

A grayscale photograph of an industrial facility with several tall, vertical distillation columns or towers against a cloudy sky. A yellow horizontal band is overlaid across the middle of the image, containing text.

REDEFINING ON-TIME QUALITY

Materials Testing Lab and NDT Inspection
with NABL, ISO 17025 and BIS approval

THE MAGIC



TCR is serving global industry leaders for close to five decades

46 Years

of experience working with Global Leaders across Industries

350+

number of TCR Global experts and consultants currently working across 3 continents

65+

Corrosion specific NDT cases

1,00,000+

Database of Microstructures specialized by Industry vertical-based solution

6,000+

Failure analysis cases

1000+

Refinery cases

5+

Exclusive partnerships globally

**FOUNDING
VISION:
PRINCIPLES OF
PRECISION,
TRANSPARENCY
AND RELIABILITY**

TCR LEGACY

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

Historical Milestones

TCR Engineering Services was incorporated in 1973

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

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

Our journey started as a disruptor for end to end inspection services to a being global leader

2018

TCR Qatar is established

2010

TCR establishes an alliance - Malaysia

2007

TCR Engineering enters into a JV in Saudi Arabia to establish **TCR Arabia** in Dammam

2006

TCR Engineering opens **TCR Kuwait**, its first international office in Kuwait

1999

TCR Engineering establishes **TCR Advanced** in Vadodara to offer research and consulting solutions for plant management

1980

First to add a chemical analysis spectrometer in India

1975

First to install 100T Tensile Machine in India

1973

TCR Engineering Services Company Founded in Mumbai



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

TCR CREDIBILITY: ACCREDITATION & APPROVALS

TCR is among the few leading & independent laboratories that meet the international standards of quality, accredited by reputed global agencies

CERTIFICATIONS



INDUSTRY/UNIVERSITY PARTNERSHIPS



CORPORATE PARTNERSHIPS



ASSOCIATIONS



Indian Society for



Non-Destructive Testing



V.K. Bafna

Chairman Emeritus
TCR Group of
Companies



Rohit Bafna

President
TCR Global



Neelam Bafna

Managing Director
TCR Engineering



Paresh Haribhakti

Global Technical Advisor
TCR Engineering



Viren Khandwala

Director, Finance
TCR Engineering



SURESH ACHARYA
Country Head



AVINASH TAMBEWAGH
Head, Advanced Testing



SRIRAM SHANBHAG
Head, Technical Lab



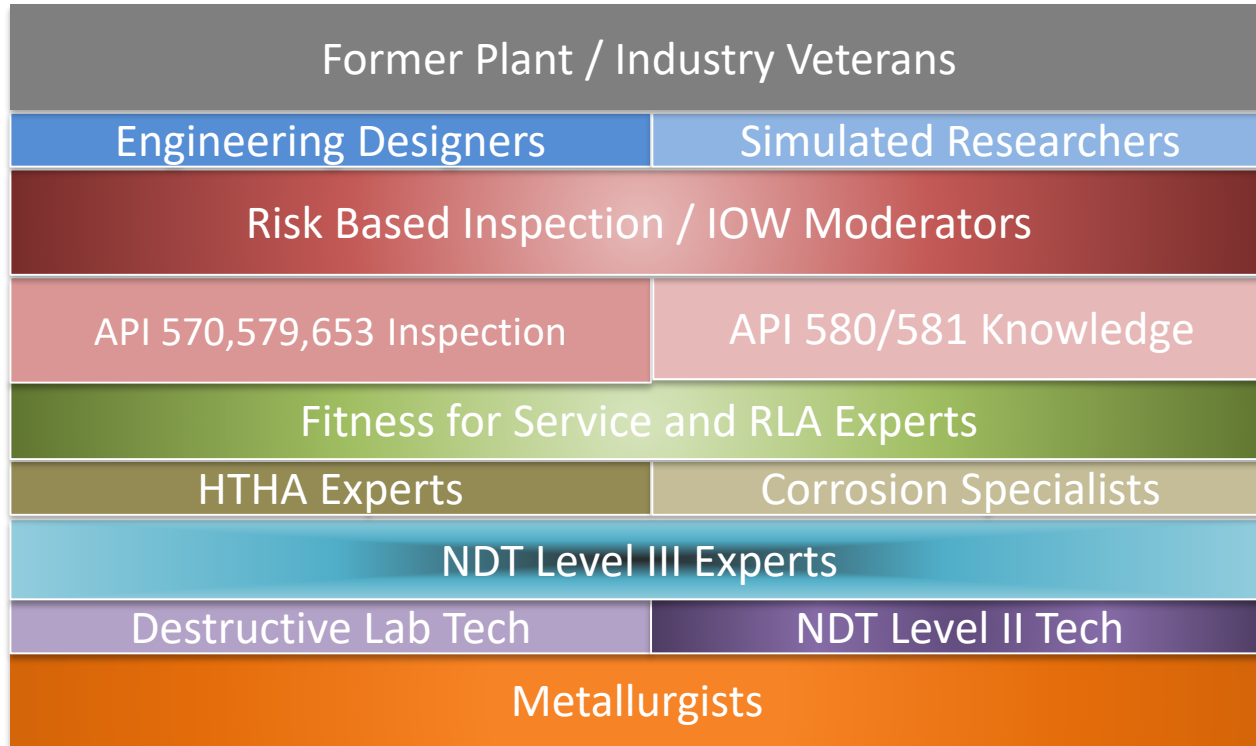
SHEMI BASKARAN
Head, NDT



GANESH SONAWANE
Head, Quality Control



LALIT SURVE
Head, Finance



KEY INDIA CLIENTS



KEY GLOBAL CUSTOMERS





Appreciation Award by Vikram Sarabhai Space Center for Contribution in the launch of space shuttle ASLV-D3



Appreciation from ISNT



Memento from NACE



American Society of Metals (ASM) acknowledged Mr. Paresh Haribhakti at International Conference on 'Material Testing & Characterization'



Recognized by KNPC, Kuwait for contributions to the 'Plant Integrity Solutions Workshop'



KK Award presented to Mr. Paresh Haribhakti, MD, TCR Advanced in the Category of Professional Field for the Year 2015 by Indian Institute of Metals (Baroda)



Mumbai and Chennai (India)



Dubai (UAE)



Dammam, Jubail and Yanbu
(Saudi Arabia)



Offshore and Sub-Sea



Vadodara (India) and Virtual



Vadodara (India)



Doha



Faheel



Muscat



ISO 17025 Accredited LAB

Material Testing Laboratory for Destructive Testing



OFFSHORE ANALYSIS IN INDIA WITH RAPID RESPONSE AND DEDICATED MACHINE SHOP,
EXPERT METALLURGISTS AND LAB TECHNICIANS



ARL Quantis
Optical Emissions
Spectrometer



Inductively Coupled Plasma
Spectrometer



Atomic Absorption
Spectrometer



Optical Emission
Spectrometer



Automatic
Carbon – Sulphur
Determination



Universal Tensile, Impact and Hardness Machines

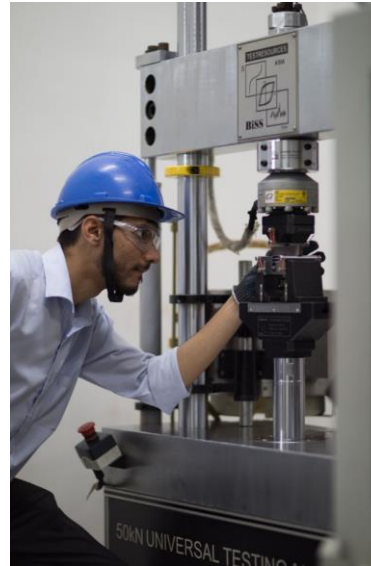


DURABILITY ANALYSES

FATIGUE & FRACTURE TOUGHNESS

CTOD, K1C, J1C, S-N Curve

ASTM E606 (Low-cycle fatigue, strain-controlled Fatigue Testing) and ASTM E466 (Load-controlled Fatigue Testing – High or Low-cycle fatigue testing) widely tested. Fatigue Tests for TMT RE-BAR & COUPLERS as per IS 16172.

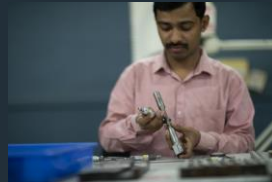


Crack-Tip Opening Displacement (CTOD) - ASTM E1290, BS 7448
Strain Fracture Toughness (KIC) - ASTM E399
Fracture Toughness - ASTM E1820
Fracture Mechanics - K1c, J1c, CTOD
Force Controlled Constant Amplitude Axial Fatigue - ASTM E466
Elevated Temperature Tension - ASTM E21
Strain-Controlled Fatigue Testing - ASTM E606
Measurement of Fatigue Crack Growth Rates - ASTM E647
Room Temperature Compression Testing - ASTM E9
Creep-Fatigue Testing - ASTM E 2714
Fatigue testing by Axial-strain-controlled method - ISO 12106
Fatigue testing by Fatigue crack growth method - ISO 12108
Static Tensile, Cyclic Tensile, Slip Test, High Cycle Fatigue, S-N Curve

STRESS VERSUS TIME AT ELEVATED TEMP CREEP & STRESS RUPTURE

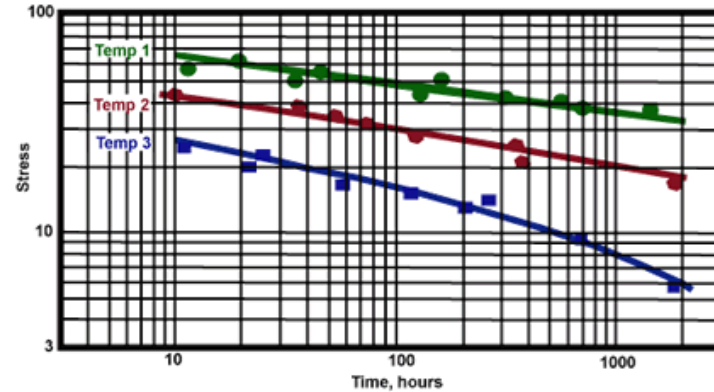
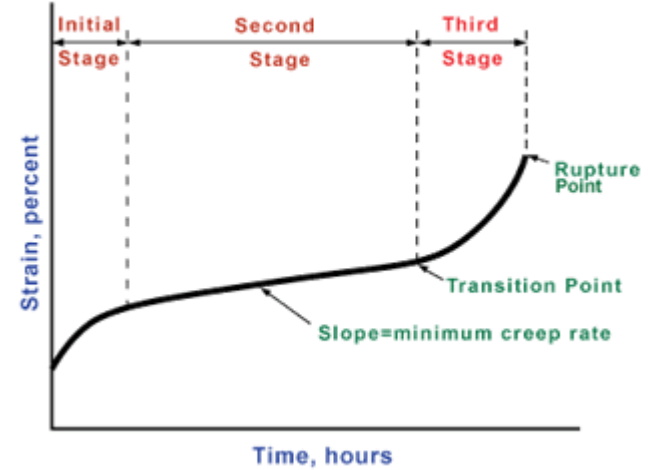
ASTM E139 and ASTM E292

Reliable temperature control using calibrated thermocouples attached to the test specimens. The load is adjusted automatically at various time intervals for efficiency.



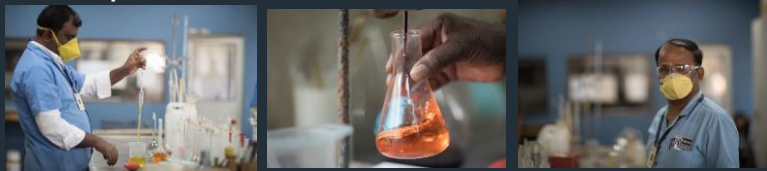
Evaluating materials for boilers, gas turbines, jet engines, ovens or any application that involves high temperatures under load.

Stress rupture test involves a tensile specimen under a constant load at a constant temperature. Stress rupture tests are employed to find out the time it takes for failure.



GRAVIMETRY/TITRIMETRY
QUANTITATIVE AND SEMI-
QUANTITATIVE ANALYSES
**WET CHEMICAL
ANALYSIS AND
SPECTROMETERS**
PPM / Sub-PPM Detection Level

Identification of chemistry in Ferrous, Non-Ferrous Metals, Ceramics, Glass, Refractory, Minerals and Ferro Alloys in all forms including drillings or turnings, solid samples, and liquids.



Atomic Absorption (AA) Graphite Furnace Spectrometer
Inductively Coupled Plasma (ICP) Spectrometer
Optical Emission Spectrometer (OES)
X-Ray Diffraction Spectrometer (XRD)
Gas Analysis (Oxygen, Hydrogen, Nitrogen)
EDAX Analysis
On-Site Positive Material Identification (Portable XRF and OES)
pH Value Determination, Acid Insoluble
Sand Content, Moisture Content, Ash Content
Sulphates, Chlorides, Silicates, Carbonates, Oxides of Iron
Calcium, Magnesium, Potassium, Sodium, Iron
Solder Alloys (Tin/Lead)
Density of Powdered Metals, Particle Size Analyzer
Coating Identification, Coating Weights



SCIENTIFIC RESEARCH LABORATORY

SOUR GAS & GENERAL CORROSION TESTING

Excellent Lab Award by NACE

Equipped with numerous high temperature/high pressure autoclaves, proving rings, salt spray chamber, Corrosion simulation in lab as well as Desktop simulation of corrosion rate with passionate corrosion scientists

Sour Gas (HIC/SSC/SOHIC) – NACE TM0284/TM0177/TM0103
Chloride Stress - ASTM G 36
SCC of Aluminum Alloy - ASTM G44/G47
Pitting/Crevice (Critical Temperature) - ASTM G48
Potentiostatic / Potentiodynamic Anodic Polarization - ASTM G5
Chloride Stress - ASTM G 36
Corrosion of Aluminum NAMLTL - ASTM G67
Exfoliation of Aluminum - G66/G34
SCC of Aluminum – ASTM G103
Intergranular – ASTM A262/ DIN EN ISO 3651
Immersion Corrosion – ASTM G31
Ammonia Vapor Test – ASTM B858, Salt Spray – ASTM B117



Replicate Site Conditions Causing Pipeline Corrosion in Lab

Ability to understand influence of an individual variable on the overall corrosion. First determine the parameters influencing corrosion in the field, and then select an appropriate laboratory methodology for simulating these parameters.

ASTM G111, 'Corrosion Tests in a High Temperature or High Pressure Environment, or Both.'; **ASTM G170**, "Evaluating and Qualifying Oilfield and Refinery Corrosion Inhibitors in the Laboratory"; **ASTM G102**, "Calculation of Corrosion Rates from Electrochemical Measurements"

1 Collect Information about the Pipeline from Client: Pipe line description, diameter, WT, grade, specification, coating etc. Operating Conditions such as Pipe line operating pressure and range, cleaning, repairs, CP, past inspection history. Fluid/Water data such as Water %, crude oil , crude oil properties, GOR and other information

2 Investigate Failed Pipe: Marking of historical liquid levels in pipe; Clock position verses wall thickness loss; Presence of nodules, scales, biological materials like slime, Presence of Isolated pitting; General metal loss with some deeper pits; Pitting morphology study relate to presence of certain chemical species or bacteria; Pit length verses pit width; Pit depth/diameter ratio; Metallurgical studies of pipe specimen

SOP to control minimize intrinsic (nature of corrosion and apparatus) and eliminate extrinsic causes (operator error and improper apparatus).

3 Simulation Study: Weight loss corrosion rate simulation in Autoclave replicating field conditions of temperature, partial pressure, Corrosive Agents and taking samples of separated water, condensate and gas composition
Electro-chemical Tests for Partial Pressure. **CO₂ Agent:** Autoclave of SS material. Maintain the partial pressure using CO₂, Nitrogen and Methane cylinders. **H₂S Agent:** Autoclave of Nickel based Alloy (C-276) with stringent safety norms

TCR will conduct at least two identical tests and determine the variation between them. If corrosion rates differ by more than 10%, two more identical tests. Mean and Standard Deviation of all four corrosion rates calculated.

4 Software Simulation: Cor.rate software analysis for most probable corrosion mechanisms and extent of severity to predict the current corrosion rate and life of the line

Additional Tests: Flow Behavior Analysis, Water condensation lab study for sulphate reducing bacteria, Acid producing bacteria culture studies using fluids of pipeline, scale tendency and flow regimes/phases (oil-water separation, turbulence etc.) simulation, multiple corrosion inhibitor dosage/type evaluation, topographical analysis

SUB-SEA OFFSHORE PLATFORMS



Safety Driven with years of proven services from TCR's partner company U-Sonix. All personnel have previous offshore experience

- Platform Installation Support
- Jacket inspection, Repair & Maintenance for Re-certification by class (DNV, LRS, BV)
- Pipe Lay Support
- Riser Clamp / Rise Installation
- I Tube / J Tube Installation
- Jacket Face Survey
- Pre Eng-Pre Construction Survey
- Pipeline Crossing Rectification
- Free span correction
- Anode Installation on structure & pipeline
- SBM / SPM Installation Support
- SBM / SPM - Operation, Maintenance & Replacement
- Pipeline Repair Work using Special Subsea Clamps
- Sub Marine Cable Lay Support
- Diving Assistance for All type of subsea work



WPS-PQR DEVELOPMENT WELD EXPERTS

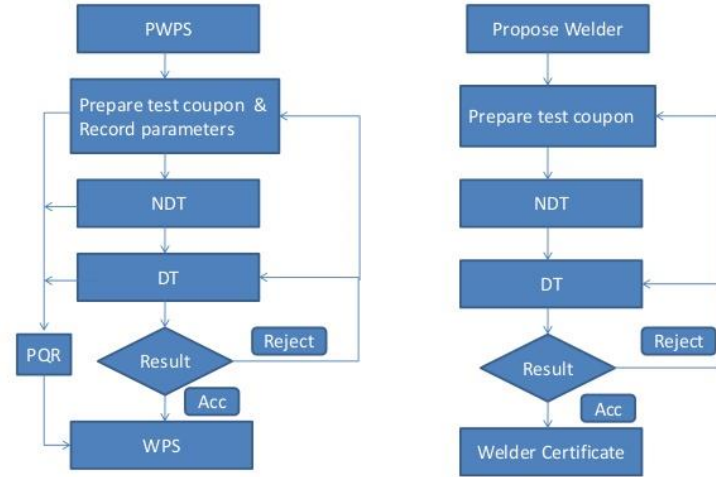
AWS D1.1, ASME IX, API 1104, EN 288

Evaluate the existing welding procedures, Perform welding quality control inspections, Supervise and inspect critical weld procedures in the field.



Complete facilities for testing welding consumable & filler material

Welding Procedure & welder qualification test



Department Head - Jaydeep Vora

- 30 years experience. Ex AVP of Godrej.
- Expert in ASME U, U2, U3, S & R stamp qualification.
- Qualified Welding Procedures on Stamicarbon - SAFUREX; Cr-Mo-V Steels; Titanium, Zirconium, Inconel, Monel; DIROS 500
- Successfully welded 2.25Cr-1Mo item weighing 950MT
- Automatic nozzle welding using SAW
- Automatic GMAW for welding Dish ends
- Tandem Submerged Arc Welding (SAW) using up to three wires simultaneously to reduce the cycle time
- Implemented High speed Electro Slag Strip Cladding

PIPELINE & WELD JOINTS RADIOGRAPHY 12 – 24" Dia Pipeline Crawler

Experienced NDT Level III expert along with dedicated team of technicians perform gamma radiography with projectors and crawlers. Computerized Radiography is available.



X-ray pipeline crawlers with high radiographic quality, high imaging sensitivity and low failure rate



SENTINEL 880 Delta
Gamma Projector

Portable frequency-converted and gas-filled
X-ray NDT equipment



Glass tube Directional

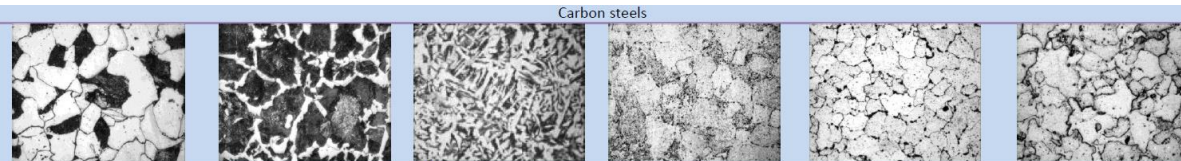


Metallographic Replica:

In-depth condition/life assessment of process plant components and detection of Graphitization, Degradation Of Pearlite, Creep, Thermal Fatigue, Oxidation, Grain Growth, Hydrogen Attack, Stress Corrosion Cracking, Sigma Phase

ADVANTAGE

TCR's metallurgists have a database of over 30,000 micro-structure interpretation study of various components and materials.



Normalized - 400X

As forged or improperly heat treated-400X

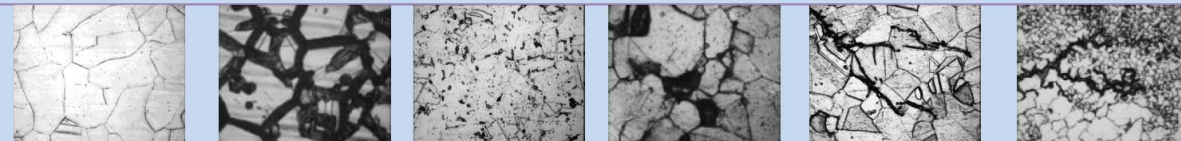
Widmanstatten ferrite and pearlite 100X

Spheroidization of pearlite 400X

Creep voids at the grain boundaries - 400X

Decarburization- 400X

Austenitic stainless steels



Solution annealed 400X

carbide precipitation- 400X

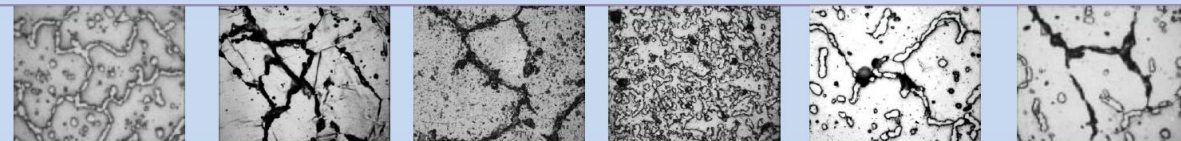
Sigma Phase 400X

IGC 400X

TGSCC 100X

IGSCC 400X

Catalytic converters / reformer tubes / hot outlet manifolds



Solution annealed HK40 400X

Inter-granular crack - HK40 400X

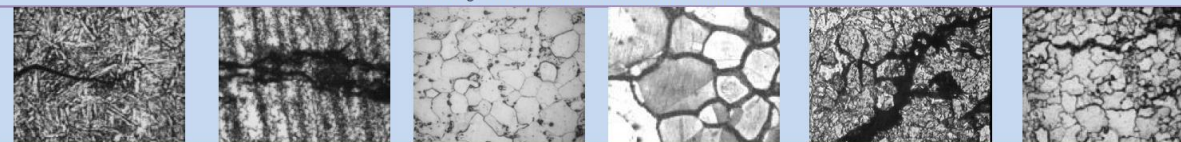
Oxidation-Incoloy 800HT 400X

Creep damage In weld HP Mod 400X

Creep damage in PM 400X

Interdendritic cracks 400X

Damage mechanisms identified in the microstructure



Quench cracks in alloy steel 400X

Caustic SCC carbon steel 400X

Graphitization damage low alloy steel - 400X

Grain boundary oxidation in CS - 100X

Inter-granular crack in rotor low alloy steel 400X

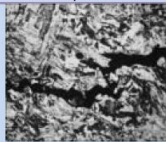
Type IV cracks P22 400X



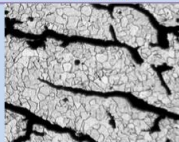
Dissimilar metal weld SS-alloy steel 200X



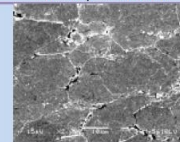
Thermal fatigue alloy steel 100X



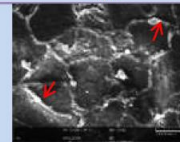
Corrosion fatigue SS 410 400X



High temperature hydrogen damage C-1/2Mo. - 100X



Creep Damage in P91/T91 2000X



High temp. sulphur induced corrosion T11. - 3500X



carbide crack



plastic film



carbide crack



Scanning Electron Microscopy



Optical Microscopy



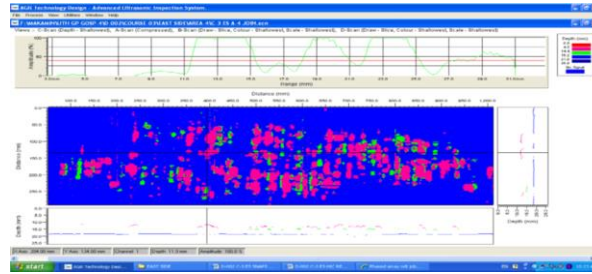
Portable Microscope



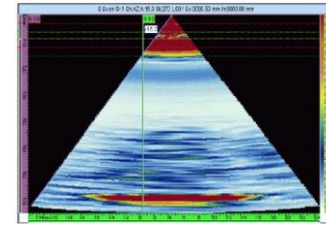
In-situ Metallography by replication method.

ON-LINE INSPECTION AND HIGH TEMP NDT HTHA AND SWC

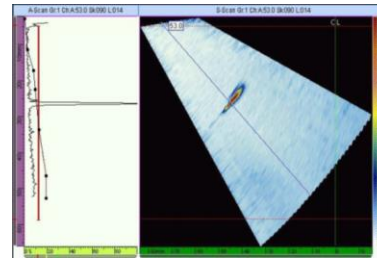
TCR Detects and Monitor's Corrosion Growth Rate/Wall Thinning and In-service defects of Plant piping, Vessels & Tanks operating at elevated temperatures up to 700° F (350° C).



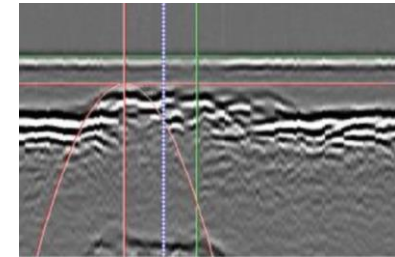
Wall thickness mapping of the area, before making hottaps



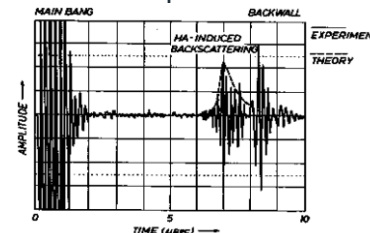
HTHA confirmation using PAUT



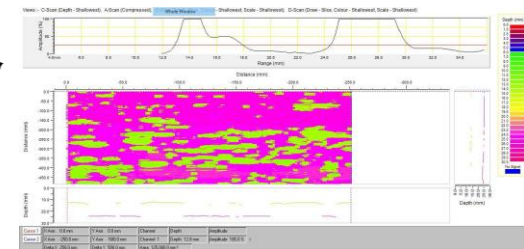
Phased Array Inspection of on-line repaired areas



Time of Flight (ToFD) inspection of heavy wall vessels or welds



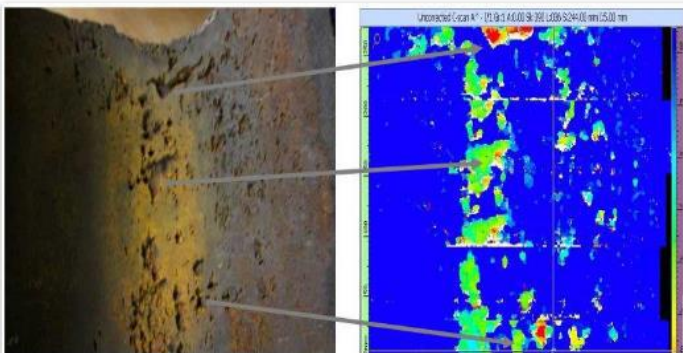
HTHA using ABUT-L



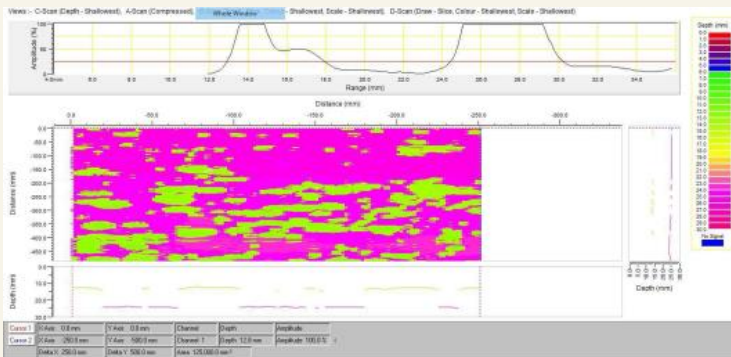
HIC/SWC/Inclusion/Lamination detection

Step-wise Cracking & HTHA

Sample evidence of corroded areas detected with ultrasonic corrosion mapping



ToFD, AUT P-Scan, PAUT, AUBT-L, AUBT-S

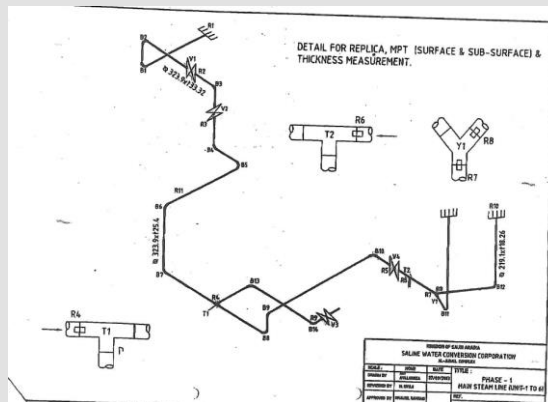


C-Scan showing Step-wise Crack

Corrosion Thickness Survey

Segregate the given lines as per Corrosion Loops

- Create Isometric drawings for all the loops
- Mark the Thickness Measurement Locations (TML) on loops as well as at Site as per isometric drawing
- Identification of inspection requirement including scaffolding, insulation removal and high temperature measurement
- Review of all thickness reports



TCR will create isometric sketches of all test points surveyed

Percent of wall loss determination

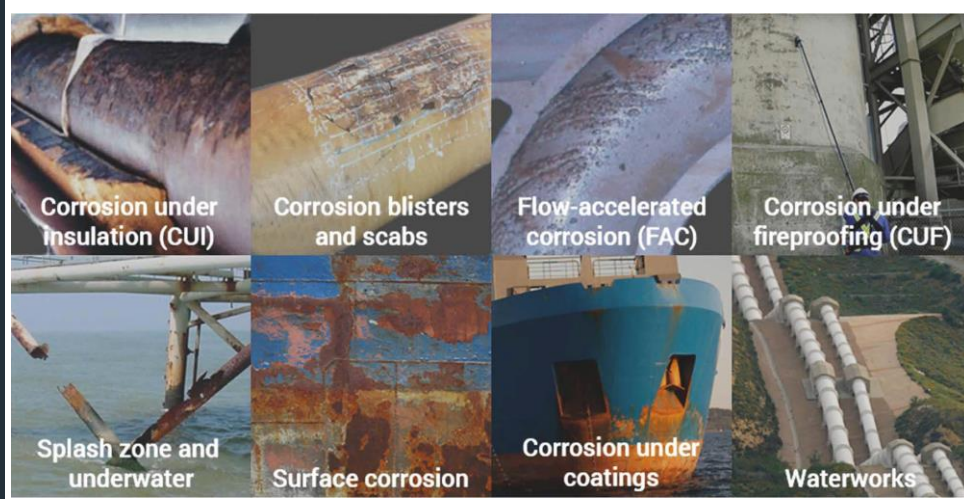
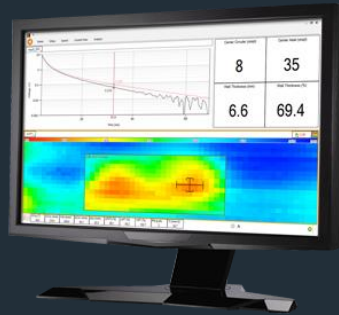
The nominal thickness is the thickness of a fitting or piping that corresponds with A.S.A. Pipe Schedule Manufacturers Chart.

There is a 12.5% mill tolerance (higher or lower) from the chart.

- Any (TML) from 12.5% thru 19% lower is light wall loss.
- Any (TML) from 20% thru 39% lower is moderate wall loss.
- Any thickness readings found to be 40% or greater is severe wall loss and recommended to be replaced and reported

PULSED EDDY CURRENT CORROSION UNDER INSULATION (CUI)

TCR-U-Sonix's Lyft CUI test equipment can scan through metal thicknesses up to 100 mm (4 in) with insulation as thick as 300 mm (12 in) in stainless steel / aluminum / galvanized steel weather jacket.



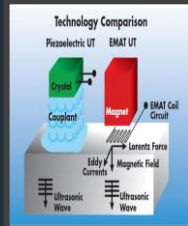
Tank floor probe enables the in-service inspection of storage tank annular rings to slide up to 400 mm (16 in) under tank floor edges, assessing the remaining wall thickness.

Splash zone probe can tackle offshore applications detect damages in metal up to 76 mm (3 in) thick and insulation or marine growth up to 203 mm (8 in) thick.

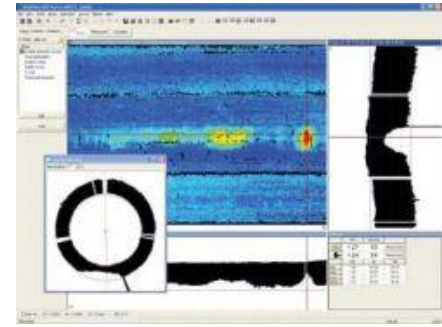
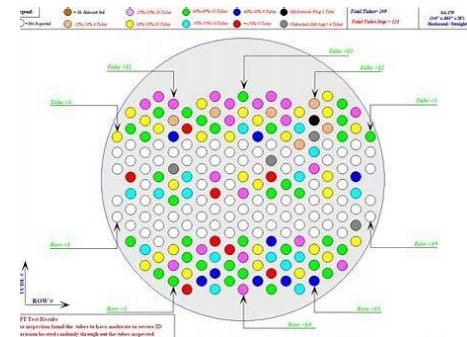
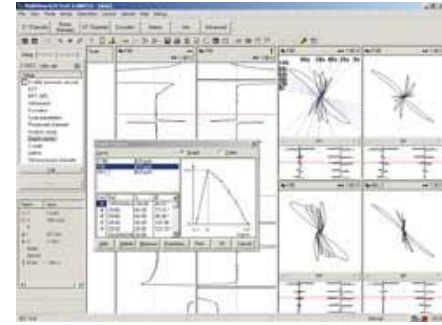
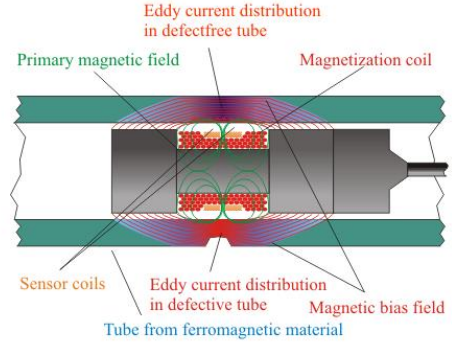
Underwater probes for deeper offshore applications are used on metal as thick as 100 mm (4 in), as well as insulation and marine growth as thick as 300 mm (12 in).

ECT, RFET, IRIS, MFL, EMAT TUBE INSPECTION

TCR's tube inspection team capable of working multiple shifts in turnaround to detect pitting, corrosion, erosion, cracking, puncture, cracks in tubes of heat exchangers, steam generators, condensers, chillers, air coolers and feedwater heaters.

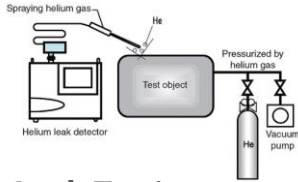


EMAT-Electromagnetic Acoustic Transducer

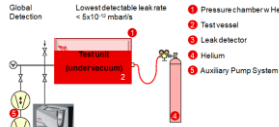


Key Differentiator

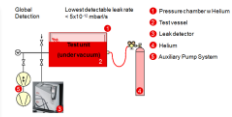
Beyond Material Composition and Crack Length, TCR provides meaningful insights that drives plant efficiency



Helium Leak Testing (Pressure Method)



Global Detect He Outside (Vacuum Method)

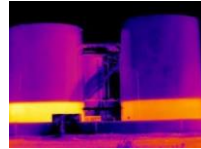


Local Detect He (Vacuum Method)

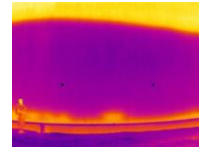


Locating the smallest leaks in pressure, vacuum, condenser, heat exchanger, steam turbine generator

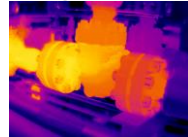
Thermography



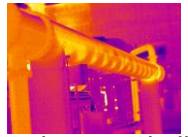
Storage Tank Level



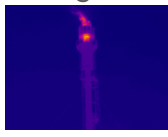
Paraffin/Sludge Level



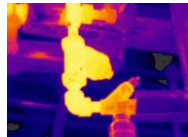
Valve



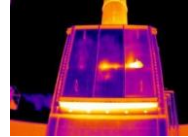
Exchanger Shell



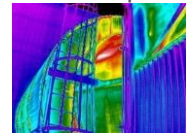
Flare Tip



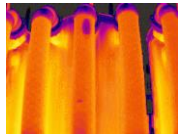
Steam Trap



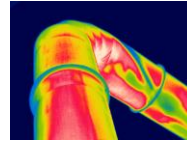
Boiler Economizer



Outlet



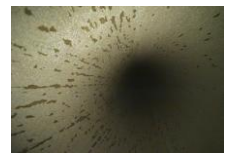
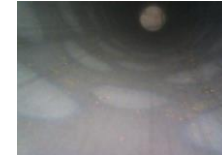
Pipe Delamination



Material Buildup



Videoscopy



Visual Inspection at unapproachable locations

TCR INNOVATION AUTOMATED REFORMER TUBE INSPECTION

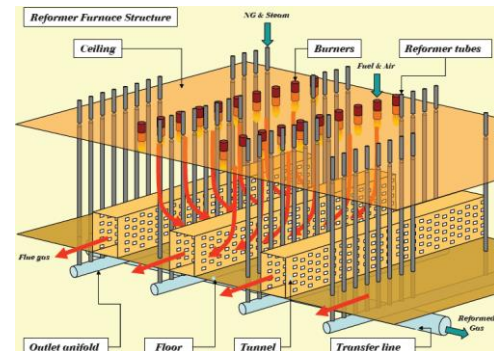
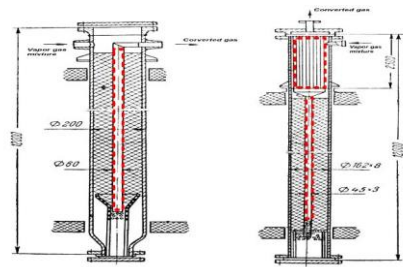
TCR's in-house developed technology solution for Automated ultrasonic scanning on reformer tubes from 105 to 190 mm outer dia.

TCR also undertakes reformer tube condition and integrity assessment & Fitness for Service (FFS) along with unique feature of "when to retire tubes"



Evaluation of damage mechanisms including creep, fissure detection, microstructure degradation, thickness loss and internal carburization

- Inspecting from an external surface without removing the catalyst
- Detection of micro level sub surface and mid-wall creep fissures
- Creep strain and bowing angle estimate at a resolution of 0.1 meter
- Eliminate erection of scaffolding



As stated by NACE

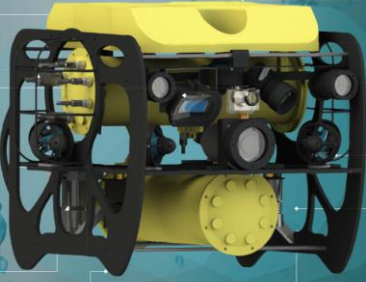
Eddy current examination is not reliable in the detection of early damage (i.e. less than 30% through-wall).

Ultrasonic Examination

The primary ultrasonic technique utilized for the detection and estimation of creep damage is through transmission ultrasonic attenuation. Recent validations have again found that ultrasonic is more reliable at the detection and quantification of creep damage, particularly in its early stages.²

ROBOTIC & VISUAL INSPECTION

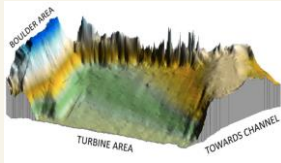
UNDERWATER



- 200M RATED VEHICLE
HIGH STRENGTH
METALLIC ENCLOSURE
- 2X FULL HD CAMERA
LOW LIGHT VISIBILITY
20X OPTICAL ZOOM
DEFOG & IMAGE
STABILIZATION
- ALTIMETER OPERATING
FREQUENCY 200KHZ,
RANGE UP TO 200 M
- SIDE SCAN SONAR
OPERATING FREQUENCY
450KHZ, 120 SWATH
- LIGHT WEIGHT FRAME
RUGGED, MODULAR, EASY
PAYLOAD ATTACHMENT
- UNDERWATER POSITIONING
HIGHLY PRECISE
USBL SYSTEM
- 3X HIGH INTENSITY
LED LIGHTS2000
/ 4000 LUMENS EACH
- 8 X POWERFUL BRUSHLESS
THRUSTERS 5DEGREE
OF FREEDOM CONTROL
- SPOT CLEANING EQUIPMENT
MODERATE MARINE GROWTH
REMOVAL, CAVITATION
JET CLEANING
- ULTRASONIC INSPECTION
THICKNESS
MEASUREMENT GAUGE



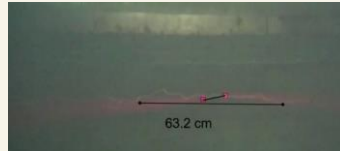
HD live video



SONAR/Bathymetric Surveys



Thickness Measurement



LASER defect quantification



Spot Cleaning of Marine Growth

UNDERGROUND & ABOVE



Robotic Crawler based pan tilt zoom camera for inspection of pipelines of 20" + diameter upto 200 meter length to ensure the lines are free from defects and foreign particles.

COKE DRUM & Vessels

In-service & Pre-commissioning Inspection : Vessels
Client : Reliance & IOCL



Carried out Inspection of Coke Drum, of 37meter height & diameter 8meter. Using Pan Tilt & 18X Optical Zoom camera with self illuminated light.

STORAGE TANK

In-service Inspection : Desalination Water Storage Tank
Client : Reliance



Carried out Inspection of Desalination Tank in Reliance as Vacuum was created. During Inspection We found heavy damage like Bending of Supporting Channels And Uniform deformation of Heavy angle in one direction when inspected from Goose neck.

TURBINE INSPECTION

Pre commissioning Inspection : Turbine Inspection
Client : RGPPL



Carried out Inspection in Power Industries on various Application on Steam & Gas Turbine, Nozzles, to inspect the condition prior to Commissioning. Using 6mm Articulating

FINFAN/HEAT EXCHANGER

Pre commissioning Inspection : Fin Fan & Heat Exchanger Tubes
Client : Reliance, Essar, IOCI, BPCI & NFC



Carried out Inspection of Tube in Heat Exchanger, Fin fan Cooler & Condenser up to the length of 30meter both side opening. Using 15meter length, 8mm diameter Articulating Videoprobe.

FORENSIC METALLURGICAL SOLUTIONS ON-CALL **FAILURE INVESTIGATION & RCA**

Damage Mechanisms

Unravel the mysteries surrounding parts and assembly failures with Fast Turnaround time with in-depth analysis reporting.

Strong Recommendations within each report to avoid future failures.



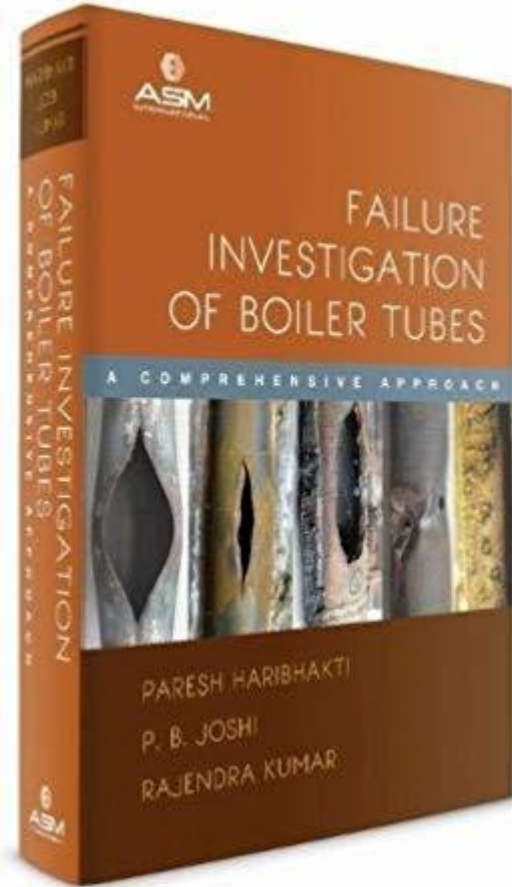
- Corrosion due to CO₂, Sour corrosion due to H₂S
- Corrosion under insulation
- Stress Corrosion Cracking (Cl, NH₃, caustic, CO/CO₂, amine, methanol)
- Microbial Induced Corrosion on cold insulation areas
- Bimetallic joint – galvanic corrosion, Crevice corrosion
- Brittle failure due to impacting
- Environmental impurities causing pitting on turbine blades
- Erosion & Erosion Corrosion
- High Temperature Creep
- Fatigue (thermal, mechanical, pressure, vibration)
- Dusting, H₂ damage/cracking



BOOK ON BOILER TUBE FAILURES INDUSTRY CONTRIBUTION

TCR's Managing Director and Chief Metallurgist Paresh Haribhakti has written an award winning book on Boiler Tube Failures and associated damage mechanisms with detailed case studies

Published by ASM International (USA) and available at various university library and engineering companies as reference study material.



Now Available on
amazon.com

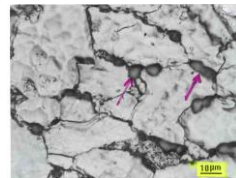
Remaining Life Assessment of Boiler, Turbine, Heat Exchanger:

Ensuring components are used to the fullest extent for operation beyond desired useful life

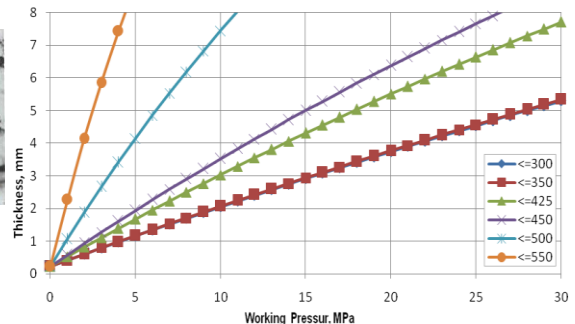
Metallurgy + Engineering + NDT + Lab Destructive

Replica, EMAT, ACRT, Creep, PAUT, ABUT, RFET, Videoscopy, Oxide Scale, SEM Analysis, Mechanical, Chemical

Components	Dimension Checks	Thickness Measurement	Microscopic Examination Replica	Hardness Testing	PT/MT	Ultrasonic Testing	Radiographic Testing
-economiser headers	X				X	X	
-waterwalls	X	X				X	
-boilers drums	X			X	X		
- lower waterwalls and headers						X	
- junction headers	X				X	X	
- waterwall risers		X			X	X	
- waterwall headers					X		
- superheater headers (welds)	X	X	X		X	X	
- reheater headers (welds)	X	X	X		X	X	
- desuperheaters :							
liners						X	
nozzles	X				X		
- HT superheater tubing	X	X	X	X	X	X	
- steam piping	X	X	X	X	X	X	X
- feedwater piping		X					X



SEM of oriented creep cavitation damage of T11 super tubes – exposed to long term over heating.



Minimum required thickness at different working conditions for materials SA178-C

Conductive

$$R_{Total} = R_1 + R_2 \quad R_{Total} = \frac{\ln(r3/r2)}{2\pi lk1} + \frac{\ln(r2/r1)}{2\pi lk2}$$

Temperature

$$\frac{T1 - T3}{R1 - R2} = \frac{T2 - T3}{R2}$$

Thermal

Thermal

Lateral Strain

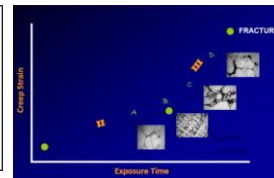
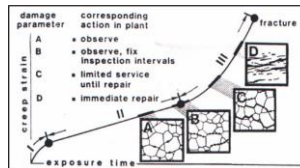
$$\bar{\sigma}_t = E \alpha \Delta t \quad \epsilon_t = \sigma_t / E \quad \epsilon_x = -\nu \epsilon_t$$

Thermal Axil

$$\sigma_x = E / (1 - \nu^2) * (\epsilon_x + \nu \epsilon_t)$$

Von Mises Theory

$$(\sigma_1 - \sigma_2)^2 + (\sigma_2)^2 + (\sigma_1)^2 = 2\sigma_y^2$$



Larson-Miller Parameter

Creep-Stress rupture data plotted as log stress versus combination of log time and rupture

FITNESS FOR SERVICE AS PER API 579/ASME FFS-1

TCR's in-depth FFS report helps clients take decisions working with plant item in spite of presence a crack, metal loss at localized area, creep damage or mechanical damage like distortion or dents



Brittle Failure / Low Temperature



Decommissioned equipment that may be used in different services



Equipment operating in creep range and cyclic services

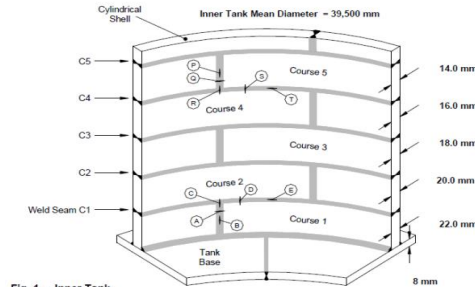


Fig. 1 - Inner Tank

Leak before break assessment of Ammonia Storage Tank

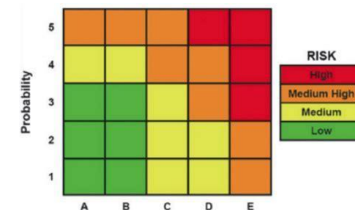


Isomerization reactor certified by TCR with detailed FFS Study post-Fire damage

Risk Based Inspection and IOW

Effective Implementation Partner

TCR's RBI specialists have got expertise of implementation of 4000+ static assets in APM Meridium. Guidance of highly experienced metallurgists, Corrosion, NDT and mechanical integrity experts with 30+ years Oil & Gas experience. Software integration team and API certified personnel.



Step 1: Evaluate corrosion loops of the process unit. Identify all potential damage or corrosion mechanisms. Assess corrosion rates. Define the IOW limits for each damage mechanism.

Step 2: Identify the RBI components and evaluate the risk using API 580 methodology or using APM tool. Analyze recommendations and issue final inspection scope.

Step 3: Evaluation of alarms, indications, and procedures necessary to recognize exceedance of the IOW limit.

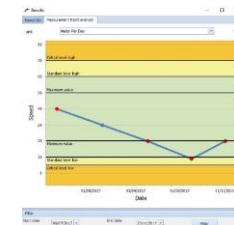
Step 4: Define the criticality of the operating limit and define the priority of the IOW limit (critical, standard or informational).

Step 5: Documentation of each IOW. Development of responses to IOW alarms and notifications.

Step 6: Training all personnel involved in the process operation in IOW implementation and timely responses to IOW indicators and alarms.

Step 7: Integrating the IOW program into the rest of the plant operations, maintenance and reliability programs, and plant data-management software.

Step 8: Revalidation of the IOWs - reviewing each IOW for effectiveness and avoidance of spurious alarms and notifications.



Reverse Engineering and Design Consultancy Engineering Design and Analysis Services



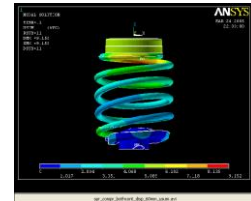
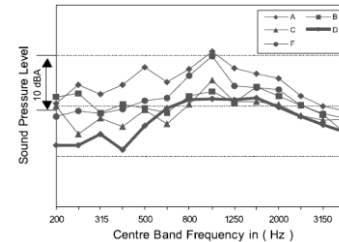
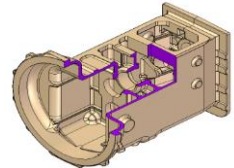
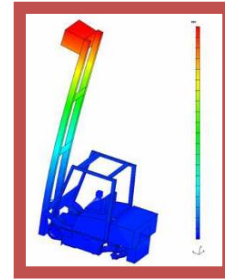
Leading Software - CATIA, Pro/ENGINEER, UniGraphics, I-DEAS, Inventor, SolidWorks, DELCAM, Ansys, CAESAR, HyperMesh, NX Nastran, Moldflow

Computer Aided Designing (CAD/CAM) for 2D to 3D Conversions, Solid Modeling, Surfacing as well as Legacy Data Conversion

Computer Aided Engineering (CAE) including Finite Element Analysis (FEA) using Ansys

Structural Analysis including Pipe Support Analysis

Noise, Vibration, Harshness (NVH) analysis



INDUSTRIAL TRAININGS **EVOLVE BY TCR**

Highly effective coaching for plant operations, inspections and maintenance personnel with experienced Teachers and practical knowledge.



- ASNT Level II programs in UT, DP, MP, RT, VT, ECT, IR
- Boiler tube failure-mechanisms and mitigation
- REAC Reactors in Refinery
- Selection of NDT for effective end result
- Intensive course on "fracture mechanics, fracture toughness and fatigue testing"
- Introduction to Corrosion and NDT
- Metallography for Non Metallurgists
- Study of different coatings for protection against corrosion under insulation/fire proofing
- Application methods for Paint Coatings and Inspection Of Painted Panels
- Corrosion in Petrochemical Process Plants
- Corrosion Under Insulation For Pipelines
- Failure of 9% Nickel steel during extended cryogenic service
- Failures and Protection methods for Above Ground Storage Tanks
- Beyond RBI: Striving for zero loss of containment
- API 510, 579, 653 Training programs

www.evolvecr.com

COMPLETE QUALITY ASSURANCE PARTNER FOR OPTIMUM PLANT HEALTH

Key Highlights

With over 46 years of experience, TCR has built a proprietary model of managing end to end inspection and advisory services and validate results as per ASTM, BS, IS and other international standards.



1 SOURCING & PROCUREMENT INSPECTION

TCR works closely with EPC and Infrastructure companies to provide integrated and end-to-end procurement for their projects. Our solutions encompass the entire procurement value chain, with each offering uniquely configured to each client's specific requirements and objectives.



Third Party Inspection and Quality Assurance Services

Factory Audit, Raw Material Inspection, In-Production Check, Loading Supervision

Product and Material Sourcing

Contract Research And Development

Mechanical Testing

Tensile & Bend, Impact, Hardness, Nick Break and Weldability, Creep, Stress Rupture, Hydrogen Embrittlement ASTM F519/B577

Fatigue and Fracture Toughness Testing

CTOD, K1c, J1c, Fatigue crack growth, High-Cycle/Low-Cycle Fatigue, S-N Curve

Chemical Analysis

Spectrometers (XRF, OES, ICP, AAS), Wet Chemical, Oil Analysis by Ferrography, RoHS Compliance, Lead Inspection, Refractory Testing
Ores and Minerals Testing, Sand Content, Oxygen, Nitrogen and Hydrogen

Corrosion Studies

Sour Gas (HIC/SSC/SOHIC) – NACE TM0284/TM0177/TM0103, Chloride Stress - ASTM G 36, SCC of Aluminum Alloy - ASTM G44/G47, Pitting/Crevice (Critical Temperature) - ASTM G48, Potentiostatic / Potentiodynamic Anodic Polarization - ASTM G5, Chloride Stress - ASTM G 36, Corrosion of Aluminum NAMLT - ASTM G67, Exfoliation of Aluminum - G66/G34, SCC of Aluminum – ASTM G103, Intergranular – ASTM A262/ DIN EN ISO 3651, Immersion Corrosion – ASTM G31 & Ammonia Vapor Test – ASTM B858

2 CONSTRUCTION & COMMISSIONING INSPECTION

TCR designs effective welding solutions coupled with baseline data creation. It provides the right functional expertise for teams to excel in plant maintenance and operations.



Base Line NDT Data Creation

Ultrasonic Flaw Detection, UT Thickness, Dye Penetrant, Magnetic Particle, Ferrite Measurement, Holiday Detection, Surface Roughness, Demagnetization, Paint and Coating Thickness

Radiography – Crawlers & Computerized

Phased Array and ToFD in lieu of RT Examination

Welder Certification and Procedure Qualification

Welding Inspectors visits for Qualification of Welder, WPS/PQR Testing per coupon as per ASME Section IX, AWS D 1.1, API 1104

Welding Procedure Specification (WPS) development

Weldability Evolution

Microstructure & Micro-Hardness Tests

Welding Consumable Evaluation

Tests as per ASME Section 2 part C

Post Weld Heat Treatment

70kva Electrical Resistance HT Machines with Talented Team, Pre-Heating

Positive Material Identification (PMI)

On site Detection of all chemical elements including C, S,P, Mn and Si

3 IN-SERVICE INSPECTION

TCR undertakes corrosion studies based on Risk-based Inspection API 580 guidelines to map business and operational risks for individual plant items for planning damage specific inspection and effective shutdowns. TCR has in-depth knowledge of high-temperature probes and an understanding of potential corrosion damage mechanisms.



Advanced NDT targeting specific Corrosion

Damages: HTHA Inspection, One Micron Detection using UT, Carburization Detection, HIC Detection, High temperature Corrosion Mapping, Mid Wall Fissures Detection, Stepwise Crack Detection (SWC)

Visual Inspection

Thermography, Robotic Underground buried Pipeline Inspection, Underwater Inspection and cleaning by ROV, Borescopy, Videoscropy

Leak Detection

Online helium leak and well as hydrogen leak testing on plant equipment

Studies

Risk Based Inspection study program to research corrosion damages

Mapping of Turnaround data based on Business/Operations Risk

4 SHUTDOWN & TURN-AROUND INSPECTION



TCR has acquired in-depth knowledge, experience, and expertise for over 45 years in managing complex shutdown projects. It ensures planned shutdowns along with rapid deployment of expert consulting teams with solutions for heat exchangers, tanks, pipelines and weld joints to get your facility back online as quickly as possible.



Visual Inspection Services

Boroscopy, Remote Visual ROV, Videoscopy, Thermography,

Pipelines and Weld Inspection

Phased Array, Time of Flight ToFD

Radiography

Tank Inspection

Robotic Inspection of Coker Drums, In-service Robotic Tank Inspection, Tank Condition by Thermography

Tube / Heat Exchanger Inspection

Eddy Current, RFET, IRIS, MFL, Helium Leak Testing, Acoustic Eye, Saturated Eddy Current, Automated Reformer Tube Inspection (ARTIS), Oxide Scale Measurement

Plant Health Assessment and Metallography Strength

In-Situ Metallography Replica, SEM and EDS analysis, Microstructure Characterization for RLA

Inspection Manpower Consulting

RBI and Asset Integrity Management Experts
Metallurgists and Corrosion Scientists
API Plant Inspectors with 510, 570, 653 as well as 579/580 experience
ASNT Level III Experts and SNT-TC-1A or PCN Level II Techs
QA/QC Inspectors for Static and Rotating Equipment
Welding Inspectors with AWS or CSWIP
Painting/Coating Inspectors with NACE or BGas
Mechanical Destructive Testing and Lab Chemists
Refractory Consultant
Valve Specialists
Heat Treatment PWHT specialists
Engineering Design Consultants on CAD/CAM
Simulated Process and Engineering Researchers

5 CONTINUUM INSPECTION

TCR optimizes plant performance by analyzing information, examining engineering design and recording key insights from the shutdown for long-term plant reliability. It also undertakes fitness for service, failure analysis, and remaining life assessment studies to give the top management and/or insurance companies a better understanding of the plant's overall health.



Failure Analysis

Pressure Equipment Integrity
Incident Investigation per API 585

Remaining Life Assessment

Fitness for Service as per API 579/
ASME FFS-1

Fire Damage Assessment

Engineering Design and Analysis Services for Plant Supports

Computer Aided Designing (CAD), Computer Aided Engineering, Reverse Engineering and Prototyping, 2D to 3D Conversion, Finite Element Modeling, Piping Stress Analysis

Plant Health Study

API 580/581 guideline based Risk-Based Inspection study and implementation

Integrity Operating Window Study as per API 584

Contract Research

Technical Help For Indigenization, Selection of Materials, Solutions Of Critical Weld Problems

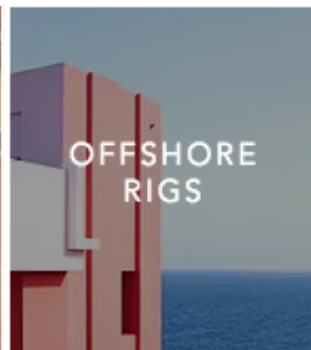
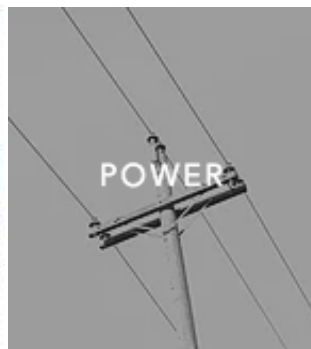
Training Programs

Metallurgy and Corrosion Evaluation, NDT and FFS

OUR SOLUTIONS ARE
TAILOR MADE FOR YOUR
**INDUSTRY
VERTICALS**

TCR offers an unparalleled perspective and extraordinary solutions that are relevant to the needs of the client. Staying away from the cookie cutter approach, TCR ensures that its offerings by comprehensive, actionable and bring about the necessary transformation for their customers.

TCR creates NDT techniques that target individual corrosion damages with the assistance of its expert team members that comprise of metallurgists, API plant inspectors, corrosion scientists, NDT level III and professionals from process, maintenance, and inspection department of plants.



INDUSTRY VERTICALS

REFINERY

Many among TCR's professionals are ex-employees of these global majors and have developed the competence to assess failures and fire damages in CDU/VDU, FCCU, hydrogen manufacturing, storage tanks, REAC, reactors, and their internals.

TCR's NDT and in-situ metallographic replica teams have undertaken several studies detecting metallurgical degradation, detachments/ fastener failures, creep, stress corrosion cracking, pitting, erosion, reheat cracking and fatigue-related damage mechanisms.



MARQUEE CLIENTS

Industry: Refinery



“ 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.

U Anand, Vice President
RELIANCE INDUSTRIES LIMITED



INDUSTRY VERTICALS

PETRO-CHEMICALS

Qchem and Sabic depend on TCR to provide expertise in evaluating leaks, process upsets and failures that can occur in reactors, storage tanks & high-temperature transfer lines/acid.

TCR can gauge transfer line leaks, tank floor/bottom, creep, pitting, SCC, Erosion-corrosion, IGC, and fatigue-related damage mechanisms.



MARQUEE CLIENTS

Industry: Petro Chemicals



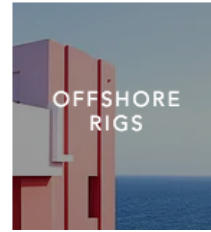
“ TCR also provided services on Remaining life Assessment of aged components by destructive analysis. We have got benefited by the getting Repair Weld Procedures of aged Incloly 800H header joints by TCR. We appreciate the enthusiasm and dedication of TCR Team members towards accepting such challenging assignments and provided us satisfactory services.

B K Gupta, Vice President
GODREJ INDUSTRIES LIMITED ”

INDUSTRY VERTICALS

OFFSHORE RIGS

TCR can appraise tubing failures, fasteners, fatigue, seawater splashing, corrosion fatigue, pitting, crevice corrosion and cavitation corrosion related damage mechanisms.



MARQUEE CLIENTS
Industry: offshore Rigs



ऑयल इंडिया लिमिटेड
(भारत सरकार का उद्यम)
Oil India Limited
(A Government of India Enterprise)



ارامكو السعودية
Saudi Aramco



TCR has competence in evaluating failures that can occur in well bore piping, chain links, pumps/rotary equipment, and drilling rigs.

INDUSTRY VERTICALS

GAS

TCR aims at providing QGas assistance in evaluating Leaks/Failures and Catastrophic explosion that can occur in Storage spheres, terminal, jetty, and LT transfer lines.

TCR has conducted several studies across fastener failures and detection of corrosion under insulation, pitting, SCC and IGC related damage mechanisms.



MARQUEE CLIENTS

Industry: Gas



Hazira LNG & Port

BG GROUP



INDRAPRASTHA GAS LIMITED



We appreciate the enthusiasm, quality of service and response to our queries, professional approach & dedication of TCR team members towards the assignment and provide is satisfactory services.

Pratapsing Parmar, Area Manager (TG Dept)

ESSAR PROJECTS



INDUSTRY VERTICALS

O&G SERVICE

TCR has worked with clients like Halliburton, Schlumberger, Weatherford, enabling it to evaluate leaks, accidents, and failures that can occur in online tapping, drilling (tubes & beads) and manufacturing of tubes.



MARQUEE CLIENTS

Industry: O&G Service



Weatherford[®]

Schlumberger

TCR can analyze tubing failures, drill line tooling failures, fatigue, corrosion fatigue, pitting and crevice corrosion related damage mechanisms.

INDUSTRY VERTICALS

EPC/INFRA

Clients like L&T depend on TCR to evaluate the composition and WPS/PQR's weld strength using destructive testing including chemical analysis, CTOD and high/low temperature tensile and impact.

TCR has expertise in evaluating the mixing of materials, improper MTC/identifications, weld joint failures and improper PWHT that can occur in material inventory, welding consumables, tank bottoms, and truss. TCR conducts several studies across fasteners, lifting lugs, weld failures/cracking, MIC-microbiological influenced corrosion, reheat cracking and SCC related damage mechanisms.



MARQUEE CLIENTS

Industry: EPC/Infra



TEKFEN CONSTRUCTION

TATA

BOMBARDIER



AFCONS INFRASTRUCTURE LIMITED



RASANDIK
Passion For Excellence



ISGEC HEAVY
ENGINEERING LTD.



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

Aman Shah, Site Manager (Infra)

Adani Projects



INDUSTRY VERTICALS

POWER

TCR's Paresh Haribhakti has authored a book published by ASM on Boiler Failures. With in-depth knowledge of boiler tubes, outlet headers, main steam line, and turbine.

TCR undertakes in-line helium leak and hydrogen leak testing of condensers and generators.

TCR can undertake metallurgical and failure studies including FFS & RLA to evaluate BTL (boiler tube leaks), metallurgical degradation, creep, erosion, pitting, general corrosion, high-a hydrogen attack, and fatigue related damage mechanisms.

TCR's clients include MEW, SEC, GE, Alstom, Siemens among others.



MARQUEE CLIENTS

Industry: Power



“ The Management & Technical Team at the site appreciates the valuable & prompt services provided by the TCR Advanced technical team at site. We expect the same from your company for all our future projects.

Abdul Hannan, QA/QC Manager
GE ELECTRIC INTERNATIONAL, INC

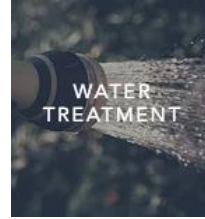


INDUSTRY VERTICALS

WATER TREATMENT

TCR has proficiency in evaluating leaks and failures that can occur in pumping stations and transfer lines.

TCR can gauge transfer line leaks, tank floor/bottom, MIC, pitting, SCC, CUI, erosion, corrosion, and crevice corrosion related damage mechanisms.



MARQUEE CLIENTS
Industry: Water Treatment



**MINISTRY OF
ELECTRICITY & WATER
STATE OF KUWAIT**



المؤسسة العامة لتحلية المياه المالحة
Saline Water Conversion Corporation



“ TCR provided failure analysis services to Merito. Thank you very much for your support all the time.

Saifulla Ahmed, Senior Application Engineer

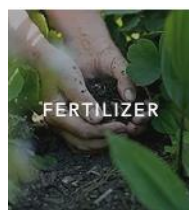
METITO OVERSEAS QATAR W.L.L. ”

INDUSTRY VERTICALS

FERTILIZER

Since 2012, TCR has provided metallurgical & engineering consulting to QAFCO for effectively assessing failure damages that occur in the reformer section, ammonia converter, ISR (isothermal shift reactor) and RGC (reform gas cooler).

TCR has undertaken several studies across failure in reforming section (reformer tubes) and has expertise in damage specific NDT to discover corrosion, erosion corrosion, cavitation, pitting, creep, IGC related damage mechanisms present in the plant.



MARQUEE CLIENTS

Industry: Fertilizer



“ We sincerely thank TCR team for carrying out failure analysis in a very detail, systematic, methodical and scientific manner. The analysis not only highlights mode and various reasons of failure, but it also throws light on the operational aspects, which might have played an important role in the initiation and which might have been the main cause of the failure. This aspect will help us in taking preventive actions for future.

M Y Joshi, Manager

GUJARAT NARMADA VALLY FERTILIZERS COMPANY ”

INDUSTRY VERTICALS

WASTE TREATMENT

TCR is proficient in evaluating leaks and environmental hazards that can occur in Incinerator boilers and their tubing, transfer lines, scrubbers.

TCR can assess boiler shell plate failures, boiler tube failures, suction line failures, SCC, H₂S corrosion, pitting, and cavitation corrosion-related damage mechanisms



TCR is leading the new way of Quality Assurance by defining the future

At TCR, we are continuously working towards improving our offerings to provide a better and a more efficient Quality Assurance for your Optimum Plant Health

Industry-specific Solution

- Plant and industry veterans with understanding of process/operations challenges
- Aware of the business risk versus failure probability
- Keeping abreast on new materials and plant items

Equipment-specific Solution

- Researching new techniques for inspection
- Constantly buying probes and accessories to ensure no downtime at site
- Train-the-trainer approach to spread knowledge

Problem-specific Solution

- Corrosion damage evaluation is a specialty
- Metallurgy is the core of all investigation
- Look at a problem through multiple angles

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THANK YOU

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