



A DIGITAL TOOL FOR PLANT LIFE EXTENSION

AiOM™

Asset Integrity Optimization and Management

The digital platform that converts decades of metallurgical evidence into fewer unplanned shutdowns, deferred capital replacement and defensible run decisions, built to API, ASME, BS and BS and ISO practice.

MIQA | Mechanical Integrity and Quality Assurance, built in

Decades of metallurgical depth, now a digital platform.

TCR Engineering Services was incorporated in 1973 by Shri V.K. Bafna, a determined metallurgist committed to sustainable, self-driven solutions for industry. TCR Advanced Engineering Pvt. Ltd., established in 1999, was jointly formed by Shri V.K. Bafna and Shri Paresh Haribhakti, a postgraduate in Materials Technology from Maharaja Sayajirao University, Vadodara.

Mr. Haribhakti authored *Failure Investigation of Boiler Tubes: A Comprehensive Approach*, published by ASM International, USA, 2021 contributed the article "Failure of Boiler and Related to ASM Handbook Volume 11A. His guiding motto: Competence. Reliability.

Studying the challenges facing industry, TCR Advanced developed **AiOM™**, a holistic tool spanning an asset's entire life, from design through commissioning, maintenance and repair, to retirement.

WHY TCR ADVANCED

Industry-specific solution

Plant and industry veterans who understand process and operations challenges, aware of business risk versus failure probability, and keeping abreast of new materials and plant items.

Equipment-specific solution

Researching new inspection techniques, investing in probes and probes and accessories to ensure no downtime at site, and a train-and a train-the-trainer approach to spread knowledge.

Problem-specific solution

Corrosion damage evaluation is a specialty, metallurgy is the core the core of every investigation, and every problem is examined examined through multiple angles.

NABL TC-6739

NABL TC-13053

NADCAP AC7101

CBB / IBR APPROVED

ISO 9001



10,000+

Investigations completed

1,800+

Clients across 25+ countries

500+

Fitness for Service assessments

500+ yrs

Cumulative team experience

Sweating the assets buys short-term gains gains and long-term risk.

Ageing plants, limited capital and shorter turnarounds push assets to operate beyond their original design basis. Maintenance costs fall for a while, but reliability drops, unexpected failures rise, and the effects on safety, environment and reputation compound.

REACTIVE: RUN TO FAILURE

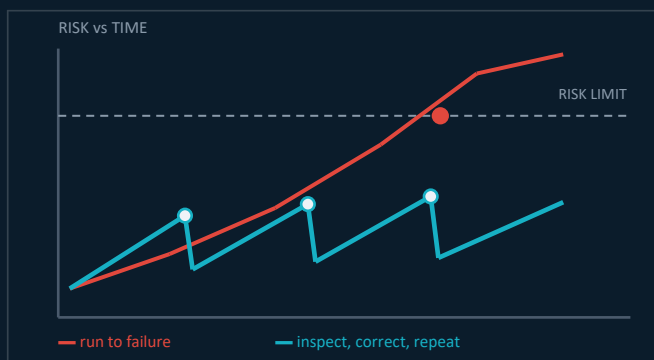
Fix it when it breaks. High safety factors, low maintenance spend, high cost when failure strikes.



Unmanaged, risk migrates red with every run-hour.

PROACTIVE: THE AIOMÁ WAY

Computer-aided, risk-based asset integrity management management across people, process and data, the AiOM™ - AiOM™-approach.



DAMAGE MECHANISMS MOST OFTEN MISSED

- Corrosion under insulation
- Liquid metal embrittlement
- Design deficiency
- Temper embrittlement
- Small-bore piping failures
- Metallurgical degradation
- Hydrogen-related damage
- Localised corrosion from process impurities
- Welding anomalies

43%

of the 100 largest onshore oil, gas and petrochemical losses, 1996-2015, were caused by mechanical integrity failure.

Source: Jarvis & Goddard, IChemE Hazards 27, 2017.



Every mechanism on this list is detectable years before it fails.

AiOM™ is how you look.

Failures announce themselves.

Four exhibits from TCR Advanced's archive of 10,000+ investigations and field practice.



THE COST OF NOT KNOWING

Loss of containment is never the first event. It is the last event in a chain that began as an unread damage mechanism.



External corrosion, found on a TCR Advanced field inspection. Visible only because someone looked.



A burst small-bore connection: the failure class routine inspection misses most often.



Detectable, years before

Every exhibit here began as microstructure: creep voids, a weld anomaly, corrosion under an intact-looking jacket. In-situ metallographic replication, shown left on a live component, and targeted NDT read that microstructure on the running plant. The difference between an exhibit and a non-event is whether somebody looked in time.

One platform, the standard tools of asset integrity.

AiOMÅ brings together the tools the internationally recognised institutions (API, ASME, SAE) have developed for managing asset risk, applied by TCR Advanced's metallurgical experts.

API 580 / 581

Risk-Based Inspection

Ranks assets by probability and consequence of failure so inspection resources focus where risk is highest.

API 579-1 / ASME FFS-1

Fitness For Service

Determines whether an asset can keep running safely, sometimes beyond its original design life.

SAE JA-1011/1012

Reliability Centred Maintenance

Analyses every credible failure scenario, its cause and remedy, so operators are ready before it happens.

API 584

Integrity Operating Windows

Flags when critical process parameters drift outside defined limits, before degradation accelerates.

API 970

Corrosion Control Documents

Centralises degradation and corrosion data across inspection, inspection, maintenance, design and design and operations.

CHANGE CONTROL

Management of Change

Ensures plant modifications are risk-assessed and approved before they reach the field.

BS 7910

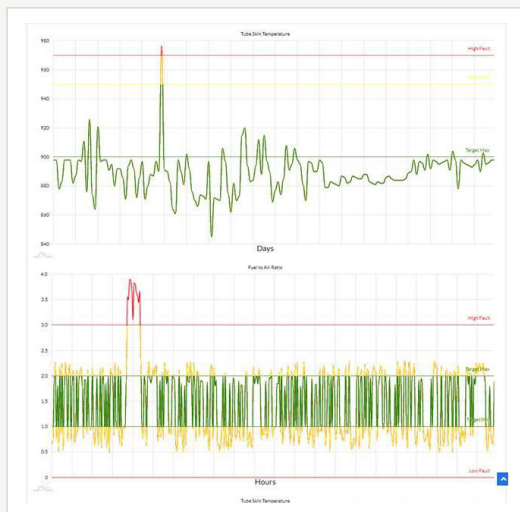
ISO 55000

ISO 31000

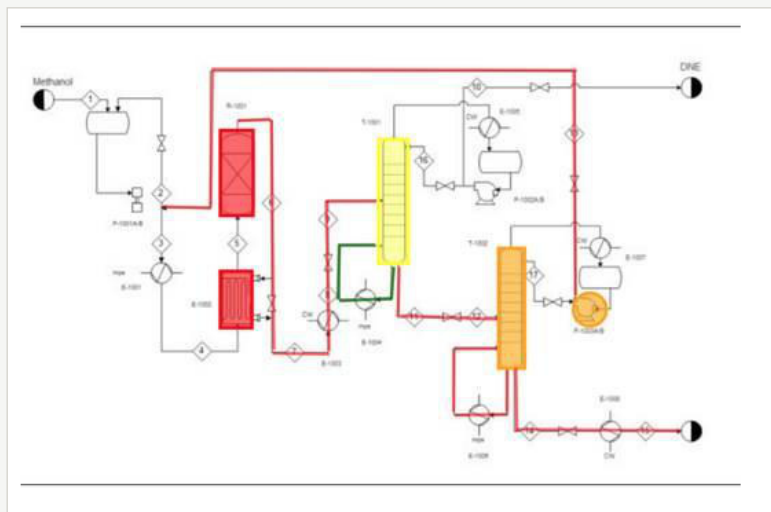
ROOT CAUSE ANALYSIS

QA PLANS

SEEN LIVE IN THE PLATFORM



Integrity Operating Windows, live per API 584.



The intelligent P&ID: every asset colour-coded by live risk.

Mechanical Integrity and Quality Assurance.

MIQA is the element of Process Safety Management, defined in OSHA 29 CFR 1910.119(j) and the CCPS guidelines, that keeps hazardous-service equipment fit for duty. In India the same duty arrives through the Factories Act, the MSIHC Rules, IBR and OISD. AiOM™ carries MIQA as a living programme; TCR Advanced also delivers it as a standalone service.

Register & SCE identification

Every pressure vessel, tank, piping system, relief device, ESD system, control and pump catalogued; safety-critical equipment identified.

Inspection & testing to RAGAGEP

Intervals and techniques per API 510, 570, 653, 576 and IBR, with documented results and performance standards.

Procurement & installation QA

New equipment, fabrication and repairs verified against specification: certificates, welder qualification, PMI per API RP 578.

Maintenance discipline

Schedules set to manufacturer guidance and operating experience, tightened wherever hazardous service demands it.

Spares & deviation control

Spare parts verified fit for the service before they reach the shelf; deferrals documented, risk-assessed and approved.

Competence & training

Requirements defined, and every person maintaining, inspecting or repairing covered equipment trained for that work.

Built into AiOM™. Also a standalone MIQA programme, sized for small and medium chemical and petrochemical plants.



Execution by TCR Advanced's own NABL accredited teams (TC-6739, TC-13053), NADCAP accredited materials testing (AC7101).

Focused, condition-based maintenance instead of blanket blanket schedules.

Fewer forced outages, and lower cost when a shutdown is unavoidable.

Damage mechanisms are identified and tracked before they become incidents.

FFS-backed decisions defer premature replacement of capital equipment.

CHARACTERISTIC DATA

RISK ASSESSMENT

DAMAGE MECHANISMS

INSPECTION REPORTS

FAILURE ANALYSIS

RELIABILITY REPORTS

INSPECTION SCHEDULES

DOWNTIME & IOW PARAMETERS

Which assets carry most of the risk?

What can safely wait for the next turnaround?

Which deferral will the regulator and the insurer accept?



Equipment Tag Master

Plant	DP, EPD & INFORMANTS PLANT	Drawn by	BOLAN
Tag Number	001	Checked by	MA Mechanical Trade Equipment
		Equipment Type	ROTOR - Inducer
		Class	M ROTOR - Inducer
		Equipment Category	Inducers
		Equipment Status	YES



Equipment Details	Equipment	Rotational
Weight (kg)	1200 kg	
Dimensions	200 mm	
Height	1400 mm	

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Asset test header: identity, history, documents.

Identification		Accessories/Options/Notes	
Is Superior Equipment?	YES	Superior Tag Number	901
Single Line Equipment?	YES	Year of Standby Equipment	9
Is PLO Tag Number?	YES	PLO Number	
Accounting Asset Number			
Inventory Details			
Start Date	01-01-2010	End Date	31-12-2010
Technical Details			
Sl. No.	Characteristics	Characteristics (Value/Unit)	
1	DESIGN CODE	T04A	
2	DESIGN PRESSURE	20 Bar-g	
3	DESIGN TEMP. HOLES TYPE	275 Celsius	
4	EXHAUSTER HOLES TYPE	20 mm	
5	MOD. HOLES TYPE	B0114L	
6	INCHES HOLES TYPE	Knee	
Math Analysis			
Corrosion Index (C)	EXP. CLAS		
General Environment Load Time (Hours)	8	Exposure to Extreme Time Intensity	5
Production Loss Value (M\$)	500000	Affected Area in Case of a Leak (sq. Meter)	50
Material Impact	NO	Handling / Assembly Status	NO
Handling / Assembly in Service	NO	Environment / Effect on Life of Component	NO
Automation Control in Case of Failure	NO	Crack Failure / result into Production Loss	YES
Corrosion Rate (mm/year)	0.01	General Assessment / CA Test	3
Time to Corrupt (CA) (year)	3	Inspection Confidence	
Probability of Failure (POF)	0		
Consequence of Failure (COF)	B		
Risk Class	Low		
Required Storage Conditions		WSP Adopted:	
BWP / ACP/Life Extension, Anti-Water Corrosion Corrosion, Corrosion Corrosion / Corrosion Corrosion, Emboss / Emboss / Corrosion		Welding, Post-weld Heat Treatment, Post-weld Heat Treatment, Post-weld Heat Treatment, Post-weld Heat Treatment	
Documents		Bill of Materials (BOM)	Materiality Matrix
Main Schedule		Exp. Related Reports	

Risk assessment sheet with the live 5x5 matrix.

The board-level case.

Capital deferred, defensibly

A Fitness for Service position per API 579-1 that keeps a healthy vessel running is signed engineering evidence, and typically costs a small fraction of the replacement it defers.

Risk you can show, not assert

One live, risk-ranked register per API 580/581 answers the factory inspector, the insurance surveyor and the customer PSM audit from the same set of records.

Memory that survives the org chart

Inspection history, damage mechanisms and engineering decisions stay on the platform when people move on. The plant stops re-learning its own failures.

THE DEPTH BEHIND THE DASHBOARD



The archive: 1,50,000+ microstructures



SEM and EDS, in-house at Vadodara



Team study with your plant engineers

An asset integrity programme is not an expense line. It is the difference between explaining a decision and explaining an accident.

Transparency. Competence. Reliability.

Impartial implementation, led by metallurgical experts.

Every AiOM™ engagement runs as a team study, experienced metallurgical experts working alongside plant alongside plant engineers to identify damage mechanisms early and act on them.

01

Tag & characterise every critical critical asset

02

Assess risk: probability & consequence of failure

03

Map expected & potential damage mechanisms

04

Monitor, report and recommend through the AiOM™ platform



TALK TO US

testing@tcradvanced.com
+91 8511179948

VISIT

250-252/9, GIDC Estate, Makarpura,
Vadodara-390010, Gujarat, India

ONLINE

www.tcradvanced.com

Asset Integrity Optimizers

Book a demo on your own plant data

AiOM™ is a trademark of TCR Advanced Engineering Pvt. Ltd. NABL/ISO 17025: TC-6739, TC-13053. NADCAP Accredited, Materials Testing Laboratories (AC7101).



TCR ADVANCED

Transparency. Competence. Reliability.



NABL Accredited (TC-6739) ISO/IEC 17025:2017 · NABL NDT (TC-13053)

NADCAP Accredited — Materials Testing (AC7101) · CBB / IBR Approved · Recognised Research Institution, MS University

TCR Advanced Engineering Pvt. Ltd.

250-252/9, GIDC Estate, Makarpura, Vadodara 390 010, Gujarat, India

testing@tcradvanced.com · www.tcradvanced.com

24-hr hotline +91 8511179948

Asset Integrity Optimizers

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