TRANS ASIA
Industrial Laboratories

PQD
FAILURE ANALYSIS

This Pre-Qualification Document (PQD) contains details about the Failure Analysis Services offered by Trans Asia. It outlines our capabilities, methodologies, and technical expertise in identifying the root causes of material, component, and system failures. The document demonstrates our systematic approach to investigating failures, implementing corrective actions, and preventing recurrence. It also highlights our commitment to quality, reliability, and continuous improvement in support of our clients' operational and safety objectives.

CONTENT

TIL Service Profile – Failure Analysis

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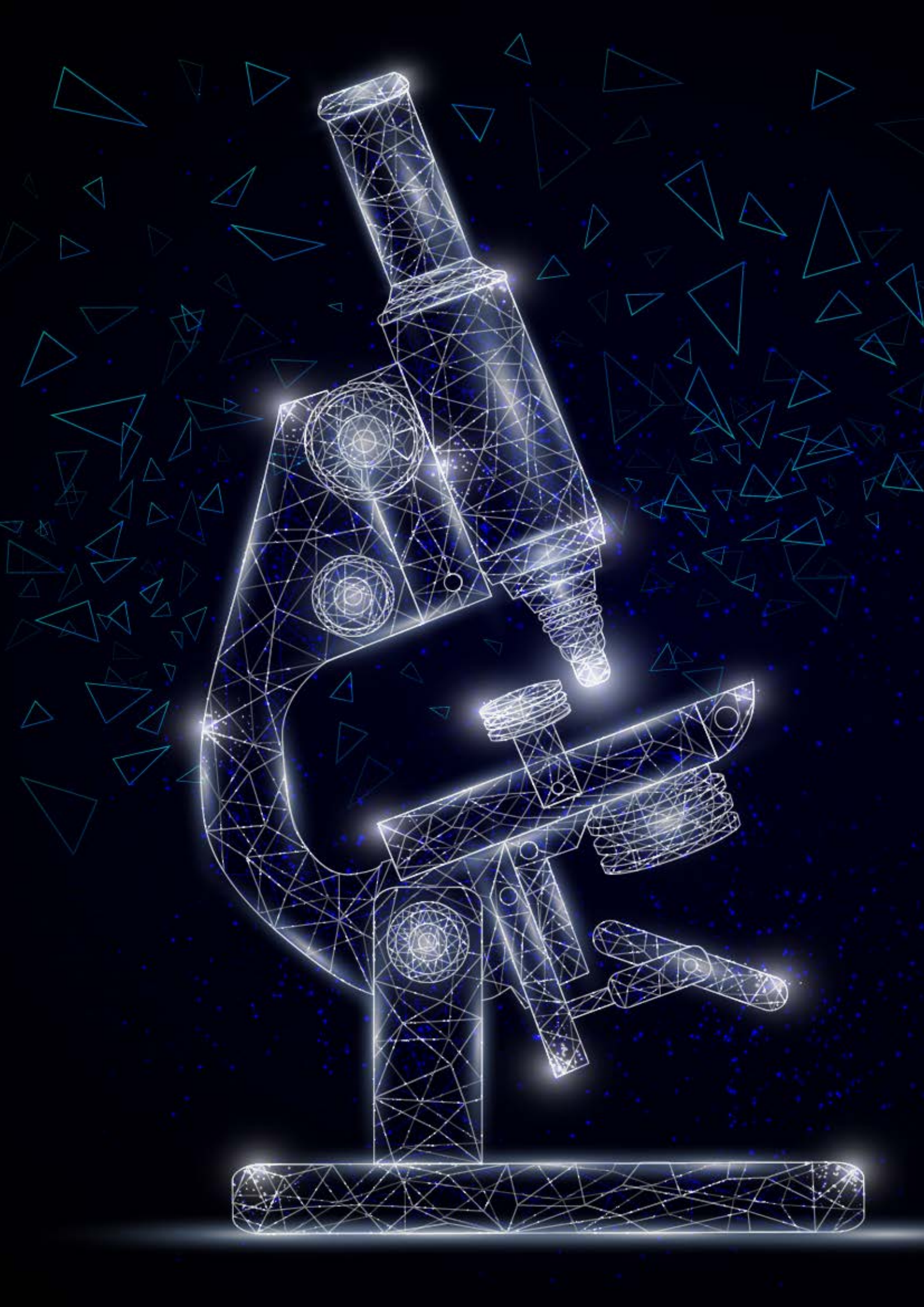
MATERIAL ANALYSIS



THINK

TRANS ASIA
Industrial Laboratories

WHEN FAILURE CASES ARISE!

Trasn Aisa is a leading provider of Testing, Inspection, and NDT services on a wide range of products, materials, processes and services and products for a diverse set of end markets, where failure in service is simply not an option.

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50X

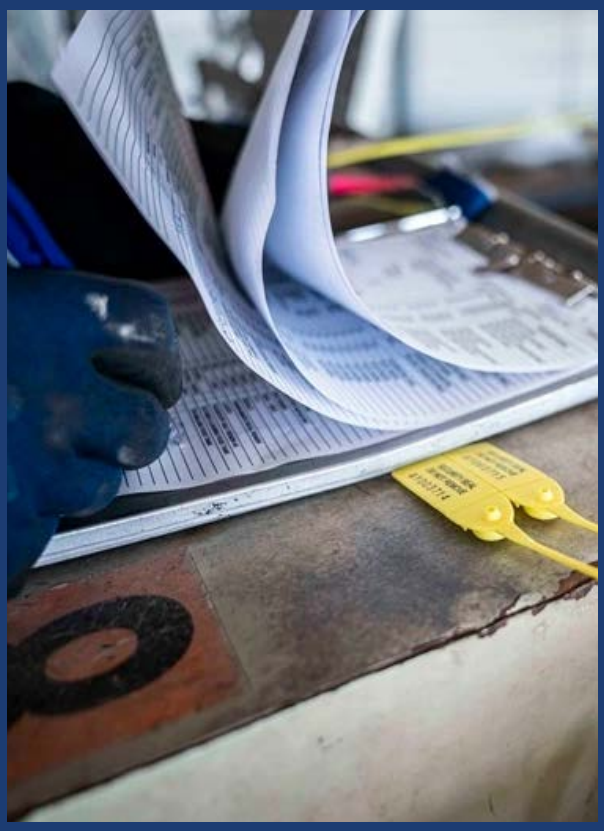
AT TRANS ASIA

VAULUES

1.

PRECISION

Excellence lies in the details. Precision guides all we do. With care and accuracy, we meet high standards, building confidence and delivering quality for customers and each other.



2.

Quality

Quality is at the heart of who we are and what we deliver. We take pride in setting high standards and meeting them every time. Our work reflects our commitment to excellence — reliable, consistent, and built to stand the test of time. We pay attention to detail, learn continuously, and never stop improving. Quality isn't just about outcomes; it's about the integrity of our process and the pride we take in doing things right. Through this dedication, we earn trust, create lasting value, and make a meaningful impact for our customers and one another.

3.

RELIABILITY

Reliability is the foundation of trust. Being consistent, dependable, and accountable, we build confidence, strengthen relationships, and maintain a strong, lasting reputation for excellence and integrity.

ABOUT US
WE ARE TRANS ASIA

Trans Asia Industrial Laboratories (TIL), part of the Trans Asia Group, is a multidisciplinary testing and inspection facility delivering reliable, high-quality services aligned with international standards. Fully equipped with advanced technology, TIL offers Physical, Mechanical, Corrosion, Metallography, Chemical, Microbiological, Environmental, and Non-Destructive Testing (NDT) services. Our certified and accredited systems (ISO 9001:2015, ISO 14001:2015, ISO 45001:2018, ISO/IEC 17025:2017, ISO/IEC 17020:2012) ensure precision and consistency.

At Trans Asia Industrial Laboratories (TIL), we envision being a benchmark of innovation and excellence, delivering dependable, precise, and value-driven integrated solutions that meet and exceed global standards.

Committed to being the preferred partner in Laboratory and NDT testing services, TIL upholds unmatched technical expertise, superior quality, and a culture of continuous innovation. The organization embraces technological advancement and scientific progress, providing efficient and cost-effective solutions that enhance industry performance, drive sustainable growth, and foster lasting partnerships built on trust and excellence.

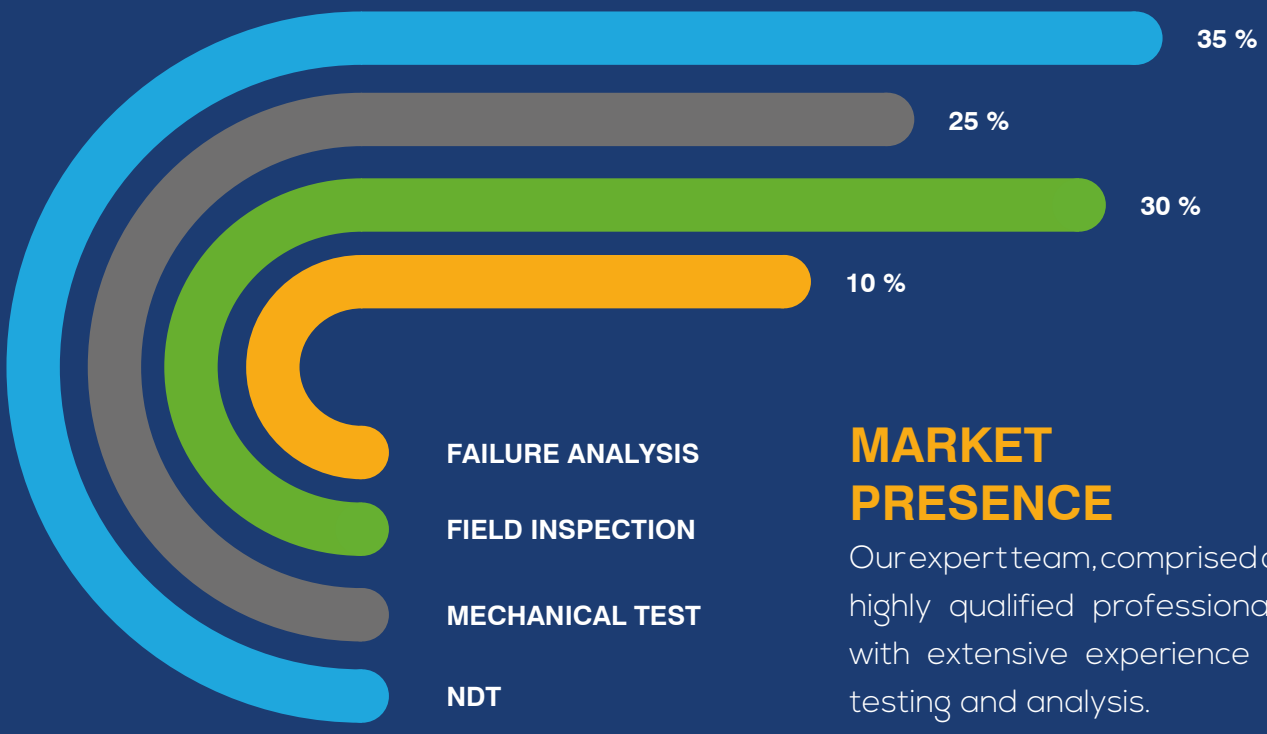
We provide reliable inspection and integrity solutions across a diverse range of industries. Our expertise ensures safety, compliance, and performance for clients operating in some of the world's most demanding environments, the clients include: Aerospace / Aviation, Automotive, Chemical, Construction, Consumer Products, Energy, Government, Industrial, Manufacturing, Military, Nuclear, Oil & Gas, Pharmaceuticals, Power Generation.

PRECISION AND EXCELLENCE

At TIL, every activity is planned to deliver high standards in commercial, technical, quality, and safety aspects—ensuring our clients receive reliable, compliant, and fit-for-purpose solutions.

WE HAVE PRESENCE IN THE MARKET

Trans Asia began in 2000 with the establishment of Trans-Asia Pipeline Services in the UAE, initially focusing on pre-commissioning services for new pipelines, such as cleaning, hydrotesting, dewatering, and drying. In 2006, the company opened a 15,000-square-meter corporate head office and operational hub in the Hamriya Free Zone, Sharjah, UAE, which included workshops, a fabrication shop, and a training center. In 2020, Trans Asia Industrial Laboratories (TIL) was founded under the Trans Asia Group to meet the growing demand for high-quality industrial testing and inspection services. In 2025, TIL expanded its capabilities with the acquisition of Al Arabiah Pipeline Testing Services in Abu Dhabi, enhancing its NDT offerings.



MARKET PRESENCE

Our expert team, comprised of highly qualified professionals with extensive experience in testing and analysis.

THINK TRANS ASIA
WHEN FAILURE CASES ARISE

Our teams of expert metallurgists, chemists, and materials scientists are internationally recognized as some of the most experienced in their field. They have decades of hands-on experience in performing root cause analysis for failures across many sectors, including Aerospace, Oil & Gas, Transportation, provide recommendations and work closely with the customer to find solutions to problems for a diverse range of products and materials.

It is the combination of our materials expertise together with our knowledge on what impact the service environment can have on a material or product, that enables us to rapidly deliver comprehensive recommendations to identify avoid resolutions and future in service failures.

THREE REASONS TO PERFORM FAILURE ANALYSIS

1

Determine the root cause of failure.

2

Prevent similar material failures.

3

Improve process, designandmaterial.

THINK TRANS ASIA WHEN FAILURE CASES ARISE

Failure analysis is a multi-faceted, holistic approach to determining how and why a material or product failed. Failure analysis is a critical aspect of product development and system improvement which not only helps us learn from the past, but helps prevent future failures.
While the root cause analysis and associated responsibility of any failure are the primary goals, the added value is provided in preventing future

Based on findings from the failure analysis process, TIL experts provide recommendations and work closely with the customer to find solutions to problems for a diverse range of products and materials. We have the combination of our materials expertise and knowledge of what impact the service environment can have on a material or a product. This enables rapid delivery of comprehensive results to identify resolutions and avoid future in-service failures.

Our multi-discipline experts are recognized as some of the most trusted in their field by providing reliable failure analysis for a variety of clients, including manufacturers, commercial intermediaries, consumers, lawyers, and insurance companies. They have decades of hands-on experience in performing failure analysis across many sectors, including aerospace, energy, transportation, construction, industrial, energy, and consumer products.

UNDERSTANDING FAILURE IN FAILURE ANALYSIS

The term "failure" can be defined as the inability of a part or assembly to perform its intended function. Whereas Failure Analysis is a process that is performed to determine the causes or factors that have led to an undesired loss of functionality. Therefore, Analysing Failures is a critical process in determining the physical root causes of problems. The process is complex, draws upon many different technical disciplines, and uses a variety of observation, inspection, and laboratory techniques.

Define the Issue
Deficiency in terms of the symptoms or indicators.

Propose a Hypothesis
List possible tests to understand nature of failure.

Gather Data
Gather series of events, history, backgroun information.

Test the Hypothesis
Validate hypohesis through tests and analysis test results.

Develop Conclusions
Describe the mechanism of failure corelating the hypothesis.

FAILURE ANALYSIS VS. ROOT CAUSE ANALYSIS

Just as failure analysis is a proven discipline for identifying the physical roots of failures, root-cause analysis (RCA) techniques are effective in exploring some of the other contributors to failures, such as the human and latent root causes.

Properly performed, failure analysis and RCA are critical steps in the overall problem-solving process and are key ingredients for correcting and preventing failures, achieving higher levels of quality and reliability, and ultimately enhancing customer satisfaction.

- DISTORTION
- FRACTURE
- CORROSION
- WEAR

These four represents

PHYSICAL FAILURE

Material failure can be divided into four types: distortion or plastic deformation, fracture, corrosion, and wear. In general, two or more physical failures occur in the same failed part.

These four categories are a convenient way to descriptively categorize and discuss failures, with the ultimate goal of understanding causes and preventing failures.

Categories of Material Failures

These four categories represent the general forms of failure, and each form of failure may have a variety of different underlying mechanisms.

CATEGORIES OF FAILURE
GENERAL CLASSIFICATION

The physical failure of materials can be placed in one of many categories depending on the classification system.

These four categories represent the general forms of failure, and each form of failure may have a variety of different

underlying mechanisms (e.g., fatigue crack propagation in the case of fracture or galvanic effects in metal corrosion).

In general, two or more physical failures occur in the same failed part.

The root causes of the failure can be divided into three levels; physical roots, human roots, and latent roots. The physical roots can be divided into four categories: design deficiencies, material defects, manufacturing or installation defects, and service life anomalies.

The human roots include inadequate inspection and improper equipment installed. The latent roots are the cultural or organizational rules that lead to the human cause, it is not direct roots.

PRINCIPLE OF FAILURE ANALYSIS

The Principal Task of a failure analyst during a physical cause investigation is to identify the sequence of events involved in the failure. Failure analysis is a process of narrowing down the possible explanations for failure by eliminating those explanations that do not fit the observation.

PERSPECTIVE CONVERGENCE APPROACH

Like the basic process of the scientific method, failure analysis is an iterative process of narrowing down the possible explanations for failure by eliminating those explanations that do not fit the observations. Generally, a failure analyst will start with a broad range of possible explanations but over time will narrow and refine the existing possibilities.

DETERMINATION AND CLASSIFICTION OF DAMAGE

- Collect data
- Identify damage modes present
- Identify possible damage mechanisms
- Test to identify actual mechanisms that occurred
- Identify which mechanism is primary and which is/are secondary
- Identify possible root causes
- Test to determine actual root cause

STAGES AND TECHNIQUES IN FAILURE ANALYSIS

The general procedures, techniques, and precautions employed in the investigation and analysis of metallurgical failures that occur in service are summarized as follows.

The stages in Failure Analysis begin first with the preliminary steps of information gathering such as:

- Collection of background data and selection of samples
- Preliminary examination of the failed part (visual examination and record keeping)
- Non-destructive testing

The tools of failure analysis are not just test machines and analytical instruments. The tools of failure analysis include test machines and analytical instruments and also conceptual tools. Conceptual tools that are essential in determining the cause of any given failure may vary. They include various pattern recognition skills (in the interpretation of macrofractographs, microfractographs, and metallographic images) and engineering and scientific knowledge based on physical metallurgy, polymer physics, solid-state physics, stress analysis, chemistry, and many other fields.

In addition, investigations of a failure employs various tests and techniques. The list below summarizes typical protocol followed during failure investigation.

- Visual inspection and
- Proper protection of component
- NDT Test like RT, UT, MT, PT
- Optical Metallography
- Scanning Electron Microscopy (SEM)
- Energy Dispersive Spectroscopy (EDS)
- X-ray Diffraction (XRD)
- Chemical Composition
- Scale Analysis
- Hardess or Micro Hardness
- Tensile Test
- Charpy Impact Test
- Chemical and Mechanical Test
- Fractography

STAGES AND TECHNIQUES IN FAILURE ANALYSIS

These preliminary steps may then be followed by assessment of the damage and conditions leading to failure.

These stages may differ depending on whether fracture, corrosion, and/or wear conditions are being investigated. In an analysis of a fracture, the following steps are described:

- Selection, identification, preservation, and/or cleaning of critical specimens
- Macroscopic examination and analysis (fracture surfaces, secondary cracks, and other surface phenomena)
- Microscopic examination and analysis of fracture surfaces
- Stress analysis to determine the actual stress state of the failed component
- Fracture mechanics

The investigation can be thought of as a forensic puzzle. The more pieces of the puzzle that are in place, the more conclusive the test results will be. It is often tempting to ask the metallurgist to minimize the amount of testing performed to save time and money. It may also be tempting to withhold background information about the part for fear of biasing the metallurgist's final conclusion. It should be understood, however, that restricting the amount of testing and withholding important information will effectively take away pieces of the puzzle that can prove critical to achieving the correct final conclusion. If the reasons for failure are not properly understood, corrective actions to prevent future failures may be ineffective.

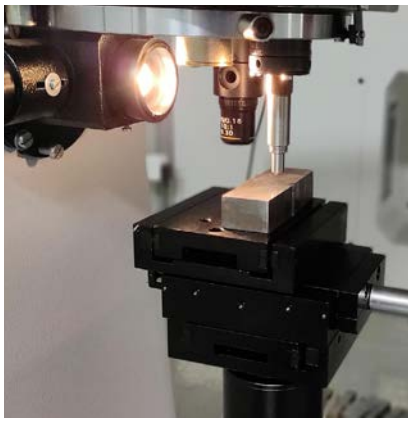
TESTING AND ANALYSIS CAPABILITIES

At Trans Asia

Our comprehensive service portfolio encompasses Laboratory Testing, NDT (Non-Destructive Testing) Solutions, Inspection Services, and PWHT (Post Weld Heat Treatment)—each designed to deliver precision, reliability, and quality assurance across various industries. We proudly serve sectors such as manufacturing, construction, oil and gas, power, automotive, aerospace, and energy.

In our Laboratory Testing division, we offer a wide range of analytical services including mechanical testing, metallurgical examination, chemical analysis, corrosion testing, and failure analysis, ensuring materials meet the highest performance and compliance standards.

TESTING AND ANALYSIS CAPABILITIES



Optical Microscope

Metallographic Analsysis

Metallography is frequently used to determine the material type, grade, or grain size, the inclusion content of a metal, test the corrosion resistance of a coating or material and provide certifications for new material or mixed batches, microstructure analysis, and failure analysis.

SEM and EDS

Material Characteriztion

SEM analysis, provides high-resolution imaging useful for evaluating various materials for surface fractures, flaws, contaminants or corrosion. Through SEM and EDX analysis, our metallurgical experts provide a thorough examination of material properties and give valuable insights of material.

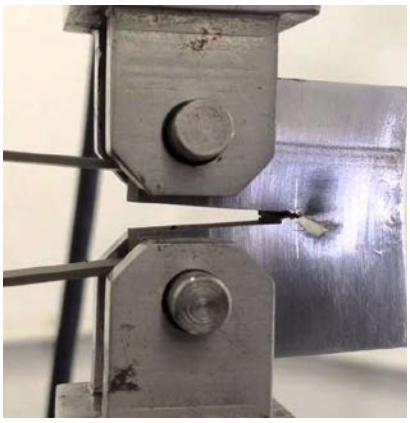
Stereoscope

Macro Topography

Stereo microscopy is used in conjunction with macro photography to closer document a fracture, weld, contamination or other feature of interest.

The stereo microscope is an optical microscope designed for low magnification (up to 80X) observation of a sample.

TESTING AND ANALYSIS CAPABILITIES



UTM
Tensile Test

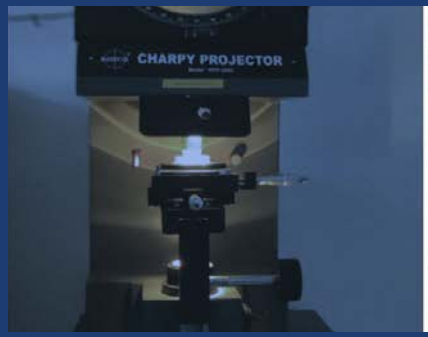
TIL's tensile testing labs provide conditions for exposing materials to a static or slowly applied force, determining their ultimate tensile strength. We perform industry-leading tensile tests for many metallic or non-metallic materials, at applicalbe room temperature or elevated temperature.

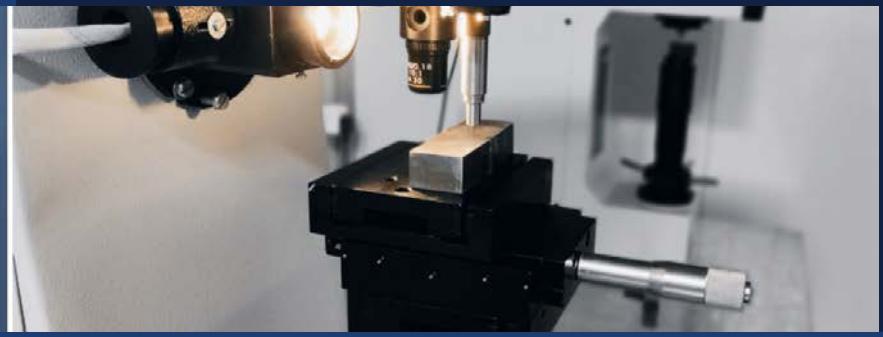
Dynamic Testing
Fatigue Test

Fatigue testing characterizes material or component behavior during cyclic loading. Our test machines can help test cyclic loads for vital properties, such as fatigue failure, fatigue limit, and fatigue life. Our analytical testing services utilize cyclic loads in test machines to understand fatigue failure.

Creep
Creep Test

The tests are performed for both stress rupture and creep testing for metals, composites, and plastics to determine the long-term stress on materials. The test is performed in furnaces or environmental chambers and recorded on a graph of strain versus time to show the creep rate.





TESTING AND ANALYSIS CAPABILITIES

HV, HRC, BHN
Hardness Test

Hardness testing applies to a range of materials, both metals, and nonmetals alike, and determines how resistant a material is against deformation, penetration, scratching, or other physical force. Our experts perform hardness testing according to the requirements of the material and its applications.

Impact
Impact Test

Impact strength tests are designed to determine the notch toughness of a material by measuring the amount of energy absorbed as it fractures. The Charpy impact test is one of the most popular techniques for determining material notch toughness and helps ensure the safety and integrity of structure.

Bend
Bend Test

These test methods cover bend testing for ductility of materials. Bend tests for ductility provide a simple way to evaluate the quality of materials by their ability to resist cracking or other surface irregularities during one continuous bend. No reversal of the bend force shall be employed during these tests.

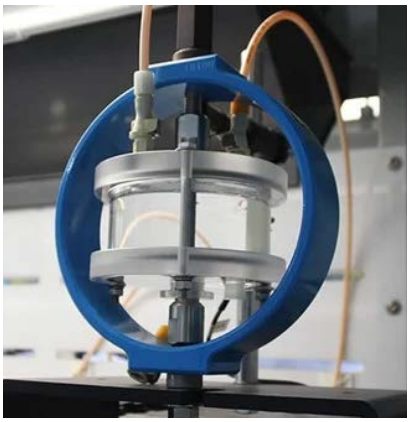
TESTING AND ANALYSIS CAPABILITIES

SST
Salt Spray Test

At TIL, our high-capacity salt spray testing labs can test a number of test specimens of many sizes, shapes and dimensions for the Salt Spray Test. We can also accommodate the duration of the exposure for the test according to specific to customers' requirements.

Non-Sour
Corrosion Test

Our corrosion experts follow international testing standards and protocols such as ASTM, NACE, and API. We can assist you with a wide range of corrosion testing services and evaluations, material selection, corrosion assessments, recommending efficiencies, and preventative mitigation measures.



Sour
Corrosion Test

Our sour service labs use hydrogen sulfide and other sour gases to replicate the highly aggressive conditions found in the Oil & Gas industry. TIL's specialized corrosion laboratories meet stringent international standards with a variety of traditional and advanced sour service corrosion testing.

TESTING AND ANALYSIS CAPABILITIES

OES
Chemical Test

TIL has chemical analysis laboratories across the US, Europe, and Asia, allowing you worldwide access to our trusted expertise and unique range of services. From trace metals identification to comprehensive failure analysis programs, our experts provide the certainty your project requires.

ICP-OES
Cheical Analysis

With cutting-edge ICP equipment, TIL's ICP analysis services offer effective and precise quantification and identification of elements in a wide range of materials across diverse industries and serving a variety of applications, with both high and low concentrations down to ppm/ppb levels.

ONH & CS
Analysis

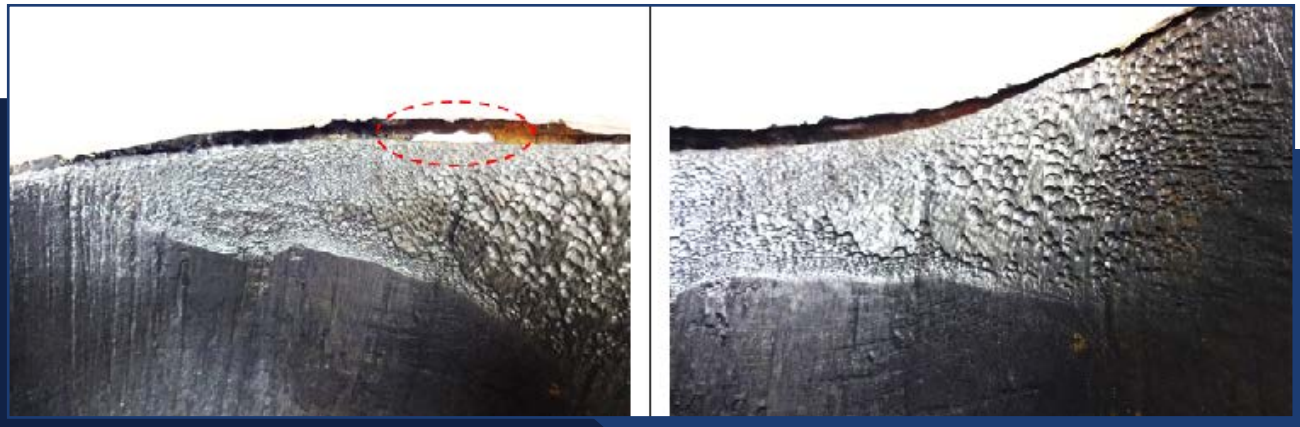
Elemental analysis using LECO and ELTRA are reliable method for determining the concentration of elements within a metallic sample, including Carbon, Hydrogen, Nitrogen, Oxygen and Sulfur. Our experts help industries to quantify these elements in their material.

INVESTIGATED
FAILURE CASES

The high number of failure analysis cases undertaken at TIL in recent years provides testimony to technical expertise TIL hold. Various components arrive to carry out failure analysis, and each case is attended with scope of work designed for the case. The adaptive methodology embraced at TIL stretch from carrying out field studies to extensive laboratory tests that has enabled TIL to establish not only in failure root-causes but also mitigation and control solutions. Following failure cases are few examples that were investigated at TIL.

INVESTIGATED FAILURE CASES

CASE 1: FAILURE ANALYSIS ON LEAKED ELBOW FROM CONDENSATE PIPING NETWORK



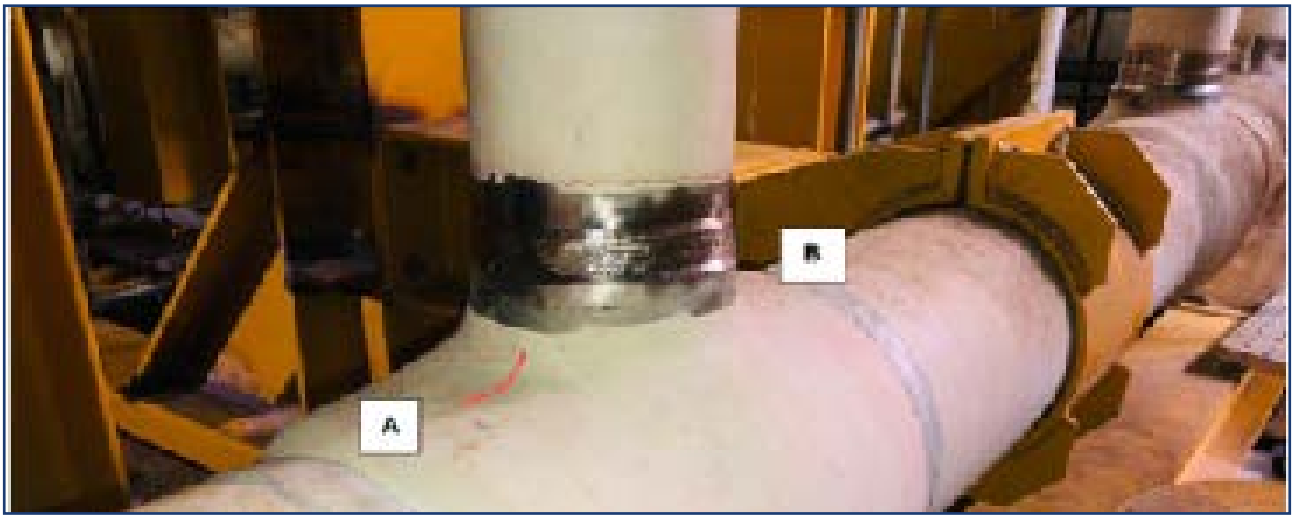
In a condensate piping network, 2 elbow and 1 equal-tee were found leaking. An Elbow – 6" Sch. Std. from the condensate piping network was sent to us for Failure Analysis, where the component had a through thickness hole at weld.

Although, the chemical composition, mechanical properties and microstructures of the elbow were typical of the grade requirement of ASTM A234 Grade WPB. However, the weld chemical composition was not found matching to the grade requirement. The visual examination and stereo-examination evidenced honeycomb-shaped cavities near the leak at damage, and general erosion-corrosion thinning at damage away from leak. The wall thickness loss of approx. 3mm was observed on the damaged area.

Based on detailed failure investigation carried out in the laboratory on the failed portion of the elbow, leakage and thinning happened due to combination of erosion-corrosion and cavitation-erosion. And the contributing factor for erosion-corrosion that led to leakage and thinning were abrasive compounds, inhomogeneity in microstructure near welding, bubble impingement at the transition near weld.

INVESTIGATED FAILURE CASES

CASE 2: LEAKAGE AND CRACKS ON SEAMLESS PIGGABLE BARRED TEE



The leakage along the crotch area of the one of the 10" x 6" barred tees on both sides of the branch during initial pressurization for hydrotest of the manifold was observed. Linear cracks on the shoulder/crotch of the barred tee were discovered on either side.

Two prominent cracks were observed in the shoulder of the barred Tee in longitudinal direction during hydro-test as a part of FAT activities. No other anomalies were observed in pipe to Tee weld joints. These two cracks were observed to be propagating near welded bar section from the inner surface of the tee and traversing to exterior surface.

Although the chemical composition of the material found meeting the grade requirement of 25% Super Duplex Stainless Steel (UNS S32760), non-conformity in mechanical properties like tensile, hardness, impact, inhomogeinity in microstructures and deviation ferrite content were reported after tests.

Based on the detailed investigations & laboratory test results, the cracks in the tee body developed because of inhomogeneity and significant presence of deleterious phases resulting in embrittlement due to improper thermal cycle exposure.

INVESTIGATED FAILURE CASES

CASE 3: FAILURE ANALYSIS ON CRACKED CS FLANGE

After welding of pipe to the flange, a crack was observed while performing inspection on the joint. Two such flanges were under failure investigation.

Although the tensile properties of one flange were found to be complying, the test result for other flange did not meet the requirement of specified grade ASTM A105. While the general core microstructure was found typical of the grade, however long interlinked embeded foreign material was observed in the microstructure at location near the crack.

The defect area was observed and characterised using SEM. And the SEM micrographs showed the disbonding of the metal matrix in the cracked region, which subsequently formed deep recess which were observed in each SEM images.

The EDS analysis confirmed the presence of predominantly O, Fe, Ca, Mn, Si, Al which constitues chemical components as oxides such as CaO, SiO2, Fe2O3, Al2O3, MnO, FeO. There chemical components are prevalent in steel slag.

So the defect was primality foreign material, deemed to be slag, the brittle nature of foreign material, made the flange susceptible to cracking under stress condition.

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Scope of Work for Failure Analysis

SCOPE OF WORK (SOW)

METALLURGICAL FAILURE INVESTIGATION

Client: (Client Name)
(Address)

Attention: Mr./Ms. _____
Position
Mobile:
Email:

PROPOSED SCOPE OF WORK (SOW)

This document outlines the standard procedure followed by Trans Asia Industrial Laboratories LLC (TIL) for conducting metallurgical failure investigations on metallic components that exhibit leakage, cracking, corrosion, deformation, fracture, or any other abnormal condition during service.

The objective of this investigation is to:

Determine the nature and origin of the failure.

Identify metallurgical, mechanical, and environmental factors involved.

Establish the underlying root cause of failure.

The investigation typically includes visual inspection, non-destructive examination, chemical analysis, mechanical testing, macro/microstructural examination, SEM–EDS, and when required, XRD analysis, depending on the component condition.

A comprehensive technical report will be issued, summarizing all findings and providing root cause conclusions along with preventive and corrective recommendations.

REFERENCE PHOTOGRAPHS *(as provided by the client)*

(Figures to be inserted when available)

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***Table 1**: Scope of Work.*

Sl. No.	Test Description	Failed Components				
		Sample-1	Sample-2	Sample-3	Sample-4	Sample-5
1	Visual Examination	Yes	Yes	Yes	Yes	Yes
2	NDT – PT / MT / UT (as applicable)	Yes	Yes	Yes	Yes	Yes
3	Stereo Microscopy	Yes	Yes	Yes	Yes	Yes
4	Chemical Composition Analysis	Yes	Yes	Yes	Yes	Yes
5	Hardness Test / Survey	Yes	Yes	Yes	Yes	Yes
6	Macro Examination	Yes	Yes	Yes	Yes	Yes
7	Micro Examination	Yes	Yes	Yes	Yes	Yes
8	SEM - EDS Analysis	Yes	Yes	Yes	Yes	Yes
9	XRD Analysis	Yes	Yes	Yes	Yes	Yes
10	Root Cause Analysis & Comprehensive Report	Yes	Yes	Yes	Yes	Yes

DETAILED SCOPE OF WORK

1. VISUAL EXAMINATION

All components will be examined in as-received condition to assess physical condition, deformation, pitting, leakage points, crack zones, discoloration, deposits, mechanical damage, weld condition, and fit-up quality. High-resolution photographs will be recorded documenting ID/OD conditions and regions of interest.

2. NDT EXAMINATION

All components will be examined in as-received condition to assess physical condition, deformation, pitting, leakage points, crack Based on component type and failure nature, the following may be performed:

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- Liquid Penetrant Testing (PT) – surface-breaking cracks.
- Magnetic Particle Testing (MT) – ferromagnetic materials.
- Ultrasonic Testing (UT) – internal defects
- Eddy Current Testing (ECT) – tube inspection

Findings will be used to decide sectioning locations.

3. STEREO EXAMINATION

Representative regions will be examined under a stereo microscope (up to 50× magnification) to characterize surface morphology such as pitting shape, crack network, or corrosion product features. These images will provide 3-D visualization of the damaged areas prior to sectioning.

4. CHEMICAL COMPOSITION ANALYSIS

PMI (XRF) and/or OES will be used to confirm alloy grade and check for elemental deviations that may influence corrosion, cracking, or mechanical performance.

5. HARDNESS TEST / SURVEY

Vickers hardness (HV10) measurements will be taken at selected sound and damaged regions to assess localized softening or work-hardening effects due to thermal exposure, erosion, or mechanical deformation. Results will aid in correlating material condition with observed failures.

6. MACRO EXAMINATION

Sectioned samples will be ground and etched to evaluate:

- Wall thinning
- Crack initiation and propagation
- Corrosion penetration depth
- Weld fusion, HAZ, and defects
- General damage morphology

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7. MICRO EXAMINATION

Polished and etched metallographic specimens will be examined under an optical microscope (50–1000×) to study.

- Base-metal grain structure and any evidence of recrystallization or overheating.
- Corrosion morphology (pitting, intergranular, or dealloying type).
- Crack initiation features, propagation mode, and association with inclusions or defects.
- Presence of oxides, sulfides, or deposits along grain boundaries.

8. SEM-EDS ANALYSIS

Scanning Electron Microscopy (SEM) will be performed on selected areas to study crack morphology and corrosion product features at high magnifications. Elemental analysis (EDS) will identify constituents such as chlorine, sulfur, or oxygen to establish possible mechanisms like chloride-induced pitting, erosion-corrosion, or sulfidation.

9. XRD ANALYSIS

Crystalline phases in corrosion products or deposits will be analyzed to identify oxides, chlorides, sulfides, carbonates, or scales correlating to service environment. The results will help correlate the corrosion environment and the nature of deposits contributing to tube failure.

10. ROOT CAUSE ANALYSIS & COMPREHENSIVE REPORT

All results will be correlated to identify the dominant failure mechanism such as:

- Localized corrosion / pitting
- Stress corrosion cracking
- Thermal fatigue
- Mechanical overload
- Erosion–corrosion
- Metallurgical defects
- Improper fabrication or welding

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A comprehensive report will be published including:

- Test results
- Micrographs & SEM images
- Analytical charts
- Discussion
- Conclusion
- Preventive & corrective recommendations

-End of Scope of Work-

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SOP – Failure Analysis

FAILURE ANALYSIS OF METALS & ALLOYS

ISO/IEC 17025:2017

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Document Change Record

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Sr. Metallurgist	Technical Manager	Sr. Lab Technical Manager	Controlled / Uncontrolled	1 - 5

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CONTENTS

1.0 SCOPE:

In an industry, failure of components can occur due to various reasons. Failure investigation to find-out the causes of failure us mandatory to maintain safe, efficient and economic future of operation. Evaluation of failed arts may revel needed changes in design, materials or operating procedures.

2.0 REFERENCE:

- Failure Analysis & prevention – ASM Handbook, Volume 11

3.0 PROCEDURE:

3.1 Collection of background data:

Service history, specifications and other relevant information pertaining to failure are obtained. These data are normally presented by the client. However, it is sometimes necessary to visit the site for personal assessment of failed component and the location.

3.2 Selection of samples:

The samples which will be suitable for the intended purpose and which represent the characteristics of the failure are to be selected before initiating the investigation. Additional evidence of damage beyond that which is immediately apparent is to be looked. The samples are identified appropriately.

3.3 Visual Examination:

The selected samples are examined visually. Particular attention should be given to the surface of fracture and the paths of cracks. The significance of any indications of abnormal conditions or abuse in service should be observed and assessed. Visual Examination is done in as received condition and after cleaning as well. Dimensional measurements also recorded. All-important fracture features shall be documented.

SEM Fractography to analyze the fracture features.

SEM EDS : to understand the elemental composition of corrosion residue.

3.4 Photographic Documentation:

A complete photographic record of important details and findings during the course of investigation is made. This can be used for evaluation and reporting.

After photographic documentation, failed sample is sampled and sectioned at desired location for further analysis.

3.5 Testing & Evaluations:

The following testing, which can provide information and lead to conclusions, are performed based on the investigation requirements:

Wet Chemical analysis to identify composition, verify the type / grade of the material and any heat treatment condition of the material: Using ICP OES & Eltra SOP 02

Scale analysis of corrosion deposits (if sufficient quantity available) to determine presence of corroding agents.

Perform Mechanical tests for Hardness / Tensile / yield strength etc. Get the surface hardness across the surface of the breaking point: using UTM & Hardness Tester as per SOP 01 & 04.

Impact Testing: Using charpy impact tester machine capacity 400J as per SOP 03 ASTM E 23.

Microstructure and macro structure tests As per ASTM E340 / E 407 / ASM Handbook Vol 9 & 11. SOP reference 09 & 23.

3.6 Analyzing evidence & formulating conclusions:

The obtained information and results of examinations and tests are analyzed and evaluated to formulate the final conclusion about the cause or causes of failure.

4.0 REPORTING:

A detailed report including all findings, photographic documentation and conclusion is prepared.

5.0 CLIENT FEEDBACK:

The client may sometimes request TIL's assistance in explaining the course of investigation. TIL's metallurgist may sometimes be requested to carry out a presentation in the presence of client and/or Third Party.

Sample Report

TRANS ASIA
Industrial Laboratories

FAILURE ANALYSIS

On Corroded Plug Valve

For Client-X

- Report # XXX/M/FA/XXXX
- TIL Job # TIL/XXXX/XX/M/XXX
- Date: XX XXXX XXXX

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FAILURE ANALYSIS REPORT

On

Corroded Plug Valve

1A14487 - 2405VAS012-4

- Report # XXX/M/FA/XXXX
- TIL Job # TIL/XXXX/XX/M/XXX
- Date: XX XXXX XXXX

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Failure Investigation Report		
Attention: Mr. XXXXX **M/s. Client-X** Address Dubai, United Arab Emirates.	**TIL Job #**	TIL/XXXX/XX/M/XXX
	Sample ID	MXXXX
	Order #	Email Dated XX-XX-XXXX
	Reference	ASM Handbook Vol. 11 & 13
	Test description	Failure Analysis
	Date of Issue	XX-XX-XXXX

1. General

The report is divided into several sections. The **Background** section of the report contains information on the component and the data provided by the client. The **Visual Examination** highlights the condition of the sample as-received. The subsequent sections include the individual tests and results derived from the investigation by TIL. The **Discussion & Conclusion** section collates all the test results.

2. Background

The damaged plug valve (Part No. 1A14487, Serial No. 2405VAS012-4) sample was delivered to Trans Asia Industrial Laboratories LLC (TIL), Dubai by Mr. XXXXX of M/s. Client-X. TIL was requested to carry out analysis to determine possible cause(s) of failure. As per the client, the plug valve exhibited internal surface corrosion shortly after limited-service exposure.

Client provided the following background information:

Table 1: Background Information.

	Component-1	**Component-2**
Component Name/Description	Plug Valve (Part No. 1A14487; Serial No. 2405VAS012-4)	Retainer Pin (unplugged from same plug valve assembly)
Components belong to Equipment	Valve	Valve
Material Specification	SPM Spec 4S16654 4140 Steel	AISI 6150 Steel
Application/Service	Isolating process fluids in standard upstream service.	-

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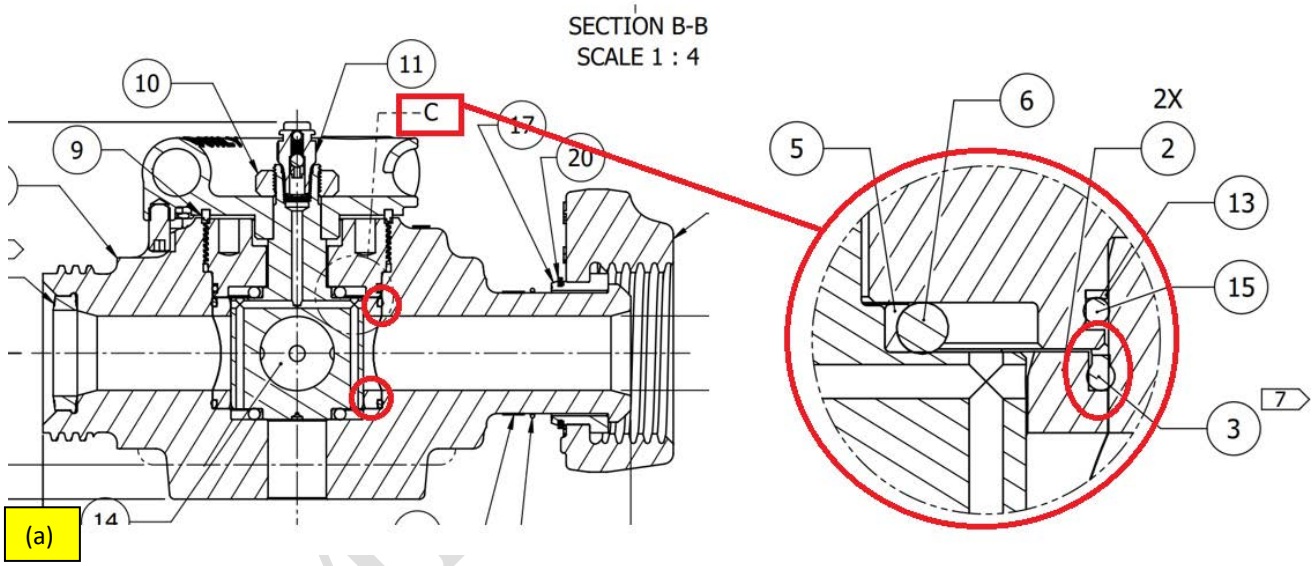
Operating / Environmental Condition	Static exposure to tap-water during factory pressure test. Trace chlorides and carbonates typical of tap water. One static test (~3 minutes) followed by drainage and storage prior to dispatch.	-
Any In – Service Duration (How long the failed component was in service)	Few months in operation; corrosion also noted in unused valves.	-
Any other relevant information	Tight tolerance between plug and body; potential for fluid entrapment under the gasket. Localized pitting and crevice-type corrosion on the internal seal surface, visible on both sides of the flow port.	-



(a)

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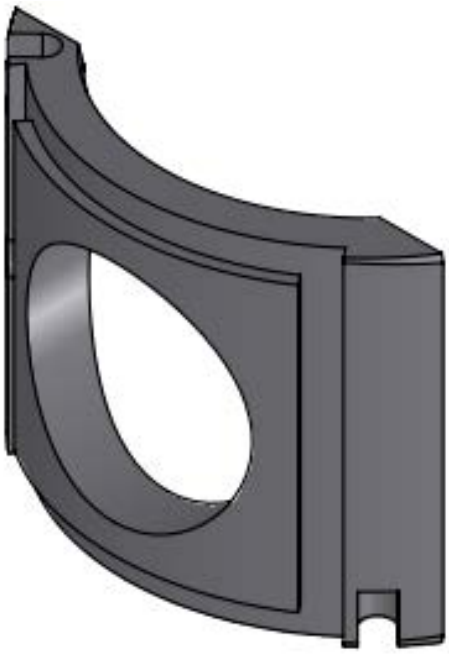
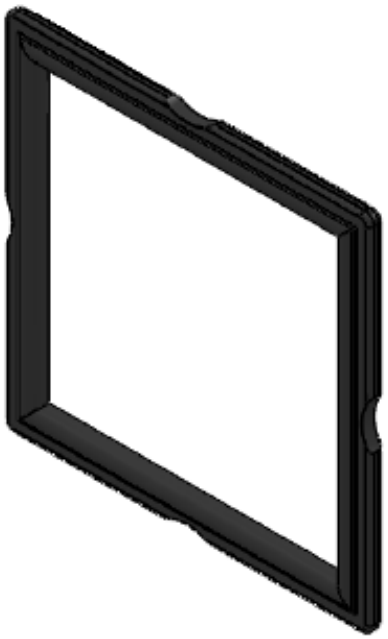


(b)



(c)

Photograph #1: a) illustration of the assembled valve. b) seal segment c) HNBR gasket.

3. Methodology

TIL identified the sample as **"MXXXX"** and the following tests were performed on the sample to assess the damaged component and determine the root cause.

i) **Visual Examination:** The as-received damaged component was visually inspected for the various features of failure, and the observations and photographic evidence were collected. Images of cracked region were captured using the digital camera and stereoscope as required.

ii) **Stereoscopic Examination:** To evaluate topography and macroscopic features of underlying surface.

iii) **Chemical Analysis:** Chemical composition of the samples was analyzed by OES (Optical Emission Spectroscopy) method to determine the elemental composition and to compare with the grade of manufacture provided by the client.

And as per request from the client, Leco Carbon-Sulfur analyzer was also utilized to determine sulfur content in the material.

iv) **Mechanical Test:** Mechanical properties like tensile test, hardness test, impact test, bend test etc. wherever applicable and required as part of standard test are performed.

v) **Metallographic Examination:** The structure of material was analyzed by standard metallographic procedure to observe the macrostructure and microstructure. Also, inclusion analysis, and check for presence of intermetallic phases were performed on the specimen.

vi) **EDS Analysis:** To characterize the composition of deposits, present at the surface of the component.

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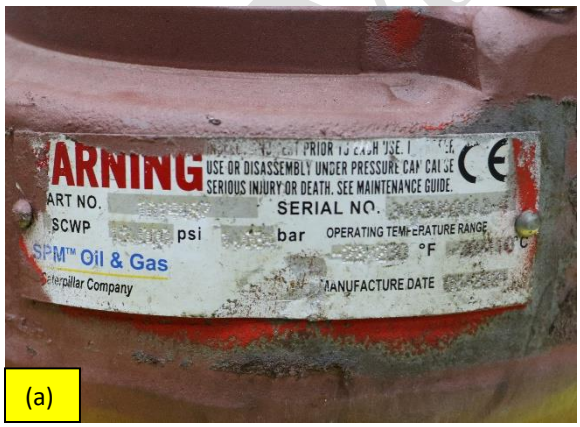
4. Visual Examination

The damaged plug valve was visually inspected in as-received condition to find out the macro defects, fracture features and surface conditions.

Photograph # 2: As-received condition of the plug valve showing intact external body with red-oxide coating and manufacturer identification markings. No mechanical damage, deformation, or cracks were visible on the outer surface.



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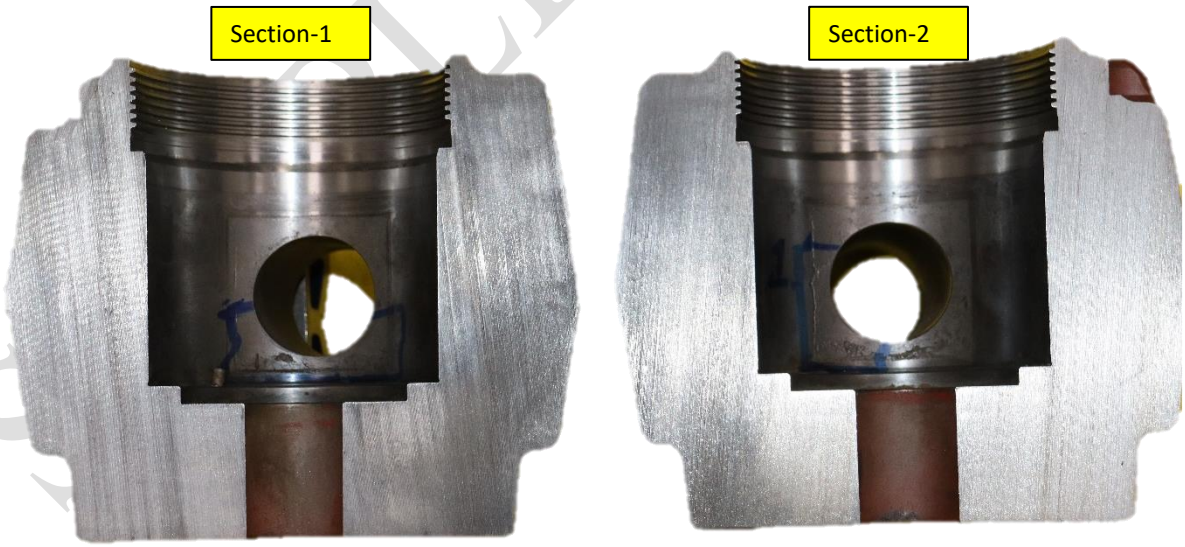
Photograph # 3: (a-c) Close-up views showing punch markings and sample identification on the valve body prior to sectioning. The valve surface remains free from external corrosion or surface defects.



Photograph # 4: Plug valve after sectioning in half along the flow bore, showing two internal sections (Section-1 and Section-2) selected for detailed examination. The surface around internal bore exhibits cavities and roughness.

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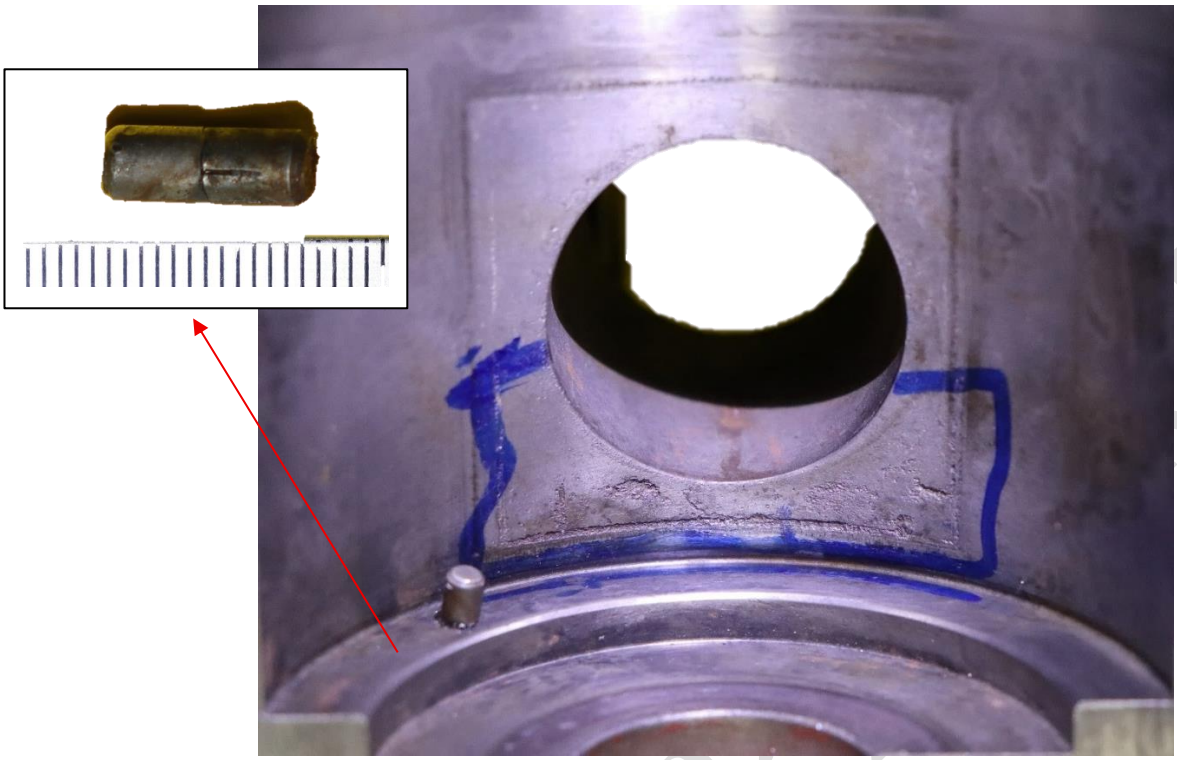
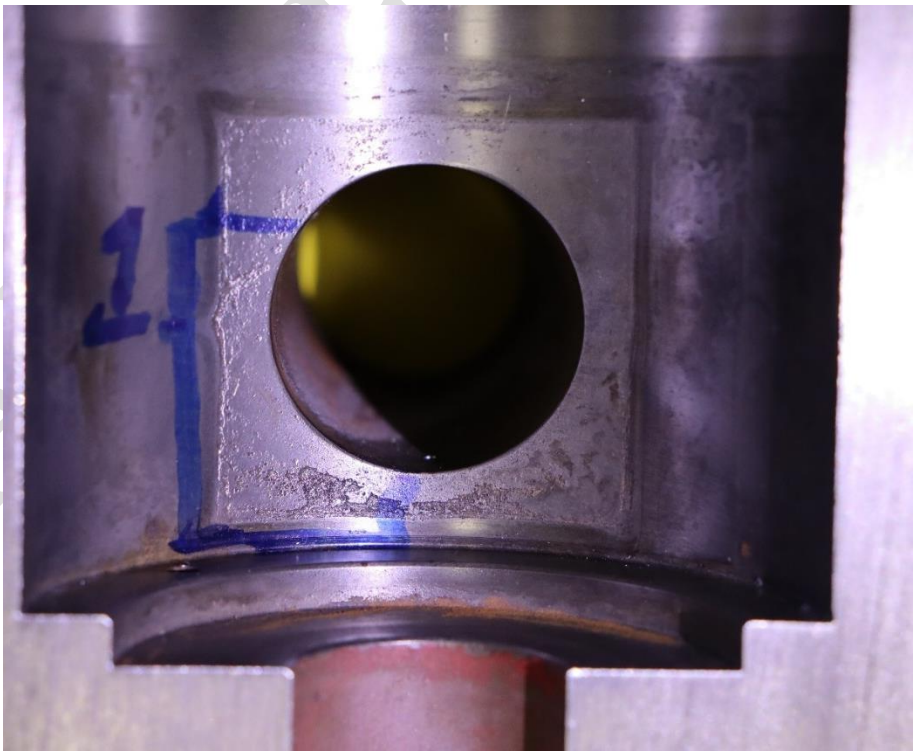


Photograph # 5: Section-1 view showing cavities around the flow port, with cavities concentrated at the lower portion of the bore near the retainer-pin side. The cavities are irregular, undercut, and interconnected, while the upper regions display only a few scattered shallow cavities.



Photograph # 6: Section-2 view showing pits around the flow port, with cavities concentrated at the lower portion of the bore near the retainer-pin side. The pits are irregular, undercut, and locally merged, while the upper regions display only a few scattered shallow pits.

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The plug valve (Part No. 1A14487, Serial No. 2405VAS012-4) was received in assembled condition with identification markings intact. The exterior, coated with red oxide paint, showed no evidence of deformation, mechanical damage, or handling marks. The body and plug assembly exhibited satisfactory structural integrity.

Internal inspection revealed numerous inter-connected cavities along the seating surface of the gasket. The damaged area had a distinct square periphery coinciding the shape of gasket. The damage manifested as discrete cavities and surface roughening concentrated at the gasket/sealing interface on both inlet and outlet sides, more severe at the lower bore region adjacent to the retainer-pin side—an area susceptible to fluid entrapment during testing or storage.

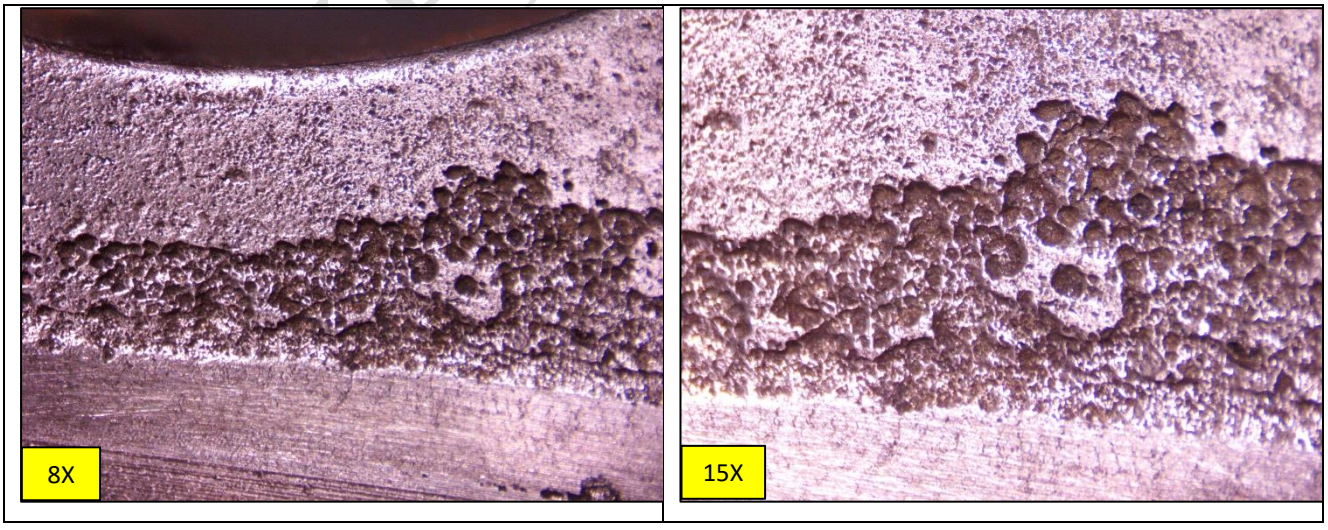
The damage formed a square or annular band coinciding the gasket geometry, possible crevice-type attack confined underneath the gasket seat. Surrounding surfaces retained machining marks, suggesting that degradation was localized.

The retainer pin exhibited bending and partial shear near mid-length without complete fracture, indicative of mechanical overstress or assembly misalignment.

Overall, examination confirmed numerous inter-connected cavities suggesting localized corrosion damage like crevice or pitting corrosion beneath the gasket interface, concentrated at the lower region near the retainer pin, consistent with fluid stagnation and entrapment effects.

5. Stereoscopic Examination

The damaged sample was cleaned and analyzed under a stereomicroscope to check the macro-morphology of damaged surface at a lower magnification of 8X-50X.



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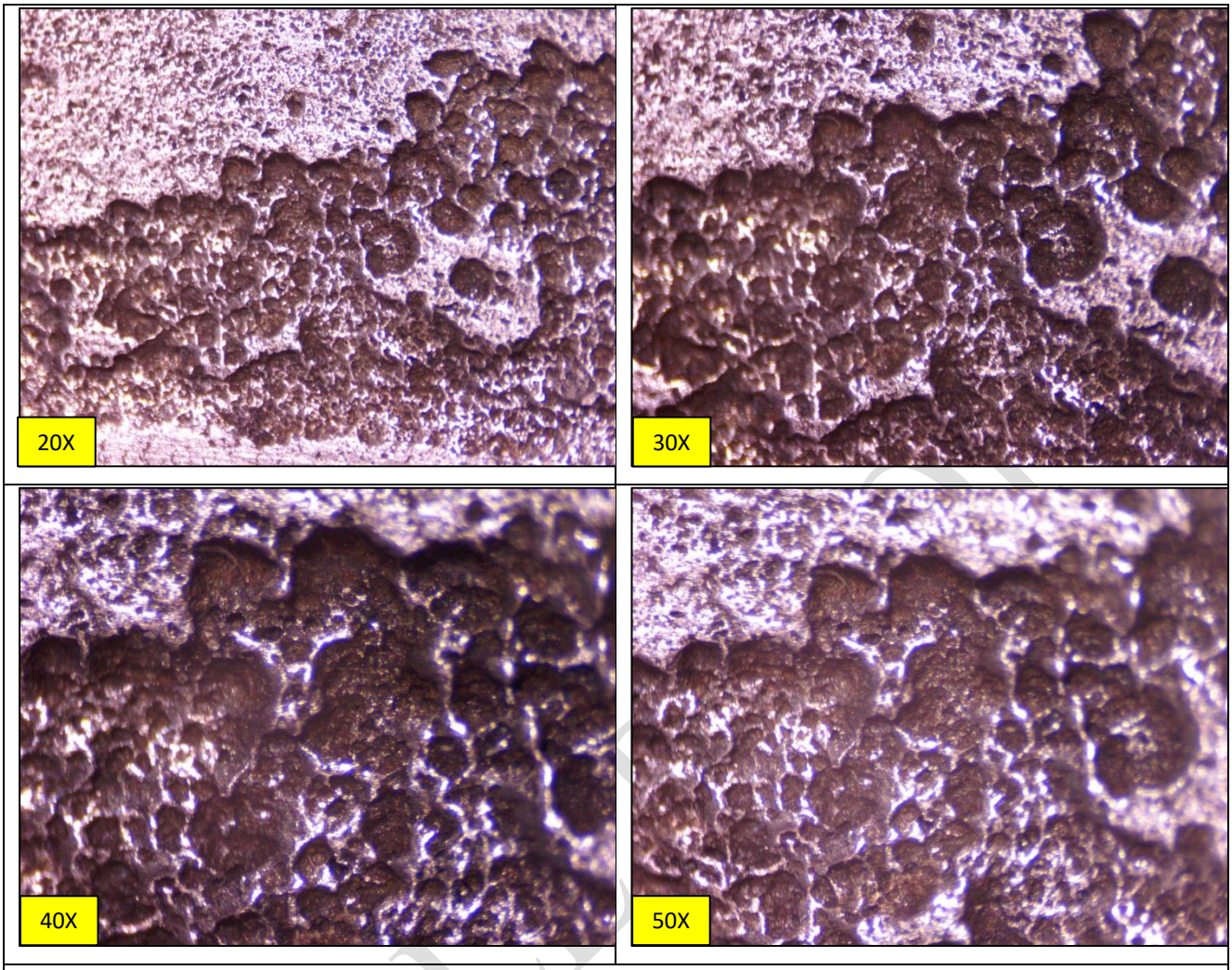
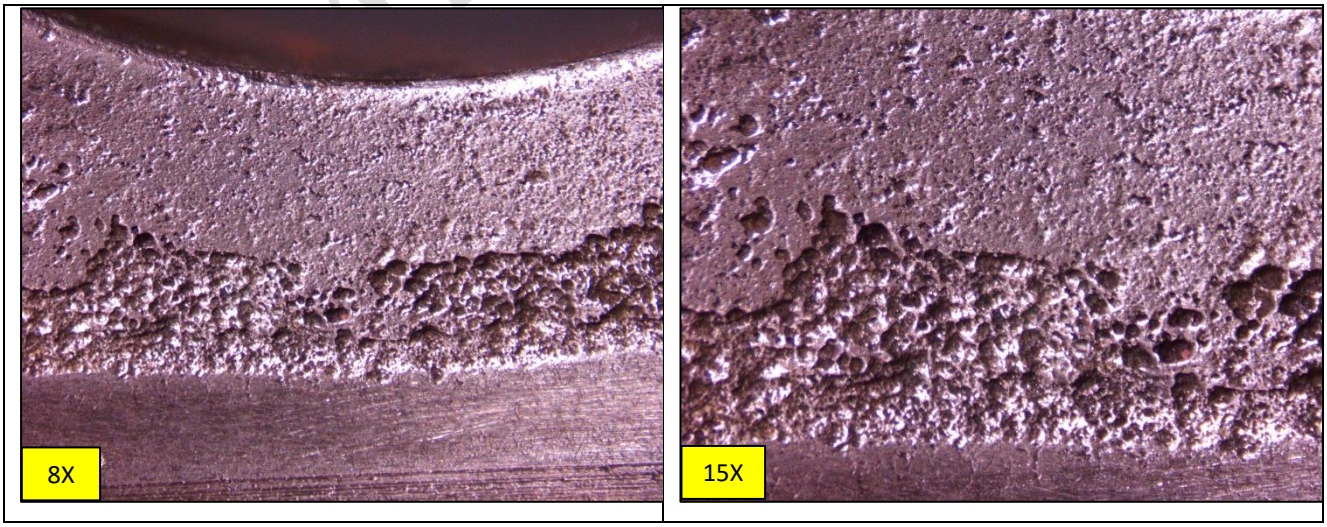


Photograph # 7: Stereo microscope images of the pit surface at Location-1 (8X–50X magnification). The pits appear irregular, undercut along the edges, and covered with thin oxide films. The surrounding metal remains smooth, suggesting localized crevice-type corrosion at the seal interface.



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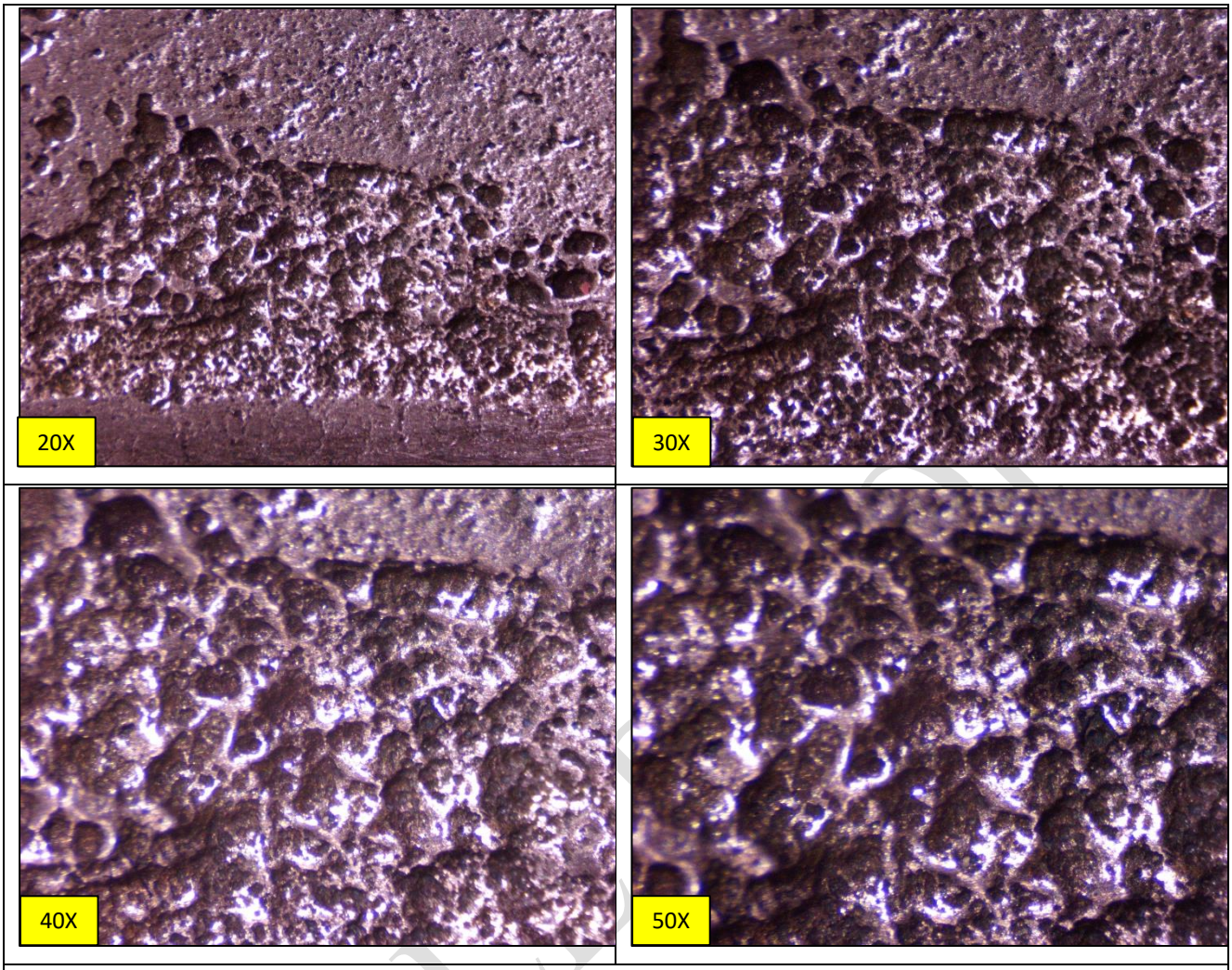

Photograph # 8: Stereo microscope images of the pit surface at Location-2 (8X–50X magnification). The cavities are clustered and shallow with rough interiors and darkened edges due to corrosion deposits. Similar morphology was observed as in Location-1, indicating consistent localized attack.

Stereoscopic examination on the damaged surfaces of the plug-valve body (Case 1) was conducted at 8×–50× magnification to characterize morphology and surface topography. Two representative sites (LOC-1 and LOC-2) from affected regions in Sections 1 and 2 around the flow bore were examined.

Both areas exhibited localized damage having crevice-type features confined to the gasket/seal area. The cavities were irregular, undercut, and interconnected. Cavity depth and density were highest at the lower bore region adjacent to the retainer-pin/drain-port side, while the upper area showed fewer, shallower pits with partially preserved machining marks.

The damage appeared to have square band consistent with the gasket contact footprint, confirming deterioration localized to the sealing zone and indicative of crevice or pitting damage due to entrapment.

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6. Chemical Composition Analysis

Chemical analysis was carried out by Optical Emission Spectrometer (OES), LECO and PMI-XRF on the damaged component to determine the chemical composition of the material. The specimen was drawn from the unaffected location of the plug valve. Test results are tabulated in Table #2 against the grade requirement.

Table 2: Chemical Analysis.

Elements Analyzed (Weight %)	Plug Valve			Retainer Pin	
	OES Results	LECO Results	SPM Spec 4S16654 4140 Requirement	PMI-XRF Results	AISI 6150 Requirement
Carbon, C	**0.475**	**0.480**	0.38 – 0.43	-	0.48 – 0.53
Silicon, Si	0.249	-	0.15 – 0.35	-	0.15 – 0.35
Manganese, Mn	0.815	-	0.75 – 1.00	**1.08**	0.70 – 0.90
Phosphorus, P	0.015	-	0.015 Max.	-	0.035 Max.
Sulfur, S	**0.019**	**0.014**	0.012 Max.	-	0.040 Max.
Chromium, Cr	**1.18**	-	0.80 – 1.10	**0.076**	0.80 – 1.10
Molybdenum, Mo	0.23	-	0.15 – 0.25	0.066	-
Nickel, Ni	-	-	-	0.145	-
Copper, Cu	-	-	-	0.163	-
Vanadium, V	-	-	-	-	0.15 Max.

Chemical composition analysis on the plug valve body and retainer pin sample was conducted using Optical Emission Spectrometry as per ASTM E415 and by LECO Carbon-Sulphur analyzer. And on the retainer pin by PMI–XRF as per ASTM E1476.

The sulfur content in the material composition of plug valve was found higher than the requirement of client's specification SPM 4S16654 Rev# R16.

The chemical composition results were found non-conforming to the material grade for both plug valve and retainer pin.

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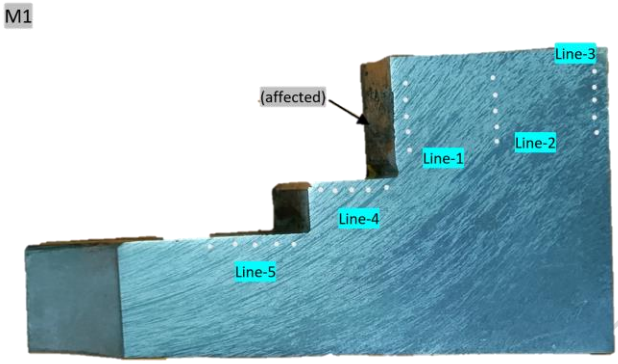
7. Mechanical Test

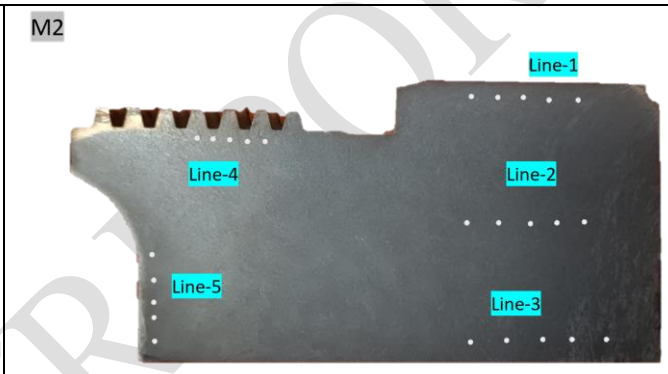
7.1. Tensile Test

Tensile testing was not conducted due to the impracticality of extracting a standard test specimen from the sample's geometry.

7.2 Hardness Test

Vickers hardness test was carried out at 10 kg load on the specimen extracted from the plug valve as per standard ASTM E92. Hardness results are shown in Table # 3.





Photograph # 9: Extracted macro specimens (M1 and M2) from the plug valve section showing hardness indentation lines 1–5. Indentations were taken near the internal surface and through the core to evaluate hardness variation. The figure shows the layout used to compare affected and unaffected regions.

Table 3: Vickers Hardness Test Results.

Macro ID	Locations	Indent Spot	Test Results, HV
M1 (Valve) [SPM Spec 4S16654 4140 Requirement (24—34 HRC) (~ 260-336 HV)]	1.0 mm from the Internal Surface	Line-1	323, 321, 325, 323, 323
	Core	Line-2	319, 317, 321, 321, 322
	Core	Line-3	321, 323, 319, 319, 317
	1.0 mm from the Internal Surface	Line-4	321, 323, 325, 327, 327
	1.0 mm from the Internal Surface	Line-5	327, 325, 327, 325, 323
M2 (Valve) [SPM Spec 4S16654 4140 Requirement (24—34 HRC) (~ 260-336 HV)]	1.0 mm from the Internal Surface	Line-1	319, 321, 321, 323, 321
	Core	Line-2	319, 317, 317, 316, 317
	Core	Line-3	317, 319, 321, 319, 317

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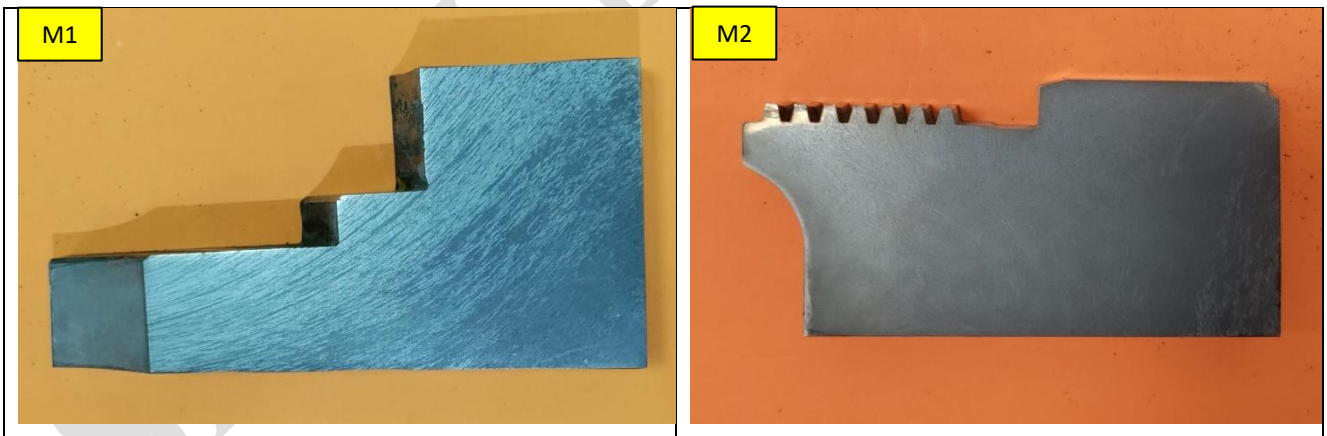
	1.0 mm from the Internal Surface	Line-4	325, 327, 323, 323, 323
	1.0 mm from the Internal Surface	Line-5	325 ,323, 327 ,325, 323
M3 (Pin) [Client's Requirement (40—45 HRC) (~ 392-451 HV)]	Core	--	224, 219, 222, 220, 221

The plug-valve specimens (M1 and M2) exhibited uniform hardness across all traverses, matching SPM Spec 4S16654 4140 material grade. The retainer pin (M3) showed an average hardness of ~220 HV (~22 HRC), markedly below the client specified 40–45 HRC (≈392–451 HV) for AISI 6150 grade.

8. Metallurgical Examination

Metallurgical specimens were sectioned from the damaged sample by cold sawing. The sample was polished up to 1200 grit size on Silicon Carbide emery papers, further polished up to 0.05 microns using high purity alumina powder & nap cloth. Mirror-like polished surfaces were obtained and then etched with aqua regia for examination under an optical microscope with different magnifications (100 - 500X) to reveal the microstructural constituents. The following photographs describe the micrographs as polished and as well in etched condition.



Photograph # 10: Micro specimens M1 (affected) and M2 (unaffected) extracted from the plug valve for metallographic examination.

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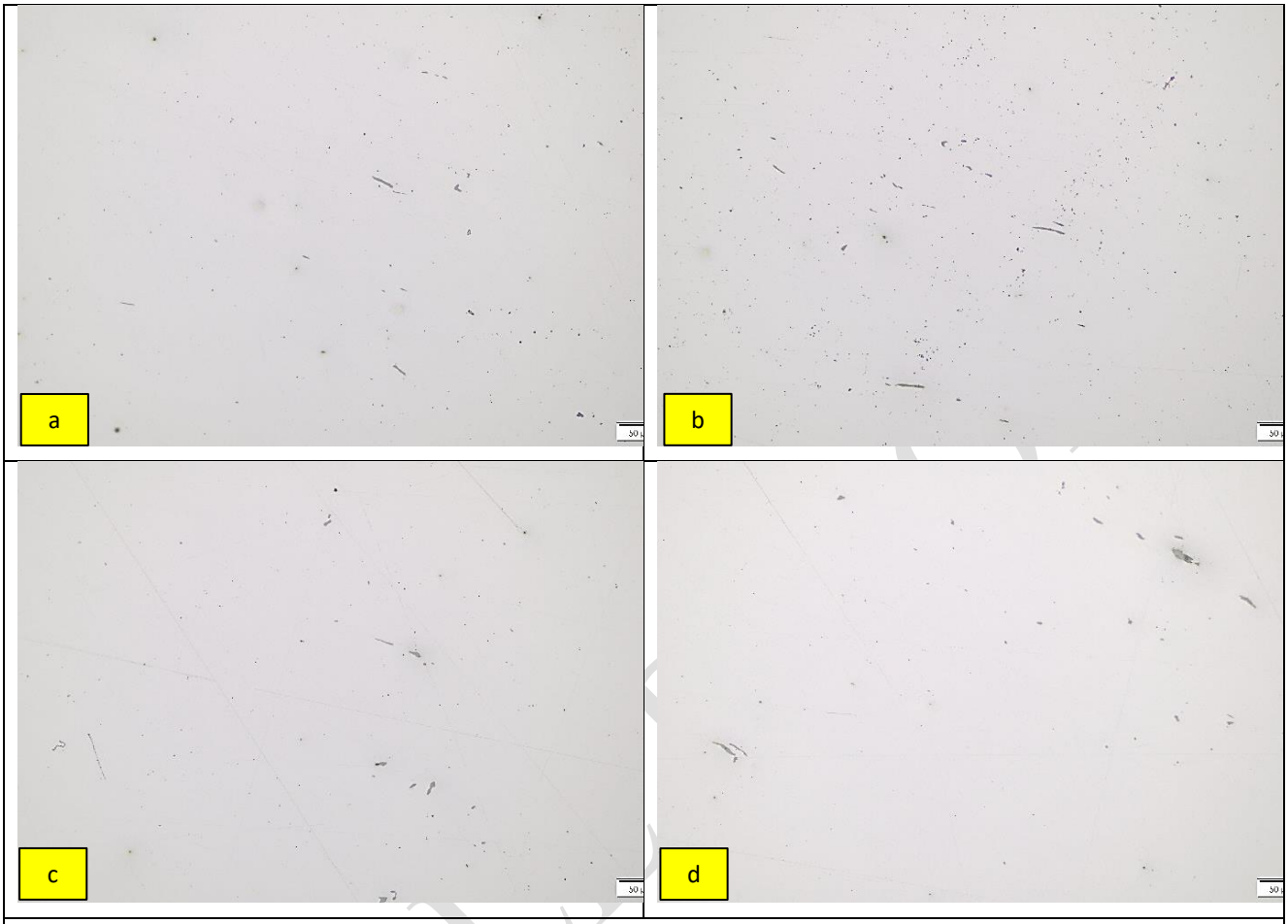
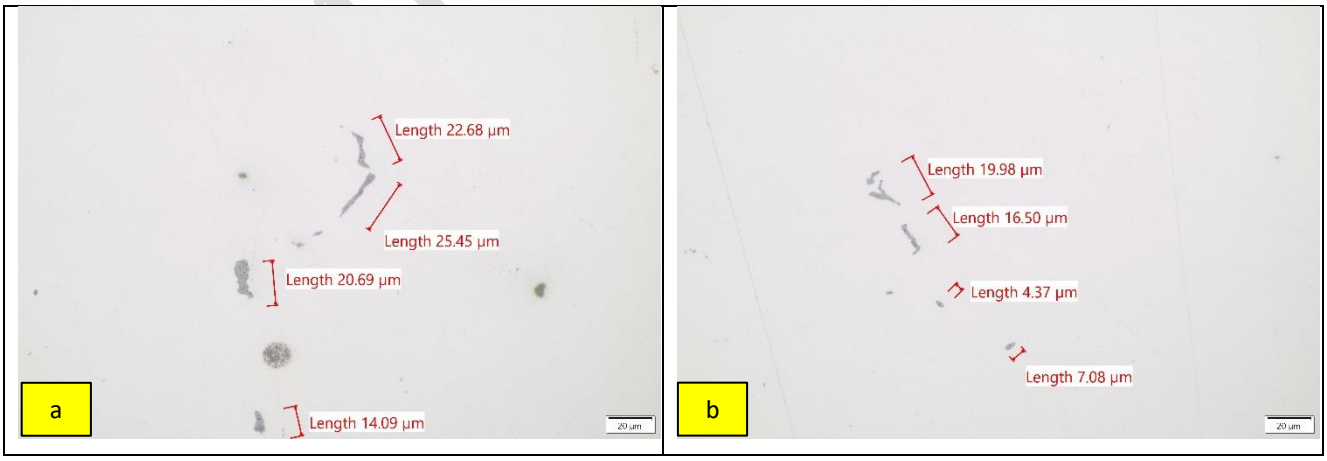
Microstructure: As-polished condition



Photograph # 11: Specimen M1. Micrographs are shown in as-polished condition. Numerous sulfide type inclusions are observed. (a-d) 200X



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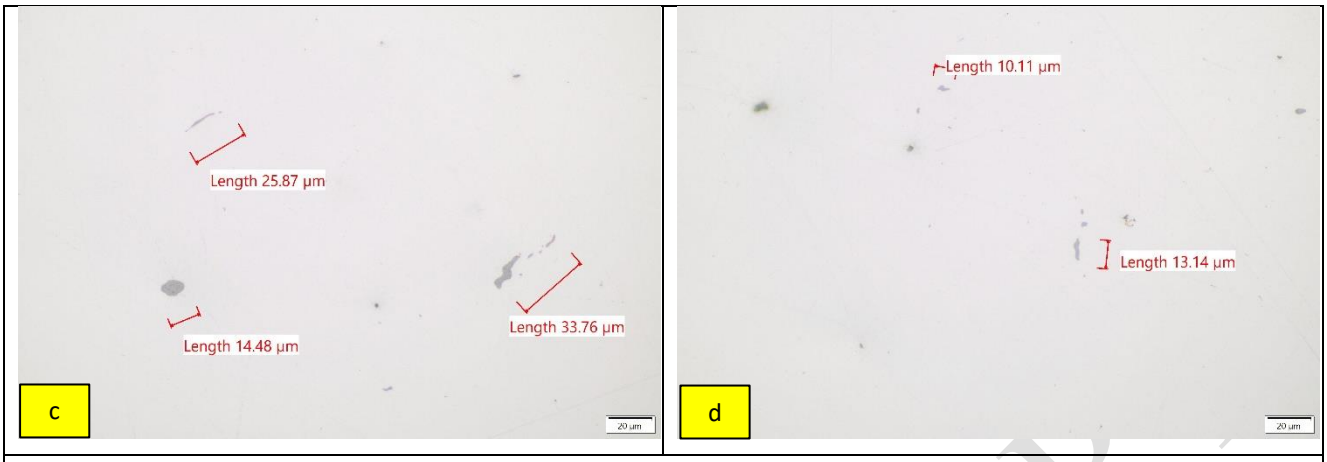
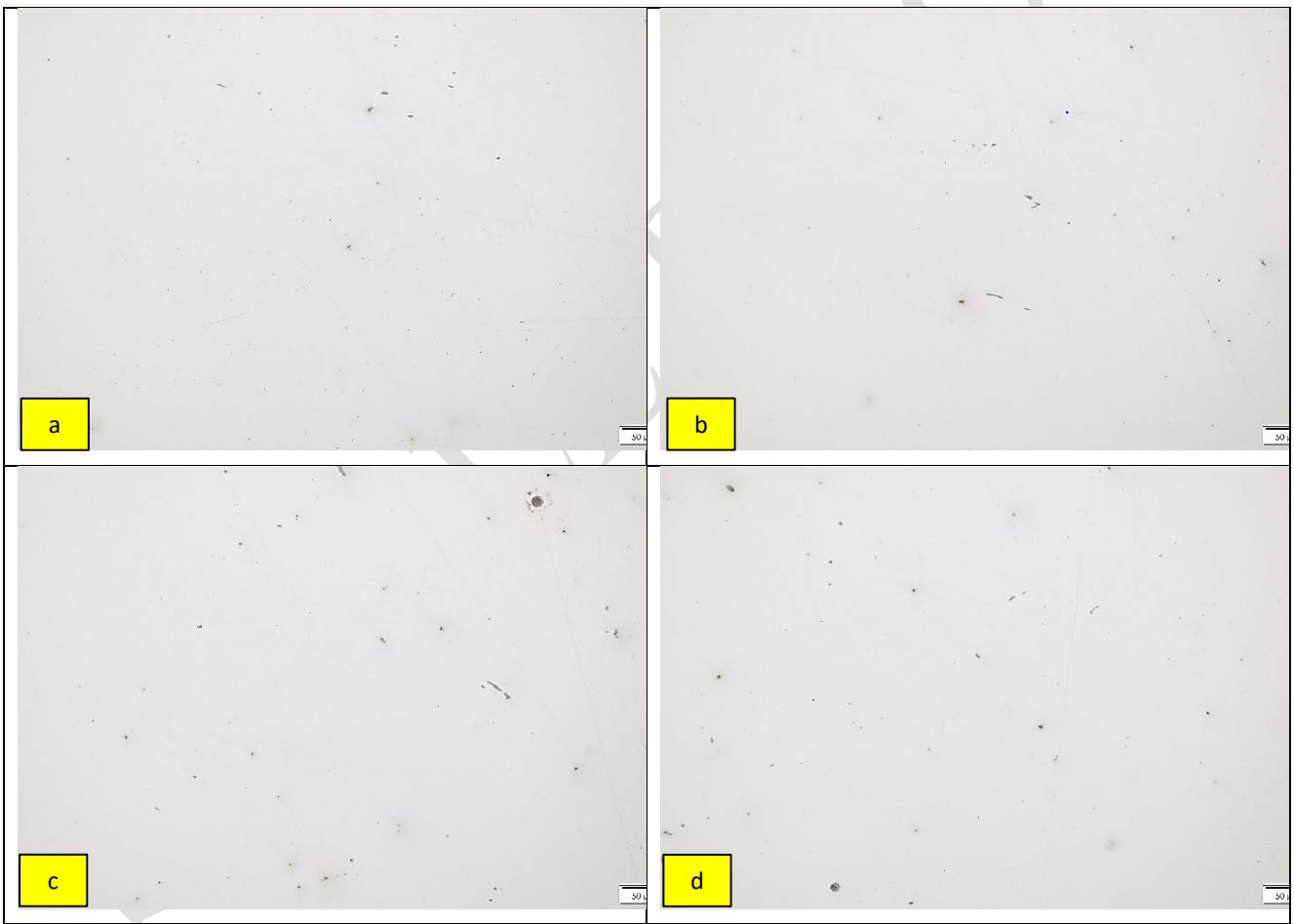


Photograph # 12: Specimen M1. Micrographs are shown in as-polished condition. Numerous sulfide type inclusions are observed with its length reported (10.11 to 33.76 µ). (a-d) 500X



Photograph # 13: Specimen M2. Micrographs are shown in as-polished condition. Numerous sulfide type inclusions are observed. (a-d) 200X

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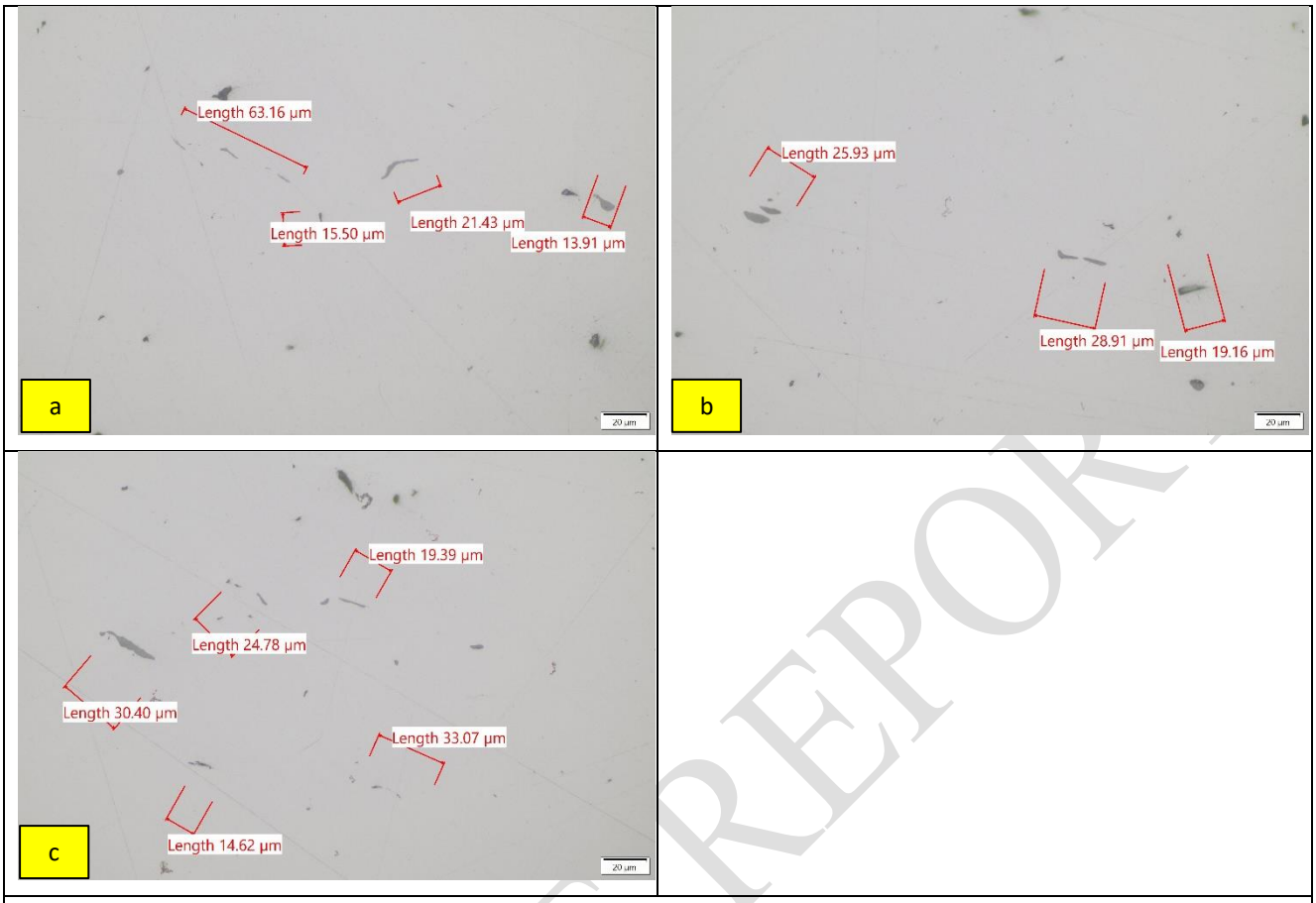

Photograph # 14: Specimen M2. Micrographs are shown in as-polished condition. Numerous sulfide type inclusions are observed with its length reported (13.91 to 63.16 µ). (a-c) 500X

Table 4: Inclusion Rating.

INCLUSION RATING - METHOD A								
Sample ID	Type A - Sulfide		Type B - Alumina		Type C - Silica		Type D – Oxide	
	Thin	Heavy	Thin	Heavy	Thin	Heavy	Thin	Heavy
INC-M1 Loc 1	1.0	0.5	0	0	0	0	0.5	0
INC-M1 Loc 2	1.5	1.0	0	0	0	0	0.5	0
INC-M1 Loc 3	1.0	0.5	0	0	0	0	0.5	0
INC-M1 Loc 4	1.0	0.5	0	0	0	0	0.5	0
INC-M2 Loc 1	1.0	0.5	0	0	0	0	0.5	0
INC-M2 Loc 2	1.0	0.5	0	0	0	0	0.5	0

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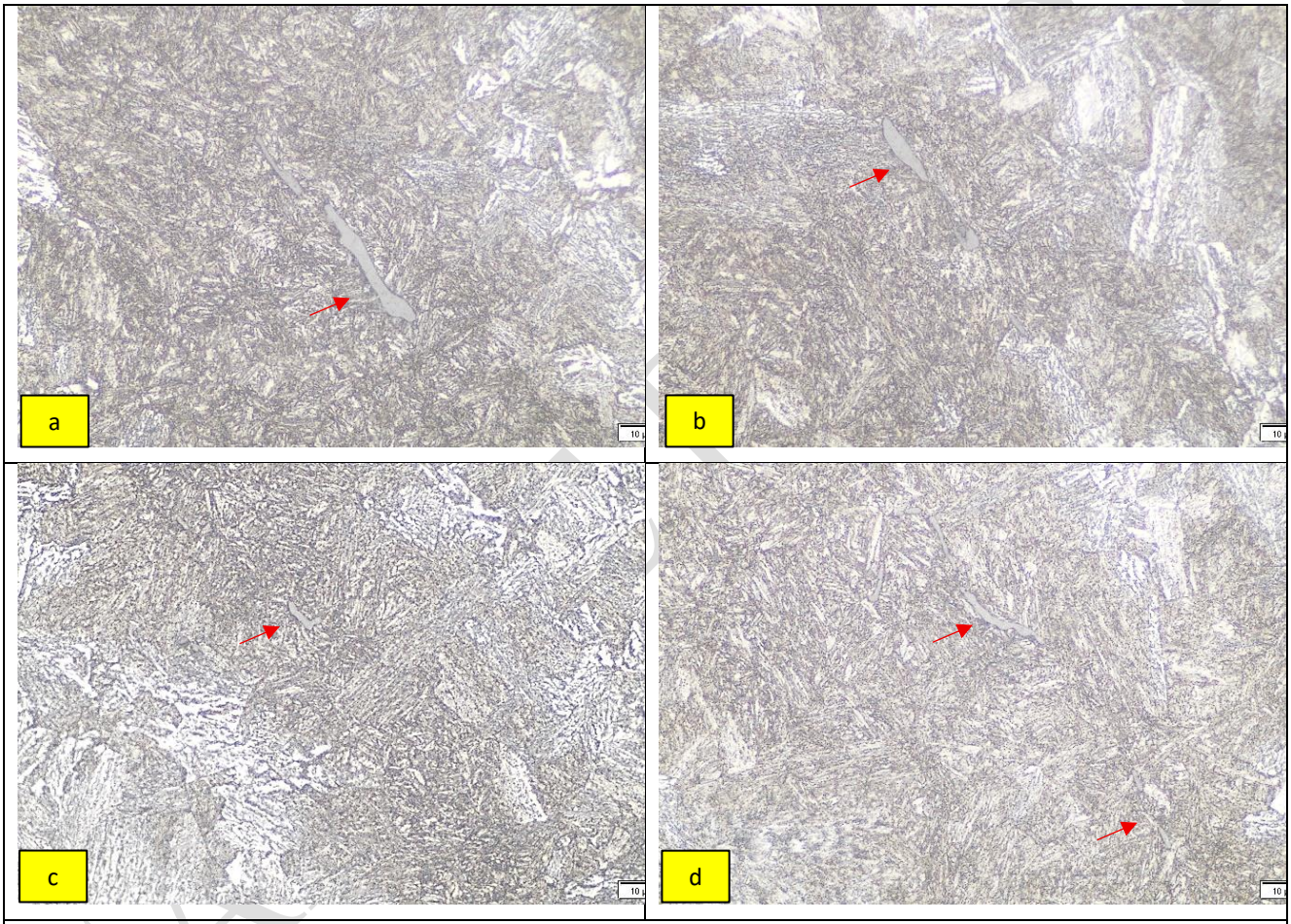
INC-M2 Loc 3	1.0	0.5	0	0	0	0	0.5	0
INC-M2 Loc 4	1.0	0.5	0	0	0	0	0.5	0
Client's Requirement: Max. 2.0								

Microstructure: Etched condition



Photograph # 15: Specimen M1. Microstructure consists of tempered martensite and elongated sulfide type inclusions (indicated by red arrows). (a-d) 1000X

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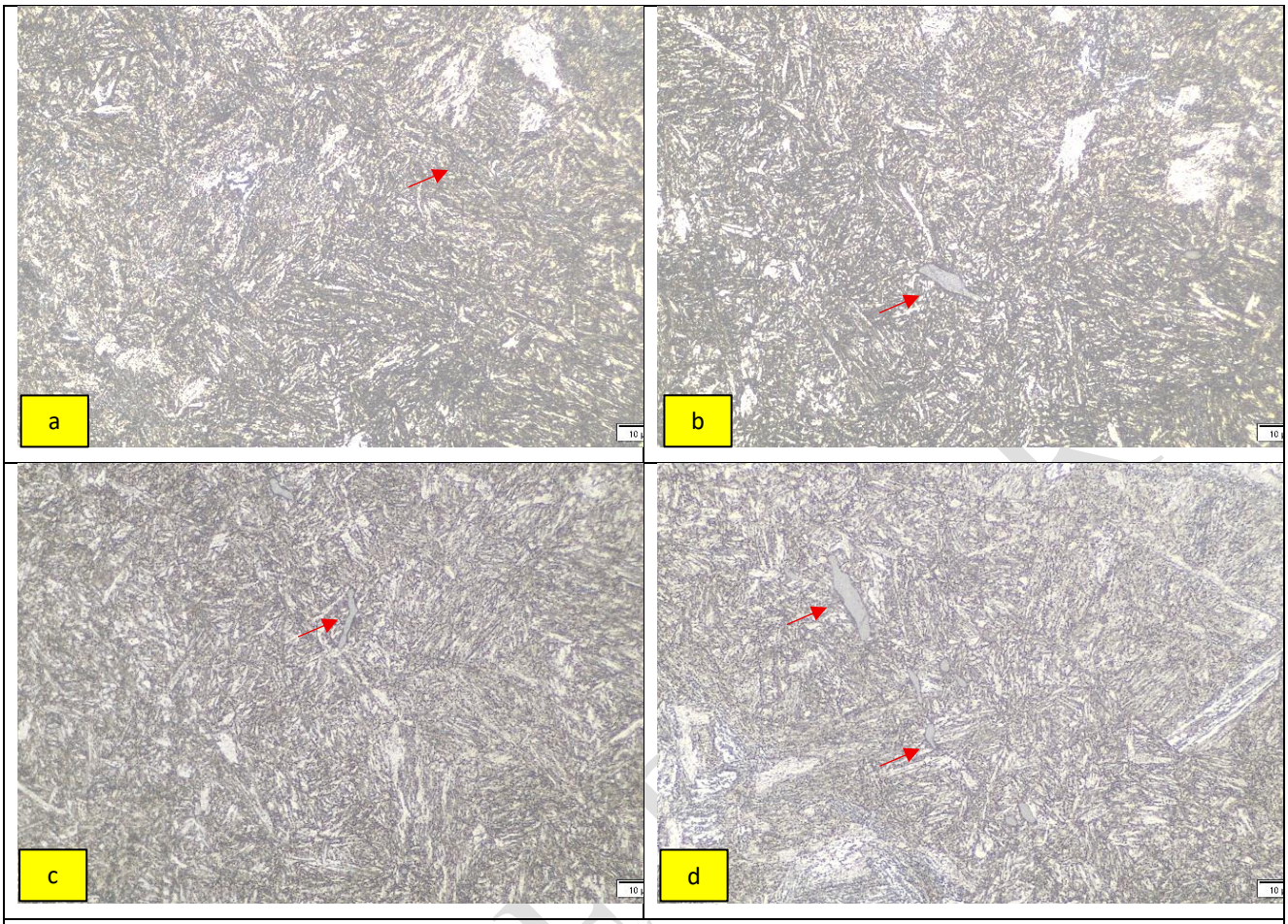

Photograph # 16: Specimen M2. Microstructure consists of tempered martensite and elongated sulfide type inclusions (indicated by red arrows). (a-d) 1000X

In the as-polised condition, elongated type A sulfide(MnS) inclusions were observed along the forging direction. These inclusions were thin to moderately heavy, discontinuous, and measured approximately 10–60 µm in length. Inclusion severity was within the client's acceptance limit (maximum 2.0) as verified as per ASTM E45/E1245 standards.

The microstructure in etched condition revealed a tempered martensitic matrix typical of quenched-and-tempered 4140 steel. The microstructure was uniform and homogeneous across all examined regions, with no evidence of overheating, decarburization, carbide coarsening, or abnormal transformation products, microcracks or heat-treatment defects.

Although inclusion ratings met client's requirement, the elongated MnS inclusions are known to its characteristics initiation sites for crevice or pitting corrosion in stagnant and acidic/chloride containing enviromnet, such as beneath gasket sealing interfaces. Under such conditions, preferential dissolution of MnS inclusions releases sulfur that destabilize the passive film and promote localized corrosion.

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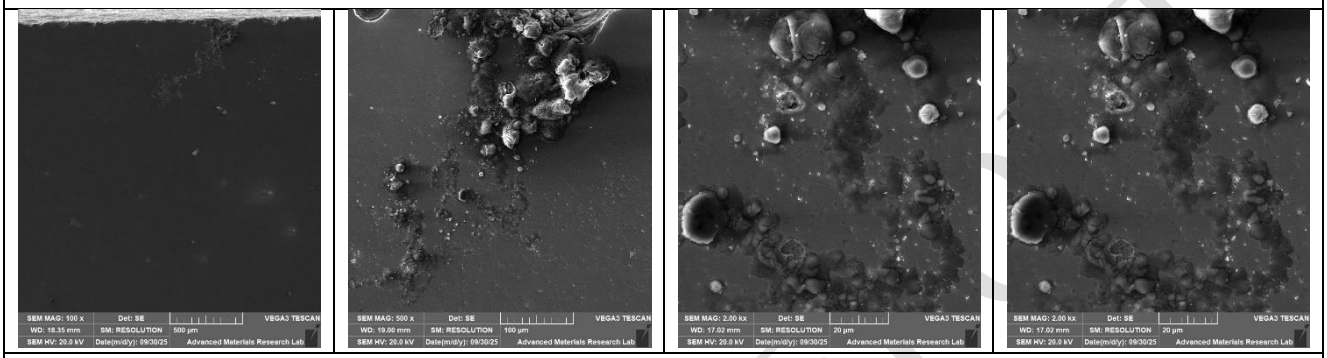
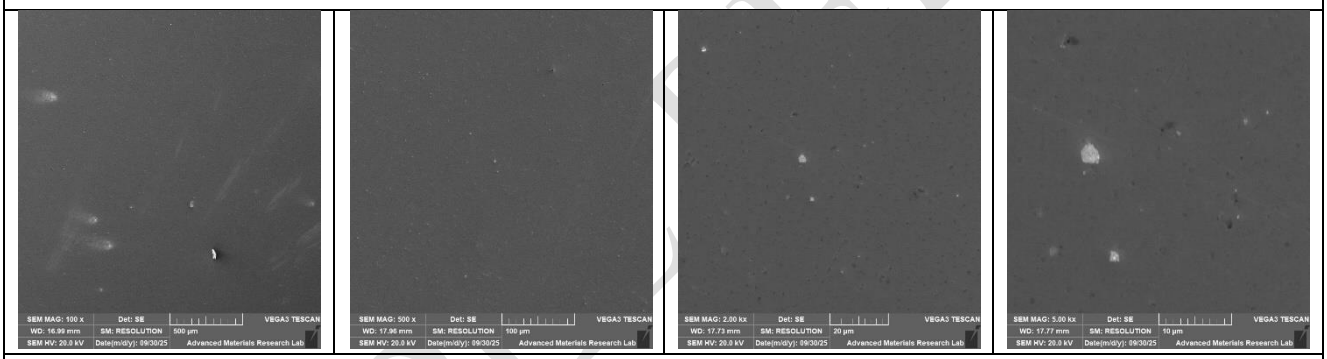
9. SEM-EDS Analysis

Scanning Electron Microscopy (SEM) combined with Energy Dispersive Spectroscopy (EDS) was performed on specimens extracted from the plug-valve body (Case 1) to characterize pit morphology, surface deposit composition. The examination was conducted in accordance with ASTM E1508. Three analysis sites were selected: Location A on the affected corroded zone, and Locations B and C on the unaffected core regions.

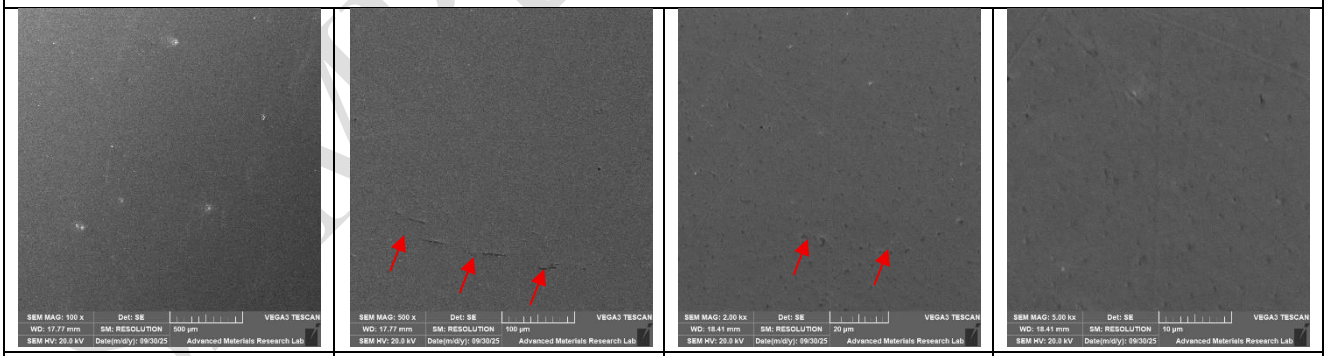
Location-A



Location-B



Location-C



100X	500X	2000X	5000X

Photograph # 17: SEM micrographs captured at magnifications ranging from 100X to 5000X. Locations A and B exhibit oxide films and shallow surface cavities consistent with localized corrosion attack, while Location C reveals non-metallic inclusions (red arrow), including oxide particles within the matrix.

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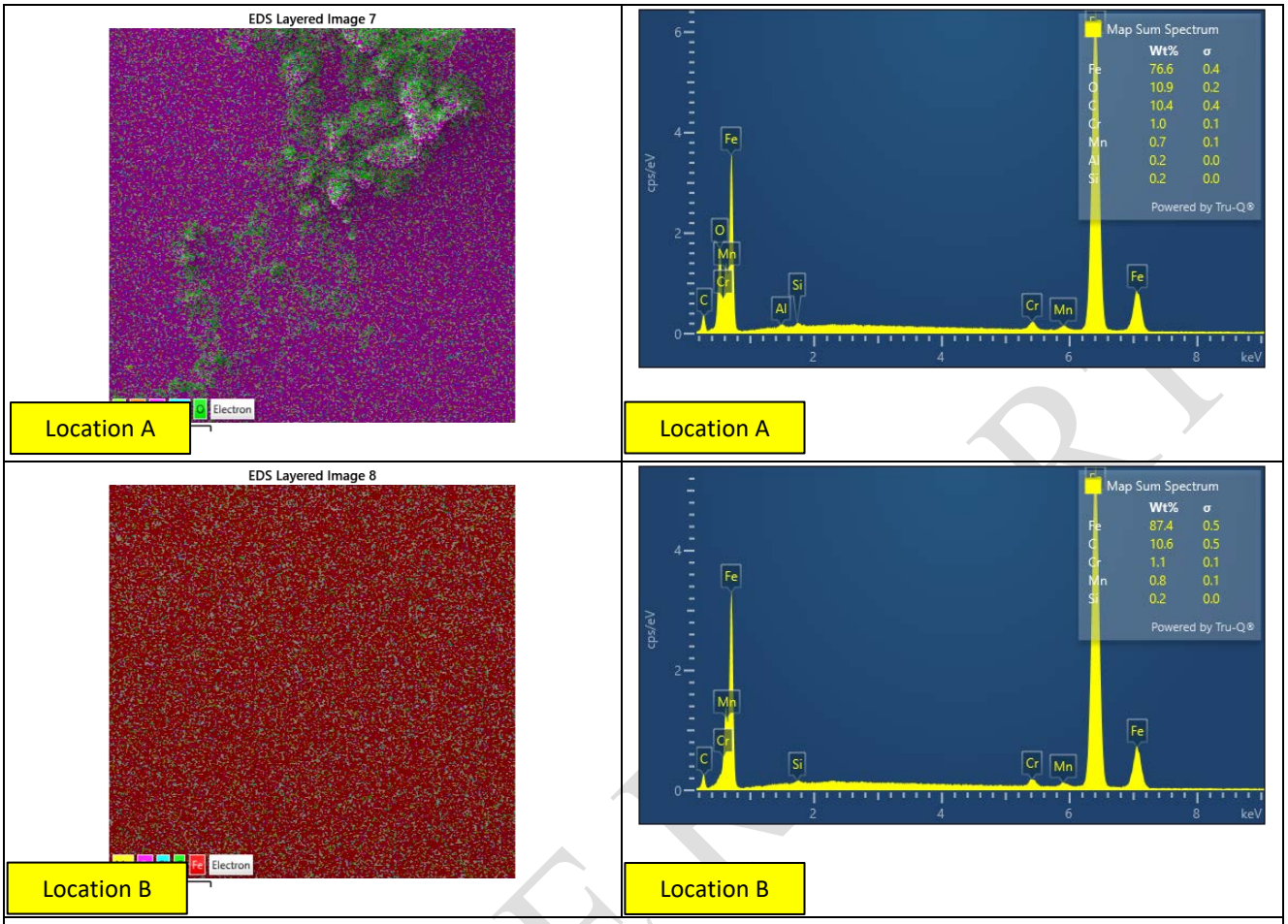

Photograph # 18: EDS spectrum images obtained from Location-A and Location-B identifying Fe as the base element with traces of C, O, Cr, Mn, and Si. The results indicate corrosion product composition consistent with mild oxidation of steel surface.

Table 5: EDS Test Results.

Sl. No	Element	Symbol	Unit	Location-A	Location-B
1	Iron	Fe	Wt, %	76.6	87.4
2	Oxygen	O	Wt, %	10.9	10.6
3	Carbon	C	Wt, %	10.4	--
4	Chromium	Cr	Wt, %	1.0	1.1
5	Manganese	Mn	Wt, %	0.7	0.8
6	Aluminium	Al	Wt, %	0.2	--
7	Silicon	Si	Wt, %	0.2	0.2

SEM micrographs obtained at 100X–5000X magnifications again revealed presence of sulfide inclusions. The affected surface (Location A) displayed oxide films and shallow cavities indicative of localized corrosion. The

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adjacent core region (Location B) showed light oxidation and minor surface depressions, suggesting limited corrosion activity. The inner core (Location C) contained non-metallic inclusions, primarily oxide particles and elongated MnS inclusions, embedded within the matrix.

EDS spot and layered analyses confirmed a uniform Fe and O distribution over the corroded areas, with minor alloying elements (Cr, Mn, Si) present. Oxygen enrichment verified the formation of Fe–O-based corrosion products.

Overall, the SEM–EDS results indicate that the affected surface is characterized by Fe–O-rich oxide films and shallow pits, while the core region contains oxide and MnS inclusions, consistent with optical metallography findings.

10. Discussion

The following discussion and conclusion have been developed within a reasonable degree of scientific and engineering certainty and are based upon the materials and information we have reviewed to date. Further information may be forthcoming (i.e., after continued review of the material received and if requested by the client, or if additional material is submitted for examination) and, as such, we reserve the right to alter our opinion if and when this additional information is provided.

Visual examination revealed localized interconnected cavities and rough surface along the gasket/sealing interface on both inlet and outlet sides of the flow port. The cavities were most severe at the lower portion of the bore, near the retainer-pin side, forming a square-shaped band that followed the gasket geometry. The retainer pin was observed to be bent and partially sheared, without complete fracture, suggesting mechanical overstress.

Stereoscopy of the affected sealing surfaces (LOC-1 and LOC-2) confirmed irregular, undercut cavities and rough texture confined to the gasket contact region. The cavity depth and density were higher toward the lower bore area, while the upper region exhibited fewer shallow pits with retained machining marks. The corrosion pattern corresponded precisely to the gasket footprint, confirming geometry-controlled deterioration limited to the sealing zone.

Chemical composition (OES / PMI-XRF) of the plug-valve body indicated 4140 steel as the base material, but with carbon (0.475%), sulfur (0.019%) and chromium (1.18%), exceeding specification limits (C: 0.38–0.43 %, S: 0.012% Max, Cr: 0.80–1.10 %), rendering the material non-conforming to the client specification SPM 4S16654 Rev# R16 4140 grade. Similarly, the chemical composition of pin sample (M3) was found non-conforming to the specified AISI 6150 grade.

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LECO carbon and sulfur analysis results showed carbon = 0.480% and sulfur = 0.014%. The sulfur content exceeded the client specification SPM 4S16654 Rev. R16 for 4140 grade (S: 0.012% max) and was also higher than the typical level observed in corrosion-free valves (≈0.005%), indicating a greater likelihood of increased MnS inclusion density. The carbon content likewise exceeded the specified range, rendering the material non-conforming to the specification.

Hardness testing on both affected (M1) and unaffected (M2) regions showed uniform hardness values between 317–325 HV, conformed to SPM 4S16654 Rev# R16 4140 material (260-336 HV). The retainer-pin sample (M3) exhibited a low average hardness of ~220 HV (~22 HRC), which is below the client's requirement 40–45 HRC.

Optical metallography revealed a tempered-martensitic matrix typical of quenched-and-tempered 4140 grade with elongated MnS (Type A) inclusions aligned along the forging direction. The inclusion severity was within the client's acceptance limit (≤ 2.0) but higher in density than in standard clean steels, suggesting reduced resistance to localized corrosion.

SEM–EDS analysis of the same plug-valve samples identified oxide films and shallow surface cavities in the affected zones and oxide-type and MnS inclusions in the core region. EDS elemental maps showed Fe and O uniformly distributed over the corroded surfaces, confirming oxide-film formation associated with corrosion products, while inclusions displayed Mn and S peaks consistent with MnS composition.

Sulfide inclusions, particularly manganese sulfides (MnS), act as initiation sites for crevice or pitting corrosion because their dissolution in a confined, aggressive environment creates a localized area of high corrosivity. The dissolution of these inclusions increases the concentration of corrosive species like aqueous sulfide ions and chloride ions, which further lowers the pH and promotes the breakdown of the protective passive film, leading to crevice corrosion.

The investigation established that the plug-valve material exhibited chemical deviations, elevated sulfur content, and elongated MnS inclusions, while the retainer pin displayed material mismatch and inadequate hardness. Corrosion was localized to the seal interface region, following the gasket seat geometry, consistent with crevice-type localized attack under stagnant test conditions.

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11. Conclusion

The failure analysis on the subject of the localized damage on plug valve in an internal tap water environment was investigated in this work. The following conclusions can be drawn on the basis of the conducted analysis.

i. The microstructures of valve body consisted of tempered martensite typical of the material grade, where numerous sulfide type inclusions were observed.
ii. Presence of detrimental elongated sulfide inclusions act as initiation sites for localized corrosion damage such as crevice or pitting corrosion.
iii. The chemical properties of the valve were found non-conforming to the requirement of client's specification SPM 4S16654 Rev# R16 4140 (specifically in the sulfur content).
iv. The chemical properties of the retainer pin were found non-conforming to the requirement of AISI 6150.
v. Conclusively the damage is attributed to the localized form of corrosion such crevice or pitting due to presence of detrimental sulfide inclusion in the material formed by elevated sulfur content.

Author

Vivek Kumar
Senior Metallurgist

Approved by

Mujipur Rahaman
Technical Manager

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Key Personnel and CV

Key Personnel

S. No.	Name of the Employee	Designation
1	Kush Kumar	Operations Manager
2	Mujipur Rahaman	Technical Manager / Failure Analyst
3	Mark Arthur Rego	Senior Chemist
4	Vivek Kumar	Senior Metallurgist / Failure Analyst
5	Gabriel Gomes	Lab Supervisor
6	Tarun Genji	Testing Enginner
7	Sricharan Pallela	Junior Testing Engineer
8	Gnanamanikandan	Machinist
9	Ranjith Reghunathan	Machinist
10	Rajeesh Reghunathan	Machinist
11	Tariq Shah	Machinist
12	Ahmed Saeed	Machinist
13	Satish Kumar Karanam	Machinist
14	Babu Rao Samala	Machinist
15	Narsi Rao Yannapu	Machinist

TRANS ASIA INDUSTRIAL LABORATORIES
CURRICULUM VITAE

Kush Kumar

Name	:	**Kush Kumar**
Designation	:	Operation Manager
Job Role	:	Company Operations
Email	:	kush@transasialab.com
Tel	:	+971 50 867 6001

Multi-dimensional professional with 15 years of experience in various sectors like Material Testing, Manufacturing, Trading, Oil & Gas, Iron & Steel.
Core competencies in Operations, Technical, Sourcing, Engineering, Procurement, Business Development, Budget Planning, Vendor Management.

Qualification : **Bachelor of Technology** (Honours) in Metallurgical and Materials Engineering from **Indian Institute of Technology, Kharagpur**

Certifications :

API 570: In-service Inspection, Rating, Repair and Alteration of piping systems. **Certification No. 53974 : Expired**

API 510: Pressure Vessel Inspection Code: In-service Inspection, Rating, Repair and Alteration. **Certification No. 55055 : Expired**

API 653: Tank Inspection, Repair, Alteration and Reconstruction. **Certification No. 56216 : Expired**

Training : **BOSIET:** Basic Offshore Safety Induction Emergency Training. **Certificate No. 0058570029041441033 : Expired**

Specification/Codes :

American Society of Mechanical Engineers (ASME)
American National Standards Institute (ANSI)
American Petroleum Institute (API)
American Society for Testing of Materials (ASTM)
British Standards (BS)
American Welding Society (AWS)
NACE standards

Current Employment Details and Experience

1) **Designation: Operations Manager**
   Duration: October 2025 – Present
   Organization: Trans Asia Industrial Laboratories, Dubai
   Responsibilities:

- Drive operational excellence by ensuring team alignment with strategic and business objectives.
- Implement best practices, innovative ideas, and continuous improvement measures to enhance operational and management performance.
- Provide cross-functional support to teams and clients across NDT, technical inspection, corrosion testing, mechanical testing, metallurgical evaluation, and failure analysis services.
- Oversee the delivery of inspection and testing solutions ensuring accuracy, reliability, and compliance with industry standards and customer requirements.
- Collaborate with process owners to streamline workflows, resolve operational challenges, and optimize resource utilization.
- Define, assign, and monitor KPIs, quality metrics, and performance targets to drive accountability and continuous improvement.
- Lead regular meetings to communicate company policies, objectives, and safety, quality, and delivery commitments.
- Ensure strict adherence to quality management systems (ISO/IEC standards) and compliance with all statutory, regulatory, and client-specific requirements.
- Support business development initiatives by formulating strategies to acquire new clients, expand service offerings, and improve revenue and EBITDA performance.
- Manage P&L responsibilities, ensuring cost efficiency and profitability across all service lines.
- Champion Kaizen and Lean initiatives to improve productivity, reduce waste, and enhance operational efficiency.
- Foster a culture of teamwork, empowerment, and professional growth through effective leadership and open communication.
- Ensure NDT, lab testing and inspection services are executed with the highest standards of safety, quality, and integrity, utilizing advanced methods and technologies.
- Drive continuous training and skill development programs for staff in advanced inspection and testing methodologies.

Previous Employment Details and Experience

2) **Designation: Operations Manager**
   Duration: June 2023 – September 2025
   Organization: Element – Metallurgical Services Pvt. Ltd., Mumbai

Responsibilities:

- Responsible for driving operations to ensure team converge towards achieving strategic goals.
- Implement ideas, suggestions, best practices to enhance operational and management excellence.
- Provide technical expertise, support and advisory to team and clients for the understanding of capabilities and solutions brought forward.
- Partner with all process owners in streamlining activities to overcome and eliminate challenges within operations.
- Assign, review and monitor KPIs and tasks to enhance team performance with respect to external commitments and internal targets.
- Communicate and reiterate policies, objectives and goals through periodic meetings with emphasis on Safety, Quality and Delivery.
- Ensure operations are run in strict compliance to quality systems, local statutory and regulatory guidelines.
- Develop and participate in formulation of strategies towards acquiring new prospects for increasing business revenues, enhancing EBIDTA and managing P&L.
- Identify initiatives and encourage team's participation in Kaizen activities to improve productivity, improve efficiency and take proactive measures.
- Mold team through conducive environment where everyone feels empowered to contribute and do not hesitate to be part of cohesive team work.

3) **Designation: Mechanical Lab and Testing Services Manager**
Duration: August 2020 – May 2023
Organization: Emirates Industrial Laboratory, Dubai.
Responsibilities:

- Manage and develop a team of direct reports while creating a knowledge sharing culture.
- Oversee and support daily activities with planning and execution of laboratory tests including lab samples, material inspection and report releases.
- Overseeing laboratory metallurgical analysis and testing.
- Provide expertise through specialized knowledge and experience in failure investigation, metallographic and fractographic interpretation, corrosion, fracture mechanics, heat treatment and microstructural development.
- Ensure ISO 17025 is implemented and maintained during continued laboratory operation.
- Ensure that procedures are in place to support company objectives and assure first-class customer response and departmental efficiency.
- Manage and monitor, resources, and personnel to ensure efficient and safe operations oflaboratories.
- Ensure adherence to testing standards, operating procedure, regulatory requirements.
- Ensure the lab establishes and maintains a calibration program for testing equipment.
- Provide input for new products introduction, coordinate testing of new products internally andexternally, and participate in launch activities.

- Continuous focus on how to develop the business to meet customer requirements and expectations.
- Actively support customer service efforts by providing internal and external customer support.

4) Designation: Technical Manager/Product Innovation Director
Duration: May 2015 – August 2020
Organization: Bright Star, Dubai.
Responsibilities:

- Provide training, direction and technical expertise related to product design, manufacturing and its application.
- Identify resources and equipment requirements essential to delivery of quality products.
- Identify, develop, and sourcing of new products, that are both technically and commercially viable.
- Liaison with all other departments in responding to requirement/ inquiries related to technical, quality and sourcing matters.
- Work closely with Deputy Managing Director to assess business strategy and establish business goals.

5) Designation: Technical Supervisor
Duration: August 2014- May 2015
Organization: Emirates Industrial Laboratory, Abu Dhabi.
Responsibilities:

- Technical supervision of staff and management of work activities related to Metallurgy, NDT and Chemistry Department.
- Project co-ordination and management of NDT services for ADMA OPCO.

6) Designation: Metallurgist
Duration: December 2012- Present
Organization: Emirates Industrial Laboratory, Dubai.

Emirates Industrial Laboratory, a leading inspection company, covers services in Laboratory testing, Engineering, Inspection and consultancy to Petrochemical, Oil and Gas, Power, Construction and other cognate industries.
Responsibilities:

- Perform metallurgical failure analysis/investigation of components failed in-service from various industries.
- Conduct metallurgical/corrosion tests/ replica metallography on the samples for the conformance/qualificationagainst ASTM/NACE/ASME/other applicable standards.
- Visit plant sites/operational locations to gather information/data related to condition assessment.
- Maintaining quality systems as per company policy.

Achievements:

- ***Failure Investigation*** on various components & equipments from the Marine, Oil & Gas refineries and other Engineering Industries to determine the causes and to give remedies. This involved the preparation of detailedreports with technical findings & evidences, discussion, conclusion, recommendation and photographic documentation.
- **Major Clients:** ADMA-OPCO, Schlumberger, DUBAL, DUSUP, Trelleborg, DryDocks Dubai, Samsung Engineering, Weir Engineering Services and more...
- Carry out ***metallurgical examination*** to understand the inherent microstructure as well as defects or abnormalities present in the material. It also included the determination of ASTM grain size, Degree of

banding,hardening depth, Inclusion count, manual count for ferrite content etc.

- Carrying out ***Positive Material Identification (PMI)*** to identify the material and grade of components and equipments.
- Carrying out ***Ferrite Content Measurement*** at sites using FERRITESCOPE.
- Carry out ***Insitu Replica Metallography*** on Tubes, Pipes, shell plate and other equipments of Marine, Oil and Gas Refineries and on Engineering components and equipments to find out the microstructural changes and to assess metallurgical conditions of the equipment. Prepare detailed reports with Micrographs, Microstructure Description, and Discussion with Interpretation, Results and Conclusion.

Inspection Projects:

- **DAEWOO E&C – Ruwais Refinery Expansion 4 project, Ruwais,** June-July, 2014
  Lead a team to carry out in-situ metallography replicas on piping of various sizes for grain size measurement asper E 112 methodology by manual count method.
  A total of 2064 replica were taken on low temperature service carbon steel pipes and fittings.

- **Bunduq Company Limited – Abu Dhabi,** May 2014
  Carried out Remote visual inspection with the aid of borescope to inspect any corrosion/thermal damage or abnormalities incurred in the vessel, equipment and piping. The inspection was carried out on Gas Injectionpackages in accordance with API 570/510.

- **Qatar Gas and Qatar Gas-Laffan Refinery - Qatar,** January 2014
  Taken in-situ metallography replicas on Laffan Refinery equipments, viz heat exchangers, Furnaces/Heater,Reactors tubes and shell.
  A total of 50 replicas were taken of Caron steel, Alloyed steel and austenitic stainless steel grade.

- **ADNATCO-NGSCO – Dry docks world – Dubai,** December 2013
  Taken in-situ metallography replicas on cargo manifold spool support plates of LNG ISH and LNG SHAHAMAHvessels along with hardness, ferrite measurement.
  A total of 6 replicas for ISH vessel and 4 replicas for SHAHAMAH vessels were taken of austenitic stainless-steelgrade.

- **Topaz Engineering – Dubai,** November & December 2013
  Taken in-situ metallography replicas on economizer tubes of MUBARAZ and MRAWEH vessels, along with fieldhardness measurement.
  A total of 3 replicas for Mubaraz vessel and 2 replica for Mraweh vessel were taken on different tubes of ST 35.8 material grade.

- **ADMA-OPCO – DAS Island, Abu Dhabi**, July & October 2013
  Taken in-situ metallography replicas on superheater and radiant tubes of two Babcock type water tube boiler, along with field hardness measurement and Remote Visual inspection with the aid of Borescope as a part of FFSevaluation.
  A total of 8 replicas were taken on 8 different tubes of SA192 material grade on each boiler.

- **HarrisPye - Dry docks world Dubai** – Catalunya spirit vessel, April 2013
  Taken in-situ metallography replicas on Boiler super heater tubes of Catalunya Spirit vessel. A total of 24 replicas (6 right-side and 6 left-side of Star Board side boiler and similarly 12 on

Port side boiler) were taken on 24 different tubes of two different grade of low alloy steel (1 Cr, 0.5 Mo and 2.25 Cr, 1 Mo).

- **BW Fleet Management- Dry docks world Dubai-** BW-UTAH Vessel, June 2013
  Taken in-situ metallography replicas on Port hose handling crane of BW-UTAH vessel.
  A total of 10 replicas were taken at different location for DH 32 material grade (carbon steel)

7) Designation: Engineer- Quality Assurance
Duration: December 2011– October 2012
Organization: Jindal Saw Gulf LLC, Abu Dhabi

Jindal Saw Gulf LLC, a ductile iron pipe (DN 250-2200) manufacturing industry through Spun centrifugal casting process with initial capacity 300000 TPA.

Achievements:

- Established Quality Assurance laboratory with performance testing (type testing), tensile testing, compositional analysis using Optical Emission Spectroscopy, Micro-structural Analysis, Brinell hardness testing and Sieve Analysis facilities.
- Successful erection and commissioning of centrifugal casting machine in the plant, contributed as a member.
- Prepared QMS (ISO 9001) and Occupational Environment Health and Safely management plan.
- Assisted in the delivery of the internal audit program.
- Developed and implemented Quality Plans and Inspection and Test Plans necessary to assure the quality of product and service delivery.
- Assisted in the development of Procedures and Work Instructions required by the organization to ensure control of processes.
- Analyzed and stabilized elemental compositions, temperature and other heating conditions of melt/Mg-converter for efficient Mg-recovery, smooth casting and consequent heat treatment process.

8) Designation: Junior Manager; Graduate Engineer Trainee
Duration: June 2011 – September 2011; June 2010 – June 2011
Organization: Tata Metaliks Kubota Pipes Ltd.

Tata Metaliks Kubota Pipes Ltd., a ductile iron pipe (DN 80-800) manufacturing industry through Spun centrifugal casting process with initial capacity 200000 TPA.

Achievements:

- Analyzed major non-conformities (leaks and cracks) in products (ductile iron pipes), presented and established countermeasures for prevention that in turn demonstrated 15 % decrease in the non-conformities.
- Led Kaizen initiatives in the casting area for control of major non-conformities in the products.
- Developed standard operating procedures for field staff and laboratory personnel and prepared Laboratory quality manual.
- Employed statistical analysis of quality assurance data deploying spreadsheets. Developed MatLab Program for obtaining real time analysis and observable trends of production vis-à-vis non-conformities of pipes.

9) **Designation: Summer Internship-Research Assistant**
Duration: May 2009 –July 2009
Organization: Faculty of Nuclear Science and Physical Engineering, Czech Technical University, Prague, Czech Republic

Responsibilities:
To study the effect of inhomogeneous plastic deformation and inhomogeneous thermal fields on real structure of surface layers of metals, investigation by X-ray methods.

Achievements:
- Developed MatLab program to verify and compare and contrast the results obtained from pre-installed software.
- Residual stress measurement using X-ray diffraction techniques. Conducted experiments on steel samples collected from heavy machinery and automotive industries.

Academic Projects:

1) **Title: Structure Property Relations of Cu-Cr-Zr alloy, a plasma facing diverter plates.**
Duration: July 2009 –May 2010
Organization: Metallurgical and Materials Engineering, IIT Kharagpur

Achievements:
- Commenced project of metallurgical investigation on Cu-Cr-Zr samples.
- Conducted experiments where samples were subjected to varied number of thermal fatigue cycles with different aging conditions.
- 7% increase in hardness was observed at higher number of thermal cycles given to the samples.

2) **Title: Creation of dislocation in Cu-system and stabilization using Molecular Dynamics (MD) and visualization of structure in Visual Molecular Dynamics (VMD).**
Duration: July 2008 –November 2009
Organization: Metallurgical and Materials Engineering, IIT Kharagpur

Achievements:
- Developed Fortran program for computer simulation of Cu-system and introduced dislocation in the structure.
- Stabilization of the structure in MD simulation.
- Visualization of destabilized and stabilized structure in VMD.
- The model was used to demonstrate the motion of dislocation in Cu to junior students.

3) **Title: Minimization of the cost production concurrently maximization of production from industrial data, using strength pareto evolutionary Genetic Algorithm.**
Duration: July 2008 –November 2009
Organization: Metallurgical and Materials Engineering, IIT Kharagpur

Achievements:

- Developed MatLab program for Strength Pareto evolutionary algorithm to simulate optimization.
- Minimized production cost and optimized production volume.

Skills:

Java, C++, MatLab, AutoCad, Solidworks, MS Office Excel, Word, Power Point, Photoshop

Extra Academic Activities:

1) **Position: Captain, Fine and Applied Arts, Patel Hall of Residence**
   Period: 2009 –2010
   Organization: IIT Kharagpur

Achievements:

- Led the team to 2nd position in Inter-hall competitions (out of 12 teams).
- Acquired position among top three teams after a gap of 3 years.
- Bagged three medals (one each of gold, silver and bronze) in Inter-hall Fine Arts Cup.

2) **Position: Captain, Illumination and Rangoli, Patel Hall of residence**
   Period: 2009 –2010
   Organization: IIT Kharagpur

Achievements:

- Was directly involved in allocating the budget of Rs. 80,000 approximately.
- Managed a team of 450 students.

3) **Position: Head, Accommodation Team, COMPOSIT**
   Period: 2008 –2009
   Organization: IIT Kharagpur

Achievements:

- Supervised the registration and accommodation of nearly 500 participants.

4) **Position: Secretary, Fine and Applied Arts, Patel Hall of Residence**
   Period: 2007 –2008
   Organization: IIT Kharagpur
   Achievements:
   - Successfully coordinated events in Fine Arts.
   - Solely responsible for designing costumes and sets for Inter-hall dramatic events.

EQUIPMENTS HANDLED

- Universal Testing Machine (ANALOG)
- Universal Testing Machine (DIGITAL)
- Salt Spray Testing Machine
- Fatigue Testing Machine
- Creep Testing Machine
- Charpy Impact machine 300 Joules (BS and ASTM)
- Hardness tester – Rockwell Scales A, B, C
- Hardness tester – Vickers scale (Load ranging from 5kg to 100kg)
- Micro Hardness tester -Vickers scale (Load ranging from 10g to 1kg)
- Portable Hardness tester - Krautkramer Microdur II & Equotip Hardness tester
- PMI - Equipment
- Optical Metallurgical Microscope (50 to 1000 X)
- Stereo Microscope - to examine fracture features, weld macros and bent specimen.
- Ferrite scope - determination of ferrite number and percentage of stainless and super duplex stainless steels.

TRANS ASIA INDUSTRIAL LABORATORIES L.L.C

CURRICULUM VITAE

Employee Name:	Mujipur Rahaman A
Designation:	Technical Manager | Principal Metallurgist | Failure Analyst
Date of Birth:	17th June 1986
Educational Qualification:	Masters in Welding Technology Bachelor's in Metallurgical Engineering.
Technical Qualification:	Certified NDT Level-II in PT, MT, UT, and RT as per ASNT-SNT-TC-1A. Certified T-BOSIET (as per OPITO approved Regulations). Certified H2S Awareness & Escape Training Level-II (as per ADNOC). Certified ISO 45001:2018 & ISO 14001:2015 Internal Auditor. Certified Lean Six Sigma Green Belt. Trained IATF 16949:2016 and ISO 9001:2015 for Internal Auditing.
Total Years of Experience:	**15**

Professional Experience at glance

Employer	Designation	Duration
TransAsia Industrial Laboratories LLC, Dubai, UAE	Technical Manager | Principal Metallurgist | Failure Analyst	Aug'2022 to Present
NDT Corrosion Control Services, Abu Dhabi, UAE	Laboratory Manager | Senior Metallurgist	Dec'2020 to Aug'2022
Greaves Cotton Limited-Diesel Engine Manufacturing Unit, Pune, India	Manager - Quality Assurance	Sep'2017 to Nov'2020
Wheels India Limited (TVS Group) Automotive Components Division, Chennai, India	Deputy Manager - New Product Development	Dec'2016 to Sep'2017
Qatar Steel Company (QASCO) Mesaieed, Qatar	Senior Technician - Primary Steel Making Department in Steel Melt Shop	Mar'2013 to Feb'2014
Arcelor Mittal & Nippon Steel Ltd (*formerly known as*, Essar Steel India Ltd), Surat, India	Deputy Manager - CONARC Furnace-Steel Melt Shop.	Mar'2010 to Feb'2013
Indian Seamless Metal Tubes Ltd (ISMT Ltd) Pune, India	Graduate Engineer (Metallurgy) - Heat Treatment Department at Seamless Tube Plant.	Aug'2009 to Mar'2010

Key Skills:

- Failure Analysis.
- Metallurgical Testing.
- Mechanical Testing.
- Heat Treatment Processes.
- Forging Process.
- ISO 17025 / ISO 9001 Audit.

Highlights/ Previous Experience Details:

- Plan and execute laboratory tests in response to mechanical, chemical, and metallurgical analyses.
- Expertise in root cause analysis, failure investigation and generating technical reports.
  Major Clients are, *Dubai Petroleum, ADNOC Offshore, ADNOC Gas Processing, ADNOC Refining and NPCC.*
- Execute field inspections, especially Replica Metallography, to assess and report on microstructural degradation and actual metallurgical conditions. *Onsite*: *Taweelah, Fujairah, Mirfa, Ruwais, Bab & Habshan.*
- Metallurgical evaluation of macro and microstructure, ferrite count, carbide volume fraction, grain size, inclusion rating and chemical composition analysis (OES) on various ferrous and non-ferrous alloys.
- Knowledge of various corrosion testing techniques to qualify raw materials and weldments.
- Evaluate Welder Qualification Tests to qualify Welding Procedures, Welders, and Welding consumables.
- Maintaining company quality records and ensuring quality systems in accordance with company policy.
- Training personnel in the use and implementation of lab test procedures.

Metallurgical Evaluation of metallic materials.

- General macro examination as per ASTM E340
- General microstructure of the materials as per ASTM E3/E407.
- Grain size measurement as per ASTM E112.
- Ferrite count (manual point count method) as per ASTM E562.
- Inclusion counts as per ASTM E45.
- Determination of intermetallic phases as per ASTM A923.
- Evaluations of HIC, SSC, Quench cracks; Surface hardening inconsistencies; metallic, intermetallic & nonmetallic inclusions. Manufacturing defects such as Lap, Seam, casting & forging defects other anomalies in the microstructure.
- Familiar with *Mechanical Tests* in accordance with various international codes/specifications in the presence of third party/Client and interpretation of its conformity with standards (ASTM, BS, API, AWS, ASME).
- Carrying out *Weld Procedure as well as Welder Qualification* tests to qualify the Welding Procedure, Welders, and Welding consumables as per international specifications.
- Hands-on experience with various Corrosion Testing to qualify raw materials.

- Hydrogen Induced Cracking Test as per NACE TM0284 / MR0175/ISO 15156-1&2.
- Sulfide stress corrosion cracking Test as per NACE TM0177 / TM0316.
- Pitting corrosion test for duplex and super duplex stainless steels as per ASTM G48
- Inter-granular corrosion test for austenitic stainless steel as per ASTM A262.
- Inter-granular corrosion test for Nickel-rich, Chromium bearing alloys as per ASTM G28. & A923A

Investigation of Metallurgical Failures in oil & gas refineries, marine, industrial, and commercial equipment. Conducting investigations & preparing analysis reports with photographic documentation, technical findings, discussion, conclusion, and material recommendations. Extensive experience with corrosion-related failures of oil/gas production and refinery components.

Failure investigations were conducted for the following major & esteemed clients:

- ADNOC OFFSHORE, Abu Dhabi.
- ADNOC Gas Processing, Abu Dhabi.
- Dubai Petroleum Establishment, Dubai.
- ADNOC Refining, Abu Dhabi
- NPCC, Abu Dhabi.
- Dry-docks, Dubai.

In-situ Replica Metallography was carried out on boilers, reactors, furnaces, and other equipment that is used in marine, oil, and gas refining facilities. The equipment is also assessed and reported on its actual metallurgical condition, in addition to its microstructural degradation due to thermal damage.

Following are replica examinations conducted at shutdown projects,

- United Arab Emirates (UAE): *[Taweelah-A2, Fujairah-F2, Habshan #5, Mirfa, Ruwais Refinery- RRE & RRW, Bab & Habshan]*
- *Oman: [Sohar Refinery-OQ Refineries and Petroleum Industries]*
- Algeria: *[Sorfert Algerie SPA]*
- Egypt: *[Egyptian Methanex Methanol Co. S.A.E, Abu Qir Fertilizers and Chemicals Industries Company]*

Major Projects Worked:

Client / End User	Project Details	Work Activities
PGP Energies (Petrogas)	Failure Investigation / Analysis	Failure Analysis of Pipe samples.
Advanced Engineering Solutions (AES) Abu Dhabi, United Arab Emirates	Failure Investigation / Analysis	Metallurgical Investigation Report of Surface Contamination on Metal Mesh Cladding (SDSS)
Dubai Natural Gas (DUGAS) Dubai, UAE	Failure Investigation / Analysis	Failure Investigation Report on 30inch Gimbal Expansion Joint
Bureau Veritas - Dubai Branch	Failure Investigation / Analysis	Failure Analysis of Deposits
Daikin, Dubai, UAE	Failure Investigation / Analysis	Failure Analysis of Deposits
DSI FZE, Dubai, UAE	Failure Investigation / Analysis	Failure Analysis of Main Body
Bureau Veritas - Dubai Branch	Failure Investigation / Analysis	Failure Analysis of Heated Plate (ALSTOM)
Drydocks World (A DP World Company)	Failure Investigation / Analysis	Failure Analysis of Cracked Pipe
United Piping Solutions	Failure Investigation / Analysis	Failure Analysis of Leaked Feed Line Pipe (8")
BUREAU VERITAS S.A. ABU DHABI BRANCH	Failure Investigation / Analysis	Failure Analysis of Utility Water Header Line Leak
Dubai Natural Gas (DUGAS) Dubai, UAE	Failure Investigation / Analysis	Failure Investigation Report on Corroded Elbow sections of the Anti-Fouling system Piping
DSI FZE, Dubai, UAE	Failure Investigation / Analysis	Failure Analysis on Broken Guide Pin

SPM Oil & Gas (A Caterpillar Company) Dubai, UAE	Failure Investigation / Analysis	Failure Analysis of Corroded Plug Valve
PTPA Middle East FZE. Sharjah, UAE	Failure Investigation / Analysis	Failure Analysis of Welded Pipe
Stanford	Failure Investigation / Analysis	Failure Investigation on Power Transmission Shaft Sleeve
NDT Corrosion Control Services Abu Dhabi, United Arab Emirates	Failure Investigation / Analysis	Failure Investigation on Corroded Spool with Bottom Leak
Bureau Veritas-Oman	Failure Investigation / Analysis	Failure Investigation on Truck Boom
Trenchless	Failure Investigation / Analysis	Failure Investigation on Drill pipe
Bureau Veritas Kingdom of Saudi Arabia	Failure Investigation / Analysis	Failure Investigation on AMP3 COIL E31
BUREAU VERITAS S.A. ABU DHABI BRANCH	Failure Investigation / Analysis	Failure Investigation on Tabreed Pipe
B.V Dubai	Insitu Replica Metallography	TEPC HASSAYAN POWER PLANT
Arise Star LLC-Egypt	Insitu Replica Metallography	NIGERIAN AGIP OIL COMPANY PORT HARCOURT
B.V Dubai	Insitu Replica Metallography	M-STATION BOILER INSPECTIONS
THOMASSEN SERVICE MIDDLE EAST LLC Dubai, United Arab Emirates	Insitu Replica Metallography	TURBINE ROTOR (240149.3000 / 10411.01 – FRAME 6001 Unit Rotor)
Dubai Electricity and Water Authority (DEWA) Dubai, United Arab Emirates	Insitu Replica Metallography	DEWA_(M and L Station) HRSG Unit
Bureau Veritas-Oman	Insitu Replica Metallography	Replica Onsite - Pulley Shaft
Shine Star Eng. Steel & Welding LLC Sharjah, United Arab Emirates	Lab Testing	In-house development project under Shine Star Eng. Steel & Welding LLC
GREEN OASIS GENERAL TRADING & KING CITY TECHNICAL WORKS	Lab Testing	Transmission PipeLines DN1600/1400 CS from Khuraijah New WDC to Alghayl New WDC
CBI EASTERN ANSTALT	Lab Testing	FBT ADDITIONAL CRUDE OIL STORAGE TANK (T-111) at MAF Tank Farm, PDO,MUSCAT,OMAN.
ABS Engineering FZE-Sharjah	Lab Testing	BISAT PRODUCTION FACILITY (BISAT-C)
TECTON ENGINEERING & CONSULTANT	Lab Testing	Transmission PipeLines from UAQ New RO Plant to Khuraijah
VELATH ENGINEERING	Lab Testing	WEST QURNA I-MAJOR TIE-INS DS8 FACILITIES
ABS Engineering FZE-Sharjah	Lab Testing	MISSAN OIL FIELD DEVELOPMENT PROJECT -IRAQ
ABS Engineering FZE-Sharjah	Lab Testing	CLEANS FUEL PROJECT/BIO SLUDGE TANK & Sludge Heated Tank- THAILAND
DANEM GROUP-DUBAI	Lab Testing	Ruche Phase 1 Topside Production Facility
Arabian Gulf Steel Industries	Lab Testing	REBARS MATERIAL TESTING
Dubai DryDocks	Lab Testing	Valhall PWP Wellbay module-PQR QUALIFICATIONS
MC DERMOTT	Lab Testing	BORWIN-6 - PROCEDURE QUALIFICATIONS/MC DERMOTT
Grankraft / Coremetal / German Steel / Flowline Mechanical Engineering	Lab Testing	Saudi Red Sea Project

TRANS ASIA INDUSTRIAL LABORATORIES L.L.C

CURRICULUM VITAE

Employee Name:	Vivek Kumar Manimaran
Designation:	Senior Metallurgist & Failure Analyst
Date of Birth:	28-08-1990
Educational Qualification:	Bachelor of Engineering - Metallurgical Engineering | 2011 | PSG College of Technology
Technical Qualification:	Experienced in Failure Investigation, Root Cause Analysis, Metallurgical Examination, Mechanical Testing, Corrosion Test, and In situ-Replica Metallography.
Total Years of Experience:	**14**

Professional Experience at glance

Employer	Designation	Duration
1. TransAsia Industrial Laboratories, Dubai	Senior Metallurgist & Failure Analyst	June 2023 – Present
2. Emirates Industrial Laboratory, Dubai	Assistant Manager / Metallurgical Engineer / Failure Analyst	September 2018 – June 2023
3. Shardlow India Limited, Chennai	Senior Engineer / Metallurgist	June 2011 – August 2018

Key Skills:

- Failure Analysis.
- Metallurgical Testing.
- Mechanical Testing.
- Heat Treatment Processes.
- Forging Process.
- ISO 17025 / ISO 9001 Audit.

Highlights/ Previous Experience Details:

- Metallurgical Examination (Metallography) – To determine the Microstructural Phases, grain size, Degree of banding, Nitriding depth, Case hardening depth, Inclusion count, manual count for ferrite content, etc.
- Mechanical tests – Include Tensile test, Charpy Impact Test, Hardness (Field and In-house) test, Nick-Break test, Fracture Test, Flattening Test, Flaring Test, Load test. Welding Procedure Qualification (PQR) and Welder Qualification (WQT) as per various codes such as ASTM, BS, API, ASME, and other Classification Codes (LRS, BV, DNV, etc.).
- Failure Investigation on various components & equipment from the Marine, Oil & Gas refineries, and other Engineering Industries to determine the causes and to give remedies. This involved the preparation of detailed reports with technical findings & evidence, discussion, conclusion, recommendation, and photographic documentation.
- Corrosion Tests – Pitting & Crevice Corrosion Test as per ASTM G48, Intergranular Cracking (IGC) as per ASTM A262, Hydrogen Induced Cracking (HIC) as per NACE TM 0284 and Sulfide Stress Cracking test as per NACE TM 0177.
- In-situ Replica Metallography as per In-house procedure.
- Coordination with third-party surveyors for inspection and testing.
- Chemical Analysis – by Optical Emission Spectrometer.
- ISO 17025 / ISO 9001 Quality
- Provide training for staff in technical and quality aspects.
- Provide guidance, writing, implementation, and maintenance of Quality Management Systems documents such as standard operating procedures, work instructions, risk assessment, uncertainty measurements, verification and maintenance of machines, supplier evaluation, customer satisfaction, proficiency testing programs, internal quality control based on requirements of ISO/IEC 17025, ISO 9001, and ISO/ IEC 17020.

Major Projects Worked:

Client / End User	Project Details	Work Activities
PGP Energies (Petrogas)	Failure Investigation / Analysis	Failure Analysis of Pipe samples.
Advanced Engineering Solutions (AES) Abu Dhabi, United Arab Emirates	Failure Investigation / Analysis	Metallurgical Investigation Report of Surface Contamination on Metal Mesh Cladding (SDSS)
Dubai Natural Gas (DUGAS) Dubai, UAE	Failure Investigation / Analysis	Failure Investigation Report on 30inch Gimbal Expansion Joint
Bureau Veritas - Dubai Branch	Failure Investigation / Analysis	Failure Analysis of Deposits
Daikin, Dubai, UAE	Failure Investigation / Analysis	Failure Analysis of Deposits
DSI FZE, Dubai, UAE	Failure Investigation / Analysis	Failure Analysis of Main Body
Bureau Veritas - Dubai Branch	Failure Investigation / Analysis	Failure Analysis of Heated Plate (ALSTOM)
Drydocks World (A DP World Company)	Failure Investigation / Analysis	Failure Analysis of Cracked Pipe
United Piping Solutions	Failure Investigation / Analysis	Failure Analysis of Leaked Feed Line Pipe (8")

BUREAU VERITAS S.A. ABU DHABI BRANCH	Failure Investigation / Analysis	Failure Analysis of Utility Water Header Line Leak
Dubai Natural Gas (DUGAS) Dubai, UAE	Failure Investigation / Analysis	Failure Investigation Report on Corroded Elbow sections of the Anti-Fouling system Piping
DSI FZE, Dubai, UAE	Failure Investigation / Analysis	Failure Analysis on Broken Guide Pin
SPM Oil & Gas (A Caterpillar Company) Dubai, UAE	Failure Investigation / Analysis	Failure Analysis of Corroded Plug Valve
PTPA Middle East FZE. Sharjah, UAE	Failure Investigation / Analysis	Failure Analysis of Welded Pipe
Stanford	Failure Investigation / Analysis	Failure Investigation on Power Transmission Shaft Sleeve
NDT Corrosion Control Services Abu Dhabi, United Arab Emirates	Failure Investigation / Analysis	Failure Investigation on Corroded Spool with Bottom Leak
Bureau Veritas-Oman	Failure Investigation / Analysis	Failure Investigation on Truck Boom
Trenchless	Failure Investigation / Analysis	Failure Investigation on Drill pipe
Bureau Veritas Kingdom of Saudi Arabia	Failure Investigation / Analysis	Failure Investigation on AMP3 COIL E31
BUREAU VERITAS S.A. ABU DHABI BRANCH	Failure Investigation / Analysis	Failure Investigation on Tabreed Pipe
B.V Dubai	Insitu Replica Metallography	TEPC HASSAYAN POWER PLANT
Arise Star LLC-Egypt	Insitu Replica Metallography	NIGERIAN AGIP OIL COMPANY PORT HARCOURT
B.V Dubai	Insitu Replica Metallography	M-STATION BOILER INSPECTIONS
THOMASSEN SERVICE MIDDLE EAST LLC Dubai, United Arab Emirates	Insitu Replica Metallography	TURBINE ROTOR (240149.3000 / 10411.01 – FRAME 6001 Unit Rotor)
Dubai Electricity and Water Authority (DEWA) Dubai, United Arab Emirates	Insitu Replica Metallography	DEWA_(M and L Station) HRSG Unit
Bureau Veritas-Oman	Insitu Replica Metallography	Replica Onsite - Pulley Shaft
Shine Star Eng. Steel & Welding LLC Sharjah, United Arab Emirates	Lab Testing	In-house development project under Shine Star Eng. Steel & Welding LLC
GREEN OASIS GENERAL TRADING & KING CITY TECHNICAL WORKS	Lab Testing	Transmission PipeLines DN1600/1400 CS from Khuraijah New WDC to Alghayl New WDC
CBI EASTERN ANSTALT	Lab Testing	FBT ADDITIONAL CRUDE OIL STORAGE TANK (T-111) at MAF Tank Farm, PDO,MUSCAT,OMAN.
ABS Engineering FZE-Sharjah	Lab Testing	BISAT PRODUCTION FACILITY (BISAT-C)
TECTON ENGINEERING & CONSULTANT	Lab Testing	Transmission PipeLines from UAQ New RO Plant to Khuraijah
VELATH ENGINEERING	Lab Testing	WEST QURNA I-MAJOR TIE-INS DS8 FACILITIES
ABS Engineering FZE-Sharjah	Lab Testing	MISSAN OIL FIELD DEVELOPMENT PROJECT -IRAQ
DANEM GROUP-DUBAI	Lab Testing	Ruche Phase 1 Topside Production Facility
Arabian Gulf Steel Industries	Lab Testing	REBARS MATERIAL TESTING
Dubai DryDocks	Lab Testing	Valhall PWP Wellbay module-PQR QUALIFICATIONS

Major Projects

MAJOR PROJECTS

CLIENT / CONTRACTOR	END USER	PROJECT EXECUTED
PGP Energies (Petrogas), Dubai, UAE	Dubai Natural Gas Company	Metallurgical Investigation Report of 4" pipe samples.
Advanced Engineering Solutions (AES) Abu Dhabi, United Arab Emirates	Guggenheim Museum Project, Abu Dhabi	Metallurgical Investigation Report of Surface Contamination on Metal Mesh Cladding (SDSS)
Dubai Natural Gas (DUGAS) Dubai, UAE	Emirates National Oil Company Limited (ENOC) LLC Dubai, UAE	Failure Investigation Report on 30inch Gimbal Expansion Joint. Failure Investigation Report on Dish End for Catofin Reactor R204. Failure Investigation Report on MRO Assembly (Tag # 22-RO-1572). Failure Investigation Report on Corroded Elbow sections of the Anti-Fouling system Piping.
DSI FZE, Dubai, UAE	Petrofac International Ltd.	Failure Analysis of Main Body. Failure Analysis on Broken Guide Pin.
Bureau Veritas - Dubai Branch	ALSTOM (METROPOLIS Bogies overhauls worldwide)	Failure Analysis of Heated Plate (ALSTOM)
Drydocks World (A DP World Company)	NORSOK – Norsk Sokkels Konkurranseposisjon	Failure Analysis of Cracked Pipe
BUREAU VERITAS S.A. ABU DHABI BRANCH	Abu Dhabi National Oil Company (ADNOC)	Failure Analysis of Finned Tube. Failure Analysis of Jacketted Pipe. Failure Analysis of Utility Water Header Line Leak. Failure Analysis of Column Tray Top, Bottom & Pan. Failure Invesigation on Pulley Shaft.
United Piping Solutions	Shoaiba Phase-1 Desalination Plant, Saudi Arabia	Failure Analysis of Leaked Feed Line Pipe (8"). Failure Analysis of Leaked Brine Line Pipe (6")
SPM Oil & Gas (A Caterpillar Company) Dubai, UAE	ADNOC Onshore	Failure Analysis of Corroded Plug Valve
PTPA Middle East FZE. Sharjah, UAE	Crescent Petroleum	Failure Analysis of Welded Pipe
Levant Metal Alloys Dubai, UAE	Weatherford International Dubai, UAE	Failure Analysis of Defected Pipe
Stanford Marine	Zakher Marine International	Failure Invesigation on Power Transmission Shaft Sleeve
Bureau Veritas-Oman	Abu Dhabi National Oil Company (ADNOC)	Failure Invesigation on Fin Fan Tubes (ADNOC). Failure Invesigation on Polymer Substance. Failure Invesigation on Chill water Pipe.
NDT Corrosion Control Services Abu Dhabi, United Arab Emirates	Abu Dhabi National Oil Company (ADNOC)	Failure Invesigation on Corroded Spool with Bottom Leak.

		Failure Invesigation on Leaky 6 Off-Gas Piping Sections.
Bureau Veritas-Oman	Abu Dhabi National Oil Company (ADNOC)	Failure Invesigation on Lukoil CNC ASTM A106 Pipe. Failure Invesigation of Drill pipe.
Trenchless	DEWA – Dubai Electricity & Water Authority	Failure Invesigation on AMPI COIL E112
Bureau Veritas Kingdom of Saudi Arabia	Maaden Phosphate Company Ras Al Khair, KSA	Failure Invesigation on AMMONIA 3 HP STEAM SH COIL. Failure Invesigation on AMP3 COIL E31. Failure Invesigation on Tabreed Pipe.
Bureau Veritas-Oman	PDO – Petroleum Development Oman	Failure Invesigation on Bearing Housing
Bureau Veritas-Oman	Oman Shipping Company / ASYAD Shipping	Failure Invesigation on Propeller Blade
Altus Shipping	ADNOC Offshore	Failure Invesigation on Pipe Deposit Sample
BUREAU VERITAS S.A. ABU DHABI BRANCH	ADNOC Gas Processing	Failure Invesigation on 3inch Balancing Line
Bureau Veritas-Oman	PDO – Petroleum Development Oman	Failure Invesigation on Shaft
Bureau Veritas-Oman	Occidental Oman (OXY)	Failure Invesigation on Polished Rod
Bureau Veritas-Oman	PDO – Petroleum Development Oman	Failure Invesigation on Pipe Deposit Sample
DSI FZE, Dubai, UAE	ENOC – Emirates National Oil Company	Failure Analysis of Pipe
PGP Energies (Petrogas)	DUGAS – Dubai Natural Gas Company	Failure Analysis of 2" Pipe

List of Equipment

TRANS ASIA Industrial laboratories

Master List of Machinery & Equipments

Metallurgy Department

S. No.	Equipment / Instrument	Manufacturer	Model	Serial No	TIL Equipment ID
1	Universal Testing Machine	FIE India	UTES 100 HGFL-TS	12/2019-6363	TIL/M/01
2	Extensometer (Electronic)	FIE India	EE-2	1910335	TIL/M/02
3	Charpy Impact Testing Machine	FIE India	IT-40 ASTM	11/2019-1559	TIL/M/03
4	Vickers Hardness Testing Machine	FIE India	VM-50	11/2019-1966	TIL/M/04
5	Micro Vickers Hardness Testing Machine	FIE India	MV1 - TS	11/2019-1960	TIL/M/05
6	Rockwell / Brinell Hardness Testing Machine	FIE India	RASNEB-3	11/2019-3935	TIL/M/06
7	Metallurgical Microscope (OLD)	QUASMO India	IQ-M50	53923	TIL/M/07
8	Stereo Microscope	QUASMO India	SZB-45 S	53918	TIL/M/08
9	Portable Microscope	RADICAL India	RMM-5A	I-191110	TIL/M/09
10	Profile Projector	RADICAL India	RPP-250C	I-131111	TIL/M/10
11	Surface Roughness Tester	MAHR	--	36784/25	TIL/M/11
12	Lateral Expansion [Dial Gauge]	BAKER	Type K02	XGI656	TIL/M/18
13	Digital Thermometer with probe	STELLAR	T412	22082200	TIL/M/22
14	Vernier Caliper [Testing]	BAKER	SDN 30	C1406100028	TIL/M/27
15	Wifi Data Logger	Testo	Saveris 2-T2	54826803	TIL/M/30
16	Temperature Water Bath	Being	BW-22	221059102	TIL/M/31
17	Digital Caliper [Mech Testing]	Mitutoyo	500-196-30	B23452928	TIL/M/34
18	Metallurgical Microscope	Olympus	GX53F	4D47865	TIL/M/35
19	Dial Gauge (0.001)	INSIZE	2112-101	20031T0543	TIL/CO/19
20	OES Bench Top	Spectro Analytical Instruments - Germany	SPECTROMAXx LMM07	150477	TIL/C/01
21	ICP OES	Ametek	Spectro Genesis	20002903	TIL/C/02
22	Carbon / Sulfur Detector ELTRA	Eltra	Elementrac CS-i	105033319	TIL/C/03

Accreditation and License

حكومة دبي
GOVERNMENT OF DUBAI

DUBAI
للاقتصاد والسياحة
Economy and Tourism

رخصة تجارية
Commercial License

License Details / تفاصيل الرخصة

License No.	854777	رقم الرخصة	
Company Name	TRANS ASIA INDUSTRIAL LABORATORIES L.L.C	اسم الشركة	ترانس اسيا للمختبرات الصناعي ش.ذ.م.م
Business Name	TRANS ASIA INDUSTRIAL LABORATORIES L.L.C	الاسم التجاري	ترانس اسيا للمختبرات الصناعي ش.ذ.م.م
License Category	Dep. of Economic Development	فئة الرخصة	دائرة التنمية الاقتصادية
Legal Type	Limited Liability Company(LLC)	الشكل القانوني	ذات مسئولية محدودة
Expiry Date	02/10/2026	تاريخ الإنتهاء	Issue Date 03/10/2019 تاريخ الإصدار
D&B D-U-N-S ® N		الرقم العالمى	Main License No. 854777 رقم الرخصة الام
Register No.	1452995	رقم السجل التجارى	DCCI No. 328598 عضوية الغرفة

License Members / الاطراف

رقم الشخص/No.	الإسم / Name	الجنسية / Nationality	الصفة / Role	الحصص / Share
1417910	سانتوش دانتولورى كاسى فيسواناده فارا براساد دانتولورى SANTOSH DANTULURI KASI VISWANADH VARA PRASAD DANTULURI	الهند / India	مدير / Manager	
202028	سورياندرانات جهياه دهانيكولا SURENDRANATH ANJHIAH DHANEKULA	الهند / India	مدير / Manager	

License Activities / أنشطة الرخصة

النشاط	الحالة	Status	Activity
خدمات الفحص اللاإتلافي	فعال	Active	Nondestructive Testing Services
مختبر تحاليل كيماوية وبيولوجية	فعال	Active	Chemical & Biological Laboratory
فحص خطوط الانابيب ومعالجتها	فعال	Active	Pipelines Inspection & Repairing
خدمات فحص ومراقبة البيئة	فعال	Active	Environmental Testing & Inspection Services
مختبر للفحوص الميكانيكية والفيزيائية	فعال	Active	Physical & Mechanical Testing Laboratory

Print Date 06/10/2025 15:37 تاريخ الطباعة

Receipt No. رقم الإيصال

الإمارات
THE EMIRATES

يمكنك الآن تجديد رخصتك التجارية من خلال الرسائل النصية القصيرة، أرسل رقم الرخصة إلى 6969 (دو/ اتصالات) للحصول على اذن الدفع.

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وثيقة إلكترونية معتمدة وصادرة بدون توقيع من دائرة الاقتصاد والسياحة في دبي .لمراجعة صحة البيانات الواردة في الرخصة يرجي مسح رمزالاستجابة السريعة

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العنوان / Address

صندوق بريد	391679	P.O. Box	
رقم القطعة	364-444	Parcel ID	
البريد الإلكتروني	KRISHNAKUMAR@TRANSASIAPSS.COM	Email	
تليفون		Phone No	
فاكس		Fax No	
هاتف متحرك	971-55-1849461	Mobile No	

مستودع رقم 10 ملك حميد احمد احمد محمد الطاير - القوز الصناعية الأولى

الملاحظات / Remarks

رقم الإيصال Receipt No.

تاريخ الطباعة 15:37 06/10/2025 Print Date

يمكنك الآن تجديد رخصتك التجارية من خلال الرسائل النصية القصيرة، أرسل رقم الرخصة إلى 6969 (دو/ اتصالات) للحصول على اذن الدفع.

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الإمارات
THE EMIRATES

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Partners

تفاصيل الرخصة / License Details

رقم الرخصة	854777	License No.	الرقم العالمي	0	D&B D-U-N-S ® No.

اصحاب الرخصة / License Partners

الإسم / Name	الجنسية / Nationality	مسلسل الشخص/ Sr. No.	الحصص / Share
Khalifa Thani Ali Khalifa Bin Ghalita / خليفه ثانى على خليفه بن غليطه	United Arab Emirates / الامارات	403523	51.0000000%
TRANS- ASIA PIPEINE SERVICES FZC / ترانس - اسيا لخدمات الانابيب ش م ح	United Arab Emirates / الامارات	787210	49.0000000%

رقم الإيصال Receipt No.

تاريخ الطباعة 15:37 06/10/2025 Print Date

CERTIFICATE OF REGISTRATION

This is to certify that

Trans Asia Industrial Laboratories LLC

Al Quoz Industrial Area-1, Al Tayer Ware House-10,
P.O. BOX: 391676, Dubai, United Arab Emirates

Operates a Quality Management System which has been assessed for conformance with

ISO 9001 : 2015

Scope of certification

The management system is applicable for Visual Inspection, NDT testing services like conventional NDT & Advance NDT (excluding Radiographic testing), Physical & Mechanical destructive testing, Metallurgy testing, Corrosion testing (HIC, SSCC & SOHIC), Chemical (Ferrous & Nonferrous material), Environmental testing & Third party Inspection services.
NACE Code: 71.20

Certificate No: **SGQC/QMS/225/2020**

Date of re-assessment: **23 March 2023**

Date of recertification: **31 March 2023**

Date of original certificate: **08 March 2020**

Date of expiry: **30 March 2026**

This certificate will be valid until **30 March 2026** and will be replaced by a new certificate after successful completion of the recertification audit and compliance with SGQC Regulations.

Signed by:

Managing Director

This is an accredited certificate authorised for issue by Accreditation Service for Certifying Bodies LLC who have assessed SGQC against defined criteria and in cognisance of ISO/IEC 17021-1:2015 'Conformity Assessment - Requirements for bodies providing audit and certification of management systems'. This certificate is only valid when confirmed by the register listed in the International Register of Quality Assessed Organisations www.irqao.com

ISO 9001: 2015
SGQC/QMS/225/2020

If there is any doubt as to the authenticity of this Certificate, please do not hesitate to contact the Head Office
Tel: +971 2 6718050 P.O. Box: 106559, Abu Dhabi, U.A.E
Email: info@sgqc-middleeast.com, Web: www.sgqc-middleeast.com

CERTIFICATE OF REGISTRATION

This is to certify that

Trans Asia Industrial Laboratories LLC

Al Quoz Industrial Area-1, Al Tayer Ware House-10,
P.O. BOX: 391676, Dubai, United Arab Emirates

Operates an Environmental Management System which has been assessed for conformance with

ISO 14001 : 2015

Scope of certification

The management system is applicable for Visual Inspection, NDT testing services like conventional NDT & Advance NDT (excluding Radiographic testing), Physical & Mechanical destructive testing, Metallurgy testing, Corrosion testing (HIC, SSCC & SOHIC), Chemical (Ferrous & Nonferrous material), Environmental testing & Third party Inspection services.
NACE Code: 71.20

Certificate No: **SGQC/EMS/047/2020**

Date of re-assessment: **23 March 2023**

Date of recertification: **31 March 2023**

Date of original certificate: **08 March 2020**

Date of expiry: **30 March 2026**

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ISO 14001: 2015
SGQC/EMS/047/2020

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Email: info@sgqc-middleeast.com, Web: www.sgqc-middleeast.com

CERTIFICATE OF REGISTRATION

This is to certify that

Trans Asia Industrial Laboratories LLC

Al Quoz Industrial Area-1, Al Tayer Ware House-10,
P.O. BOX: 391676, Dubai, United Arab Emirates

Operates an Occupational Health & Safety Management System which has been assessed for conformance with

ISO 45001 : 2018

Scope of certification

The management system is applicable for Visual Inspection, NDT testing services like conventional NDT & Advance NDT (excluding Radiographic testing), Physical & Mechanical destructive testing, Metallurgy testing, Corrosion testing (HIC, SSCC & SOHIC), Chemical (Ferrous & Nonferrous material), Environmental testing & Third party Inspection services.
NACE Code: 71.20

Certificate No: **SGQC/OHS&MS/008/2020**

Date of re-assessment: **23 March 2023**

Date of recertification: **31 March 2023**

Date of original certificate: **08 March 2020**

Date of expiry: **30 March 2026**

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Signed by:

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ISO 45001:2018
SGQC/OHS&MS/008/2020

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Email: info@sgqc-middleeast.com, Web: www.sgqc-middleeast.com

مركز الإمارات العالمي للاعتماد
Emirates International Accreditation Centre

ACCREDITATION CERTIFICATE

LB-TEST-225

Emirates **I**nternational **A**ccreditation **C**entre

has accredited

TRANS ASIA INDUSTRIAL LABORATORIES L.L.C

Warehouse No 10 | Al Qouz Industrial Area 1

Dubai | United Arab Emirates

In accordance with the requirements of

ISO/IEC 17025:2017

General requirements for the competence of testing and calibration laboratories

to undertake the tests in the attached accreditation scope

This Accreditation is invalid without the attached accreditation scope and shall remain in force within the validity period printed below, subject to continuing compliance with the requirements of the accreditation criteria.

Validity: 27/11/2023 to 14/10/2026

Initial Accreditation Date: 15/10/2020

ilac-MRA

مركز الإمارات العالمي للاعتماد
Emirates International Accreditation Centre

Amina Ahmed Mohammed
CHIEF EXECUTIVE OFFICER
APPROVAL

Trans Asia Industrial Laboratories L.L.C

Warehouse No 10, Al Qouz Industrial Area 1

Dubai- United Arab Emirates

Date: 18-12-2024

Environmental Testing

Accreditation History		
Issue no.	**Details**	**Date**
04	Reissued due to a modification in tess methods	18-12-2024
03	Renewal of the accreditaion and reduction in scope (remove the Microbiology tests)	27-11-2023
02	Certificate validity was extended for 3 months from 15-10-2023 to 14-01-2024 and reduction in scope .	15-10-2023
01	Granted accreditation from EIAC	15-10-2020

Metallurgy Testing

Accreditation History		
Issue no.	**Details**	**Date**
04	Reissued due to extension in scope	18-12-2024
03	Renewal of the accreditation	27-11-2023
02	Certificate validity was extended for 3 months from 15-10-2023 to 14-01-2024 and reduction in scope .	15-10-2023
01	Granted accreditation from EIAC	15-10-2020

Trans Asia Industrial Laboratories L.L.C

Warehouse No 10, Al Qouz Industrial Area 1

Dubai- United Arab Emirates

Issue no.: 04 **Date: 18-12-2024** **Valid to: 14-10-2026**

Type of Activity	Test Materials/Products	Test Name	Test Method
Chemistry	Domestic, Potable, Non potable Water & Recreational water	Metals Aluminum (Al),Antimony (Sb), Arsenic (As), Barium (Ba), Beryllium (Be), Boron (B), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Nickel (Ni), Selenium (Se), Silver (Ag), Zinc (Zn), Molybdenium (Mo), Tin (Sn), Tantalium (Ta), Telllurium (Te), Thorium (Th), Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K)	APHA 3120 B 24th Edition, & 3030 E (for digestion) 24th Edition
Chemistry	Domestic, Potable, Non potable Water & Recreational water	pH	APHA 4500 H+B, 24 th Edition
Chemistry	Domestic, Potable, Non potable Water & Recreational water	Conductivity	APHA 2510 B, 24 th Edition
Chemistry	Domestic, Potable, Non potable Water & Recreational water	Turbidity	APHA 2130 B 24th Edition

Trans Asia Industrial Laboratories L.L.C

Warehouse No 10, Al Qouz Industrial Area 1

Dubai- United Arab Emirates

Issue no.: 04 **Date: 18-12-2024** **Valid to: 14-10-2026**

Type of Activity	Test Materials/Products	Test Name	Test Method
Chemistry	Domestic, Potable, Non potable Water & Recreational water	Carbonates	APHA 2320 B 24th Edition
Chemistry	Domestic, Potable, Non potable Water & Recreational water	Bicarbonates	APHA 2320 B 24th Edition
Chemistry	Domestic, Potable, Non potable Water & Recreational water	Total Alkalinity	APHA 2320 B 24th Edition
Chemistry	Domestic, Potable, Non potable Water & Recreational water	Ca Hardness as CaCo3	TIL/CHEM/SOP-10 Issue no. 01, Rev. 02 APHA (24th Edition, 2023) 2340 B & 3120 B
Chemistry	Domestic, Potable, Non potable Water & Recreational water	Total Hardness (by calculation)	APHA 2340 B 24th Edition
Chemistry	Domestic, Potable, Non potable Water & Recreational water	Chloride	APHA 4500 Cl B 24th Edition
Chemistry	Domestic, Potable, Non potable Water & Recreational water	Total dissolved solids	APHA 2540 C 24th Edition
Chemistry	Domestic, Potable, Non potable Water & Recreational water	Total suspended solids	APHA 2540 D 24th Edition

Trans Asia Industrial Laboratories L.L.C

Warehouse No 10, Al Qouz Industrial Area 1

Dubai- United Arab Emirates

Issue no.: 04 **Date: 18-12-2024** **Valid to: 14-10-2026**

Type of Activity	Test Materials/Products	Test Name	Test Method
Mechanical Testing	Ferrous & Non Ferrous	Standard Test Method for Tension testing of Metallic materials	ASTM A370 ASTM E8 BS EN 6892 Part 1
Mechanical Testing	Ferrous & Non Ferrous	Cross Weld Tensile Test	ASME SEC IX AWS D1.1 AWS D1.2 AWS D1.6 API 1104 BS EN ISO 15614 Part 1 BS EN ISO 4136
Mechanical Testing	Ferrous & Non Ferrous	Through Thickness Tensile Test (TTT)	ASTM A770/A770M BS EN ISO 10164
Mechanical Testing	Ferrous & Non Ferrous	Charpy impact test Standard Test Methods and Definitions for Mechanical Testing of Steel Products (Ambient to Minus 196 Deg C)	ASTM E23 BS EN ISO 148 Part 1 ASME SEC II Part C
Mechanical Testing	Ferrous & Non Ferrous	Standard Test Method for Rockwell Hardness of Materials – HRC	ASTM E18 BS EN ISO 6508 Part 1

Trans Asia Industrial Laboratories L.L.C

Warehouse No 10, Al Qouz Industrial Area 1

Dubai- United Arab Emirates

Issue no.: 04 **Date: 18-12-2024** **Valid to: 14-10-2026**

Type of Activity	Test Materials/Products	Test Name	Test Method
Mechanical Testing	Ferrous & Non Ferrous	Standard Test Method for Knoop and Vickers Hardness of Materials – Vickers Hardness Test (Hv5,10&30)	ATM E92 BS EN ISO 6507 Part 1
Mechanical Testing	Ferrous & Non Ferrous	Macro Hardness Survey of weld	ASME SEC IX AWS D1.1 AWS D1.6 API 1104 BS EN ISO 15614 Part 1 NACE MR 0175/ISO 15156 Part 2
Mechanical Testing	Ferrous & Non Ferrous	Guided Bend Test for Ductility of Welds & Material	ASTM E290 ASTM E190 ASME SEC IX AWS D1.1 AWS D1.2 AWS D1.6 API 1104 BS EN ISO 15614 Part 1 BS EN ISO 5173 A+1
Mechanical Testing	Ferrous & Non Ferrous	Fracture Test (Fillet)	ASME SEC IX AWS D1.1

Trans Asia Industrial Laboratories L.L.C

Warehouse No 10, Al Qouz Industrial Area 1

Dubai- United Arab Emirates

Issue no.: 04 **Date: 18-12-2024** **Valid to: 14-10-2026**

Type of Activity	Test Materials/Products	Test Name	Test Method
Mechanical Testing	Ferrous & Non Ferrous	Nick break test	API 1104 AWS D1.2
Mechanical Testing	Ferrous & Non Ferrous	Standard Test Method for Tension testing of Metallic materials	ASTM B557 API 5L 46th Edition
Mechanical Testing	Ferrous & Non Ferrous	Charpy impact test Standard Test Methods and Definitions for Mechanical Testing of Steel Products (Ambient to Minus 196 Deg C)	ASTM A370
Mechanical Testing	Ferrous & Non Ferrous	Macro Hardness Survey of	BS EN ISO 9015 Part 1
Mechanical Testing	Ferrous & Non Ferrous	Guided Bend Test for Ductility of Material	ASTM A370
Mechanical Testing	Ferrous & Non Ferrous	Fracture Test (Fillet)	BS EN ISO 9017 BS EN ISO 5817
Mechanical Testing	Ferrous & Non Ferrous	Proof Load Test	ASTM A370 ISO 898 Part 1 ISO 898 Part 2
Metallography	Ferrous & Non Ferrous	Macro etching of Metals and Alloys(Material)	ASTM E340 ASTM E381

Trans Asia Industrial Laboratories L.L.C

Warehouse No 10, Al Qouz Industrial Area 1

Dubai- United Arab Emirates

Issue no.: 04 **Date: 18-12-2024** **Valid to: 14-10-2026**

Type of Activity	Test Materials/Products	Test Name	Test Method
Metallography	Ferrous & Non Ferrous	Micro etching of Metals and Alloys(Material)	ASM Handbook Vol 9-9th Edition ASTM E407
Metallography	Ferrous & Non Ferrous	Macro & Micro Examinations of material & Weldments	ASME SEC IX AWS D1.1 AWS D1.2 AWS D1.6 API 1104 BS EN ISO 17639
Metallography	Ferrous & Non Ferrous	Insitu Replica Metallography	ASTM E1351
Metallography	Ferrous & Non Ferrous	Micro Detecting Detrimental Intermetallic Phase	ASTM A923 Method A
Metallography	Ferrous & Non Ferrous	Grain Size Measurement	ASTM E112
Metallography	Ferrous & Non Ferrous	Ferrite Measurement by Manual Count Method	ASTM E562
Corrosion	Ferrous & Non Ferrous	Pitting Corrosion Test	ASTM G48 Method A & C, & ASTM A923 Method C

Trans Asia Industrial Laboratories L.L.C

Warehouse No 10, Al Qouz Industrial Area 1

Dubai- United Arab Emirates

Issue no.: 04 **Date: 18-12-2024** **Valid to: 14-10-2026**

Type of Activity	Test Materials/Products	Test Name	Test Method
Corrosion	Ferrous & Non Ferrous	Intergranular Corrosion Test Austenitic Stainless Steel	ASTM A262 Method B & E
Corrosion	Ferrous & Non Ferrous	Intergranular Corrosion Test Wrought, Nickel-Rich, Chromium-Bearing Alloys	ASTM G28 Method A
Corrosion	Ferrous	Hydrogen Induced Cracking Test (HIC)	NACE TM 0284
Corrosion	Ferrous	Sulfide Stress corrosioncracking Test (SSCC) Method A	NACE TM 0177 NACE MR 0175/ISO 15156 Part 1 & Part 2
Corrosion	Ferrous	Sulfide Stress corrosion cracking Test (SSCC) Four point bend Test	NACE TM 0177 & ASTM G39 NACE MR 0175/ISO 15156 Part 1 & Part 2 EFC Publications 16
Corrosion	Ferrous	Stress Oriented Hydrogen Induced Cracking (SOHIC)	NACE MR 0175/ISO 15156 Part 1 & Part 2 EFC Publications 16

Trans Asia Industrial Laboratories L.L.C

Warehouse No 10, Al Qouz Industrial Area 1

Dubai- United Arab Emirates

Issue no.: 04 **Date: 18-12-2024** **Valid to: 14-10-2026**

Type of Activity	Test Materials/Products	Test Name	Test Method
Chemistry	Ferrous & Non Ferrous	Carbon & Low Alloy Steel, Austenitic Stainless steel, Nickel Alloy, Steel products, Brass products, Bronze products, Carbon & high Alloy steel, Aluminium alloy sand casting,Seamless Copper,Copper Alloy (seamless Red brass), Steam or Valve Bronze Castings,Copper-silicon Plate	ASTM E415 ASTM E1086 ASTM A751 ASTM B26 ASTM B42 ASTM B43 ASTM B61 ASTM B96
Chemistry	Ferrous & non-ferrous	Aluminium & its alloys	ASTM E1251
Chemistry	Ferrous & non-ferrous	Copper & its alloys	BS EN 15079

مـركـز الإمـارات الـعـالـمـي لـلاعـتـمـاد
Emirates International Accreditation Centre

ACCREDITATION CERTIFICATE

IB-188

Emirates **I**nternational **A**ccreditation **C**entre

has accredited

TRANS ASIA INDUSTRIAL LABORATORIES LLC

Warehouse No 10 | Al Tayer Warehouse | Al Qouz Industrial Area 1

Dubai | United Arab Emirates

In accordance with the requirements of

ISO/IEC 17020:2012

Conformity Assessment-Requirements for the operation of various type of bodies performing inspection

to undertake the inspection in the attached accreditation scope

This Accreditation is invalid without the attached accreditation scope and shall remain in force within the validity period printed below, subject to continuing compliance with the requirements of the accreditation criteria.

Validity: 23-11-2023 to 05-09-2026

Initial Accreditation Date: 06-09-2020

ilac-MRA

مـركـز الإمـارات الـعـالـمـي لـلاعـتـمـاد
Emirates International Accreditation Centre

Amina Ahmed Mohammed
CHIEF EXECUTIVE OFFICER

مركز الإمارات العالمي للاعتماد
Emirates International Accreditation Centre

Scope of Accreditation

IB-188

Trans Asia Industrial Laboratories LLC

Warehouse No 10 | Al Tayer Warehouse | Al Qouz Industrial Area 1

Dubai | United Arab Emirates

Date: 23-11-2023

Accreditation History			
Issue no.	**Scope Name**	**Details**	**Date**
03	Nondestructive Testing	Renewal of the accreditation	23-11-2023
02	Nondestructive Testing	Certificate validity was extended for 6 months from 06-09-2023 up to 05-03-2024	06-09-2020
01	Nondestructive Testing	Granted accreditation from EIAC	06-09-2020

Scope of Accreditation
IB-188

Trans Asia Industrial Laboratories LLC

Warehouse No 10 | Al Tayer Warehouse | Al Qouz Industrial Area 1

Dubai | United Arab Emirates

Issue No.: 03 **Date: 23-11-2023** **Valid to: 05-09-2026**

Inspection Category	Inspection field	Range of inspection	Stage of Inspection	Inspection criteria	Inspection Activity Type
Nondestructive Testing					
Product	Structural Engineering of Welds and Materials	Magnetic particle examination - Visible - Flourescent	New Construction Inservice	ASME Section V BSENISO 17638	A
		Visual examination - Direct Visual - Remote	New Construction Inservice	ASME Section V BSENISO 17637	A
		Liquid penetrant examination - Visible - Flourescent	New Construction Inservice	ASME Section V BSENISO 3452	A
		Ultrasonic testing - thickness measurement Digital	New Construction Inservice	ASME Section V BSENISO 14127	A
		Ultrasonic testing - Flaw detection - flaw detection - Manual Contact - Pulseecho	New Construction Inservice	ASME Section V AWS D1.1 BSENISO 17640	A
		Paint Coating Thickness measurement	New Construction Inservice	SSPC PA2	A
		Hardness Testing - LEEB - UCI	New Construction Inservice	ASTM A 956 ASTM A 1038	A
		Ferrite Measurements - Magnetic	New Construction Inservice	ASTM A 799 ASTM A 800 BSENISO 8249 AWS A4.2	A