test as per DIN EN ISO 3651 – 2 method B
- IGC test as per DIN EN ISO 3651 – 2 method C
- Pitting corrosion test as per G48 method A for 24 hours
- Pitting corrosion test as per A923 method C for 24 hours
- Pitting corrosion test as per A923 method A
- Corrosion Rate by Potentiostatic method
- Crevice Corrosion Test as per ASTM G48 method B
- Crevice corrosion as per ASTM A 923 (Method A, B & C)
- Chloride Stress Corrosion Cracking for 500 hours
- Hydrogen Induced Cracking Testing per NACE TM 0284 for Plate / Forgings, Tubes, Bars / Studs
- Sulfide Stress Corrosion Cracking per NACE TM 0177 at 24 Deg C, ATM Pressure for 720 hours.
- Sulfide Stress Corrosion Cracking per NACE TM 0177 at 90 Deg C, 16 bar Pressure for 720 hours.
- Salt Spray Test as per ASTM B117, quoted on a per hour basis for the first 24 hours. Please note that the size of chamber at TCR is 400 mm X 400 mm X 300 mm.

I. **Scanning Electron Microscope with EDS Analyser**

TCR has procured state of the art Scanning Electron Microscope (SEM) attached with Energy Dispersive Spectrometer (EDS) system. SEM is a great diagnostic tool for:

- Freiure 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 submicron features in microstructure
- Identification of Inclusions in metals

SEMART SS-100 offers simple and very user friendly operating console. It is equipped with turbo molecular pumping system to achieve the high vacuum. It requires absolutely no start-up time. The EDS Analyzer X-Max 20 is a versatile X-Ray spectrometer system which does not require Liquid nitrogen for its operation. This greatly reduces the start-up time of EDS accelerating voltages and lower spot sizes resulting in improved accuracy and quantification of elements which issometimes is a limitation of the conventional EDS detectors with 10 mm2 area.
3. Engineering Consulting

TCR’s dedicated engineering and metallurgical consulting team in India is a perfect partner for solving manufacturing and product quality problems. Several senior consultants with many years’ experience are available to help and advice on corrosion or materials selection queries. Our team can also advise on your welding engineering and heat treatment problems. From initial product design, through final production, TCR in-depth engineering consulting services ensures that clients are producing the best possible product.

Areas of routine consulting assistance include:

- Determining the right material for a product
- Corrosion engineering, corrosion testing and corrosion investigations
- Metallurgical failure analysis and welding evaluations.
- Investigate the effect of environmental conditions on a product or material
- Prepare material and process specifications for in-house quality control
- Compare vendor or competitive products
- Estimate the remaining service life of a product or machine component
- Develop Non Destructive Testing (NDT) Plan and TOFD/Phased Array procedures
- Manage Quality Control Projects
- Identify equivalents between Indian and foreign specifications
- Assist to solve product quality problems
- Assist in cost-benefit analysis post failure analysis
- Expert witness and opinion assistance in case of trade conflicts, materials disputes, and litigation issues
- Creating a custom Metallurgical Image Analysis Software

The consulting practice has recently added the following additional advanced service offerings:

- Finite Element Analysis and Stress Analysis
- Advanced materials & processes
- Fractography
- Surface Engineering
- Tribology
- Welding esp. repair welding and cast iron welding
- Thermal Spraying
- Atomized Powder Production(technology, QA, application wise requirements of powders)
- Life Cycle Analysis and Engineering Asset Management
- Global Warming–Role of Tribology & Surface Engineering
- CAD/CAM Modeling

The engineering consulting team at TCR routinely banks upon its professional team with strong engineering experience and fully equipped material testing laboratory facility to efficiently uncover the root cause of a failure and help recommend the best solution to prevent recurrence.

A. Failure and Root Cause Analysis

TCR has completed more than 1800 failure investigation assignments, including 200 major projects on manufacturing and metallurgical failures on ASME boiler and pressure vessels, gas turbine engine components, oil and gas transmission pipelines, food processing equipment’s, heat exchangers, medical supplies, refineries, petrochemical plants, aircraft/aerospace, offshore structures, industrial machinery, weldments and ships. The failure analysis team’s strength is in evaluating high temperature and high pressure failures.

The team has access to the complete range of testing facilities at our network of laboratories including access of optical microscopes, Scanning Electron Microscopes (SEM) equipped with Energy Dispersive Spectrometry (EDS), microstructure analysis software and photographic instruments.
Methodology for Failure Investigation

TCR Engineering works with clients to plan the failure analysis before conducting the investigation. A large amount of time and effort is spent carefully considering the background of failure and studying the general features before the actual investigation begins.

In the course of the various steps listed below preliminary conclusions are often formulated. If the probable fundamental cause of the metallurgical failure becomes evident early on in the examination, the rest of the investigation focuses on confirming the probable cause and eliminating other possibilities. The metallurgical failure analyst compiles the results of preliminary conclusions carefully considering all aspects of the failure including visual examination of a fracture surface, the inspection of a single metallographic specimen, and the history of similar failures.

Procedure to conduct a Failure Analysis

Cause of failure is determined using state-of-the-art analytical and mechanical procedures and often includes simulated service testing. A combination of analysis and physical testing locates problems and provides recommendations for solutions. The investigation team produces detailed written reports to ensure that clients fully understand and are able to independently examine the analytical results and conclusions.

The complete evaluation sequence is summarized as under:
- Collection of background data and selection of samples
- Preliminary examination of the failed part
- Complete metallurgical analysis of failed material
- A thorough examination of the failed part including Macroscopic and Microscopic examination and analysis (electron microscopy, if needed)
- If necessary tests may also include Weld Examination, Case Depth, Decarburization Measurement, Coating/Plating Evaluation, Surface Evaluation and/or Grain Size Determination
- Chemical analysis (bulk, local, surface corrosion products, deposits or coating and microprobe analysis)
- Tests to simulate environmental and physical stress that may have played a role in the failure
- Analysis of fracture mechanics.
- Selection and testing of alternative products and/or procedures that will significantly improve performance
- On-site evaluation and consulting services and Formulation of conclusions and writing the report (Including recommendations)

B. RLA and Condition Assessment of Boilers

TCR has a strong practice in accessing boilers for their condition and remaining life.

There are two RLA approaches viz., Level – II assessment and Level-III assessment.

A pragmatic approach is adopted by TCR in handling the cases of remaining life assessment. Efforts are put in to collect as much data as possible on the component / equipment history. Often brain storming sessions are conducted with the concerned people using the equipments includingthe outside experts who are familiar with the operational details. To collect opinions and ideas, which are evaluated vis-à-vis the testing and studies conducted at a latter stage.

CALCULATION BASED APPROACH

Calculation procedures are often employed to determine the expanded lives of components under creep, fatigue and creep fatigue conditions. From plant records, information on temperature and cycling history is gathered. By use of standard material properties and damage rules, the fractional life expended up to a given point in time can be estimated.

DESIGN APPROACH

Components which are operated bellow creep regime are generally designed on the basis of yield strength, tensile strength and fatigue strength with suitable safety factors. Under normal condition deformation and fracture is not time
dependent. As long as the applied stresses do not exceed the design stresses these components should last indefinitely; but in practice various factors causes reduction in life.

The Remaining life assessment approach is derived as under:

1. Understanding the actual degradation mechanism
   - FATIGUE
   - THERMAL FATIGUE
   - THERMO MECHANICAL FATIGUE
   - THERMAL AGING
   - CREEP
   - EMBITTERMENT
   - CORROSION

2. Visual examination
3. NDT involving In-situ Metallography, Ultrasonic Testing, Magnetic Particle Inspection, DP Test, Ferrite Measurement.
4. STRESS ANALYSIS - Stress analysis is carried out to know the strength of the material.
5. NON DESTRUCTIVE TESTING - NDT inspection data provide an good in-site to the component integrity.
6. LABORATORY TESTING - Laboratory testing of cut samples provide valuable information about the material soundness.
7. JUDGMENT OF FITNESS OF THE EQUIPMENT- Based on available data, a judgement of the fitness of the equipment is done.
8. SUGGESTIONS ON REPAIRING IF ANY - If required, repairing of the equipment is suggested, for life extension.
9. JUDGMENT OF REMAINING LIFE BASED ON ANALYSIS - Finally, the estimates for remaining life is carried out.

Often the physical properties are verified and not so common tests like Stress ruptures are conducted. Having ascertained the extent of degradation, judgment on the remaining life is made. In addition to this periodic inspection procedures are spelled out to monitor the health of the equipment during the course of operation. The results point out if any operational mistake, restriction in free movement by thermal expansion or any other damage mechanism prevailing is revealed and preventive maintenance approach can be formulated.

DEFINITIONS OF COMPONENT LIFE- When RLA is performed:

HISTORY BASED CRITERIA: 30 to 40 years have elapsed, Statistics of prior failures indicate impending failure, Frequency of repair renders continued operation uneconomical, Calculations indicate life exhaustion

PERFORMANCE BASED CRITERIA: Severe loss of efficiency indicating component degradation, Large crack manifested by leakage, severe vibration or other malfunction, Catastrophic burst

INSPECTION BASED CRITERIA: Dimensional changes have occurred, leading to distortions and changes in clearances, Inspection shows microscopic damage, Inspection shows crack initiation, Inspection shows large crack approaching critical size

CRITERIA BASED ON DESTRUCTIVE EVALUATION: Metallography or mechanical testing indicates life exhaustion

DATA REQUIREMENT FOR LIFE ASSESSMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Level – II</th>
<th>Level – III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feature</td>
<td>More detail</td>
<td>Most detail</td>
</tr>
<tr>
<td>Failure history</td>
<td>Plant records</td>
<td>Plant records</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Measured or nominal</td>
<td>Measured</td>
</tr>
<tr>
<td>Condition</td>
<td>Inspection</td>
<td>Detailed inspection</td>
</tr>
<tr>
<td>Temperature and pressure</td>
<td>Operational or measured</td>
<td>Measured</td>
</tr>
<tr>
<td>Stresses</td>
<td>Simple calculation</td>
<td>Refined analysis</td>
</tr>
</tbody>
</table>
LEVEL – II ASSESSMENT

For Level-II assessment, TCR will undertake following approach.

1. Collection of back ground data and history of Boiler Operation.
2. Thorough visual examination by an expert
3. Dimensional measurement at critical locations
4. Collection of scale and deposits samples and it’s analysis.
5. Detailed Thickness Survey
6. Internal oxide scale measurement at Super Heater Tube and Re-heater Tube
7. WFMPI of main weld joints of Header and Steam Drum
8. In-Situ metallography to find out thermal ageing and creep related problem for RLA point of view.
9. In-Situ hardness measurement with portable hardness tester.

Under level-II assessment no destructive analysis of tube sample and boroscopy is included. A detailed report along with evidences of damage of any and recommendations will be provided by estimation of RLA.

LEVEL – III ASSESSMENT

Under level-III assessment, detailed assessment of Boiler for which the details approached are given below.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>COMPONENT</th>
<th>VIS</th>
<th>UT</th>
<th>MPI</th>
<th>LPT</th>
<th>IMG</th>
<th>DT</th>
<th>DEPO</th>
<th>IOT</th>
<th>ACRT</th>
<th>DIM</th>
<th>FIBRO</th>
<th>HARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Boiler Drun</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B2</td>
<td>Boiler Pass I &amp; II maintenance</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>I) Furnace</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>II) 2nd Pass water wall tubes</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td></td>
<td>III) Economizer</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>IV) Primary Super Heater</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>V) Secondary Super Heater</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>VI) Headers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B3</td>
<td>Ducts</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>I) Ducts</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>II) Expansion Joints (at gas side)</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B13</td>
<td>Soot Blower</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Special Tests :- Hanger Inspection, Alignment Check

FEA      Finite Elemental Analysis
VIS      Visual Inspection
A detailed report along with evidences of damage of any and recommendations will be provided by estimation of RLA. Typically, at TCR we propose following line of approach to undertake the RLA of package boiler

1. Visual Examination
2. Thickness Measurement of critical areas.
3. Ultrasonic test on critical joints
4. Collection of scales/water from different sections and analysis in the laboratory.
5. In situ metallography on critical locations.
6. In situ hardness testing
7. Literature survey and experience of other in assessing the extent of judgments.

Correlation of all testing, process parameter history of operation would be undertake to assess reaming life of Boiler. Recommendations would be made to attain longer, reliable and safe operation of boiler. The final report would be submitted with results of testing, explanation of damages observed during testing and observation in document form.

Following table show details of the nature of NDT to be conducted on Package Boilers.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Component</th>
<th>Tests</th>
<th>Location to be checked</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Main Cylindrical Shell</td>
<td>Visual</td>
<td>100% after removal of insulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thickness Measurement</td>
<td>Random</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WFMPI/UT</td>
<td>Weld joints, Side holes, mud holes and blow down outlet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Replica &amp; Hardness</td>
<td>Replica &amp; hardness shall be on weld/HAZ &amp; parent</td>
</tr>
<tr>
<td>2</td>
<td>Furnace tubes with bowling hoops</td>
<td>Visual</td>
<td>100% thru the hot gases side with weld joints</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thickness Measurement</td>
<td>Random</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WFMPI &amp; UT</td>
<td>Weld Joints</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Replica &amp; Hardness</td>
<td>Replica &amp; hardness shall be on weld/HAZ &amp; parent</td>
</tr>
<tr>
<td>3</td>
<td>Smoke Tubes and Stay Tubes</td>
<td>Visual</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WFMPI</td>
<td>Tube to Tube Plate weld joints</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thickness Measurement</td>
<td>Random</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Replica &amp; Hardness</td>
<td>Replica &amp; hardness shall be on weld/HAZ &amp; parent</td>
</tr>
<tr>
<td>4</td>
<td>Front &amp; rear tube plates and end plates of wet back</td>
<td>Visual</td>
<td>External Side</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WFMPI/UT</td>
<td>Circumferential Weld seam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thickness Measurement</td>
<td>Random</td>
</tr>
<tr>
<td></td>
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<td>Replica &amp; Hardness</td>
<td>Replica &amp; hardness shall be on weld/HAZ &amp; parent</td>
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<td>Reversal Chamber</td>
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<td>Replica &amp; Hardness</td>
<td>Replica &amp; hardness shall be on weld/HAZ &amp; parent</td>
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WFMPI=Wet Fluorescent Magnetic Particle Inspection, UT=Ultrasonic Test
MPT: The technique adopted shall depend on dia of the pipe welds - MPT shall be preferred for Dia>=4 inches
MPT: The technique adopted shall also depend on surface condition of the welds.

* Only those parts / components which are assessable, bare and thoroughly cleaned would be attended and examined.
C. Plant Shutdown Management

TCR can rapidly source, deploy a strong and talented NDT manpower for various assignments for Petrochemical and Power industry in India and can easily deploy strong engineering and NDT team on contract basis at your onshore/offshore location within the Gulf/Middle-East area including Kuwait, Bahrain, Oman, Saudi Arabia also in South Africa in recent times,

TCR works with industry organizations, research and development facilities, and clients to develop new inspection equipment, applications and procedures. This ensures that we will always be able to offer our clients the best technology available for their needs. Using the most up to date technologies helps TCR minimize our client's down time and ensure they get the most comprehensive information possible on the condition of their equipment.

TCR's highly trained NDE professionals go through rigorous training and meet or exceed all industry requirements. In addition, TCR provides extensive in-house training and ensures all of our NDT professionals are current on all relevant industry codes and regulations. TCR has an ongoing commitment to continually bring new inspection solutions to our clients that will help provide them with better information to make decisions as well as help save them money with their integrity management programs.

With over 200 professional NDT technicians, our size and expertise make TCR the logical choice to meet your inspection requirements. Whether it is for daily inspection activities or large turn around projects, TCR provides clients with the industry's best integrity management solutions.

TCR's qualified personnel have worked on various projects in India and in the Gulf region in various disciplines of NDT such as Radiography, Ultrasonic, Welding, MPI, In-situ Metallography & Positive Material Identification. The inspection personnel have worked on design, fabrication, construction, inspection and erection of Pressure Vessels, Heat Exchangers, Towers, Stacks, Tanks, Plant Pressure Piping, Offshore oil wells and many advanced projects.

ASNT Level III personnel have a minimum of 7-15 years of experience and Level II personnel have 5-10 years of experience. Senior experience team members are also available; some with over 25 years of experience. Junior NDT inspectors have 2-5 years of experience and can undertake visual inspection, ferrite assessment, PMI operations, etc.

Skill Sets of NDT Personnel available for Shutdown projects with TCR include:

- API 510 Pressure Vessel Inspectors
- API 570 Piping Inspectors
- API 653 Tank Inspectors
- API 579 Fitness for Service
- Metallurgists including experts in RBI (API 580/581), Failure analysis, RLA
- ASNT Level III Experts
- BGas Paint Inspectors
- Mechanical Engineers
- Civil Engineers
- Instrumentation Design Engineers
- Piping Engineers
- Painting/Coating Inspection Professionals
- Corrosion Engineers
- IRATA (Rope Access) Technicians
- Multi-Skilled NDT Level II Technicians (ASNT/PCN)
- CSWIP/AWS Certified Welding Inspectors
- QA/QC Inspectors and Engineers / Saudi Aramco Approved inspectors
- Chemists, Material Testing Lab Technicians
- Heat Treatment (PWHT) Technicians
- NACE Cathodic & Coating Inspectors
- NDT Level III in multiple subjects (with Welding Inspector Qualification)
- NDT Level II in UT with Auto UT, Phased Array and TOFD Experience
- NDT Level II with extensive experience on pressure vessels and Multi-Skilled Usage
- ASNT MSLT Level II with Leak Testing experience
- ASNT Level II in Eddy Current (ET)
- ASNT UT Level II with TKY experience
- Plant Process Engineers
- Project Managers
- Construction Managers
- Procurements Managers
- HSE Managers /Officers
- AutoCAD Operators/Designers
- PDS/PDMS Designers
- Safety Officers/Engineers
- Process Design Engineers
- ASNT RT Level II and RTFI
- QA/QC Inspectors with Static and Rotating Equipment Experience
- Electrical Inspectors
- Ultrasonic Inspection (UT), Magnetic Particle Inspection (MPI), Radiography

D. Contract Research and Development
TCR can effectively operate and manage an in-house laboratory for a corporation while retaining the innovative, professional and superior quality service. TCR brings to these engagements, its strong process, our management expertise as well as results reporting method based on integrity and reliability. TCR’s dedicated engineering and metallurgical consulting team is a perfect partner for solving manufacturing and product quality problems. Several senior consultants with many years’ experience are available to help and advice on corrosion or materials selection queries. Our team can also advise on your welding engineering and heat treatment problems.

From initial product design, through final production, TCR’s in-depth engineering consulting services ensures that clients are producing the best possible product.

Areas of routine research assistance include:
- Determining the right material for a product
- Corrosion engineering, corrosion testing and corrosion investigations
- Metallurgical failure analysis and welding evaluations.
- Investigate the effect of environmental conditions on a product or material
- Prepare material and process specifications for in-house quality control
- Compare vendor or competitive products
- Identify equivalents between local and foreign specifications
- Assist to solve product quality problems
- Assist in cost-benefit analysis post failure analysis
- Reverse Engineering and Rapid Prototyping

TCR also undertakes research projects in the areas of Computer Aided Designing (CAD) including Engineering Design, Legacy Data Conversion, Detailing Plant & Process Layout, CAM, Computer Aided Engineering (CAE) including Finite Element Mode

E. Metallurgical Image Analysis Software
TCR Engineering has developed Microstructure Characterizer Software, an image analysis tool. Using this software, a Metallurgist or a Material Science engineer can characterize different types of micro structural images for grain size, coating thickness and phases; get images from one or more files; and intensify the image using the filtering and enhancement features.

Microstructure Characterizer Software 3.0 (MiC) characterizes micro structural features using standard methods of material characterization such as ASTM grain size measurements, coating thickness, linear and angular measurements,
comparison of super imposed grain size reticules, inclusion rating as per IS and ASTM standards, nodularity measurements, powder particle size distribution and so on. It helps generate custom made formatted reports of live and stored images and offers results as the computer display as well as hard copy multicolor printouts.

The software has been deployed at more than 295 commercial laboratories and universities till date. Custom modifications to this software can be done in conjunction with the engineering consulting team at TCR.

F. Product Sourcing

Leveraging the relationships with customers at the laboratory, TCR started providing sourcing services in 2004.

TCR covers the entire sourcing process from finding the right suppliers to transferring the design specifications. TCR will setup the right supply chain and logistics control, ensuring that the shipment meet all export guidelines. Finally our strength and deep domain expertise in material testing and inspection services helps maintain quality control on all shipments.

TCR continuously harvests her relationships with manufacturers and traders in India by taking the time to meet with these companies including touring their facilities and “first hand” confirming their capabilities. TCR can source, inspect and test ferrous and non-ferrous metals, casting & forging, sheet metal, bar, pipe, stainless steel, nuts, bolts, engineering goods, non-metallic materials such as polymer, ceramic, glass, machined parts, and machine tool components from India.

The Sourcing Process from India by TCR

Our 5-step sourcing process is tailored around the following process:

- TCR initially seeks details on product type, drawing, material specifications, required amount and quality with target delivery date from the client.
- TCR goes into the marketplace, contacting Manufacturers, traders and Steel producers, to establish production capability, availability, quality and unit price.
- TCR provides a product price quote in a FOB price format. We directly negotiate with the supplier and provide a competitive bid.
- If price and quality parameters are acceptable by the client, TCR instructs the manufacturer to produce an appropriate sample prototype for approval. The Prototype is shipped to the client.
- Once samples are approved, product order is placed with all manufacturing suppliers. Payment and shipping logistics are verified by TCR.

G. Technical Help for Indigenization

To unfold the metallurgical status/properties of imported components by destructive/nondestructive studies, to generate baseline standard for indigenization. Technical help is provided to decide manufacture route and guidance is provided to derive quality checks on indigenously developed components.

Details required from client:
1. Working condition of component.
2. Type of loading & stresses.
3. Design and operation condition.
4. Service history of component.
5. Life of an important component.

H. Selection of Materials

Weight loss experiments. Samples of different metals/alloys are exposed under simulated or actual process plant solution in the laboratory with and without stirring. This technique has limited application. Coupon of different metals/alloys is exposed to actual plant environment. A systematic approach is formulated based on requirement of intended services,
literate survey, and relevant standards like NACE, ASTM and API. The laboratory study is performed on exposed sample to categorize their performance and suitable MOC is recommended. Electrochemical experiments to find out relative corrosion resistance performed by accelerated testing under laboratory conditions. MOC selection is done with readymade database and experience of others from published literature.

I. Quality Improvement
TCR undertakes total quality improvements for stringent requirements against international specifications. Thorough survey is undertaken by auditing existing manufacturing procedure. Stagewise investigations are followed for manufacturing of product including raw material. Effects of processing conditions are derived with respect to different properties of the component. Based on the study recommendations are made for improvements in metallurgical process/raw material. Required optimum quality control checks are suggested to ensure consistency in quality for continuous production. TCR deputes a team of metallurgical engineers to perform this task. report comprises of fundamentals of metallurgical processing variables on final properties of component is submitted along with recommendations.

J. Solutions of critical weld problems
TCR., has vast expertise of solving critical weld repair solution of the aged plant components. Nowadays the material resources are limited and value of new product is increasing day by day. The repair weld solutions can salvage the critical components of process plant and can made huge saving in terms of production loss. The repair weld technology requires in depth understanding of metallurgical degradations vis-a-vis operating conditions. Clear understanding of physical metallurgy and welding technology. There is a right solution of every problem and the solution can be found out by engineering and technical common sense with strong fundamentals.

TCR has been leader in many aspects. The off shoot of knowledge bank at TCR is the successful stories behind more than 1800 failure investigations of the industries. This insight in to the failure mechanisms has strengthen the knowledge of TCR technical team which is directly implemented for repair weld solution. When any plant of critical machinery component is under breakdown the immediate right solution is sought after manier times the repair weldings are done with little or No understanding about the metallurgical fundamentals which in turn proves to be disastrous and management looses the trust in the technical competency. This philosophy promotes hast decisions for replacing the components at premium cost. Instead of this a systematic detailed metallurgical investigation would provide the extent and nature of degradation there by utilizing knowledge of metallurgy a proper welding procedure can be devised. TCR has helped the industries by providing the repair solutions on critical pump casing, shaft, nitrided components reformers, and so on.

The engineering consulting team can be approached with detailed history of problem. Our team can reach to your sight within 24 hrs and start generating information and data on the components to be repaired. For successful repair a mock up test is necessary from the same material preferably for the aged material of similar grade. Incase it is not available then virgin material of the similar grade is also useful. A mock up test will establish the confidence in welder and welding parameters. After successful welding through NDT testing is recommended to ensure the trouble free welding joint for future service.
4. Non Destructive Testing (NDT) Services

At TCR Engineering Services, a team comprising of expert NDT Technicians, metallographers and metallurgists perform Time of Flight Diffraction (TOFD), Infrared Thermography, Helium leak testing, Radiography, MFL, Eddy Current, Metallographic Replication, Ferrite Measurement, Portable Hardness Measurement, PMI, Ultrasonic Flaw detection, Magnetic Particle and Liquid Dye Penetrant testing, Ultrasonic Thickness Gauging survey, Storage/Sphere Tank Inspection. Field service Metallography and structural inspection are also offered. TCR’s experienced personnel are respected for their integrity and recognized by all the relevant inspection authorities.

Our NDT services are routinely performed in the following market sectors: nuclear / energy, space and aerospace, petrochemical, automotive, construction, transport, defense and general engineering.

NDT Facilities

- Time of Flight Diffraction and Phased Array Equipment from Olympus NDT
- Kraut Krammer Ultrasonic Flaw Detector and an Ultrasonic Flaw Detector with printer facility
- Einstein II Ultrasonic Flaw Detection
- Epoch LT Ultrasonic Flaw Detection
- Dye Penetrant Test
- Portable Alloy Analyzers
- Fisher Ferritscope
- Insipol Metallography Kit
- Eddy Current Testing Equipment
- Helium Leak Testing Machine
- Olympus MS 5800 for Tube Inspection
- MFL by Silverwing
- Acoustic Eye for Tube Inspection
- Positector, Portable Hardness Tester, Ultrasonic thickness gauges
- Magnetic Yoke with AC/DC and Permanent
- Ultraviolet light for MPI
- Post Weld Heat Treatment Equipment with Control Panel and Recorder
- Surface Roughness Tester TR 100
- Portable Magnetic Permeability Tester
- Digital Radiography
- X-Ray Camera and Gamma Ray Camera

NDT Capabilities

- Time of Flight Diffraction (TOFD) and Phased Array
- Eddy Current Testing, MFL, IRIS, RFET
- MFL for Pipelines
- MFL for Storage Tanks
- Corrosion Mapping
- Long Range UT
- Acoustic Emission
- Acoustic Eye
- Helium Leak Testing
- Ferrite Measurement
- PMI
- Ultrasonic Inspection
- Dye Penetrant
- Magnetic Particle Testing
- Thermography
- Weldability Study
- Visual Inspection and Field Services
- Portable Hardness
- Non-Destructive Testing; ASNT Level III and Level II
- Residual Life Assessment (RLA) of Boilers and pressure vessels
- Electrical Conductivity In Laboratory or on site with Controlled Temperature Copper Conductivity
- In-Situ Metallography(Electrolytic/ Manual Polishing)
- In-Situ Oxalic Acid Etch Test
- Hydrostatic Testing
- Magnetic Permeability
- PWHT
- Surface Roughness Testing
- Boroscopy
- Corrosion Mapping
- Internal Rotary Tube Inspection (IRIS)
- Alternating Current Field Measurement (ACFM)
- Holiday Detection

A. Radiography

TCR undertakes Gamma radiography & X-ray. Radiographic inspection is based on the exposure by either X-ray or radioactive source (Ir-192, Co-60, Cs-137 etc). The principle of industrial radiography is Differential Absorption. This means that different materials absorbs different amount of radiation based on thickness variation, density or presence of defects like cracks, lack of fusion, lack of penetration, gas porosities slag, undercuts etc.
Radiography Testing provides a permanent image in the form of radiographs (films), which provides sensitive image of internal structure of the material tested.

RT Applications includes:
1) Welded seams
2) Castings & forgings
3) Machined parts
4) Boiler inspections
5) Welder certifications.

**External X-ray Radiography**

By this we can perform SWSI & DWSI techniques.

**Gamma Ray radiography**

Gamma ray radiography is very useful in remote areas, as it does not require any power like in X-rays. Also it is easily transportable.
B. In-Situ Metallography

Performed as an NDT service, In-Situ Metallography from TCR determines in-service degradation of critical components of process plants operating under high temperature, high pressure or corrosive atmosphere. TCR’s Metallurgists have strong experience in the interpretation of microstructures. The Metallurgists have more than 30,000 replica microstructure interpretations that have been logged and captured to our databases. These databases contain extensive information from various plants that have been captured over the course of us performing this service. The databases also include rare collections of varying microstructure damage levels for various industries such as power, oil and gas, petrochemical, fertilizers, and other process industries.

The In-Situ Metallography team is highly skilled in the art of replica preparation. TCR has custom developed special purpose in-situ polishing devices which assist to enable metallographic polishing in difficult locations and allows the field services team to carry out high quality replication even on warm components.

The team has 5 sets of In-Situ Metallography equipment’s that include the Insipol 2000 and advanced electrolytic flow type polisher and etcher, portable rough grinder with self-adhesive papers, portable microscope capable up to 400x magnification and replica kits with plastic based slides for replica preservation.

- The In-Situ metallography is performed for following areas:
- To find out in-service degradation of critical components of the process plants operating under high temperature/high pressure/corrosive atmosphere.
- Damage Assessment of fire affected equipment of the plants.
- Microstructure survey for critical components viz., Boilers, Pipelines, Reactors and Vessels for condition monitoring/health assessment.
- To develop a data bank of critical components of equipment of process plant by periodical monitoring for preventive maintenance and planning for inventory control.
- To provide suggestions on their welding used components of process plants.
- To check the quality of the microstructure of component for intended service before put in to use.

Examples of Replicated structures

C. Positive Material Identification (PMI)

TCR’s on-site inspection and testing team has over 12 highly sophisticated Portable Alloy Analyzer Spectrometers which can in-situ non-destructively and accurately measure the chemical composition of materials. TCR Engineering’s Positive
Material Identification service is fast becoming an integral part of process safety management in the petroleum refining, petrochemical and electric power generation industries in the Middle-East and Asia-Pacific.

Using portable alloy analyzer spectrometers, TCR’s engineers can provide elemental identification and quantitative determination without regard to form, size and shape. No samples need to be cut for PMI. Elements that can be identified using PMI include: Ti, V, Cr, Mn, Co, Fe, Cu, Zn, Ni, Se, Nb, Mo.

The TCR Engineering Services PMI division has expert engineering and inspection personnel to undertake incoming material inspection and can provide on-site alloy verification for Quality Control and Stock control purposes. TCR can analyze Melt and Weld and can provide a comprehensive maintenance assessment.

Using portable XRF analyzers, TCR provides scrap traders in India with the information necessary to make quick, confident decisions on material purchases, and the speed and throughput necessary to quickly sort volumes of materials and take advantage of sales opportunities.

TCR provides PMI services to a number of Metal producers, Foundries, Metal fabricators, Scrap yards, Scrap traders in the industry, Electric utility companies, Fossil and nuclear power plants, Refining and petrochemical industry, Construction engineering, and the Chemical process industry.

The range of equipments available for undertaking Positive Material Identification (PMI) at TCR is unparalleled in India. The PMI Services Team has Portable X-Ray Florescence (XRF) based instruments including Delta Inspector DI 2000 by Olympus NDT Corporation, USA, NitonXLt and the InnovX-Sys.

The team can also conduct positive material identification test to detect Carbon composition on-site using the ARC Met 8000, a Portable Optical Emission Spectrometer. The portable Optical Emission analyzer is designed to identify all the key elements in metals - especially where highest accuracy and/or the analysis of light elements like C, Al, S, P, Mg, Si is needed and when sorting low alloys and aluminums. It is ideal, for example, for separation of 316 H (>0.04% C) and 316 L (<0.03% C).

A wide range of alloys can be analyzed on site using PMI including:

- Carbon and low alloy steels
- Copper Alloys
- Stainless and High Alloy Steels
- Aluminum Alloys
- Nickel Alloys
- Duplex and Super Austenitics
- Titanium Alloys
- Zirconium Alloys

TCR has provided PMI services on over 1200 projects including major oil and petrochemical installations in India, Saudi Arabia, Kuwait, Malaysia, and the Middle-East. Some PMI projects were undertaken in conjunction with third party inspection of EIL, Lloyd's, KTI, TUV, DNV & BARC. Inspection services team members of TCR assist the Recycle and Resell Scrap traders in increasing their profit margins by measuring precious metals in electronics - Pt, Ir, Ru, Rh, Pd. This helps traders to quickly sort inventory to sell at optimum prices for each business transaction.

Engineers and Inspectors from TCR’s PMI services team can travel across India, Hong Kong, China, Singapore, Malaysia, Indonesia, Russia, Dubai, and the Middle-East. PMI Services to North America and throughout Europe are also available.

D. Automated UT using Time of Flight Diffraction and Phased Array

Time of Flight Diffraction (TOFD) is an advanced and automated weld examination technique that assists in Fitness For Purpose (FFP) inspections. Using TOFD, the expert NDT team members at TCR perform amplitude-independent accurate flaw sizing on a wide coverage area.

TOFD is a fast and efficient way to scan a lot of weld area in a very short time period. Dead zones near the front and back surface can be enhanced using combined TOFD and conventional pulse echo techniques.
TCR Engineering Services offers services of creating TOFD scan plans and procedures in India. The team has done the following noteworthy ToFD projects:

- 100% weld inspection of Storage Tanks at Kuwait as per API 650 appendix U
- Inspection of pipelines in Rabigh, Saudi Arabia as per ASME Code Case 181
- Pressure Vessel inspection in India as per ASME Code Case 2235-9

TOFD is a fast and efficient way to scan a lot of weld area in a very short time period. Dead zones near the front and back surface can be enhanced using combined TOFD and conventional pulse echo techniques. TOFD is a quick and accurate tool for flaw sizing. Phased Array technology (using a TCG or DAC) and flaw location indicators with experienced analysts is also recommended.

ASME Boiler and Pressure Vessel Standard Section VIII Code Case 2235-9 states that is acceptable to use the TOFD for Ultrasonic examination in accordance with ASME Section V, Article 4. ASME Code Case 2235-9 mentions about replacing RT with UT and has resulted in incorporating TOFD into pressure vessel work for both detection and sizing of flaws. This now allows TOFD to be used on all Section VIII pressure vessels. TOFD is perfectly acceptable to use as per Code Case 181 and Code Case 179 of ASME B 31.3 for piping products.

Time-of-flight diffraction (TOFD) technique is an ultrasonic NDT technique which relies on the diffraction of ultrasonic energies from 'corners' and 'ends' of internal structures (primarily defects) in a component being tested. Using TOFD, the expert NDT team members at TCR perform amplitude-independent accurate flaw sizing on a wide coverage area.

TOFD is a fast and efficient way to scan a lot of weld area in a very short time period. Dead zones near the front and back surface can be enhanced using combined TOFD and conventional pulse echo techniques.

This technique has many advantages:
- Wide coverage area using a pair of transducers
- Accurate flaw sizing; amplitude-independent, Sizing technique using time-of-flight information
- One-line volume inspection, provides very fast scanning
- Setup independent of weld configuration
- Very sensitive to all kinds of defects. No sensitivity to defect orientation
- Amplitude-insensitive, acoustical coupling less critical

While TOFD is a very powerful and efficient technique, it suffers from limited coverage resulting from two dead inspection zones. The first dead zone is near the surface, as a result of the lateral wave; the second is at the backwall, resulting from the width of the backwall reflection. TCR’s NDT equipment allows inspections simultaneously combining TOFD with conventional pulse echo. Pulse echo complements TOFD and covers the dead zones.

Experienced analysts from TCR will have clues to the characterization of these types of flaws using TOFD however at times the definitive conclusions may be rare. In the case of Phased Array technology an experienced analyst has a greater chance of determining flaw type based on the percentage of sound transmitted back to the probe.
TCR uses products from Olympus’s OmniScan technology which has capabilities to indicate to the operator the exact location of a flaw with respect to the weld centerline and bevel face. An experienced analyst from TCR is able to characterize fusion flaws based on location and amplitude response.

ASME Boiler and Pressure Vessel Standard Section VIII Code Case 2235-9 states that is acceptable to use the TOFD for Ultrasonic examination in accordance with ASME Section V, Article 4. ASME Code Case 2235-9 mentions about replacing RT with UT and has resulted in incorporating TOFD into pressure vessel work for both detection and sizing of flaws. This now allows TOFD to be used on all Section VIII pressure vessels.

API 579 in its current draft form states the Recommended Practice for Fitness-for-Service (The crack depth, length, angle and distance to other surface breaking or embedded cracks is typically determined using UT examination techniques, either TOFD or angle beam).

Draft-API 580 states the Risk Based Inspection Recommended Practice (Base Resource Document recommends automated ultrasonic shear wave testing as a highly effective inspection technique for crack detection and sizing. The capability of the Automated UT technique/type is evaluated using probability of detection (POD) curves from round-robins in the past where TOFD showed the best performance).

British Standards Institute's welding standards policy committee has created the BS 7706 as a guide for the calibration and setting-up of the Ultrasonic Time of Flight diffraction (TOFD) technique for defect detection, location and sizing of flaws. Another well documented guide is the Pr EN 583-6.

E. Helium Leak Testing

TCR’s Helium Leak Testing instrument has a roughing capacity of 10 m3/h (7 cfm) with usable helium sensitivity in the 10-11 atm.cc/s range. The unit has a dedicated sniffing unit, based on a well-proven leak testing concept, and is also available for outboard leak testing applications.

TCR experienced operators will come directly to a customer site and perform most any leak tests. TCR currently test on sites from nuclear carriers, polymer plants, oil refineries, gas and steam turbine power plants in Kuwait, Saudi and India. TCR’s technicians are highly mobile and perform helium leak testing on heat exchangers, steam turbines and condensers, distillation towers, buried pipelines and many other systems and components.

TCR's services include vacuum leak testing for any type of vacuum vessel or system and pressure probe testing for systems that normally operate at or above ambient pressure. Virtually any system that has a requirement for leak tightness or that is suspected of causing a problem due to leakage can be tested by one of these methods of helium leak testing with a high degree of reliability.

The Helium Leak Testing unit of TCR utilizes has a proven mechanical vacuum pump technology designed specifically for heavy usage in very harsh industrial environments. The helium stability of the rotary vane pump guarantees excellent stability of the helium signal. The low rotational speed of the M.D.P. (Molecular Drag Pump) at 27,000 rpm makes this unit totally bullet proof against accidental air inrushes. Further, it allows the leak detector to be moved while in operation.

The high compression ratio of the M.D.P. facilitates the gross leak test at a high pressure (7.5 Torr / 10 mbar) which speeds up the leak test process of outgassing parts. The internal layout of the unit allows easy access to all the components.

In addition, the unit also offers evolved features to assist the operator in his daily test operation:

- Auto-calibration, with built-in temperature compensated calibrated leak (dedicated to the sniffing mode)
- Helium background suppression with “floating” zero to keep the signal from going negative and to increase sensitivity.
- Automatic signal correction
- Audio alarm with variable pitch (up to 90 dBA)
- Vocal synthesizer
F. Thermography

It is used to find out temperature anomalies present in the equipment during their operation. This is a non-contact method of testing and viewing is remote. Even helicopters can be used for testing large regions. This is a very recent addition of the NDE. Any hot object emits the heat radiation. An Infrared sensor which can pickup such radiation to form the image of the hot body.

The hot and cold regions on the surface can be analysed for the healthy condition of the object. Thermography is useful for applications such as Deposits or blockages in pipe lines carrying hot or cold fluids, Refractory or insulation deterioration in Furnaces, Boilers, heaters, converters etc. Electric sub-stations for control panels, transformers, switch gear etc. for overloading, loose or damaged contacts, Overheated bearings in rotary equipment e.g. Motors, generators, turbines etc.

J. Paint Inspection

TCR undertakes inspection of paint and / or coatings as applied to metal surfaces. Senior TCR paint inspectors are qualified BGas (British Gas Corporation) and NACE certified inspectors. The inspector will be responsible for verifying that the following items (as required) conform in all respects to the specific requirements of the relevant specification.

- The blasting and coating materials
- The blasting and coating equipment
- The temperature and humidity
- The surface condition
- The application procedure(s)

The paint and coating inspection team of TCR is fully equipped and has at it's disposal Wet paint thickness gauge(s), Dry paint film thickness gauge(s), Holiday detector(s), Hygrometer with dew point calculator and Metal surface thermometer. The expert paint and coating inspectors of TCR are responsible for monitoring and verifying that work inspected conforms in all respects to the specific requirements of the relevant code, specification and/or standard with respect to the paint/coating procedure, the physical application as well as the te physical examination, including testing.

TCR's expert inspectors undertake and are responsible for the preparation of concise but detailed records, including records as required, for the following:

- Materials control and identification
- Climatic conditions and Surface condition
- Details of abrasive(s) and application procedure
- Abrasive/wire brush standard
- Details of coating and application procedure
- Equipment calibration
- Inspection results

K. Alternating Current Field Measurement (ACFM)

Alternating Current Field Measurement also referred to as ACFM is a one-pass method to inspect welds and most other materials to locate and size surface breaking cracks. TCR performs ACFM in association with its international partner. This technique replaces conventional dye penetrants and magnetic particle testing and the ultrasonic’s required to size defects.

Digital Crack Detection Method

- Sizes Cracks (Length & Depth) Applications
- Detects through Coatings, Paint & Scale
- No Recoating Required
- No Metal Contact Required
- More Precise than Conventional Methods
- High Temperature Applications
An electromagnetic field is induced into the surface being inspected. When the probe is passed over a surface breaking crack, the electromagnetic field is disturbed allowing detection of the anomaly. This field is measured using the proprietary software which allows crack depth and length measurements in real-time.

Probes of almost any configuration can be customized for nearly any application imaginable.

Applications of ACFM include:
- Structural Welds on Platforms
- Structural Welds on Drilling Rigs
- Pipeline Girth Welds & Supports
- Pressure Vessel System Welds
- Cooling Tower Welds
- Compressor Fin Surfaces & Threads
- Drill Collar Welds

L. Electro-Magnetic Acoustic Transmission (EMAT)

Using EMAT technique with parametric probes, TCR can take the high temperature thickness measurement only up to a surface temperature of around 325°C. Above this temperature the thickness readings are not stable, reliable and repeatable. Hence thickness measurement shall not be done for lines and equipment with temperature above 325°C.

The surface for thickness shall be clean from rust, scale or any other kind of deposits and shall be fairly smooth. A metallic file, wire brush, small chisel and emery paper can be used for cleaning and getting a clean surface for thickness survey. No hammering is permitted for removal of scale/deposits. In case the above method does not yield the desired cleaning, then mechanical cleaning by power brush should be used. Grinding shall be used as a method for cleaning only as an exceptional case with prior permission from inspection engineer.

Thickness can be taken on painted surface provided the paint is visually seen to be adhering to the surface without any blisters. For critical measurement where the corrosion rate calculations are important from remaining life point of view, paint removal should be done before doing thickness survey.

Piping

In case of piping, corrosion loops shall be the basis for carrying out thickness survey for all on-site piping. Offsite piping and tank farm piping may have special loops made for thickness monitoring. Each corrosion loop in case of on-site piping shall have a combined isometric shown. The TML’s are serially marked on the combined isometric. Base readings if any being taken (before commissioning) shall be random values measured on the components. Routine on stream or shutdown thickness measurement at these locations shall be done in the form of a scanning. The scanning format shall be in a grid of size 1.5” x 1.5”. The component on which the scanning is to be done shall have the grid marked with a chalk before thickness scanning. All the TML’s need not be scanned. Out of all the locations some TML’s shall be identified for regular scanning. The select TML’s shall be identified by inspection engineer based on probability of corrosion at these locations (as compared to other locations in the loop) and accessibility considerations. Access for thickness scanning by way of ladders, scaffolding or portable trolleys shall be provided by respective maintenance department. In case corrosion is observed in these TML’s then other TML’s in the loop shall also be included for thickness scanning.

Hot Tap Locations

In case of thickness survey of equipment piping for hot tap locations the following steps shall be followed.

Maintenance shall mark the location of the new nozzle. The locations shall be as per exact type and dimensions of the component to be welded on the parent pipe. Inspection engineer shall also verify the type of component to be welded viz, weldolet, pipe of pipe connection, nozzle with reinforcement pad, split sleeve nozzle etc.

Inspection engineer shall mark the center line of the proposed weld joint. A width of 1.5” to 2” shall be marked on either side of the proposed weld center line. A close thickness survey shall be taken along the center line and on the either sides. The minimum thickness measured shall be reported in the hot tap file.
If the thickness measured is comparable to nominal or the previous measured values (if available at the same locations or at different locations in the same pipe) then it could be assumed that there is no corrosion at the location. If the thickness measurement indicates severe corrosion, and thickness measured is very close to the minimum allowable for hot tapping then hot tapping should be avoided at the location as it will be difficult to pick up a thickness point with minimum thickness by this procedure.

Minimum thickness required for hot tapping is 4.8mm. If the pipe is corroded and actual thickness is in the range 6 – 8mm, then alternate methods should be used to check the pipe thickness and certifying the same fit for hot tap.

**Thickness Locations In Tanks**
In case of storage tanks, thickness shall be measured from outside as follows on the first and second shell course from bottom. In all other shell courses thickness shall be measured along the staircases. Few thickness points shall be taken near the weld and few at the center of the shell course plate. In case of roof plate, thickness shall be measured on each plate. Two thickness points at the center of each plate and one thickness point at the corner of each plate. In case of bottom plate, thickness measurement is possible only during an internal inspection. Thickness shall be measured on each plate. Two thickness points at the center of each plate and one thickness point at the corner of each plate.

**Recording of Thickness Measured**
We will measure the thickness and record it on a format that has the following details.
- Plant, Tag Number of equipment/pipeline or appropriate description in case tag number does not exist for the component/job.
- Date of measurement and Sl. No. Meter used for thickness measurement
- Details of the meter used for thickness measurement like frequency etc.
- Identification number of the standard block used for calibration of the meter before starting the job
- Nominal thickness of the component being checked for thickness
- Name of the technician measuring the thickness

In case of piping, where spot readings have been measured at TML’s the TML number shall be written and the readings measured shall be entered against the TML number.

In case of equipment a development drawing of the equipment shall be submitted approx. showing the location of thickness measurements. The thickness may be entered on the sketch itself. Alternately the TML’s can be marked on the sketch and corresponding thickness values for each TML may be submitted separately.

In case of close scanning of a location in an equipment or a piping location, the readings shall be submitted as a grid. The grid will have the orientation of the grid (N/S/E/W) with possible reference from a nearby nozzle, weld etc. The grid identification at site is required so as to check the thickness at the same location and compare the same for corrosion, if any. The grid size shall be clearly mentioned on the sketch.

**Thickness Values More Than Pervious Readings**
It is also not unusual to record thickness values more than the previous measured readings at the same locations or in the same grid. This is considering the inherent limitations in the thickness measurement technique. Some of the factor that contribute to the increase in thickness could be
- Inability to put the probe exactly at the same location. If the probe is kept even a couple of millimeters away from previous location there could be different and probably a higher reading.
- Corroded surface profile on the inside surface of the component from where the sound waves are reflected back.
- Surface preparation prior to the thickness survey

**M. Long Range Guided Wave Ultrasonic Testing (LRGWUT)**
The Long Range Guided Wave Ultrasonic Technique (LRGUT) was designed to inspect 100 percent of a pipe segment from one single location.

Torsional or longitudinal guided waves are induced into the pipe body and propagated along the pipe segment being inspected. When these guided waves identify an anomaly or pipe feature, they mode convert into laminar waves and reflect back to the tool's original location. Using a laptop these signals are digitally captured. The time-of-flight for each signature is calculated to determine it's distance from the tool. The cross sectional area is calculated by amplitude and then the circumferential extent determined by the focused beams (broken down in octants) to determine the significance of the defect.

TCR performs LRGWUT in association with its international partner. This partner meets and exceeds the PHMSA 18 points to examine casings and crossings.

LRGWUT's primary application is within the Oil and Gas Refining, Petrochemical, Storage, Offshore and Pipeline Transportation industries used to inspect difficult to access piping systems such as:
- Insulated Pipe in Refineries
- Offshore Pipeline Risers
- Cased Road or Railway Crossings
- Loading Lines and associated Pipe work
- Tank Dyke Pipeline Crossings
- Above Ground or Buried Flow Lines
- River or Bridge Pipeline Crossings
- As part of ECDA & ICDA Methodologies
G. Heat Treatment Facility
TCR offers post weld heat treatment by using electricity as source of heating for stress relieving of weld joints. All TCR’s heat treatment services are designed to minimize downtime, improve structural integrity, and enhance effective plant life. Additionally, depending on the mobility of the required equipment many of our heating processes can be applied on-site or at your facility.

TCR has specialized fully automatic programmable equipment capable of controlling Heating rate, Holding time and cooling rate to carry out a wide range of heat treatment processes like post weld heat treatment of PQR test coupons, and various components. TCR is capable of doing Post weld heat treatment of carbon steel piping welds (pipe-work, headers, flange joints, valves and branches) by means of the electrical resistance method, in the form of ceramic heater pads. The Heat treatment equipment is supplied with chart recorder to record up to 8 thermocouples simultaneously for meeting the critical requirement of heat treatment.

Oil Firing on Pressure Vessels
TCR Engineering has a talented crew that uses diesel fuel as source of heating for stress relieving for pressure vessels with the sole objective of reinforcing process and component integrity and quality. The experience heat treaters from TCR have the experience, equipment, and expertise to develop custom configuration for your particular process. Our heating processes include low-Range, Mid-Range & High-Range Temperature Heating.

TCR's high velocity burners enable excellent temperature distribution and uniformity at all times due to the intense scrubbing action. TCR is also able to construct temporary furnaces at our clients sites where internal firing is not a practical or cost effective option.

The heat treatment operation will be effected by the firing of the furnace using one or more gas/oil high velocity burners with a nominal rating of 1,500,000 Kcals/hr (6,000,000 Btu/hr) per burner. Armoured flexible hosing to Combustion Air Fan (s), with a maximum output of 2800/Nm3 per hour via a 150mm diameter outlet, at a pressure of 700mm W.G, will connect each burner. Each burner will be fitted with a (25/20) stainless steel outlet nozzle designed to clear the furnace wall adjacent to the intended opening(s) and in such a way as to eliminate the possibility of any direct impingement on components.

H. Acoustic Eye
Acoustic Eye’s breakthrough, non-invasive solution for today’s hard-to-inspect tubes up to 4” inner diameter enables ultra-fast, accurate inspection of boilers, Fin Fans and other heat exchangers, regardless of tube shape or material. Featuring patented Acoustic Pulse Reflectometry (APR) technology, Dolphin G3™ is an advanced, yet easy-to-use tool that overcomes the limitations of many conventional inspection techniques. With its simple operation, automated analysis and report generation, there is far less dependency on operator expertise. Providing reliable inspection of even the most challenging tube sizes and configurations, Acoustic Eye increases inspection cycle efficiency and operational cost savings.

I. Automated Reformer Tube Inspection System (ARTIS)
ARTIS is abbreviated for Automated Reformer Tube Inspection System. TCR has indigenously developed an automated robotic crawler to aid ultrasonic inspection of reformer tubes. It provides a tabular and interactive digital output. The 1st point on every tube is referred at bottom of tube climbing up to the 14 meters height and provides tube data at every 0.1 meter distance. The ARTIS can simultaneously collect the tube data such as ultrasonic dB level of attenuation, diameter of tube and bowing angle at every location. An interactive, graphical user interface is part of digital report along with conventional hardcopy print in tabular format.
The major advantages of the ARTiS are as follows.

- The method follows same technique of manual ultrasound coupling and hence it is industry wide proven for the intended inspection.
- A macro level view of overall tubes condition in the reformer is also reported, emphasizing troublesome areas / corner of furnace, if any.
- The outcome of inspection work becomes more systematic and traceable with point wise reading on each tube for ultrasound attenuation and creep strain.
- It avoids the need of scaffolding requirement and saves total tube inspection time and helps achieving reduction in shutdown time of plant.
- Automation deploys limited water source for coupling and nearly eliminates need for overhead water drum arrangement which overcomes additional issues related to drum filling, vacuum water clogging etc.

J. Eddy Current Testing with IRIS, MFL and RFET

TCR uses electromagnetic induction to detect flaws in conductive materials. Eddy-current testing can detect very small cracks in or near the surface of the material, the surfaces need minimal preparation, and physically complex geometries can be investigated. It is also useful for making electrical conductivity and coating thickness measurements. TCR's testing devices are portable, provide immediate feedback, and do not need to contact the item in question.

TCR's team of Eddy Current Testing professionals has inspected over 40,000 tubes annually in heat exchangers using this technique.

K. Digital Radiography

TCR Undertakes COMPUTER AIDED RADIOGRAPHIC TESTING (CART). The use of computers to aid in the generation of radiographic images through the use of linear array detector systems in place of traditional film. The CART Industrial Inspection System works on the basis of differential densities. When a product passes through the system, a grey scale X-Ray image of the product is created. Different densities / thicknesses show up in the image as different shades of grey. The image is captured and displayed through the control panel monitors. Image enhancements like zoom, contrast, brightness, etc. are possible. Advanced Software Algorithms are used to clearly highlight discontinuities in the image so that qualifying the sample as per standards can be done easily and accurately.

Samples are passed on a conveyor system and are exposed to X-Rays. The X-Rays which have passed through the samples are captured in a detector system. The system transfers the captured information to a data processing unit, where the data is converted into a displayable image format. The image is then displayed on the monitor of the CART System.
5. Heat Treatment Services

TCR Engineering Services now offers Pre and Post Weld Heat Treatment Services.

Post Weld Heat Treatment Services (PWHT) is performed after welding/machining to improve the Chemical mechanical properties of weldment / machined surfaces. In concept, PWHT covers many different potential treatments. However, in steel fabrication, most common procedure used is Stress Relieving.

Machining and/or Welding induce stresses in parts. The bigger and more complex the part; the more the stresses. Stress Relieving is done by uniformly heating fabricated equipment or the vessel or vessel part to a sufficiently high temperature, but below the lower transformation temperature range, then subjecting it to a thermal retardation for a sufficient time depending upon the material thickness and then finally uniformly cooling it which is also of utmost importance.

Heat Treatment Services from TCR include pre-heating, post-heating, stress relieving(SR), intermediate SR, normalizing, solution annealing, water quenching, tempering, step cooling, drying of refractory material. The experienced technicians of TCR as capable of performing heat treatment on weld joints, piping, regenerator, stripper column, pressure vessel, boiler headers, modules, deck pipeline and structure, boiler heater tube, and also Dotherm testing.

TCR has at its disposal well equipped tools including electrical furnace with 220 and 80 volts panel, latest 12 point recorder with digital display, coil and pad type heating element, oil firing systems and extremely skilled technician. TCR can also design, fabricate, calibrate and run a custom electrical furnace for clients.

6. Welder Certification and Procedure Qualification

TCR Engineering Services has expanded its quality assurance and third party inspection services to include a comprehensive welder certification and welding procedure qualification program.

As part of this enhanced service offering, TCR undertakes the following:
- Welder Qualification Testing for performance qualification and certification of welders (a welder / welding operator performances qualification - WQT) to ASME, ANSI, AWS, API code
- Preparation of Weld Procedure Qualification as per client or project requirements.
- Coupon Testing as per Weld Procedure Qualification which includes visual examination, mechanical testing, metallographic examination and nondestructive testing.
- Documentation of the Procedure Qualification Record as per ASME, ANSI, AWS, API codes
- In depth weld inspection to include review of the applicable qualification e.g. 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 having due regard for self, welder and other workers in vicinity, particular in respect of ultraviolet radiation from arc during welding.

The welding inspector deployed at a site from TCR will be responsible for monitoring and verifying that the following functions of the work conform in all aspects to the specific requirements of the relevant code, specification and/or standard:
- Check correct weld procedure(s) employed.
- Check weld procedure and welder qualifications.
- Inspect weld profile preparation.
- Inspect joint fit-up
- Check filler metals and consumable materials
- Check correct welding performance parameters observed
- Perform visual examination upon completion of welding
- Monitor pre and post weld heat treatment, where specified.
- Monitor the physical examination including non-destructive test, hydrostatic test, mechanical test etc. If needed, the inspector may choose to send test coupons to the TCR Engineering Services’ material testing laboratory.
- Ensure that all necessary visual inspection is completed and verify that all other necessary non-destructive examinations are executed in the specified manner for the method and coverage by appropriately qualified personnel.

When, and where, required the inspector shall employ the following equipment to aid in the performance of duties:

a) Inspection mirrors.

b) Torch or other electrical lighting facilities (permitted by safety codes eg. 24V system etc.)

c) Physical size measuring instruments such as welding gauge, rule, vernier etc.

d) Electrical parameter measuring instruments such as ammeter, voltmeter etc.

e) Temperature measuring instruments (thermometer)/aids (thermo chalk).

All TCR welding inspectors are generally certified in accordance with the requirements of at least one of the following schemes - Certification Scheme for Weld Inspection Personnel (CSWIP), American Welding Society (AWS), BGAS (previously British Gas ERS), and/or ASNT Level II VT. All inspectors have the ability to interpret various standards including ASME B&PV Code, Section IX, API Std. 1104 and ANSI / AWS D1.1.

7. Risk Based Inspection and Fitness for Service

The reliable and proven Risk based Inspection (RBI) technology process developed by PP SIMTECH (UK), with key guidance from API 580/581 and UK HSE, has been accepted globally as good engineering practice by leading international companies. PP SIMTECH has successfully implemented RBI at BP, Dow Chemicals, GPIC, ADNOC-Fertil, Norsk Hydro, BASF, INEOS. In India, PP SIMTECH (UK) has partnered with TCR Engineering Services, India's leading Material Testing, QA and Inspection Company. This partnership has resulted in the formation of a new joint venture company – TCR PP SIMTECH Pvt. Ltd.

The TCR PP SIMTECH team includes Mechanical Engineers, Metallurgists, Corrosion Engineers, NDT Experts, RBI Experts and Project Managers and provides plants with RBI, Fitness-For-Service (API 579), Material Damage Mechanisms Assessment, Metallurgical Investigation & Failure Analysis and In-service Inspection.

RBI technology offers oil and petrochemical industries, chemical, fertilizer and power plants the immense benefits of a risk-based approach to inspection which includes an increase in plant availability and cost saving, minimum duration of shutdowns, change in inspection strategies and intervals and improved safety compliance. The RBI team study also improves the team working and communication between all plant departments.

rbiAsyst™, a Fully auditable & transparent software system developed by PP SIMTECH, is designed to facilitate the RBI team study and successful implementation of RBI technology process at a plant site.

The RBI team study facilitated by TCR PP SIMTECH and rbiAsyst™ software provides all plant management and operations team to identify and resolve complex item technical issues associated with static equipment including reactors, furnaces, strippers, distillation columns, heat exchangers, pressure vessels, reformers, boilers, fired heaters with associated items such as interconnected piping and storage tanks.

Reliable assessment and calculation of risk profile of an item, based on its "active" and "potential" Damage Mechanism ensures that the resulting inspection interval for the item is reliably optimized in a safe and cost-effective manner.

The approach to risk-based inspection is based on a strong co-operation between the plant personnel and TCR PP SIMTECH experts. The adopted process of guided expert judgment is based on operational experiences and sound technical basis for the evaluation of possible degradation mechanisms.

Benefits of RBI include:

- Increased safety and equipment reliability
- Fewer planned shutdowns
- Fewer unplanned shutdowns
- Longer inspection intervals
• Potential fewer inspection and maintenance costs
• Evaluation of effectiveness of inspection activities
• Increased consistency of inspection planning
• Identification of potential damage mechanisms
• Priorisation of inspection
• 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

Plant and equipment items covered by our RBI technology process include:-
• All types of pressure vessels including reactors, furnaces, strippers, absorbers, distillation columns, heat exchangers, crackers, crude heaters and other fired heaters, reformers, utility power boilers and associated equipment.
• Interconnected Piping between these items within the plant site.
• Over ground and buried cross country fluid (gas or liquid) distribution Pipelines.
• All types of Storage Tanks.

It must be recognized however, that it is the reliability of the RBI technology process, the inclusion of the best practices, the comprehensiveness of the team study method, the engineers involved in this from the plant site and the quality of the output which deliver the set objectives and desired benefits. We believe that incorporation of these fundamental requirements in the evolution and development of our RBI technology process has made PP SIMTECH the global leader in this technology and apprironly different from others. This is evidenced by published quotes from our clients.

The hallmark of our RBI technology process is the method used to reliably assess and calculate the risk profile of an item, based on its “active” and “potential” Damage Mechanism identified by the RBI study team, which in turn ensures that the resulting inspection interval for the item is reliably optimized in a safe and cost-effective manner. Operating limits are also defined by the RBI team to prevent increase in damage rate or initiation of a new damage mechanism. Where the business or safety risks are unacceptable, risk mitigating options are also recommended as part of the output.

Our RBI team study process improves both team working and knowledge sharing at plant site as well as communication between all departments. Additionally it captures valuable plant knowledge from senior engineers in the team thus enhancing corporate memory and effective training of junior engineers.

We have an experienced team of professionals which includes Mechanical Engineers specialized in RBI and Fitness-For-Service assessment technologies, Metallurgists, Corrosion Engineers, Inspection Engineers, NDT Experts and Project Managers.

With this integrated expertise we can provide your plant sites with best-in-class.....
• RBI technology implementation services
• Total Asset Integrity Management technology support
• Fitness-For-Service (API 579, BS 7910) and Remaining Life assessments
• Root Cause Material Damage assessments, Metallurgical Investigation & Failure Analysis
• Training & Technology Transfer to in-house engineers to effectively manage plant integrity

8. Fitness for Service

TCR undertakes FFS Assessment work based on BS 7910 standards (which covers more areas than API 579). Essentially, the fracture mechanics procedure in API 579 is mainly copied / reworded from the procedure in BS 7910 (and previously PD 6493). The BS 7910 fracture mechanics methodology and its application has been successfully proven worldwide by many companies including those in US for at least 35 yrs (from nuclear pressure vessels to high consequence items in the exploration, refining & petrochemical industry, irrespective of the Item code of construction), many times over compared to API 579. The assessment we propose to do is Level 2 to BS 7910.
Fitness for service assessment is performed to make sure that process plant equipment, such as pressure vessels, piping, and tanks, will operate safely and reliably for some desired future period. API Recommended Practice 579 provides a general procedure for assessing fitness for service. The assessment procedure evaluates the remaining strength of the equipment in its current condition, which may be degraded from its original conditions. Common degradation mechanisms include corrosion, localized corrosion, pitting and crevice corrosion, hydrogen attack, embrittlement, fatigue, high-temperature creep, and mechanical distortion. Methods for evaluating the strength and remaining service life of equipment containing these types of degradation are presented and reviewed. Examples are presented to illustrate the application of these methods to process plant equipment.

Process plant equipment is often exposed to corrosive environments and/or elevated temperatures. Under these conditions, the material used in this equipment can degrade or age with time in service. As important equipment such as pressure vessels, piping, and storage tanks become older, the plant operator must decide if they can continue to operate safely and reliably to avoid injuries to personnel and the public, environmental damage, and unexpected shutdowns. Fitness for service assessment procedures provide a means for helping the plant operator make these decisions based on sound, established engineering principles.

Fitness for service assessment is a multi-disciplinary engineering analysis of equipment to determine if it is fit for continued service until the end of a desired period of operation, such as until next turnaround or planned shutdown. Common reasons for assessing the fitness for service of equipment include the discovery of a flaw such as a locally thin area (LTA) or crack, failure to meet current design standards, and plans for operating under more severe conditions than originally expected. The main products of fitness for service assessment are (1) a decision to run, alter, repair, monitor, or replace the equipment and (2) guidance on inspection interval for the equipment. Fitness for service assessment applies analytical methods to evaluate flaws, damage, and material aging.

The analytical methods are based on stress analysis, but they also require information on equipment operations, non-destructive examination (NDE), and material properties. Stress analysis may be performed using standard handbook or design code formulas or by means of finite element analysis (FEA). With modern computer technology, the use of FEA is quite common. Fitness for service assessment requires both knowledge of past operating conditions and a forecast of future operating conditions. Interaction with operations personnel is required to obtain these data. NDE is used to locate, size, and characterize flaws. The material properties should include information of material damage mechanisms and behaviour in the service environment, especially on the effects of corrosion and temperature.
9. Third Party Inspection and Quality Assurance Services

TCR Engineering Services, from its offices in Mumbai, provides inspection and quality assurance services to help retailers, trading partners, importers and manufacturers assess product quality and meet the regulatory requirements of their industry vertical. Independent, third-party inspection and quality assurance services results in improved product quality, with a reduction in customer complaints, noncompliance and product recalls.

The on-site inspection team covers the all states across India. The pricing structure for the on-site inspection services is set competitively and is based on man-day charges.

Typically TCR's inspectors undertake:

- 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 and final inspection at works as per above documents. Inspection could be by TCR alone or along with Customer's representatives
- Verification of calibration status of all the inspection, 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 our requirements and indicate along with supplier the proposed corrective actions.
- The Inspection reports along with all the necessary supporting documents such as Stage Inspection reports / Test certificates, etc. are sent through courier immediately to the Client by post or email

TCR’s inspection services activities include:

A. Factory Audit

TCR Engineering Services Factory Audit service verifies the capability of a manufacturer to meet contract conditions for quality, quantity and delivery terms. Such assessments are often tailor-made as per a client's needs and requirements. By availing of this service, we eliminate the need for a client to be present on-site at the manufacturer's plant or factory.

B. OEM Development

TCR Engineering Services with over 33 years of experience has a team possessing a strong engineering background. This team stands ready to offer consultation based on the latest technological advances, incorporating current national and international norms and standards. TCR can help assist in creating a first production prototype, technical documentation, standards evaluation, establishing production and quality criteria, and technical transfer to the supplier.

C. Raw Material Inspection Services

As part of all product sourcing projects, TCR undertakes Raw Material Inspection Services. We conduct on-site visits to the supplier / manufacturer's plant to determine evaluate fabrication techniques, assembly procedures or quality issues, and ensure that the production is as per client specified requirement. Inspection can range from a simple walkthrough to extensive sample retrieval and onsite analysis. Our sample custody is continuous from on-site photography and logging, through laboratory analysis and secure storage. Prior to initiating a raw material inspection service, TCR seeks to obtain a data sheet for the assignment.

Material Inspection Services are essential to ensure that all material supplied meets client / project defined specifications. TCR can perform quality analysis (QA) on all engineering goods sourced from India and validate them as per ASTM, BS, GS, JS, IS and other international standards.
D. Picking of Samples and Testing Coordination
Our inspectors can select a pre-determined number of samples from production at a factory and seal them, label & send them to our material testing laboratory for testing according to customer requirements. At the TCR Engineering Services material testing laboratory, we provide Mechanical Testing, Chemical Analysis, Positive Material Identification (PMI), Non Destructive Testing, Metallography, Corrosion Testing, Failure Analysis, Raw Material Inspection, Metallurgical Product evaluation, Engineering Research and Consulting.

E. Initial Production Check
The inspection team from TCR Engineering Services can perform a visual inspection of products as available at the beginning of the production cycle against a client's instructions and Purchase Order specifications. The "Initial Production Check" when combined with a "Final Random Inspection" and any other on-line production checks, helps in taking corrective actions at an early stage of production cycle. The inspection team will send out intermediary reports to the client and keep them informed about the production progress relative to the delivery terms.

F. In-Production Check
The inspection team performs a visual inspection of products as available during production. The inspection team may subject some products for random material testing. The in-production check service helps in reducing the final random inspection failure risk.

G. Random Inspection
The TCR Engineering Services inspection services team performs a final random inspection comprising of a detailed visual inspection of goods before shipment. It is generally conducted on the premises of the manufacturer, on samples selected according to defined sampling procedures. The inspection criteria covering quality, quantity, marking and packing are based on the client's specifications and reference samples, as provided. Upon completion of the final random inspection a detailed inspection report is sent to the client and the inspection certificate issued to the supplier if all findings are positive.

H. Loading Supervision
To further manage the product delivery, the TCR Engineering Services inspection team offers Loading Supervision which involves, "as appropriate," the checking of the container condition, identification of the loaded packing units with the previously inspected consignment, tallying of the total number of shipping packing units and sealing of the container. Loading Supervision service is offered in combination with the Final Random Inspection.
10. Engineering Design and Analysis Services

TCR provides Engineering Design and Analysis such as Computer Aided Designing (CAD) including Engineering Design, Legacy Data Conversion, Detailing Plant & Process Layout, CAM, Computer Aided Engineering (CAE) including Finite Element Modeling, Structural Analysis and Noise, Vibration, Harshness (NVH) analysis, and Project Management Services.

Computer Aided Designing (CAD)

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<td>Drafting Conversion from 2D to 3D Data extraction Data validation Parametric models Castings Plastic parts Sheet metal parts</td>
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Computer Aided Engineering

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Consulting & Project Management

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<td>CMM Micro Profile Tester Roundness Roughness tester Profile Projector CAD Modeling &amp; Surfacing</td>
<td>Rapid prototyping CNC Machining Jigs and Fixtures</td>
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11. TCR Training Institute for Material Science and NDT

TCR Training Institute for Material Science and NDT in Navi Mumbai, India is committed to train latest technologies in NDT and Material Science to improve the skills of metallurgists, engineers and technicians. The curriculum is formalized to provide custom training programs, best practices and leading knowledge in Metallography, Thermography, Time of Flight (ToFD) Diffraction, Phased Array (PA), Helium Leak Testing, Eddy Current Testing, Magnetic Particle Testing, Liquid Penetrant Testing, Radiography Testing, and Ultrasonic Testing. All courses are designed to impart practical knowledge that can be applied immediately to the outside world.

All NDT examinations are held in accordance with ASNT Std. SNT-TC-1A by an ASNT Level III Professional. Metallography students are trained directly in a laboratory environment with challenging real-life projects.

TCR Institute for Materials Technology trainers have several years of experience in the technical training industry. The training style is highly effective, and the trainers are all professionals in the technical education field, most with years of experience both in the classroom and with applied technology skills. The classrooms are second to none.

TCR Institute for Materials Technology understands the changing and dynamic nature of this industry. A dedicated Curriculum Developer researches and qualifies new courseware for purchase, licensing, or develops/partners with a vendor for courseware ensuring that our courseware standards and materials stay current.

In some circumstances, immediate job openings are available for qualified students.

A. Technical Training Courses

TCR Engineering is a leading provider of technical courses targeted towards plant inspection, maintenance and operations personnel in India in the areas of Metallurgy, Corrosion Studies including sour gas corrosion detection, Remaining Life and Failure Investigation. TCR Engineering also offers a results-oriented and focused curriculum for training on Non Destructive Testing (NDT) in a number of subjects. A list of courses can be given upon request.
## Mechanical Testing Equipment

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</table>
SHT4106/3091104  
TCR/MEC/EQP/13  
TCR/MEC/EQP/01 | 0-1000kN/ ±1%  
Mfg. Date- Nov 2009 | NPL/ Testing Machine Services |
| Universal Testing Machine with Electronic extensometer | GDR Sr. No:283/40-1976,  
Sr. No: 106/05/02  
Sr No: 270 (Extn. Mr)  
TCR/MEC/EQP/01 | 0-1000 kN / ±1%  
0.25 mm | NPL/ Testing Machine Services |
| Universal Testing Machine With Electronic extensometer | MCS-MP/ 156-12/06  
Sr No: 186-0207  
TCR/MEC/EQP/02 | 0-400 kN / ±1%  
0.50 mm | NPL/ Testing Machine Services |
| Universal Testing Machine | SFM30  
Make: United  
Sr No: 293/05  
TCR/MEC/EQP/03 | 0-130 KN | NPL/ Material Testing Services |
| Universal Testing Machine | KIC-2-100/0-C  
Sr No: 110/04  
TCR/MEC/EQP/09 | 0-100KN | Under calibration |
| Charpy / Impact Testing Machine | FIE/ TI/30 Sr No:789  
1975  
TCR/MEC/EQP/04 | Izod-156J | NPL/ Material Testing Services |
| Charpy Impact Testing Machine | FT 300 ASTM  
Sr No: 06/12/02  
TCR/MEC/EQP/05 | 300J | Calibration Due |
| Impact Testing Machine | Mode: ZBC242/150  
Make: SANS, China  
Sr No: 20910025  
TCR/MEC/EQP/02 | 0.450J  
(calibration valid upto 150J) | NPL/Material Testing Machine Services |
| Brinell / Vickers Hardness Tester | HPO 250 F-Nr:308/92,  
1979  
TCR/MEC/EQP/06 | HBW 80-400  
Hv5 40-1200  
Hv10: 80-1000  
±2% | NPL/ Testing Machine Services |
| Rockwell Hardness tester | RA/FIE  
Sr No: 77/021  
1976  
TCR/MEC/EQP/07 | HRB 30-100  
HRC 20-70  
±1% | NPL/ Testing Machine Services |
| Rockwell Superficial Hardness Tester | RAS/FIE  
Sr No: S-7001  
1976  
TCR/MEC/EQP/12 | HR 30f:  
29.82  
±1% | NPL/ Testing Machine Services |
| Wilson Wolpert Hardness Tester | Sr No: 930/250  
TCR/MEC/EQP/11 | - | Calibration Due |
| Brinell / Vickers Hardness Tester | HPO 250 F-Nr:308/27,  
1981  
TCR/MEC/EQP/08 | HBW 80-400  
Hv5 40-1200  
Hv10: 80-1000  
±2% | NPL/ Testing Machine Services |
| Micro Hardness Tester | Make: LECO USA  
Location: Metallurgy Lab  
M-400-HI  
Sr No:170765/ 1996  
TCR/MET/EQP/06 | 0-1000gms  
±3% | - |
| V Notching Machine | Location: Machine Lab  
Fine Marketing  
1976  
TCR/MEC/EQP/15 | 2 mm V Notch | - |
| Hydraulic Pipe Bending Machine | Location: Metallurgy Lab  
Sr No: 965  
TCR/MEC/EQP/15 | - | - |
| Hydraulic Test Pump & Compressor | Location: Hydro Testing Lab  
Horizon  
TSO-05  
TCR/MEC/EQP/16 | 600kg/cm2 | NPL/OTIS |
| Cupping machine (Scale) | Location: Metallurgy Lab  
FIE /1990  
TCR/CUPPING/SC/01 | 0.20 to 3 mm | NPL/OTIS |
| Digital Thermometer with sensor (New) | Location: Physical Lab  
MARVEL SE, Sr No: 090/001  
TCR/MEC/EQP/19 | -199 to 50  
Deg C  
Elec. P. | NPL/ Kalashtri |
<p>| Digital Thermometer with sensor (New) | MARVEL SE, Sr No: 111/080603 | -199 to 100 | NPL/ Kalashtri |</p>
<table>
<thead>
<tr>
<th>Name of Equipment</th>
<th>Model/ Type/ Make &amp; IN SERVICE</th>
<th>Range/ Accuracy</th>
<th>Date of calibration</th>
<th>Calibration Due on</th>
<th>Traceability</th>
</tr>
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<tbody>
<tr>
<td>Metallography Testing Equipment</td>
<td></td>
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</tr>
<tr>
<td>Metallurgical Microscope with image analyzer</td>
<td>LECO 500 USA, 1989</td>
<td>±0.005 C ±0.005 S</td>
<td>Daily</td>
<td></td>
<td></td>
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<tr>
<td>Shadowgraph checking</td>
<td>Metzer Biomedicaf</td>
<td>50X</td>
<td></td>
<td>NPL/LAWKIM</td>
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<tr>
<td>Olympus inverted microscope</td>
<td>Olympus -GX51 inverted system</td>
<td>50X - 1000X</td>
<td></td>
<td>IRTEC</td>
<td></td>
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<tr>
<td>Insitu Metallography Kits</td>
<td></td>
<td></td>
<td></td>
<td>2 Sets</td>
<td></td>
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<tr>
<td>BMI 101A Microscope</td>
<td>BMI 101A Sr. No. – 20050065</td>
<td>100X-600X</td>
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**Chemical Analysis - Instrumentation**

<table>
<thead>
<tr>
<th>Name of Equipment</th>
<th>Model/ Type/ Make &amp; IN SERVICE</th>
<th>Range/ Accuracy</th>
<th>Date of calibration</th>
<th>Calibration Due on</th>
<th>Traceability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic Carbon Sulphur Determinator</td>
<td>LECO/CS244 USA 1990 Sr. NO. 2042 TCR/INT/EQP/02</td>
<td>±0.005 C ±0.005 S</td>
<td>Daily</td>
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<tr>
<td>Automatic Carbon Sulphur Determinator</td>
<td>LECO/CS400 USA 1997 Sr. No. 3153 TCR/INT/EQP/03</td>
<td>±0.005 C ±0.005 S</td>
<td>Daily</td>
<td></td>
<td></td>
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<tr>
<td>Automatic Carbon Sulphur Determinator</td>
<td>LECO/CS230 USA APR 2009 Sr. No. 4930 Model No. 619-000-200 TCR/INT/EQP/07</td>
<td>±0.005 C ±0.005 S</td>
<td>Daily</td>
<td>In service from Dec 12</td>
<td></td>
</tr>
<tr>
<td>Automatic Oxygen, Nitrogen, hydrogen Determinator</td>
<td>LECO ONH 836 Model No. 632-100-400 Sr. NO. 3006</td>
<td>±1% of Concentration</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atomic Absorption Spectrometer (AAS)</td>
<td>Perkin Elmer Analyst 200 Sr. No. 20056110104 TCR/INT/EQP/05</td>
<td>±1% of Concentration</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optical emission Spectrometer (OES)</td>
<td>ARL QUANTRIS/ Switzer. JUNE 2006 Sr. No. 15 TCR/INT/EQP/01</td>
<td>±1% of Concentration</td>
<td>Daily</td>
<td></td>
<td></td>
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<tr>
<td>Optical emission Spectrometer (OES)</td>
<td>Thermo fisher scientific ARL 3460 Switzer. year 2012 Sr. No. 4948 TCR/INT/EQP/01</td>
<td>±1% of Concentration</td>
<td>Daily</td>
<td></td>
<td></td>
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<tr>
<td>Instrument</td>
<td>Model/Make</td>
<td>Description</td>
<td>Accuracy</td>
<td>Calibration Frequency</td>
<td>Calibration Dates</td>
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<td>---------------------------------</td>
<td>-----------------------------------------</td>
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<td>-----------------------</td>
<td>--------------------------</td>
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<tr>
<td>ICP Spectrometer</td>
<td>PRODIGY SPEC JUNE 2005</td>
<td>±1% of Concentration</td>
<td>Daily</td>
<td>-</td>
<td>02/10/2014</td>
</tr>
<tr>
<td>UV Spectrophotometer</td>
<td>Make:Chemito Model 2100</td>
<td>±1% of Concentration</td>
<td>Daily</td>
<td>-</td>
<td>02/10/2014</td>
</tr>
<tr>
<td>XRF Spectrometer</td>
<td>Model: Supermini Sr. No. IR 16013-3</td>
<td>±1% of Concentration</td>
<td>Daily</td>
<td>-</td>
<td>02/10/2014</td>
</tr>
<tr>
<td>Electronic Digital Balance</td>
<td>Mettler, Model- AB 54-s</td>
<td>0-50 gm ±0.1 mg</td>
<td>04/10/2013</td>
<td>02/10/2014</td>
<td>NPL/ASPL</td>
</tr>
<tr>
<td>Electronic Digital Balance</td>
<td>Mettler, Model- AB 204</td>
<td>0-210 gm ±0.1 mg</td>
<td>04/10/2013</td>
<td>02/10/2014</td>
<td>NPL/ASPL</td>
</tr>
<tr>
<td>Weight Box</td>
<td>-</td>
<td>0.1 mg -100gm</td>
<td>26/12/2013</td>
<td>26/12/2014</td>
<td>NPL/ASPL</td>
</tr>
<tr>
<td>Rough Balance</td>
<td>Make Penta model TLW Sr. No 4852</td>
<td>0.002 kg-500 gm ±0.1 gm</td>
<td>02/10/2012</td>
<td>01/10/2014</td>
<td>NPL/ASPL</td>
</tr>
<tr>
<td>Oven (Wet Analysis)</td>
<td>TCR/SAO/EQP-014</td>
<td>0-300°C</td>
<td>02/10/2012</td>
<td>01/10/2014</td>
<td>NPL/ASPL</td>
</tr>
<tr>
<td>Oven (Wet Analysis )</td>
<td>Lab Hosp Sr. No. 901115</td>
<td>0-300°C</td>
<td>02/10/2012</td>
<td>01/10/2014</td>
<td>NPL/ASPL</td>
</tr>
<tr>
<td>Electrolytic Analyzer With Analog Ammeter &amp; Voltmeter</td>
<td>TCR/AM/01 TCR/VM/01</td>
<td>10 A/15V ± 1% FSD</td>
<td>02/10/203</td>
<td>01/10/2014</td>
<td>NPL/ASPL</td>
</tr>
<tr>
<td>Electrolytic Analyzer With Analog Ammeter &amp; Voltmeter</td>
<td>TCR/AM/02 TCR/VM/02</td>
<td>10A/15 V ± 1% FSD</td>
<td>02/10/2013</td>
<td>01/10/2014</td>
<td>NPL/ASPL</td>
</tr>
<tr>
<td>Glass Thermometer</td>
<td>Make GRM INIDIA TCR/MECH/TM/02</td>
<td>-10 to 110 C</td>
<td>14/11/2011</td>
<td>13/11/2012</td>
<td>NPS/ASPL</td>
</tr>
<tr>
<td>Glass Thermometer</td>
<td>Make GRM INIDIA TCR/WAQ/EQP/22</td>
<td>-10 to 360 C</td>
<td>28/12/2013</td>
<td>27/12/2014</td>
<td>NPL/ASPL</td>
</tr>
<tr>
<td>Glass Thermometer</td>
<td>Make GRM INIDIA TCR/WAQ/EQP/23</td>
<td>-10 to 360 C</td>
<td>28/12/2013</td>
<td>27/12/2014</td>
<td>NPS/ASPL</td>
</tr>
<tr>
<td>Glass Thermometer</td>
<td>Make GRM INIDIA TCR/WAQ/EQP/24</td>
<td>-10 to 360 C</td>
<td>14/11/2011</td>
<td>13/11/2012</td>
<td>NPL/ASPL</td>
</tr>
<tr>
<td>Glass Thermometer</td>
<td>Make GRM INIDIA TCR/WAQ/EQP/25</td>
<td>-10 to 360 C</td>
<td>14/11/2011</td>
<td>13/11/2012</td>
<td>NPS/ASPL</td>
</tr>
<tr>
<td>Temperature and humidity meters</td>
<td>TCR/TEMP/02 -_make HTC-1 Spectro room</td>
<td>--</td>
<td>27/12/2013</td>
<td>26/12/2014</td>
<td>ASPL/NPL</td>
</tr>
<tr>
<td>Temperature and humidity meters</td>
<td>TCR/TEMP/03 -_make HTC-1 ICP Room</td>
<td>--</td>
<td>27/12/2013</td>
<td>26/12/2014</td>
<td>ASPL/NPL</td>
</tr>
<tr>
<td>Temperature and humidity meters</td>
<td>TCR/TEMP/04 -_make HTC-1 Wet Lab</td>
<td>--</td>
<td>27/12/2013</td>
<td>26/12/2014</td>
<td>ASPL/NPL</td>
</tr>
<tr>
<td>Temperature and humidity meters</td>
<td>TCR/TEMP/05 -_make HTC-1 Corrosion lab</td>
<td>--</td>
<td>21/11/2011</td>
<td>20/11/2012</td>
<td>OTIS/NPL</td>
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<tr>
<td>Temperature and humidity meters</td>
<td>TCR/ARB/TEMP/01 -_make HTC-1 SAUDI lab</td>
<td>--</td>
<td>21/11/2011</td>
<td>20/11/2012</td>
<td>OTIS/NPL</td>
</tr>
<tr>
<td>Temperature and humidity meters</td>
<td>TCR/ARB/TEMP/012 -_make HTC-1 SAUDI lab</td>
<td>--</td>
<td>21/11/2011</td>
<td>20/11/2012</td>
<td>OTIS/NPL</td>
</tr>
</tbody>
</table>
## Inspection - Positive Material Identification (PMI), RoHS, Feritscope, Portable Hardness

<table>
<thead>
<tr>
<th>Name of Equipment</th>
<th>Model/ Type/ Make &amp; IN SERVICE</th>
<th>Range/ Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Niton XLT 898 Sr. No. 18807</td>
<td>USA</td>
<td>±5%</td>
</tr>
<tr>
<td>Delta Inspector 2000</td>
<td>USA</td>
<td>±5%</td>
</tr>
<tr>
<td>Innov-Alpha Demo Sr. No. 4444</td>
<td>USA</td>
<td>±5%</td>
</tr>
<tr>
<td>Innov-X Sr. No. 10791</td>
<td>USA</td>
<td>±5%</td>
</tr>
<tr>
<td>Innov-X system Sr.No 500625</td>
<td>USA</td>
<td>±5%</td>
</tr>
<tr>
<td>Innov-X System DS-2000 Sr. No 560099</td>
<td>USA</td>
<td>±5%</td>
</tr>
<tr>
<td>Niton XL2 Sr. No. 73308</td>
<td>USA</td>
<td>±5%</td>
</tr>
<tr>
<td>Niton XL2 Sr. No. 85754</td>
<td>USA</td>
<td>±5%</td>
</tr>
<tr>
<td>Niton XL2 Sr. No.</td>
<td>USA</td>
<td>±5%</td>
</tr>
<tr>
<td>ARC-MET 8000 Mobile OES analyser Sr.No 800469</td>
<td>USA</td>
<td>±5%</td>
</tr>
<tr>
<td>ARC-MET 8000 OES Analyzer Sr. No 800441</td>
<td>TOSHNIWAL PH-02</td>
<td>0-14 pH</td>
</tr>
<tr>
<td>pH meter</td>
<td>TOSHNIWAL PH-01</td>
<td>0-14 pH</td>
</tr>
<tr>
<td>Water Conductivity meter</td>
<td>Make Hanna Mdl HI 2300 Sr.NO. 08119182</td>
<td>NA</td>
</tr>
<tr>
<td>Electrical Conductivity Meter</td>
<td>Technofour</td>
<td>NA</td>
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## Wet Chemical Analysis

<table>
<thead>
<tr>
<th>Name of Equipment</th>
<th>Model/ Type/ Make &amp; IN SERVICE</th>
<th>Range/ Accuracy</th>
<th>Traceability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muffle Furnace</td>
<td>TCR/WAO/EQP/09</td>
<td>0-1000°C</td>
<td>NPL</td>
</tr>
<tr>
<td>Muffle Furnace</td>
<td>TCR/WAO/EQP/010</td>
<td>0-1000°C</td>
<td>NPL</td>
</tr>
<tr>
<td>Oven</td>
<td>Lab Hosar/ TCR/WAO/EQP/016</td>
<td>0-300°C</td>
<td>NPL</td>
</tr>
<tr>
<td>Oven</td>
<td>EXPO/TCR/WAO/EQP-014</td>
<td>0-100°C</td>
<td>NPL</td>
</tr>
<tr>
<td>Oven</td>
<td>TEMPO/Sr.no.4121O4</td>
<td>0-300°C</td>
<td>NPL</td>
</tr>
<tr>
<td>Glass Thermometer</td>
<td>KWALITY/ TCR/MEC/EQP/22</td>
<td>-100 - +50°C/ ± 2°C</td>
<td>NPL</td>
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<tr>
<td>Glass Thermometer</td>
<td>JRM/ TCR/MEC/EQP/31</td>
<td>-50 - +50°C/ ± 1°C</td>
<td>NPL</td>
</tr>
<tr>
<td>Glass Thermometer</td>
<td>JRM/ TCR/MEC/EQP/3129</td>
<td>-10 - 360°C/ ± 1°C</td>
<td>NPL</td>
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<tr>
<td>Analog DC Ammeter</td>
<td>LCC/TCR/WAO/EQP/018</td>
<td>0-10 A ± 1% FSD</td>
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<tr>
<td>Analog DC Voltmeter</td>
<td>LEE/ TCR/WAO/EQP/DCC 018</td>
<td>0-15 V ± 1% FSD</td>
<td>-</td>
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<tr>
<td>Electronic Digital Balance</td>
<td>Metler, Model- AB 54-s TCR/wao/eqp/011</td>
<td>0-51 gm ±0.1 mg</td>
<td>NPL</td>
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<tr>
<td>Electronic Digital Balance</td>
<td>Metler, Model- AB 204</td>
<td>0-200 gm ±0.1 mg</td>
<td>NPL</td>
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<tr>
<td>Analog DC Voltmeter</td>
<td>Sr. No. 861015239</td>
<td>0-15v</td>
<td>NPL</td>
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## Inspection and Quality Audit Equipment

<table>
<thead>
<tr>
<th>Name of Equipment</th>
<th>Model/ Type/ Make &amp; IN SERVICE</th>
<th>Range/ Accuracy</th>
<th>Traceability</th>
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</thead>
<tbody>
<tr>
<td>Metric Scale</td>
<td>TCR/CUP/mach./01</td>
<td>0-20 mm</td>
<td>NPL</td>
</tr>
<tr>
<td>Metric Scale</td>
<td>Technika TCR/MS/02</td>
<td>0-1000 mm</td>
<td>NPL</td>
</tr>
<tr>
<td>Dial Vernier Caliper</td>
<td>Mitutoyo Sr. No. 1096302</td>
<td>0-150 mm</td>
<td>NPL</td>
</tr>
<tr>
<td>External Micrometer</td>
<td>Mitutoyo Sr.No.2031020</td>
<td>0-25 mm</td>
<td>NPL</td>
</tr>
<tr>
<td>External Micrometer</td>
<td>Mitutoyo Sr.099416</td>
<td>0-25 mm</td>
<td>NPL</td>
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<tr>
<td>Tube Micrometer</td>
<td>Mitutoyo Sr.No.5606368</td>
<td>25-50 mm</td>
<td>NPL</td>
</tr>
<tr>
<td>External Micrometer</td>
<td>Mitutoyo Sr.No.7749020</td>
<td>25 mm</td>
<td>NPL</td>
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<tr>
<td>Pipe Micrometer</td>
<td>TESA TCR/VC/TESA)/01</td>
<td>0-15 cm</td>
<td>NPL</td>
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<tr>
<td>Vernier Caliper</td>
<td>Aero space Sr.no. 059016033</td>
<td>0-20 mm</td>
<td>NPL</td>
</tr>
<tr>
<td>Digital Vernier Caliper</td>
<td>TCR/DC/01 Sr. No. 209043</td>
<td>0-150 mm</td>
<td>NPL</td>
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<tr>
<td>Vernier Caliper</td>
<td>Aerospace Sr.059016033</td>
<td>0-600 mm</td>
<td>NPL</td>
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<tr>
<td>Dial Vernier Caliper</td>
<td>Mitutoyo Sr.No.07082256</td>
<td>0-200 mm</td>
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## Corrosion Testing Equipment

<table>
<thead>
<tr>
<th>Name of Equipment</th>
<th>Model/ Type/ Make &amp; IN SERVICE</th>
<th>Range/ Accuracy</th>
<th>Traceability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Gauges</td>
<td>Pioneer TCR/PG/07</td>
<td>0-600 Kg/Cm2</td>
<td>NPL</td>
</tr>
<tr>
<td>Pressure Gauges</td>
<td>Bourdon / TCR/PG/05</td>
<td>0-250 Kg/Cm2</td>
<td>NPL</td>
</tr>
<tr>
<td>Pressure Gauges</td>
<td>Wika/ TCR/PG/08</td>
<td>0-40 Kg/Cm2</td>
<td>NPL</td>
</tr>
<tr>
<td>Pressure Gauges</td>
<td>Hi Tech / TCR/PG/09</td>
<td>0-70 Kg/Cm2</td>
<td>NPL</td>
</tr>
<tr>
<td>Pressure Gauges</td>
<td>Fair / TCR/PG/09</td>
<td>0-70 Kg/Cm2</td>
<td>NPL</td>
</tr>
<tr>
<td>Pressure Gauges</td>
<td>A LOT/ TCR/PG/10</td>
<td>0+42 Kg/Cm2</td>
<td>NPL</td>
</tr>
<tr>
<td>Pressure Gauges</td>
<td>A LOT/ TCR/PG/14</td>
<td>0-70 Kg/Cm2</td>
<td>NPL</td>
</tr>
<tr>
<td>Pressure Gauges</td>
<td>WIKA</td>
<td>0-1000 Kg/cm2</td>
<td>NPL</td>
</tr>
<tr>
<td>Pressure Gauges(Corrosion Lab)</td>
<td>Hi-ech/1752/ TCR/PG/COR/01</td>
<td>0-70 Kg/Cm2</td>
<td>NPL</td>
</tr>
<tr>
<td>Pressure Gauges(Corrosion Lab)</td>
<td>Hi-ech/1762/ TCR/PG/COR/02</td>
<td>0-70 Kg/Cm2</td>
<td>NPL</td>
</tr>
<tr>
<td>Pressure Gauges(Corrosion Lab)</td>
<td>Hi-ech/1753/ TCR/PG/COR/03</td>
<td>0-70 Kg/Cm2</td>
<td>NPL</td>
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<tr>
<td>Pressure Gauges(Corrosion Lab)</td>
<td>AKVALA/TCR/PG/12 Sr.No. 51013028</td>
<td>0-70 Kg/Cm2</td>
<td>NPL</td>
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<tr>
<td>Pressure Gauges(Corrosion Lab)</td>
<td>AKVALA/TCR/PG/13 Sr.No. 51013031</td>
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<td>NPL</td>
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<tr>
<td>Thermocouple (Corrosion Lab)</td>
<td>Marvel Electronics Sr. No. 080220(D)</td>
<td>0-800 deg. C</td>
<td>NPL</td>
</tr>
<tr>
<td>Thermocouple (Corrosion Lab)</td>
<td>Marvel Electronics Sr. No. 080220(D)</td>
<td>0-800 deg. C</td>
<td>NPL</td>
</tr>
<tr>
<td>Digital Coating Thk. Gauge with Foils</td>
<td>Defelsko corp. model-6000-FN2</td>
<td>0-1500 micron</td>
<td>NPL</td>
</tr>
<tr>
<td>Digital Thermometer with Sensor(Old)/for impact test</td>
<td>Model-221P RTD Sr. No. 066601</td>
<td>-196 To 200 Deg C</td>
<td>NPL</td>
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<tr>
<td>Digital Thermometer with</td>
<td>Model-Pt-100-RTD</td>
<td>-196 To 50</td>
<td>NPL</td>
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<tr>
<td>Item Description</td>
<td>Sr. No.</td>
<td>Specifications</td>
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<td>------------------------------------------------------</td>
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<tr>
<td>Sensor (New) for impact test</td>
<td>098901</td>
<td>Deg C</td>
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<tr>
<td>Dial gauge</td>
<td>7532</td>
<td>0.10 mm</td>
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<tr>
<td>Dial Gauge</td>
<td>J8037</td>
<td>0.10 mm</td>
<td></td>
</tr>
<tr>
<td>Dial Gauge</td>
<td>1386/1</td>
<td>0.3 mm</td>
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<td>Dial Gauge</td>
<td>G9496</td>
<td>0.10 mm</td>
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<tr>
<td>Dial Gauge</td>
<td>1386/1</td>
<td>0.3 mm</td>
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<tr>
<td>Dial Gauge</td>
<td>3534/5</td>
<td>0.10 mm</td>
<td></td>
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<tr>
<td>Dial Gauge</td>
<td>J8037</td>
<td>0.10 mm</td>
<td></td>
</tr>
<tr>
<td>Dial Gauge</td>
<td>9813k7</td>
<td>0.1 mm</td>
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<tr>
<td>Dial gauge</td>
<td>78018</td>
<td>0.1”</td>
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<tr>
<td>High Pressure vessel (Autoclave)</td>
<td>2T2-6175-327-0606 &amp; 328</td>
<td>7 Nos.</td>
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<tr>
<td>Acrylic vessel</td>
<td></td>
<td>16 Nos.</td>
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<tr>
<td>P H Meter</td>
<td></td>
<td>2 Nos.</td>
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<tr>
<td>HIC Vessel</td>
<td></td>
<td>2 Nos.</td>
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</tr>
<tr>
<td>TIC With Sensor</td>
<td></td>
<td>5 Nos.</td>
<td></td>
</tr>
<tr>
<td>Temp. Indicator with sensor</td>
<td>SE/7CS1&amp;7CS2</td>
<td>0.1000</td>
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<tr>
<td>Temperature Controller With Sensor (6 Channel)</td>
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<tr>
<td>Temperature controller with sensor</td>
<td>SE/200</td>
<td>Ambient</td>
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<tr>
<td>Hydrogen Sulphide Cylinder</td>
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<td>1 No.</td>
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<tr>
<td>Hydrogen Sulphide Controller</td>
<td></td>
<td>4 Nos.</td>
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<tr>
<td>Hydrogen Sulphide Detector</td>
<td>MSA H2s ALTER</td>
<td>1 No.</td>
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<tr>
<td>H2S Mask</td>
<td></td>
<td>1 Nos.</td>
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</tr>
<tr>
<td>Temperature Sensors</td>
<td></td>
<td>5 Nos.</td>
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<tr>
<td>CR AL SIMPLEX Thermocouple</td>
<td>2K408THC1666 to 69 &amp; Sensor 5</td>
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<tr>
<td>Temperature Sensors</td>
<td>2K7THC0001</td>
<td>4 Nos.</td>
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<tr>
<td>Temperature Sensors</td>
<td>2K7THC0223</td>
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<td>Temperature Sensors</td>
<td>2K7THC0222</td>
<td>4 Nos.</td>
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<tr>
<td>Temperature Sensors</td>
<td>SENSOR 4</td>
<td>4 Nos.</td>
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<tr>
<td>Temperature Sensors</td>
<td>Sensor 1 to 4</td>
<td>4 Nos.</td>
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<tr>
<td>Temperature Sensors</td>
<td>P05D60JHHA2</td>
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<td>Temperature Sensors</td>
<td>P05D60JHHA</td>
<td>3 Nos.</td>
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<tr>
<td>Temperature Sensors</td>
<td>P06C346JHHC2</td>
<td>3 Nos.</td>
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<tr>
<td>Temperature Sensors</td>
<td>P06C346JHHC1(0707)/71</td>
<td>4 Nos.</td>
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<tr>
<td>Constant temp.(Water)Bath</td>
<td>INSU/TCR/CHE/EQP/WB-01 &amp; 02</td>
<td>0.100</td>
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<tr>
<td>Proving Rings</td>
<td>02035</td>
<td>12 kN</td>
<td></td>
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<tr>
<td>Proving Rings</td>
<td>02034</td>
<td>12 kN</td>
<td></td>
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<tr>
<td>Proving Rings</td>
<td>02028</td>
<td>12 kN</td>
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<tr>
<td>Proving Rings</td>
<td>02026</td>
<td>12 kN</td>
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<tr>
<td>Proving Rings</td>
<td>02025</td>
<td>12 kN</td>
<td></td>
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<tr>
<td>Proving Rings</td>
<td>02013</td>
<td>12 KN</td>
<td></td>
</tr>
<tr>
<td>Proving Rings</td>
<td>02014</td>
<td>12 KN</td>
<td></td>
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<tr>
<td>Proving Rings</td>
<td>02015</td>
<td>0.1200 Kgs Calib. Due</td>
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<tr>
<td>Proving Rings</td>
<td>97504</td>
<td>0.2000 Kgs NPL</td>
<td></td>
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<tr>
<td>Proving Rings</td>
<td>97502</td>
<td>0.2000 Kgs NPL</td>
<td></td>
</tr>
<tr>
<td>Proving Rings</td>
<td>97506</td>
<td>0.2000 Kgs NPL</td>
<td></td>
</tr>
<tr>
<td>Proving Rings</td>
<td>97508</td>
<td>20 KN</td>
<td></td>
</tr>
<tr>
<td>Proving Rings</td>
<td>97505</td>
<td>0.2000 Kgs Calib. Due</td>
<td></td>
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<tr>
<td>Proving Rings</td>
<td>97507</td>
<td>0.2000 Kgs Calib. Due</td>
<td></td>
</tr>
<tr>
<td>Proving Rings</td>
<td>3957</td>
<td>20 KN</td>
<td></td>
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<tr>
<td>Proving Rings</td>
<td>3956</td>
<td>20 KN</td>
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<tr>
<td>Proving Rings</td>
<td>03001</td>
<td>06 KN</td>
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</tr>
<tr>
<td>Proving Rings</td>
<td>03002</td>
<td>06 KN</td>
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<tr>
<td>Proving Rings</td>
<td>03003</td>
<td>0.600 Kgs Calib. Due</td>
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<tr>
<td>Proving Rings</td>
<td>03004</td>
<td>0.600 Kgs NPL</td>
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<tr>
<td>Proving Rings</td>
<td>02033</td>
<td>12 KN</td>
<td></td>
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<tr>
<td>Proving Rings</td>
<td>97503</td>
<td>0.2000 Kgs NPL</td>
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</table>
### Industrial Safety and NDT Shutdown Project Management

<table>
<thead>
<tr>
<th>Name of Equipment</th>
<th>Model/ Type/ Make &amp; IN SERVICE</th>
<th>Range/ Accuracy</th>
<th>Traceability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Extinguisher</td>
<td>Foam Inverted Type - B</td>
<td>9 Kg</td>
<td></td>
</tr>
<tr>
<td>Fire Extinguisher</td>
<td>Powder B&amp;C</td>
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<td></td>
</tr>
<tr>
<td>Fire Extinguisher</td>
<td>Dry Chemical Powder, Type – B/C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire Extinguisher</td>
<td>Dry Chemical Powder, Type – B/C</td>
<td></td>
<td></td>
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<tr>
<td>Fire Extinguisher</td>
<td>Dry Chemical Powder, Type – B/C</td>
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<tr>
<td>Fire Extinguisher</td>
<td>Dry Chemical Powder, Type – B/C</td>
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</tr>
<tr>
<td>First Aid Kits</td>
<td>3 Sets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helmets</td>
<td>2 Nos.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boiler Suits</td>
<td>10 Nos.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand Gloves</td>
<td>50 Nos.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Shoes</td>
<td>10 Pairs</td>
<td></td>
<td></td>
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<tr>
<td>Safety Goggles</td>
<td></td>
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</table>

### NDT - Instrumentation

<table>
<thead>
<tr>
<th>Name of Equipment</th>
<th>Model/ Type/ Make &amp; IN SERVICE</th>
<th>Range/ Accuracy</th>
<th>Traceability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrasonic Testing Eqpt.</td>
<td>Krautkramer / USK7 Sr. No: 27276-4561</td>
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<tr>
<td>V1 Block</td>
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<td></td>
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<tr>
<td>Normal Probes</td>
<td>Ultratech / SN-16</td>
<td>2MHZ 24 NP</td>
<td>1 No.</td>
</tr>
<tr>
<td>Normal Probes</td>
<td>Ultratech / SN-16</td>
<td>2MHZ 10 NP</td>
<td>1 No.</td>
</tr>
<tr>
<td>Normal Probes</td>
<td>Ultratech</td>
<td>4MHZ 10 NP</td>
<td>1 No.</td>
</tr>
<tr>
<td>Angle Probes</td>
<td>A4 8 x 9-60</td>
<td>SN. 34</td>
<td>1 No.</td>
</tr>
<tr>
<td>Angle Probes</td>
<td>A4 8 x 9-60</td>
<td>SN. 70</td>
<td>1 No.</td>
</tr>
<tr>
<td>TR Probes</td>
<td>TR4 MHZ 410</td>
<td>SN.111</td>
<td>1 No.</td>
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<tr>
<td>Ultrasonic Thickness Gauge</td>
<td>Pulseecho system</td>
<td>M1200-DL Sr. No. 2151</td>
<td>NPL/OTIS</td>
</tr>
<tr>
<td>Ultrasonic Thickness Gauge</td>
<td>Moldsonic</td>
<td>EDISON-1/Sr. No 3536-0210</td>
<td>1 No.</td>
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<tr>
<td>Probes</td>
<td>MPL 510-364</td>
<td></td>
<td>1 No.</td>
</tr>
<tr>
<td>Probes</td>
<td>MPL 510-365</td>
<td></td>
<td>1 No.</td>
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<tr>
<td>Probes</td>
<td>MPL 310-237</td>
<td></td>
<td>1 No.</td>
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<tr>
<td>Magnetic Particle Testing Eqpt. &amp; Materials</td>
<td>Yoke</td>
<td>V7/13 AC/DC</td>
<td>PT No 518601 1 No. East West</td>
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<tr>
<td>Dry Powder</td>
<td>Magnaflux –8A</td>
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<td>1 Bottle</td>
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<td>Black Water Based Powder</td>
<td>Automeg BW-245</td>
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<td>6 Nos.</td>
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<td>Magnetic Ink Black Oil Base</td>
<td>Instacheak MSL 61 B</td>
<td>Fluorescent Test</td>
<td>1 No.</td>
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<tr>
<td>Ultraviolet Light</td>
<td>A M Trading UMV 001</td>
<td>12 V - 230 V</td>
<td>1 No.</td>
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<tr>
<td>Dry Powder Sprayer</td>
<td>UPKAR</td>
<td></td>
<td>8 Cane</td>
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<tr>
<td>D P Testing Eqpt. &amp; Materials Developers</td>
<td>PD 31 B PMC</td>
<td></td>
<td>5 Nos.</td>
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<tr>
<td>Penetrant</td>
<td>15 B PMC</td>
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<td>10 Nos.</td>
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<td>Cleaners</td>
<td>PMIC</td>
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<td>1 No.</td>
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<tr>
<td>Coating Thickness Gauges</td>
<td>Postector (6000 NF-2)</td>
<td>0-650 Micron ± 3 Micron</td>
<td>1 NO</td>
</tr>
<tr>
<td>EPOCH LT PANAMTRICS-NDT DIGITAL ULTRASONICDETECTOR</td>
<td>EPOCH LT</td>
<td>SR.NO 060124610</td>
<td>Modsonic</td>
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<tr>
<td>Einstein II DGS UT Machine</td>
<td>Modsonic Sr.No E 1502-0308</td>
<td></td>
<td>OTIS</td>
</tr>
<tr>
<td>Feritoscope (MP30E-S)</td>
<td>Fischer / USA</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Sr. No.</td>
<td>Description</td>
<td>Model/Details</td>
<td>Location</td>
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<td>--------------------------------------------------</td>
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<tr>
<td>106-23060A</td>
<td>Portable Hardness Tester</td>
<td>TH-130/ HL-200</td>
<td>China</td>
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<tr>
<td></td>
<td>Digital Coating Machine</td>
<td>Defelsko corp. model-6000-FN2</td>
<td>0.1500 micron</td>
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<tr>
<td></td>
<td>Davinci Alpha UT machine</td>
<td>Sr no. D 0152-4209</td>
<td>Sr. No. 10663000012</td>
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<td></td>
<td>Surface Roughness Tester</td>
<td>Sr. No. 10663000012</td>
<td>Sr. No. 10663000012</td>
</tr>
<tr>
<td></td>
<td>Portable Magnetic permeability tester</td>
<td>Model – Ferro master Mfg by Stefanmayr instruments, Germany Sr. NO 328 yr 2009</td>
<td>Internal</td>
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<td></td>
<td>Portable Hardness Tester</td>
<td>HL 200</td>
<td>783 H</td>
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<tr>
<td></td>
<td>Cu,Al conductivity meter (already mentioned above)</td>
<td>Technoflow</td>
<td>NA</td>
</tr>
</tbody>
</table>

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13. Customers

TCR Engineering Services believes in establishing long-term, strategic relationships with our customers as opposed to short-term, opportunity-based engagements. TCR greatly values the relationships that it has established with over 2000+ customers and are delighted to meet their technical needs.

Presented below is a brief list of some of our leading customers.

<table>
<thead>
<tr>
<th>Public Sector Undertakings</th>
<th>Private Industrial Enterprises</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Bharat Heavy Electricals Ltd.</td>
<td>• Larsen and Toubro Ltd.</td>
</tr>
<tr>
<td>• Bharat Pumps Compressors Ltd.</td>
<td>• Walchandnagar Industries Ltd.</td>
</tr>
<tr>
<td>• Rashtriya Chemicals Fertilizers Ltd.</td>
<td>• Reliance Industries Ltd.</td>
</tr>
<tr>
<td>• Hindustan Petroleum Corporation Ltd.</td>
<td>• Lloyds Steel Industries Ltd.</td>
</tr>
<tr>
<td>• Bharat Petroleum Corporation Ltd.</td>
<td>• Essar Steel Ltd.</td>
</tr>
<tr>
<td>• IBP Company Ltd.</td>
<td>• Tata Projects</td>
</tr>
<tr>
<td>• National Thermal Power Corp. Ltd.</td>
<td>• JSW Steel</td>
</tr>
<tr>
<td>• Bharat Heavy Plates Vessels Ltd.</td>
<td>• Mahindra and Mahindra Ltd.</td>
</tr>
<tr>
<td>• Bharat Aluminium Company Ltd.</td>
<td>• Rosemount India Ltd.</td>
</tr>
<tr>
<td>• Mazgaon Dock Ltd.</td>
<td>• Fisher Xomox Ltd.</td>
</tr>
<tr>
<td>• Steel Authority of India Ltd.</td>
<td>• MTAR industries</td>
</tr>
<tr>
<td>• Bharat Electricals Ltd.</td>
<td>• Punj Lloyd</td>
</tr>
<tr>
<td>• Electronic Corp. of India Ltd.</td>
<td>• Associated Cement Companies Ltd.</td>
</tr>
<tr>
<td>• Mangalore Refinery and Petrochemicals Limited</td>
<td>• Thermax Ltd.</td>
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<td></td>
<td>• Sulzer India Ltd.</td>
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<td></td>
<td>• Kirloskar</td>
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<td>• Simens</td>
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<tr>
<td></td>
<td>• ITER</td>
</tr>
<tr>
<td></td>
<td>• Emerson</td>
</tr>
<tr>
<td></td>
<td>• Virgo</td>
</tr>
<tr>
<td></td>
<td>• Lubrizol</td>
</tr>
<tr>
<td></td>
<td>• Enderes and Houser</td>
</tr>
</tbody>
</table>

For a list of international customers, please contact the sales office of TCR. The above is a list of customers in India alone.
A. Serving Multiple Industry Verticals
TCR has a long standing track record of delivering quality assurance services to some of the best known organizations in the oil and gas, refining, chemicals, electronics, construction, power generation, automotive, defense, aerospace, mining, pharmaceutical, biotechnology, manufacturing, process industry and public sector verticals.

B. Global Delivery Model
TCR’s rapidly growing global delivery services model allows TCR to be the preferred back-end material testing laboratory for some of the world’s largest corporations. This allows global customers to take advantage of reduced cost for material testing while maintaining the same quality standards that they expect in their county. To date, TCR has performed laboratory testing and inspection services for numerous customers in the North America, Europe, Africa, Middle-East and Asia-Pacific.

Over 2000+ customers in India and Overseas use TCR’s services to dramatically improve and certify their products, validate material quality, ensure innovation in the marketplace, and to achieve significant competitive advantages. As a result, these companies are bringing the right products to market, at the right time, at the right cost.

C. Major Projects
Every one of the below jobs were part of a unique and interesting challenge to our team. The most rewarding part for TCR was when the clients saw a measurable value in the work of TCR, and came back for additional services and projects. Our noteworthy projects include:

Failure Analysis Projects

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schlumberger Oilfield Services</td>
<td>Failure Investigation Of Mandrel Bypass Of Equalizer Sub.</td>
</tr>
<tr>
<td>Wartsila, Finland</td>
<td>Failure Investigation Of Crank Shaft</td>
</tr>
<tr>
<td>Thermax</td>
<td>Failure Analysis Of Cupro Nickel Tubing Of Chiller Unit</td>
</tr>
<tr>
<td>Weir Mineral India</td>
<td>Root Cause Analysis Of Shaft Failures In Vertical Pumps (Cantilever Design)</td>
</tr>
<tr>
<td>Sterlite Industries India Ltd</td>
<td>Volute Casing, Crane Hook / Pump Failure Investigation</td>
</tr>
<tr>
<td>GAIL India</td>
<td>Root Cause Analysis At A Lpg Recovery Plant</td>
</tr>
<tr>
<td>Hydri Jindal</td>
<td>Failure Investigation Of Die Cracking In Swaging Process (Cold Forming Process) On 500t Press</td>
</tr>
<tr>
<td>Siemens Limited</td>
<td>Failure Investigation Of ESV Sleeve DN 200</td>
</tr>
<tr>
<td>Welspun Gujarat Sthal Rohen Ltd</td>
<td>Failure Investigation Of Api 5i Psi 2 X60, (Pipe No: 3612) Line Pipe Failed During Hydro Test At Site.</td>
</tr>
<tr>
<td>Man Industries (India) Limited</td>
<td>Failure Investigation Of Mechanical Expander Pull Rod</td>
</tr>
<tr>
<td>Torrent Power Limited</td>
<td>Failure Investigation Of Blade Of Lp Rotor Stage 4A Of ESM 110MW Unit</td>
</tr>
<tr>
<td>Ratnamani Metals &amp; Tubes Limited</td>
<td>Failure Investigation Duplex R 2205 (50.8 X 2.13 Mm) Tube Failed During Hydro-Forming Expansion</td>
</tr>
<tr>
<td>Oil India Limited</td>
<td>Corrosion Evaluation Of Oil Well Tubing Through Root Cause Failure Investigation</td>
</tr>
<tr>
<td>Caparo Engg P. Ltd</td>
<td>Failure Investigation Of Axel A Rear Suspension Of Car</td>
</tr>
<tr>
<td>Munjal Auto Limited</td>
<td>Failure Investigation Of Exhaust Muffler KTPA</td>
</tr>
<tr>
<td>Godrej Industries Limited</td>
<td>Failure Investigation Of Reformer Tubes</td>
</tr>
<tr>
<td>ALSTOM Projects (I) Ltd</td>
<td>Failure Investigation Of High Density Balancing Weight</td>
</tr>
<tr>
<td>Hindustan Petroleum Corporation Limited</td>
<td>Failure Investigation Of Radiant Heater Outlet Header Cap</td>
</tr>
<tr>
<td>Avtec Limited</td>
<td>Failure Investigation Of Crank Shaft Of Diesel Car Engine.</td>
</tr>
<tr>
<td>Bombardier Transportation India Ltd.</td>
<td>Failure Investigation Of Notching Spring Of Tap Changer</td>
</tr>
<tr>
<td>Emerson Process Management (India) P. Ltd</td>
<td>Failure investigation of coriolis mass flow meter sensor</td>
</tr>
</tbody>
</table>
Gujarat Fluorochemicals Limited | failure investigation of Re-Boiler of HF Recovery Plant
---|---
Hero Honda Motors Limited | Failure investigation of bending and seizing problem of engine valve

### Positive Material Identification

<table>
<thead>
<tr>
<th>Company</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuwait Oil Company</td>
<td>2 crews of PMI using portable XRF and portable Optical Emission spectroscopy</td>
</tr>
<tr>
<td>Hyundai Heavy Industries</td>
<td>Portable XRF on Pipe Joints</td>
</tr>
<tr>
<td>Cochin Refinery</td>
<td>PMI for Stock sorting purposes</td>
</tr>
<tr>
<td>Indian Oil Corporation</td>
<td>4 PMI crews deployed for a period of 2 years using portable XRF spectrometers</td>
</tr>
<tr>
<td>Bharat Petroleum</td>
<td>One PMI crew for identifying incoming materials at site</td>
</tr>
<tr>
<td>Reliance Industries</td>
<td>Detection of Carbon using portable Optical Emission Spectroscopy</td>
</tr>
<tr>
<td>Petronas, Malaysia</td>
<td>PMI crew on assignment on behalf of L&amp;T, India</td>
</tr>
<tr>
<td>Larsen &amp; Toubro Ltd., Mumbai</td>
<td>Ongoing on-call PMI services provided using portable XRF spectrometers</td>
</tr>
<tr>
<td>Godrej &amp; Boyce Mfg. Co., Mumbai</td>
<td></td>
</tr>
<tr>
<td>Oswal Petro Chemicals Ltd.</td>
<td></td>
</tr>
<tr>
<td>Tyco Sanmar Ltd., Tamil Nadu</td>
<td></td>
</tr>
</tbody>
</table>

### Metallography Assignments

<table>
<thead>
<tr>
<th>Company</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constar, USA</td>
<td>SEM Analysis of Plastic samples taken on 3-4 KX, 20 KV voltage magnification</td>
</tr>
<tr>
<td>NDT-CCS</td>
<td>Evaluation of Metallographic Replicas</td>
</tr>
<tr>
<td>Reliance</td>
<td>Over 1200 metallographic replicas created and analyzed to evaluate post fire damage</td>
</tr>
<tr>
<td>Zamil Group</td>
<td>Micro Hardness Testing</td>
</tr>
<tr>
<td>Alsom</td>
<td>SEM and EDAX Analysis</td>
</tr>
<tr>
<td>Massod John Brown, Dubai</td>
<td>SEM analysis to characterize the carbide morphology types in cobalt based alloys such as FXS 414</td>
</tr>
<tr>
<td>Biosync Scientific Pvt. Ltd.</td>
<td>Measurement of drug Coating layer on Drug coated stent used in Angioplasty</td>
</tr>
<tr>
<td>Godrej Industries Limited</td>
<td>Remaining life assessment was carried out through In situ Metallography route</td>
</tr>
<tr>
<td>Lupin Limited</td>
<td>Remaining life assessment of fermentor vessel was carried out by Evaluating microstructure at critical locations</td>
</tr>
<tr>
<td>Gujarat Power Generation Co. Ltd; Bharuch</td>
<td>In situ Metallography conducted at critical locations of HRSG Unit</td>
</tr>
<tr>
<td>National Thermal Power Corporation</td>
<td>In situ Metallography conducted on critical components of turbine.</td>
</tr>
<tr>
<td>IFFCO</td>
<td>Insitu Metallography for evaluation degradation of microstructure of ammonia plant for remaining life assessment.</td>
</tr>
<tr>
<td>IPCL</td>
<td>Insitu metallography at critical locations of naptha plant</td>
</tr>
<tr>
<td>L &amp; T</td>
<td>Insitu Metallography for microstructure evaluation after various manufacturing stages of critical components</td>
</tr>
<tr>
<td>Bharat Petroleum Corporation Limited</td>
<td>Damage assessment of Scrubber column and condenser tubes.</td>
</tr>
<tr>
<td>Indian Oil Corporation Limited</td>
<td>Insitu Metallography of FCC plant</td>
</tr>
<tr>
<td>Gulbrandsen Limited</td>
<td>Damage assessment through Insitu Metallography route on ammonium chloride anhydrous vessel</td>
</tr>
<tr>
<td>Nagarjuna Fertilisers &amp; Chemical Limited</td>
<td>Insitu Metallography of ammonia plant</td>
</tr>
<tr>
<td>United Phosphorous Limited</td>
<td>Insitu Metallography of evaporator support to assess the stress corrosion cracking</td>
</tr>
<tr>
<td>Tata Chemicals Limited</td>
<td>Insitu Metallography conducted at various critical locations of Urea Plant</td>
</tr>
<tr>
<td>Gujarat State Fertilizer Company</td>
<td>Insitu-metallography work on Reducer of Outlet Bottom Header of Reformer at Ammonia – IV Plant</td>
</tr>
</tbody>
</table>
### Company Profile

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

**Hindustan Petroleum Corporation Limited**
- **Insitu Metallography of reformer tubes**

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

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

**Elecon Engineering Limited**
- **Insitu Metallography at various locations of large size Gear**

**Essar Steel Limited**
- **Insitu Metallography on cooling coil of furnace.**

### Remaining Life Assessments

<table>
<thead>
<tr>
<th>Company</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Torrent Power</strong></td>
<td>Remaining Life Assessment and Investigation of Blade failed from root to LP Rotor stage 4A of E-Station 110MW UNIT</td>
</tr>
<tr>
<td><strong>Zuari Industries</strong></td>
<td>Remaining life assessment of steam pipe line and surface cracks.</td>
</tr>
<tr>
<td><strong>Alstom Power</strong></td>
<td>RLA study through Insitu-metallography work of critical components of 120MW Turbine at MSEB-KTPS, Koradi</td>
</tr>
<tr>
<td><strong>Asha Cellulose:</strong></td>
<td>Health assessment work on R-1 Reactor at Mech Engineering; Valsad</td>
</tr>
<tr>
<td><strong>Vanakbori Thermal Power station</strong></td>
<td>RLA Study of various components of Boiler No.-2</td>
</tr>
<tr>
<td><strong>Hindustan Unilever</strong></td>
<td>RLA study of critical components of MP Boiler No.-1 (G-122) at Kundain Ind.-Hindustan Lever Ltd; Goa</td>
</tr>
<tr>
<td></td>
<td>RLA study of critical components of Boiler No.-1 at V.D.L.- Hindustan Lever Ltd; Khed, Chiplun</td>
</tr>
<tr>
<td></td>
<td>Insitu-metallography work on various components of Boiler No.-1 (UP - 4702) at Hindustan lever ltd; Orai</td>
</tr>
<tr>
<td></td>
<td>RLA study of various pressure components of Stein Mullar Boiler No.- MR 6495 at Hindustan lever ltd; Sewri.</td>
</tr>
<tr>
<td><strong>Unilever Bangladesh</strong></td>
<td>RLA (Visual, MPI, DP, Metallography, Hardness &amp; Thickness Survey) on critical locations of Package Boiler at Unilever Bangladesh Ltd; Chittagong, Bangladesh</td>
</tr>
<tr>
<td><strong>Atul Industries Vapi,Gujarat</strong></td>
<td>RLA of Chlorine storage tank</td>
</tr>
<tr>
<td></td>
<td>RLA Study (Insitu-metallography, MPI &amp; Hardness) on Old Autoclave – G 2101</td>
</tr>
<tr>
<td><strong>Alembic Limited, Vadodara,</strong></td>
<td>RLA of fermentor</td>
</tr>
<tr>
<td><strong>Gujarat Fluoro-Chemicals Limited</strong></td>
<td>METALLURGICAL ASSESSMENT OF CFC REACTOR R- 501 AND COLUMN C-513 AT FORMOSA PLASTICS COMPANY TAIWAN ROC</td>
</tr>
<tr>
<td></td>
<td>Condition Assessment work (V.E, Metallography, U.T, MPI, Hardness &amp; Thickness Survey) on AHF Bullet: V-31B</td>
</tr>
<tr>
<td></td>
<td>Health assessment work on R-201 Main Reactor CFC plant [Metallography&amp; hardness] at Alfa-laval; Pune</td>
</tr>
<tr>
<td><strong>Godrej, Valia, Gujarat:</strong></td>
<td>REMAINING LIFE ASSESSMENT OF USED N9 PIPE FOR ALCOHOL SYNTHESIS PLANT Remaing life assessment of Alcohol synthesis plant.</td>
</tr>
<tr>
<td><strong>IOCL</strong></td>
<td>Health Assessment Study of C-0.5Mo Piping in Hydrogen Unit-I Plant.</td>
</tr>
<tr>
<td><strong>Siemens Ltd</strong></td>
<td>Remaining Life assessment of turbine.</td>
</tr>
<tr>
<td><strong>Jaghadia Copper</strong></td>
<td>Condition assessment of landle furnace</td>
</tr>
<tr>
<td><strong>Aarti Industries</strong></td>
<td>RLA of turbine</td>
</tr>
</tbody>
</table>
## Corrosion Detection

<table>
<thead>
<tr>
<th>Company</th>
<th>Test Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caterpillar, USA</td>
<td>Weight loss corrosion test for over 35 samples</td>
</tr>
<tr>
<td>KPOIS, Kuwait</td>
<td>Hydrogen Induced Cracking Test as per NACE standard for over 15 plate samples</td>
</tr>
<tr>
<td>Enerflex Canada</td>
<td>HIC and SSC corrosion tests as per NACE TM 0177 and TM 0284 for over 20 samples</td>
</tr>
<tr>
<td>Ecolab Canada</td>
<td>Salt Spray test at a Coca Cola plant</td>
</tr>
<tr>
<td>GMMOS, UAE</td>
<td>HIC and SSC testing on over 15 samples</td>
</tr>
<tr>
<td>Larsen and Toubro (L&amp;T)</td>
<td>HIC testing as per NACE TM 0284 on an ongoing basis</td>
</tr>
<tr>
<td>Jital, China</td>
<td>SSC test based on Sinopec approved standard (closely adopted to NACE guidelines)</td>
</tr>
<tr>
<td>Xalloy, Thailand</td>
<td>Chloride Stress Corrosion Cracking, Inter-granular Corrosion as per ASTM A262</td>
</tr>
<tr>
<td>Johnson Screens, Australia</td>
<td>Weigh Loss Corrosion Tests</td>
</tr>
<tr>
<td>Walchandnagar Industries</td>
<td>HIC and SSC Testing</td>
</tr>
</tbody>
</table>

## NDT Projects

<table>
<thead>
<tr>
<th>Company</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONGC, Uran</td>
<td>40 team member crew deployed for shutdown activity including conventional NDT, scaffolding, and shutdown project management</td>
</tr>
<tr>
<td>NPCIL, Kota</td>
<td>Shutdown Crew deployed for NDT including 20 NDT Level II and a NDT Level III person</td>
</tr>
<tr>
<td>Unilever Bangladesh</td>
<td>Ferrite Survey, UT Thickness Measurement and Hardness Checking</td>
</tr>
<tr>
<td>Indian Naval Shipping</td>
<td>NDT and RLA Study of LPG Tanker</td>
</tr>
<tr>
<td>KOC, Kuwait</td>
<td>Automated UT using ToFD for Storage Tanks based on API 650 Appendix U. Project undertaken with HHI as EPC contractor</td>
</tr>
<tr>
<td>Tekfen, KSA</td>
<td>Automated UT using ToFD based on Code Case 181 undertaken at Aramco’s PetroRabigh site</td>
</tr>
<tr>
<td>Several projects for EIL and L&amp;T</td>
<td>Ongoing daily callouts for UT, DP, MP, PT, Ferrite Measurement, Portable Hardness</td>
</tr>
</tbody>
</table>

## Third Party Inspection Services

<table>
<thead>
<tr>
<th>Company</th>
<th>Service Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saudi Chemanol</td>
<td>Third party inspection at various locations (Kolkata, Tarapur &amp; Pune) as per Client provided ITP/QAP</td>
</tr>
<tr>
<td>Komline Sanderson, USA</td>
<td>AWS Welding Inspector as well as QA/QC Personnel deployed at a vendor site in India</td>
</tr>
<tr>
<td>EMC Sp. Z.oo., Poland</td>
<td>QA/QC inspection and Pre-shipment loading audit of electric light bulbs at a vendor site in Mysore, India</td>
</tr>
<tr>
<td>Permapipe, UAE</td>
<td>Over 6 month long project to undertake QA/QC inspection including dimensional verification and specification compliance of insulation material used in refinery piping</td>
</tr>
<tr>
<td>Elliott Company, USA</td>
<td>Factory Audit and QA/QC inspection on behalf of the USA based company at their supplier site in western India. Project is ongoing for past 2 years.</td>
</tr>
<tr>
<td>Uniflex Cables, Kuwait</td>
<td>Inspection and Witness of Goods at a supplier site in India</td>
</tr>
<tr>
<td>Bloxwich, UK</td>
<td>QA/QC inspection with daily photographs and status reports advising client of vendor’s progress and quality status</td>
</tr>
<tr>
<td>Metpost, UK</td>
<td>Inspection of fabrication and Factory Audit of casting and forging companies in India</td>
</tr>
<tr>
<td>American Industrial Supply, USA</td>
<td>Third party Inspection, Stamp Transfer and Shipment Audit</td>
</tr>
<tr>
<td>Aventech, Canada</td>
<td>Factory Audit and Sourcing Assistance of Casting Suppliers</td>
</tr>
<tr>
<td>Flowserv, UK</td>
<td>QA/QC inspection at Audco in Chennai on an ongoing basis</td>
</tr>
</tbody>
</table>

## RoHS Compliance Services

<table>
<thead>
<tr>
<th>Company</th>
<th>Service Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sys Concept, Canada</td>
<td>Detection of RoHS restricted elements using the screening and verification methods</td>
</tr>
<tr>
<td>Birla Copper</td>
<td>Test of Lead content in samples</td>
</tr>
<tr>
<td>Emerson Climate Technologies</td>
<td>RoHS testing on an ongoing basis for over 500 samples</td>
</tr>
<tr>
<td>Parveen Industries</td>
<td>RoHS compliance for 28 plastic samples</td>
</tr>
</tbody>
</table>
14. Management

We are dedicated to the belief that people are our most important asset. Whatever the nature of the challenge, whether meeting the quality assurance needs of our customers or the training needs of students, it is our passionate, committed and empowered people who ultimately make the difference. Trust is at the core of all ethical business dealings. Trust that others will do as they say and trust that we will live up to our commitments.

One key to building trust is being transparent in the way we communicate with others, and by providing timely and accurate information. TCR's diverse and experienced professionals work together toward a common goal of excellence in every aspect of the business.

A. Paresh Haribhakti, Director, TCR & Chief Failure Analyst

Paresh Haribhakti is a Director of TCR Engineering Services, Mumbai and MD of TCR Advanced Engineering Services in Baroda, India, Director in TCR Arabia, Dammam Saudi Arabia and Global Technical Consultant to TCR group of companies. With over two decade of experience in the field of metallography and microstructure examination Mr Haribhakti has solved more than 1800 industrial problems. He is pioneer in promoting in situ-metallography as an acceptable and reliable technique for process plant monitoring and components in the industries.

He has experience of failure investigation, reaming life assessment and FFS of power plants, fertilizers, chemicals and petrochemicals industries, Mr Haribhakti has intensive work experience to his credentials. He has solved materials engineering problems and performed failure analysis on components from petrochemical plants, oil and gas transmission pipelines, offshore structures, ships, pharmaceutical plants, food processing equipment, gas turbine engine components, and weldments.
Mr Haribhakti investigates the available physical evidence, and performs the necessary tests to develop the most probable accident scenario. He simplifies complex engineering theory into easy to understand and usable concepts. He uses simple analogies, everyday examples, and laymen terms to explain data and findings so clients, corporate executives, government officials, or attorneys may easily understand engineering concepts.

Mr Haribhakti has specific experience in welding, heat treating and materials technology for oil & gas drilling and production applications, including production tubing, casing and down hole motor failures. Recently, Mr Haribhakti was lead member of the Failure Investigation team consulting to Asia’s largest refinery, RIL-Jamnagar, India for damage assessment work during a fire incident in their VGO-HT2 Plant. He has provided damage assessment of Hydrocracker reactors at Baiji refinery Iraq and also helped a customer procure second hand equipment from Taiwan by a Health assessment approach.

He is skilled in the use and application of scanning electron microscopy (SEM) in support of failure analysis and fracture identification. Mr. Haribhakti also undertakes Optical metallography and interpretation of microstructures, Remaining Life Assessment, provides Heat treatment solutions and studies the degradation of microstructure under high temperature high pressure conditions. He has done extensive research in study of hydrogen embrittlement of steels and stainless steels.

Research oriented creativeness of Mr. Haribhakti spearheaded the development of a powerful image analysis software for Metallurgical use - the Microstructure Characterizer Software (MiC). He has also developed a well-respected chemical composition mapping method for identification of dilution in weld zone. He performs colour metallography to increase the capabilities of interpretation of microstructure. He has also developed custom electrolytic polishing for carbon and alloy steel material.

Mr. Haribhakti has extensive knowledge of failure investigations on metallic components related to chemical/refinery plants and to general engineering. Experience ranges from cast iron, engineering steels, aluminium, copper alloys, stainless steels, and nickel base alloys to titanium. This includes all aspects of metallurgical investigations of offshore, marine, refinery and automotive components such as; turbine blades, compressors, gearboxes, motors, pumps, rotors, shafts, valves, pipe work, fasteners, boilers, pressure vessels, plain bearings, rolling bearings, gears, pistons, spark plugs, crankshafts, camshafts, engine valves and associated valve components.

Mr. Haribhakti is a Founder member of Metallography Society of India. He is an active member of the Institute of Engineers, Institute of Foundry Man, Indian Institute of Metals and Indian Institute of Welding. Mr. Haribhakti is a B.E. (Metallurgy) and M.E. (Materials Technology) from M.S. University, Vadodara.

B. Arjun Sail, General Manager (NDT, PMI and TPI)

Mr. Sail has over 25 years of experience managing projects including the ability to manage multiple priorities while retaining high professional and ethical standards. He maintains close interaction with third-party suppliers, external laboratories, and customers. As General Manager of NDT, PMI and TPI divisions, Mr. Sail receives and analyses scope and specifications for works and services to be contracted, clarifies work aspects and verifies technical evaluation criteria. He also proposes contract type, prepares tender document and finalizes them with Finance and Management input.

Mr. Sail has managed a variety of projects and contracts from positive material identification inspections to shutdown projects in oil and natural gas companies and land based NDT team operations during tank construction and piping installations. In addition, he has experience with non-destructive evaluation techniques such as ultrasonic, liquid penetrant, magnetic particle, and eddy current testing.

Mr. Sail work closely with established clientele to maintain good standing and pursue additional opportunities. He maintains a keen entrepreneurial interest and participation in business growth and pursuit of new opportunities and offerings. At many occasions, Mr. Sail suggests and pursues new technical offerings and is at all times aware of potential new clients and pursues relationships as appropriate. He develops business practices that encourage team building and participation by others within the organization.

Mr. Sail’s role also includes responsibility for technical performance, schedule, budget, coordination of proposal responses, and support to business development. He leads a multi-disciplinary filed services team within TCR and provides
leadership, vision and direction. Mr. Sail's expertise and guidance enables TCR recruiters to accurately assess potential job seeking candidates' abilities and interests.

C. Ganesh Sonawane, Quality Assurance Manager
An extremely sound broad-based technical understanding of the laboratory sector has made Mr. Ganesh Sonawane a key contributor in creating TCR Engineering Services into a quality oriented state-of-the-art laboratory.

With strong understanding of QA principals (NABL and ISO/IEC 17025) and excellent inter-personal skills, Mr. Sonawane has provided the edge to complete projects on time, within budget and with quality. His patience, business ethics and conduct has ensured that TCR's QA standards are never compromised.

Mr. Sonawane is trained as qualified internal auditor for carrying out audits by DNV. He has expert knowledge in Analytical Chemistry, materials identification of organics and inorganic materials. He has extensive experience in problem solving and method development for non-routine testing and possesses superb knowledge of classical and instrumental method of analysis. As a quality assurance manager, Mr. Sonawane ensures that the TCR laboratory stays compliant and accredited to all applicable standards including NABL, BIS and ISO 17025. He develops and maintains the Scope of Accreditation including conducting internal quality audits on calibration processes and correct test procedures. He also assists in conducting a technical audit on the technicians performing all material testing services.

Mr. Sonawane facilitates as a point of contact and escort for customer and regulatory audits.

Mr. Sonawane has advanced knowledge of chemical sciences, especially analytical techniques and instruments with good decision making skills. He ensures accurate results reporting from all analytical instruments including the Optical Emission Spectrometer (OES), Inductively Coupled Plasma (ICP) Spectrometer, Automatic Combustion based Carbon and Sulfur determination, and Glow Discharge spectrometer.

Mr. Sonawane also performs Material Certification including Unknown Material Identification and Trace Element Analysis on Powdered Metal, Chips/Shavings and Solder Alloys (Tin/Lead), Coating Weight and Identification, Quantitative & Semi-Quantitative Analyses including Density of Powdered Metals. He also supervises the conduct of Restriction of (certain) Hazardous Substances (RoHS) testing using the Portable XRF and ICP spectrometers.

Mr. Sonawane’s analytical exposure also includes wet chemical analysis of copper ore, cobalt ore copper carbonate, cobalt carbonate , calcium carbonate , sodium carbonate, sulphuric acid, copper cathode, leach slurry and liquor from Ball mill samples. He has conducted personally analysis of raw material like copper concentrate, Rock phosphate, Ferric sulphate, sodium sulphide, River Sand, quartz chips , Lime stone, Quick lime, Hydrated lime ,Baryte etc by wet chemical analysis. He has also undertaken analysis of moisture , volatile matter, silica, ash content and fixed carbon content of coke and coal samples as well as complete analysis of Sulphuric acid for various parameters.

Mr. Sonawane is well versed in performing fire assaying of copper concentrate and baryte samples for precious metal content, analysis of copper matte ,copper slag, oxidation and reduction samples of copper metal, copper cathode, copper anode and blister samples of copper by wet and instrumental method, analysis of converter dust ,gas cooler dust and ESP dust for various impurity level by wet chemical and instrumental method of analysis as well as analysis of soft water ,Raw water, cooling tower water, DM water, copper electrode samples for various parameters.

Mr. Sonawane has a Bachelor of Science in Chemistry from Pune University.

D. S. S. Shanbhag, Chief Metallurgist
Mr. Shanbhag is a chief Metallurgist with over 26 years of experience. He serves as a technical expert on the most complex metallurgical testing projects.

Mr. Shanbhag is "Hands-on" in the laboratory and performs material testing, analysis and results interpretation of numerous samples analyzed through the laboratory including mechanical, chemical, metallography and corrosion. He is part of the investigative team that performs failure and root cause analysis of failed components.
He performs and assists in routine metallurgy, including micro preparation, etching, phase counting, grain size measurement, micro structural assessment etc. He administers the mechanical test laboratory when team members are conducting tests such as Tensile, Charpy Impact, Sour Gas corrosion testing including HIC and SSCC, and Microstructure Analysis.

He interfaces with the machining department to ensure that samples are prepared as per the ASTM, NACE, BS, IS or client-specified standards. Mr. Shanbhag reviews, recommends and implements new and enhanced testing equipment or protocols. He has the unique ability to research and analyze information of considerable difficulty and draw valid conclusions. He has a strong understanding of QA principals (NABL and ISO/IEC 17025) and good inter-personal skill.

Mr. Shanbhag is skilled in mentoring, supervising, evaluating, training and motivating employees. He provides guidance and counsel to fellow team members and is capable of cross-training department personnel to perform job functions in various testing areas.

Interface with customers and vendors in technical issues related to materials and special processes. Assist the customer relations team and help resolve issues in a timely and effective manner. Contributes to the improvement of metallurgical testing department by advising on new test equipments and latest innovative procedures.

Mr. Shanbhag has a Bachelor of Engineering in Metallurgy.

E. Manoj Singh, Mechanical Laboratory Associate
Mr. Manoj has strong material testing laboratory experience of 15 years. He is familiar with the metallurgy of carbon, alloy and stainless steels, superalloys, and with ASTM, ASME, API, IS and NACE material standards and specifications, and with both destructive and nondestructive test methodology. He has strong experience in evaluating properties of materials, materials characterization and behavior, materials specifications, mechanical testing, corrosion detection, machining of materials, and laboratory design and operation.

Mr. Manoj has coordinated, planned and overseen internal test programs, and is accomplished as a customer liaison, program manager. He keeps himself abreast of all innovations in the sour gas corrosion field by reading scientific journals, industry specifications and participating in technical discussions. He also has extensive knowledge in physical and chemical testing, corrosion, failure analysis, materials selection, welding qualification and Metallography.

He leads a team that is adept at performing various corrosion including inter-granular corrosion attack, weight loss corrosion, pitting corrosion, Sour gas corrosion tests such as sulfide stress cracking (SSCC), salt spray, stress corrosion cracking, and hydrogen-induced cracking (HIC) for oil and gas, power, construction, shipping, petrochemical and process industries.

F. Mukesh Kumar, Sr. Metallurgist
Mr. Mukesh has extensive knowledge of failure investigations on metallic components related to chemical/refinery plants and to general engineering. Experience ranges from cast iron, engineering steels, aluminum, copper alloys, stainless steels, and nickel base alloys to titanium. This includes all aspects of metallurgical investigations of offshore, marine, refinery and automotive components such as; turbine blades, compressors, gearboxes, motors, pumps, rotors, shafts, valves, pipe work, fasteners, boilers, pressure vessels, plain bearings, rolling bearings, gears, pistons, spark plugs, crankshafts, camshafts, engine valves and associated valve components.

Mr. Mukesh is well experienced in the Microstructure Characterizer Software, which has been developed internally at TCR, for grain size measurement, volume fraction, nodularity assessment, case depth measurement. Mr. Mukesh has deep rooted understanding in metallurgy including micro preparation, etching techniques, phase counting, and microstructure assessment etc.

Mr. Mukesh has a Degree in Metallurgy (BE-MET)

G. Jaidev Patel, ASNT Level III, In charge NDT Testing Division
Mr. J. H. Patel is a B. E. (Metallurgy) from M.S. University Vadodara. He is having hands on experience in Industrial experience in the field of NDT for more than ten years. He is an ASNT Level – III P. T, U.T., M.P.T. and Eddy Current testing
He was actively involved in developing Ultrasonic testing procedure for Railway tracks for Indian Railways as a consultant. He is in-charge of Testing Division of TCR Advanced Engineering Pvt. Ltd. for testing of Chemical, Physical and corrosion testing confirming to the National and International standards. He is also in charge of coordinating NDT site activities. His NDT expertise is also utilized in training and certifying NDT level II technicians. Under his able guidance more than 20 technicians have qualified for NDT Level II certification. He is actively involved executing NDT testing in life assessment and damage assessment jobs for TCR Advanced. His vast experience in NDT field and understanding of various national & international codes is useful in formulating test procedures for various testing activities.

H. Shemi Baskaran, ASNT Level III, NDT Inspector
Mr. Baskaran has 18 years of experience in QA/QC inspection in oil and Gas industry, Petrochemical and refineries and is qualified as a ASNT LEVEL III RT, MT and PT. He is experienced in static equipment inspection and Third Party Inspection of materials like plates, pipes, forgings, casting at a vendor's location. He also has hands on experience in NDT (RT, MT, PT) and Radiographic testing and film interpretation.

I. Gopul Patel, SEM Expert
Is a post graduate from Sardar Patel University. He has an extensive knowledge of vacuum Technology and has worked as Scientific officer at Department of Science and technology sponsored Research centre. He has hands on experience of operation and calibration of various sophisticated analytical instruments such as Transmission Electron Microscope, Scanning Electron Microscope with EDS, X Ray Diffraction, ICP OES, spectrometers, Thermal Analyzers such as DSC, TGA. He has experience of various advanced methods of material characterization and has worked extensively in the field of microscopy.

He has been trained for Operation of Electron microscope at PHILLIPS, The Netherlands. In fact he has handled India’s First Environmental Scanning Electron Microscope with EDAX analyser for more than five years.

He is responsible for the establishing & implementing Management system at TCR Advanced and its functionality. He is actively involved in establishing new testing facilities at lab as well as on site. He has played an instrumental role in establishing custom designed web based sample management system for handling sample flow in the laboratory.

J. Ketan Upadhyay, Reliability Engineering
Mr Ketan Upadhyaya is a B.E. (Metallurgy) from M.S. University of Vadodara and has experience of 22 years in the field of NDE, Acoustic emission techniques, Vibration measurement and signature analysis, Failure Investigations, Microstructure interpretation, Scanning electron microscopy and digital imaging system. He has worked as a metallurgist at India's largest fertilizers and petrochemicals complex, GSFC Ltd., His Job profile includes fabrication inspection, providing welding procedures for maintenance and relevant heat treatments, troubleshooting against organic and inorganic corrosion and microbial induced corrosion. He is a qualified level II for Acoustic Emission testing (IIISC Bangalore), Vibration Analyst VT-II (Entec IRD) and Ultrasonic Flaw Detection (EEC Mumbai) techniques.

He is actively involved in Plant reliability Engineering and risk based inspection projects for different components such as heater piping, reactors and static equipment of petrochemical and refinery industries. He is well familiar with API/ASME/ASTM/JIS codes and ASM literature. His association with TCR Advanced Engineering strengthens the Remaining Life Assessment, Failure Investigations and Advanced Non Destructive Examination projects.

K. Amit Bafna, Middle-East Operations Manager at TCR and TCR Kuwait
Mr. Amit Bafna has over 10 years of strong NDT and QA/QC project management experience. He has the ability to read technical documentation, motivate team members and do resource allocation. He co-ordinates with team members to ensure that all client or vendor provided drawings and specifications, technical surveys and major equipment reviews are in compliance with corporate and international standards.

Mr. Amit Bafna has a degree in Science as well as an ASNT Level II certification in compliance with CP-189. He is trained in Canada on the use of Automated UT using Time of Flight Diffraction. He is well versed in writing NDT test procedures including conducting hands-on tests in UT, DP, MP, PT, Ferrite Measurement, Hardness Survey, Positive Material Identification and In-situ Metallography. Coupled with strong leadership skills, Mr. Bafna both mentors and supervises fellow team members.
Mr. Bafna has the cost and technical responsibility for execution of specific contract(s), including devising the planning, directing, and coordinating of project activities to ensure that project objectives are accomplished within the prescribed time and funding parameters.

As a Operations Manager for Middle East, Mr. Bafna leads his team members and provides quality assurance, quality control and quality monitoring functions to ensure that all purchased commodities comply with corporate and customer technical standards. His job also includes Performing / Coordinating Quality Control activities on company purchased materials and monitoring activities on contractor issued purchase orders, assessing capabilities of potential vendors as well as performing proactive inspections through increasing surveys, organizing strategy meetings with the client's Project Management Teams and contractors including coordinating pre-shipment inspections.

Experience in managing complex business relationships, both internal and external, where conflicting priorities of team members must be managed with customer satisfaction as a primary goal. Mr. Bafna has a strong understanding of the company operations to properly support and represent TCR in a mature and professional manner. He has developed oral and written communication skills to meet variety of communication needs (performance reviews, presentations, employee training and development, and leadership).

Mr. Bafna has strong interpersonal skills that foster open upward and downward communication built on mutual respect. Ability to remain calm when faced with mounting pressure related to deadlines and multiple priorities. He has the flexibility, and maturity to represent the company at a broad range of events in the community, with customers, and within the company.

L. Rohit Bafna, Director Global Sales and Auto UT
Rohit is currently Director Global Sales based in Dubai, UAE. Under his leadership the Middle East office has grown from its incubation stage to one which is now profitable. Prestigious clients that have trusted TCR to carry out material testing and quality assurance services secured by Rohit include Saudi Aramco, Sabic, QAFCO, Natore, KOC, KNPC, OMIFCO, Suezsteel and many more international oil and gas, power, fertilizer companies.

Mr. Bafna has the cost and technical responsibility for execution of specific contract(s), including devising the planning, directing, and coordinating of project activities to ensure that project objectives are accomplished within the prescribed time and funding parameters. Where subcontracts are required, Mr. Bafna manages the development of specifications, statements of work, evaluation criteria, and requests for proposal. Mr. Bafna works with the material testing laboratory and engineering consulting divisions to analyze proposals with respect to cost/risk/quality, lead source selections and negotiation teams, and monitors subcontract costs, schedules, and technical performance.

Mr. Bafna has over 15 years of Sales and Marketing in the Material Testing and Quality Assurance business. Rohit has undergone extensive training on Ultrasonic Testing using Time of Flight Diffraction (TOFD) at Olympus in Quebec, Canada.

Mr. Bafna has a Bachelors degree in Computer Sciences from DeVry Institute of Technology, Los Angeles, California and overall over 20 years of sales experience.

M. Sohel Vaidya – Team Leader Advanced NDT Division
Mr. Sohel is an ASNT II Engineer in Ultrasonic testing, Interpretation of Radiographs, Liquid Penetrant Testing, MPT (Magnetic Particle Testing). As an Inspector he performs daily Inspection of piping fabrication, Inspection of daily fitup, weld visual inspection and preparation of documents, Monitoring welder performance and weld repair status on weekly basis, Preparing QA/QC reports, Prepare the pre-punch list prior to hydro test, Documentation of Welding, NDT reports, Preparation of reports for client submittal, Welding material control, Welder control, Welding and welding repairs, Responsible to complete necessary documents for all witnessed items, Co-ordinating with construction supervisor / engineer, Reporting for poor workmanship and violation and Co-ordination with NDT crew and third party agencies.

He has over 10 years of strong project management experience. He has the ability to read technical documentation, motivate team members and do resource allocation. Sohel co-ordinates with team members to ensure that all client or vendor provided drawings and specifications, technical surveys and major equipment reviews are in compliance with corporate and international standards.
N. Anil Joshi – ASNT Level II in MSLT (Leak Detection)
Mr. Joshi is an ASNT Level II in Leak Detection. He is well experienced in working with the Alcatel ASM 140 and Varian Helium Leak Detection Machines. He has over 30 years of experience in Helium Leak Detection. He is capable of working in the two methods which are applied for leak testing and localization of leaks, the "Vacuum method" and the "Overpressure method". He has detected leaks in-situ to prevent unplanned and expensive shut downs.

Mr. Joshi has tested components for Nuclear Power Corporation (NPC), Heavy Water Board (HWB), Bhabha Atomic Research Centre (BARC), Roll Metallizers manufactured by Gallelio, Italy, Applied Vacuum, Germany as well as Vacuum Furnaces. He has visited Varian, Palo Alto (USA), Torino (Italy), Zug (Switzerland) for training and inspection of Vacuum Coating Units.

O. Key Personnel (Lab)
MECHANICAL DEPARTMENT

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name</th>
<th>Designation</th>
<th>Academic &amp; Professional Qualifications</th>
<th>Experience related to present work</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mr. Vishal B</td>
<td>Dept Head Mechanical</td>
<td>BSc</td>
<td>10 Years</td>
</tr>
<tr>
<td>2</td>
<td>Mr. S. S. Shanbhag</td>
<td>Technical Manager</td>
<td>B. E. (Met)</td>
<td>29 Years</td>
</tr>
<tr>
<td>4</td>
<td>Mr. Prakash B. Waghmare</td>
<td>Lab Technician Fatigue</td>
<td>DME</td>
<td>05 Years</td>
</tr>
<tr>
<td>5</td>
<td>Mr. Saive Ramasamy</td>
<td>Lab. Engr.</td>
<td>DME</td>
<td>22 Years</td>
</tr>
<tr>
<td>6</td>
<td>Mr. Santosh Mahadik</td>
<td>Technician</td>
<td>H Sc.</td>
<td>12 Years</td>
</tr>
<tr>
<td>7</td>
<td>Mr. Mukesh Kumar</td>
<td>Sr. Engineer.</td>
<td>BE(Met)</td>
<td>04 Years</td>
</tr>
<tr>
<td>8</td>
<td>Mr. Prabhakar Singh</td>
<td>Corrosion Operator</td>
<td>H Sc.</td>
<td>12 Year</td>
</tr>
<tr>
<td>9</td>
<td>Mr. Manoj K Pandey</td>
<td>Associate Q.A.</td>
<td>PG ASNT Level II</td>
<td>10 Years</td>
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</table>

CHEMICAL DEPARTMENT

<table>
<thead>
<tr>
<th>Sl. No.</th>
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<th>Experience related to present work</th>
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<tbody>
<tr>
<td>1</td>
<td>Mr. Md. Israil</td>
<td>DH – Wet Chemical</td>
<td>B.Sc.(Chem.)</td>
<td>30 Years</td>
</tr>
<tr>
<td>2</td>
<td>Mr. D N Gaichor</td>
<td>Sr. Chemist</td>
<td>B.Sc.(Chem.)</td>
<td>22 Years</td>
</tr>
<tr>
<td>3</td>
<td>Mr. M. A. D’Souza</td>
<td>Sr. Chemist</td>
<td>B.Sc.(Chem.)</td>
<td>28 Years</td>
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<tr>
<td>4</td>
<td>Mr. Sachin Sakpal</td>
<td>Sr. Chemist</td>
<td>B.Sc.(Chem.)</td>
<td>10 Years</td>
</tr>
<tr>
<td>5</td>
<td>Mr. A. P. Inamdar</td>
<td>Manager Inst.</td>
<td>B.Sc.(Chem.)</td>
<td>20 Years</td>
</tr>
<tr>
<td>6</td>
<td>Mr. Sunil Kotwadekar</td>
<td>Sr. Chemist</td>
<td>B.Sc.(Chem.)</td>
<td>15 Years</td>
</tr>
<tr>
<td>7</td>
<td>Mr. B.G. More</td>
<td>Jr. Chemist</td>
<td>B. Sc.(Chem.)</td>
<td>03 years</td>
</tr>
<tr>
<td>8</td>
<td>Mr. Manoj Dubey</td>
<td>Sr.PMI / RoHS Technician</td>
<td>B. Sc.(Chem.)</td>
<td>10 years</td>
</tr>
<tr>
<td>9</td>
<td>Mrs. Renu Mishra</td>
<td>Sr. Chemist</td>
<td>B.E. Chemical</td>
<td>05 years</td>
</tr>
<tr>
<td>10</td>
<td>Mrs. Shaila kadam</td>
<td>Chemical Lab Coordinator</td>
<td>B.Sc.(Chem.)</td>
<td>15 years</td>
</tr>
<tr>
<td>11</td>
<td>Mr. Brajesh Singh</td>
<td>PMI Technician</td>
<td>B.Sc.(Chem.)</td>
<td>04 years</td>
</tr>
<tr>
<td>12</td>
<td>Ganesh Sonawane</td>
<td>QAM</td>
<td>B.Sc.(Chem.) MBA</td>
<td>08 years</td>
</tr>
</tbody>
</table>
Key Personnel (Administrative)

<table>
<thead>
<tr>
<th>Sl. No.</th>
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<th>Academic &amp; Professional Qualifications</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Deepak Amichandwala</td>
<td>Department Head Customer Service</td>
<td></td>
<td>25 years</td>
</tr>
<tr>
<td>2</td>
<td>Lalit Surve</td>
<td>Department Head Accounts &amp; Purchase</td>
<td>B. Com.</td>
<td>15 years</td>
</tr>
</tbody>
</table>

15. Advisory Board

TCR has assembled a strong team of external experts who will provide technical leadership to the company. This list of experts includes:

A. Dr. G. E. Prasad  
*Retd. Head Materials Characterization Section BARC, Ex Hon. Secretary of Indian Nuclear Society*

Dr. G.E. Prasad is a well known personality in the field of Metallurgical Investigations and Failure Analysis. He has been associated with Dept. of Atomic Energy till he retired in 2001. Dr. Prasad has also represented India in a 3 member team who was involved in Kanishka (Air India Jet) blast case. He has numerous investigations of failure in Heavy Water Project, DAE and governmental institutions around the country. Dr. Prasad has been a General Secretary of such renowned societies as Indian Institute of Metals (Mumbai Chapter), Material Research Society (Mumbai Branch) and Indian Nuclear Society (Mumbai). He is the ex. honorary secretary of the Indian Nuclear Society.

B. Mr. C.V. Srinivasan  
*UNDP Corrosion Specialist*

Mr. Srinivasan is the Technical Director, Nishi Engineers Pvt Ltd Chennai with over 42 years of professional experience. He has published 38 papers on Corrosion, Metallurgy, Welding, N.D.T in various International and National Conferences on Corrosion, metallurgy, Welding, Non-Destructive Testing, Vibration + Journals from 1965 onwards including UNDP conferences. His expertise includes conducting Third Party & Statutory Inspection / Certification of LPG/Buutane/Pentane / Ammonia/ VCM/ Chlorine / Nitrogen/ Oxygen Static Storage Vessels (Bullet / Spheres), Petroleum / Methanol/ Diesel/ HSD/ LSD/ Kerosene etc Storage vessels, Used Pressure Vessels / Used Lifting Machines / Lifting Tools, Cranes, Hoists etc.

He is an expert in conducting Risk Analysis and Safety Audit for Chemical, Fertilizer, Petro-chemical, Refinery, Steel Industries and also provides consultancy in Corrosion, Metallurgical Studies (including Failure Analysis) for Plant equipment / piping etc failures. He assists in guiding on Non-Destructive Inspection, In-situ Metallography of special equipment / piping during project stage or after some years usage as well as providing Vibration Engineering Consultancy for high speed turbo-compressor rotating machinery / high speed pumps, blowers, fans etc on a need basis.

C. Mr. K. Ravindran  
*NDT Level III*

Mr. Ravindran has the unique distinction of holding the ASNT NDT Level III certification in 11 subjects including RT, UT , MT , PT, VT, ET, LT, IR ,AE, VR and NR. He also carried the AWS CWI certifications. He has an overall experience of 25 years in inspection field of castings, forgings, pressure vessels (Designing, fabrication inspection) and pipe lines inspection. He is familiar in Destructive and Nondestructive inspection technique, as applicable to Welds, castings, forgings etc as well as inspection of raw materials with relevant specifications. He is thoroughly familiar with all the relevant applicable Codes and Standards for Nondestructive Testing and well versed in the documentation procedures. He is a post Graduate in physics, Post Graduate Diploma in Radiation Protection by Bombay University BARC (INDIA). He has over ten years
experience in conducting training courses and classes all most in all methods of NDT, welding technology and casting and foundry technology.

D. Dr. R. C. Prasad
Dr. R. C. Prasad is been working extensively in Fatigue and Fracture Mechanics. He has over 30 years of experience in the field of Fatigue and Fracture mechanics. He is currently a Professor at IIT Mumbai and is having Ph.D. in Metallurgical Engineering from IISC. He has number of publications on national and international level. He is at the moment Vice President of Society of Failure Analysism (Mumbai Chapter)

E. Dr. Rajendrakumar
Dr. Rajendrakumar is a renowned metallurgist of our country. He is a doctorate from world famous University of Shefield, UK. Dr. Rajendrakumar was the Director of National Metallurgical Laboratory, Jamshedpur and a former Director of Regional Research Laboratory, Bhopal. Dr. Rajendrakumar has more than 150 publications in national and international journals of repute. He has been a committee member of IBR for failure investigation. He has written three books on metallurgy.

F. Dr. P. B. Joshi
Dr. P B Joshi is a professor in Department of Metallurgical and Materials Engineering, Faculty of Technology and Engineering, Maharaja Sayajirao University, Vadodara. He is a Ph. D. in Material Engineering. Dr Joshi is having more than 25 years of teaching experience in the field of metallurgy. He has more than 50 research publications in International journals & National journals, and authored a book titled “Materials for Electrical and Electronic Contacts”.

G. Dr. K. Baba Pai
Dr. Baba Pai is the Head of the department of Metallurgical & Materials Engineering Faculty of Technology & Engineering, M. S. University. He is Ph D from IIT Mumbai. He is having more than 29 years of experience in Educational field. He began his career as lecturer in 1989 and became professor in the Metallurgical and Materials Engineering department since past 18 years. Under his able guidance more than 4 Students were awarded PhD. Presently three students are perusing PhD. Under his guidance. He has more that 90 national and international publications in reputed journals. Dr. Pai is actively involved in providing Testing and industrial consultancy assignments for many industries of Gujarat.

H. Mr. Jagdish Baad, Consultant
Mr. Jagdish Baad is Bachelor of Technology in Metallurgical Engineering with First Class honors from IIT, Mumbai. He is having experience of 25 years in forge shop, steel, cast iron, S.G. Iron and Non-ferrous foundries. He has worked reached to Sr. Management position starting from the Engineer level. He has handled Turn key projects related to Foundry Mechanization, Quality Assurance and Product management of critical castings for turbine, material handling and wear resistance applications. Some of them are first of its kind. For last 12 years running an independent consultancy, related to TQM-Product Management of Castings & Forgings and metallurgical related turnkey projects. Well versed in kaizen, Edward Debono /Osborn techniques in creativity management. Energy audits related to metallurgical processes. He is Life member of various institutions such as Institute of Indian Foundrymen , Indian Institute of Metals ,Indian Society of Non-destructive Testing, Indian Institute of Welding Metallurgy Society of India, Alumni Association of IIT Mumbai.

I. Mr. Prakash Bhrahmbhatt, Consultant
Mr. Prakash Brahmbhatt is Ex – GM inspection dept of M/s IPCL Erstwhile RIL. His area of responsibilities during his association with RIL includes inspection & maintenance from health assessment & reliability/integrity angle for LDPE, PPCP, PBR-I, PBR-II, PP-IV, LAB, EG plants. Since last 32 years he is working in the field of fabrication, maintenance welding, inspection, testing, up keeping, metallurgy/material science, corrosion, health assessment, reliability & integrity monitoring of piping & static equipment in the petrochemical process plants. Familiar with all different type API/ASME/ASTM/ASM etc. codes & standards in respect of inspection, NDT, welding & material of construction used in such plants in above areas/fields. He was appointed as an faculty on inspection & testing, metallurgy, welding in process plants in training center of IPCL/RIL-VMD. He was also a competent person for pressure vessel testing for GFA compliance.
J. Dr. Mukesh Pandya, Consultant

Dr. Mukesh Pandya is Ex-DGM (Research) from Gujarat State fertilizer Company (GSFC) Limited, India’s premier fertilizer company. He is having a Ph.D in corrosion from Gujarat University. He has more than 25 years of experience in corrosion evaluation, materials selection, failure investigation and online corrosion monitoring in chemical, petrochemical and fertilizer industries. He possesses indepth knowledge on various forms of corrosion. His is having vast experience in conducting laboratory and field experiments on corrosion measurements as per national and international standards. He has been a member of National Association of Corrosion Engineers (NACE) USA, for 8 years. He has provided consultancy services to many industries in India and also successfully carried out international collaborative projects with M/s Avesta, Sweeden, M/s Krupp VDM Germany and M/s Cormon UK.

K. Mr. Ron Selva, Engineering Director, PP SIMTECH – a TCR Engineering partner company

Mr. Ron Selva has over 35 years of experience in design, construction, Damage Mechanisms inspection and integrity management of static equipment items of a plant. His credentials include:

Mr. Selva is the Engineering Director of PP SIMTECH Solutions Ltd, a TCR Engineering partner company, based in the UK and a founder member of the company in 1997. The company specializes in providing asset integrity managing technology services globally.

Under Mr. Selva’s leadership PP SIMTECH is renowned for the development of a robust and innovative RBI technology process during the late nineties. This technology process is considered as “unparalleled in its application”, in articles published by companies such as British Petroleum and GPIC (Bahrain), compared to any other RBI methods available in the market. This best practice technology process is also supported by a fully transparent and auditable rbiAsystTM software system, which was jointly developed with British Petroleum in 2001 and is fully owned by PP SIMTECH. In recent years, he has successfully developed a robust and practical methodology for linking Fitness-For-Service (FFS) assessment results into the RBI assessment process.

He has over 14 years experience in RBI implementation and facilitating RBI team studies, covering a variety of plants in oil, gas, petrochemical, fertilizer manufacturing & sea water desalination industries.

Mr. Selva has over 35 years of industry recognised experience in design, construction, Damage Mechanisms inspection, and risk based integrity management of static equipment items of a plant.

During the 1980’s, he was responsible for the development of an innovative FFS assessment methodology and safety case arguments using fracture mechanics technology, which was used in the evaluation and verification of the long term integrity of nuclear reactor pressure vessels and other critical equipments in the primary pressure circuit. The safety case based on this principle was successfully presented to the UK Nuclear Installation Inspectorate and the Nuclear Safety Advisory Committee to the UK Parliament. Due to its success, the application of this methodology and the logic was later extended to cover other critical and high consequence equipment items in the refining, petrochemical and fertilizer industry. These procedures have been later incorporated into the UK and European Standards and Guidance related to Fitness-For-Service (FFS) and inspection interval assessments of equipment containing thinning damage or crack-like defects.

Mr. Selva successfully developed methods and carried out several high profile FFS and inspection assessments to resolve complex problems widespread across the industry relating to a variety of critical equipment items experiencing different types of damage. For example, NH3 storage tanks affected by SCC; large storage spheres in refineries affected by H2 damage; superheater headers subjected to creep/fatigue damage and reheat cracking; pressure swing absorbers affected by fatigue cracking; deaerators and industrial boilers subjected to corrosion fatigue; heavy wall reactors made of Hastelloy material affected by Inter Granular Corrosion and SCC.

In 2002, along with a team of senior metallurgists from PP SIMTECH and two multi-national refining and petrochemical client companies, he championed the development of susceptibility assessment models for nearly 70 Damage Mechanisms relating to oil & gas, petrochemical, fertilizer, power generation and sea water desalination industries for effective use in RBI implementation team studies and FFS assessments.
Mr. Selva is an active member of several British Standards Institute (BSI) Technical Committees responsible for the development of codes and standards: Since 1989 – involved in the development of FFS assessment codes PD 6493 and BS 7910, many of these procedures are now included in the FFS guidance API 579; from 1991 – involved in the development of the Pressure Vessel Design and Construction code BS 5500; since 1999 – involved in the development of the High Temperature Creep Assessment guidance. Additionally, he is credited for his substantial contribution to the development of the European Guidelines for NH3 storage tanks inspection intervals assessment, using RBI and FFS technologies.

He has several years experience of delivering training in static equipment Design, FFS, RBI and DMs to inspection & design engineers and RBI study team members from various engineering disciplines. Due to global recognition of his knowledge in asset integrity managing technologies, Mr. Selva has presented several papers on RBI Best Practice and Fitness-For-Service by invitation from high profile clients and organisers of various technical conferences worldwide.

L. Mr. T. Dalton, Principal Metallurgist, PP SIMTECH (UK) – a TCR Engineering partner company

Mr Dalton has nearly 35 years’ experience covering Failure investigations and Damage Mechanisms (DMs) assessment of all types of static and rotating equipment items in both new and aging plants.

Such work has been related to mechanical, thinning, metallurgical and cracking damage encountered on a wide range of equipment items of plants with diverse operating conditions involving many types of process chemicals and materials of construction. The equipment materials involved include carbon and low alloy steels, stainless steels, nickel alloys, copper alloys, aluminum alloys and other more exotic materials such as titanium and zirconium.

He has expert knowledge of all types of DMs applicable to equipment items of plants operating in the oil, gas, petrochemical, chemical, fertilizer manufacturing and power generating industries. He is conversant with ASME, API and BS codes relevant to design, construction, welding and inspection.

Mr. Dalton has acted as an expert witness for failure analysis and root cause investigations. He has presented papers in subject areas such as DMs and root cause analysis at international conferences and has several years of experience in delivering training of Inspection Engineers in welding technology, material damage and failure mechanisms as well as training of RBI study team members represented by various engineering disciplines.

Mr Dalton has been active in RBI for several years – as an RBI Specialist Engineer for the facilitation of RBI team studies or as an RBI study team member for the provision of specialist expertise as a Metallurgist / Corrosion Engineer in the identification of active and potential DMs including provision of proactive support to the RBI team in the assessment of associated DMs risks and RBI inspection intervals including RBI operating limits.

Having an extensive materials technology and root cause failure analysis background and working in a multi-discipline team environment over several years with RBI Engineers, plant Inspection Engineers, plant Operations Engineers, plant Process Engineers & Chemists, Design Engineers & NDT Specialists, has enhanced his overall knowledge and understanding of change effects on plant operational and maintenance activities and their influence on various DMs & their damage rates and equipment inspection intervals, as well as the required interaction between these disciplines.
16. Award

NACE International, India chapter has selected TCR Engineering Services (Navi Mumbai) as a recipient for the prestigious NIIS Award for “Excellent Laboratory.” NACE commended TCR on the company's achievement and deserved recognition.
17. Appreciation Letters

Appreciation letters received from various clients

GE Energy
Sabaya CCGT Project Kuwait

Date: 26-June-2012

TO WHOMSOEVER IT MAY CONCERN

General Electric appreciates TCR Engineering Services for their efforts, technical expertise and time spent on the On Line Helium Leak Inspection of Steam Turbine Condenser unit #20 (2707623) to identify the Air Ingress Points in the Condenser Negative Pressure Parts at Sabaya CCGT site, Kuwait.

Sabaya Power Project is 2020 MW combined cycle comprised of 06 GE 9F Gas Turbines-Generators, 06 Heat Recovery Steam Generators (HRSG) and 03 Steam Turbines-Generators. General Electric & HHI are the main contractors and consortium partners.

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

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

General Electric International, Inc.
Sabaya –CCGT Project – Site Office
Tameq 101
Kuwait

Cel +965-97287518 (Kuwait)
Email Peer.robins@ge.com
Dear Mr Bafna

Customer Feedback

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

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

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

Yours sincerely

Chris Evellegh, PhD
Technical Director
To,
TCR Arabia Company Limited,
Dammam, KSA

Date: 15th April, 2010

Appreciation Letter

Attention: Mr. Syed Ameen Hassan, Country Manager

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

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

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

Best Wishes,

Y.D. Kim
Mechanical Manager
Marafiq IWPP Site
Reliance Industries Limited

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

TO WHOMSOEVER IT MAY CONCERN

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

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

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

(\text{\textit{\textcopyright}} Anand)
Asst Vice President
Corrosion & Inspection dept.
Reliance Industries Limited
Refinery Division
GODREJ INDUSTRIES LTD.
Burjorjinaer, Plot No. 3, Village Kanera,
Taluka Valia, District Bharuch, Gujarat 393 131
Phone  - +91 02643 - 72356/4 lines Fax - 70218

GIL/BKG/29/9/07

September 29, 2007

To Whom It May Concern

Letter of Appreciation

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

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

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

For Godrej Industries Ltd- Valia

B K Gupta
Vice President- Engineering & Projects

Bombay office : Pranjivanagar, Eastern Express Highway, Vikhroli, Mumbai - 400079 Phone : 5170175 / 51701178
To Whom It May Concern

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

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

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

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

Mr. V. J. Shrikhande
MGR (MATERIALS SCIENCE GROUP)
Corporate research center
ASEA BROWN BOVERI LTD.

Asea Brown Boveri Limited

Postal Address
Corporate R&D
PO. Meneja
Vadodara 390 013
Gujarat State (India)

Telegraphic address
ABB (M), Vadodara

Telephone
0265-642141

Telefax
0265-642184
Report

Subject
Audit of the test laboratory TCR in Mumbai

Ref No.
M-0602-009-E

Page
1 of 3

Commissioner
Palle Slaeckmann
Commission No.
SS32075

Issued by
Bjorn Axelsson
Dep
MACC-EM
Date
2006-02-08

Field of subjects
D8

Recipient
Palle Slaeckmann, Tommy Karlsson, Camilla Eriksson, Rohit Chandorkar, Pravin Dumbare, Dattatraya Kamatkar

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

For Alfa Laval purpose TCR is approved as laboratory for tensile testing, hardness testing, microstructure evaluations (o-phase, austenite/ferrite content), slag inclusions, impact testing and chemical composition.
28 July 2007

Mr. Rohit Bafna
Director - Global Sales
TCR Engineering Services

Mr. Bafna,

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

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

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

Thanks and Kind Regards,

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

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

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

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

Standardkessel Baumgarte Service GmbH
Site Office - DEPS-KWT

GERHARD BRECHNER
PROJECT MANAGER
EMC/STANDARDKESSEL BAUMGARTE SERVICE, GmbH
Letter of Appreciation

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

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

We recommend TCR Engineering Services for our future projects.

(Handwritten signature)
To,
TCR Arabia,
Dammam, KSA

Attention: Mr. Syed Ameen Hassan
   Sales Supervisor.

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

Date: 15th June, 2008

Dear Sir:

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

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

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

Best regards,

YANG SHILEI QA/QC MANAGER

The Fifth Construction Company of SINOPEC

9051033310

P.O Box 691 Dhahran Airport 31922 Tel: 0386-3-8575978 Fax: 06566-3-8575878
E-mail: info@5th-constr.com.cn
WORK COMPLETION CERTIFICATE

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

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

(Rahul Singh)
Lt. Commander
Senior Engineer Officer
For Commanding Officer

INS Delhi
C/o Fleet Mail Office
Mumbai - 400 001

4 Jul 06

300/NR
To,
Mr. Faisal K. Al-Dabai,
TCR Arabia,
Dammam, KSA,

Subject : Appreciation Letter
Reference : Post Weld Heat Treatment Services – PP8 Project

Dear Sir:

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

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

Best regards,

Engr Marwan Khader
Project Manager

Date : 1st July, 2008
SUB: JOB COMPLETION CERTIFICATE.

To Whom It May Concern:

This is to certify that M/S TCR Engineering Services Pvt. Ltd. Has done PMI job in AVU-I of Panipat Refinery during June -2008 shutdown against Work Order No. 17360903. The job done was up to our satisfaction.

With Best Regards,

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

Ph: 01802522586,
E-Mail: churaman@ipcl.co.in
Fax:0180-2578713
Ref. No. 

Date: 19th Oct. 2008

NDT TRAINING COMPLETION CERTIFICATE

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

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

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

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

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

Approved By: Masazumi Narimatsu  
Manager, Engineering
18. Safety, Health and Environment Policy

TCR Engineering Services is very proud to have an exemplary track record in health, safety and environmental compliance, with no major lost time due to accidents since inception of the company.

TCR has a ‘Zero Tolerance’ Approach with regards to Safety compliance of its employees. TCR is committed to good Health and Safety practices based on sound risk assessments and appropriate training.

Throughout TCR a ‘zero tolerance’ approach to SHE has been adopted and together with our proactive approach on these issues, we will ensure we remain the safest chain of commercial laboratories in the region.

Safety Training

Each new member of staff is thoroughly briefed on the safety hazards associated with a laboratory environment. The training will, as a minimum, cover the safety aspects of laboratory work including the following:

- Handling of substances hazardous to health.
- Safe operation of cutting, milling, grinding and turning equipment
- Safe operation of lifting equipment
- Eye protection
- Ear protection
- Respiratory safety
- Fire Alarm System

Each member of staff is asked to sign a document to confirm that he has read and understood the safety hazards and precautions. The company supplies safety wear necessary to provide the required protection against laboratory hazards.

Safety Control

Procedures, records and maintenance contracts are in place to control safety. These include:

- Fire Alarm and extinguishers maintenance contract
- H2S Procedures
- Training Records
- Injury Records
- Control of flammable substances and acids

On-Site Safety

Each member of the site team working on a particular project will be briefed prior to his or her first visit to site on the safety hazards associated with site work. Should an organized safety-training program be in existence, staff will attend it. A site visit can be organized by the company responsible person to discuss the safety aspects with the site safety officer.

The company responsible person can carry out periodic site visits and regular safety reviews with site staff.

TCR will supply all the required safety wear necessary to provide the required protection on site, if the same is not provided by the client.

TCR Safety Policy Statement

TCR sets high standards and expects all managers to be actively involved with respect to Health and Safety and the protection of our environment.
This means:

- Each TCR location will comply with all applicable Safety, Health and Environment Regulations within the territory in which it operates
- While the Directors and Management accept their responsibilities for Health and Safety at work, they expect all employees to play their part and to fulfill their legal obligations under Health and Safety Legislation by taking reasonable care to avoid accidents to themselves and others and following company procedures. Only by full cooperation can the common objectives TCR be achieved
- Every employee has the responsibility to maintain a safe working environment in which risks arising from the TCR’s working practices are identified and controlled. Any willful violation of safety policy will result in disciplinary action.

The definition of a serious breach of Safety Policy is very difficult to categorize objectively in a prescriptive sense and therefore circumstance will dictate the appropriate disciplinary action. There are of course specific instances where summary dismissal will be applicable, i.e.

- Recklessness in the use of chemicals and radiation sources or any other hazardous materials
- Willfully removing or disabling any safety device
- Operating equipment or driving whilst clearly incapacitated through alcohol or drug abuse
- Falsification of safety records or incident reports
- Disposing illegally of any hazardous substance
- Willful negligence to carry out proper maintenance of buildings, equipment, etc.

TCR is committed to conducting its activities in such a way as to protect the safety of clients, the public at large, visitors and contractors on company premises.

**Environmental Protection**

Environmental matters are of great importance to the Company

To Avoid Damaging the Environment, all TCR employees are encouraged to strictly comply the following:

- Do not pour chemicals or other substances down internal drains. Check with your supervisor for the correct disposal procedure
- Proper waste management system must be used to ensure that all classes of waste are disposed of in accordance with current legal requirements and local rules
- Store all oils and chemicals including solvents and paints in designated bounded areas
- Refueling site transport, compressors etc. must be carried out in designate areas
- If you handle substances hazardous to the environment, make sure you are aware of the site emergency procedure for spillage or leakage
- Make sure that you are authorized and familiar with the local procedures before filling or draining process tanks or bulk storage tanks
- Report all spillages/leakages and other incidents, the breakdown or malfunction of any plant and equipment controlling discharge into the environment and any poor housekeeping
19. Locations

We welcome service and technical inquiry, from simple questions to more involved interpretations of codes and specifications. We are located at:

TCR Engineering Services Pvt. Ltd.
35 Pragati Industrial Estate,
N. M Joshi Marg, Lower Parel,
Mumbai - 400 011, India
Tel : +91- 9022137295
Fax : + 91-22-23080197
Website: www.tcreng.com

TCR Advanced Engineering, Baroda
250-252/9, GIDC Estate, Makarpura,
Naren Hardware lane,
Vadodara-390010, Gujarat, India
Tel: +91-265-2657233, +91-265-2636329
Fax: +91-265-2634375
E-Mail: baroda@tcreng.com
Website: www.tcradvanced.com

TCR Arabia Company Limited
P.O. Box 3422
# 3 & 4, next to Al Kifah Construction
besides Al-Kadi Tent Factory
near King Abdulaziz Sea Port
Dammam, Kingdom of Saudi Arabia
Tel: +966-13-8475785
Tel: +966-13-8475784
Tel: +966-13-8475014
Cell: +966-5-0499-7683
Fax: +966-13-8475768
sales@tcr-arabia.com | www.tcr-arabia.com

TCR Arabia (Jubail Branch)
Office No. 11,
Executive Business Center,
Jubail - Dammam Highway, Al-Jubail, Saudi Arabia
Tel: +966-13-3449553 /56
Fax: +966-13-3449943

TCR Arabia (Yanbu Branch)
P.O. Box -30377, Office # 001,
Al-Zakri Mall, King Faud Street,
Royal Commission,
Yanbu – 41912, Saudi Arabia
Tel: +966-14-3932321
Fax: +966-14-3935181