RAGAGEP-Based Engineering Governance

Integrating Recognized and Generally Accepted Good Engineering Practices with Mechanical Integrity, Risk-Based Inspection, Fitness-for-Service and AiOM Digital Asset Integrity

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A WORD FROM THE MANAGING DIRECTOR

Foreword

Most major industrial accidents are not caused by an absence of technical standards. They are caused by a gap between the engineering knowledge that already exists and the way that knowledge is applied to a specific asset, on a specific day, under specific operating conditions. Recognized and Generally Accepted Good Engineering Practices, RAGAGEP, is the discipline that closes that gap.

In twenty-six years of failure investigation, fitness-for-service assessment and remaining-life work across Indian and Middle East process plants, the pattern repeats. The applicable code existed. The damage mechanism was known. The failure occurred because no one had connected the standard to the equipment, the equipment to its degradation mechanism, and the degradation mechanism to an engineering decision, in a controlled and auditable way.

This white paper sets out why RAGAGEP deserves to be treated as India's next engineering-governance layer, not as one more compliance checklist, and how AiOM, our Asset Integrity Optimization and Management platform, gives that governance a digital backbone. It reflects TCR Advanced Engineering's direct experience connecting field evidence to engineering science across more than ten thousand investigations and five hundred fitness-for-service assessments.

Paresh Haribhakti
Managing Director, TCR Advanced Engineering

Executive Summary

26+	10,000+	500+	1,50,000+
Years in NDT & integrity	Failure-analysis cases	FFS assessments	Microstructure database

THE CORE PROPOSITION

Executive Summary

RAGAGEP is the engineering-knowledge layer that connects codes and standards to the physical condition and operating risk of an asset.

Major industrial accidents are rarely caused by the absence of technical standards. More frequently, they result from a disconnect between the engineering knowledge that is available and the way that knowledge is applied to individual assets, processes and operational decisions.

Recognized and Generally Accepted Good Engineering Practices provide a framework for managing this complexity. The concept is well established in process safety management and is directly connected to mechanical integrity, inspection and testing.

For India, the opportunity is to establish an engineering-governance framework that brings together statutory requirements, OISD, PESO, PNGRB, BIS, API, ASME, IEC, NFPA, ISO, OEM requirements, damage-mechanism knowledge, risk-based inspection, fitness-for-service, remaining-life assessment, management of change and asset-integrity management under one coherent discipline.

CORE PROPOSITION

RAGAGEP should be treated as the engineering-knowledge layer connecting standards with the physical condition and operating risk of an asset, not as a separate compliance obligation.

DEFINITION

What Is RAGAGEP?

RAGAGEP stands for Recognized and Generally Accepted Good Engineering Practices. The United States Occupational Safety and Health Administration describes RAGAGEP as the basis for engineering, operation or maintenance activities, and identifies its application to process-equipment design, installation, operation, maintenance, inspection, testing and inspection frequencies [1, 2, 3].

Recognized

The practice has identifiable technical recognition through codes, standards, recommended practices, technical publications or established industry practice.

Generally Accepted

The practice has sufficient acceptance within the relevant engineering community.

Good Engineering Practice

The practice is technically appropriate for the specific hazard, process, equipment and operating conditions in question.

WORKING DISTINCTION

RAGAGEP is not synonymous with 'the latest standard.' Applicability and documented technical justification are central to its use, and an older edition can remain the correct RAGAGEP for a given asset if that justification is sound [4, 5].

THE INDIAN CONTEXT

Why RAGAGEP Matters to Indian Industry

Indian refineries, petrochemical plants, fertilizer plants, chemical facilities and power plants commonly operate with multiple generations of engineering standards side by side. Original EPC specifications, historical code editions, current international standards, Indian statutory requirements, OEM practices and corporate standards can all coexist within the same facility, sometimes within the same unit.

The engineering challenge is therefore not merely to possess standards. It is to maintain a controlled, documented relationship between each standard and the equipment, service, damage mechanism and engineering decision to which it applies.

ENGINEERING QUESTION	RAGAGEP CONTRIBUTION
Which practice governs the asset?	Applicable engineering basis
Why is it applicable?	Documented technical applicability
What can degrade?	Damage-mechanism linkage
How should it be inspected?	Inspection and testing basis
Can it continue operating?	FFS/RLA and acceptance criteria
What happens after a change?	MOC and revalidation

THE BUILDING BLOCKS ALREADY EXIST

Indian Regulatory and Engineering Ecosystem

India already possesses most of the constituent elements required for a national RAGAGEP framework. The task is integration, not invention. These layers should be read together rather than treated as isolated document sets.

LAYER	TYPICAL SOURCES	ROLE
Statutory	OSHWC Code; MSIHC Rules, 1989; Petroleum Rules; SMPV(U) Rules, 2016; Boilers framework	Legal obligations
Indian sectoral	OISD; PESO; PNGRB	Hydrocarbon and process safety requirements
Indian consensus	BIS	Materials, design, testing and engineering requirements
International	API; ASME; IEC; NFPA; ISO	Specialist engineering and safety practices
OEM	Manufacturer specifications and manuals	Equipment-specific requirements
Corporate	Company engineering standards	Plant-specific implementation
Specialist	Technical assessment, recognized engineering guidance	Engineering justification

REGULATORY CONTEXT IS LIVE, NOT SETTLED

Even in the jurisdiction where RAGAGEP originated, its regulatory treatment is still being rewritten. In February 2026, the US EPA proposed rolling back 2024 Risk Management Program amendments that would have required Program Level 3 facilities to run gap analyses against current RAGAGEP and implement Safer Technology and Alternatives Analysis findings; both provisions were due to take effect May 2027 before the rollback proposal [30]. OSHA has separately been working since 2022 toward a formal RAGAGEP definition inside 29 CFR 1910.119 itself [31]. India is not importing a finished, stable concept. It has the opportunity to build a RAGAGEP framework suited to Indian statutory structure from a position of first principles, informed by where the US debate has already found friction.

A NINE-STAGE DISCIPLINE

Proposed Indian RAGAGEP Framework

A workable Indian RAGAGEP framework proceeds through nine linked stages, from identifying applicable practices through to periodic revalidation. No stage is optional; skipping straight to 'verify compliance' without first establishing and documenting applicability is the single most common failure TCR Advanced Engineering observes in client RAGAGEP registers.

STAGE	ACTIVITY	PURPOSE
1	Identify	Regulations, OISD, PESO, PNGRB, BIS, API, ASME, IEC, ISO, NFPA, OEM and corporate practices

STAGE	ACTIVITY	PURPOSE
2	Classify	Statutory, mandatory, consensus, recommended, OEM, corporate and specialist practices
3	Establish applicability	Map each practice to plant, equipment, service, material, pressure, temperature and chemistry
4	Establish engineering basis	Document why the selected practice is technically appropriate
5	Verify compliance	Assess actual equipment and work practices against the engineering basis
6	Manage deviations	Record, assess, risk-rank and close deviations with technical justification
7	Integrate with integrity	Connect RAGAGEP to inspection, RBI, damage mechanisms, FFS and RLA
8	Integrate with MOC	Review whether changes alter the engineering basis or damage mechanism
9	Revalidate	Periodically review standards, incidents, operating experience and new engineering knowledge

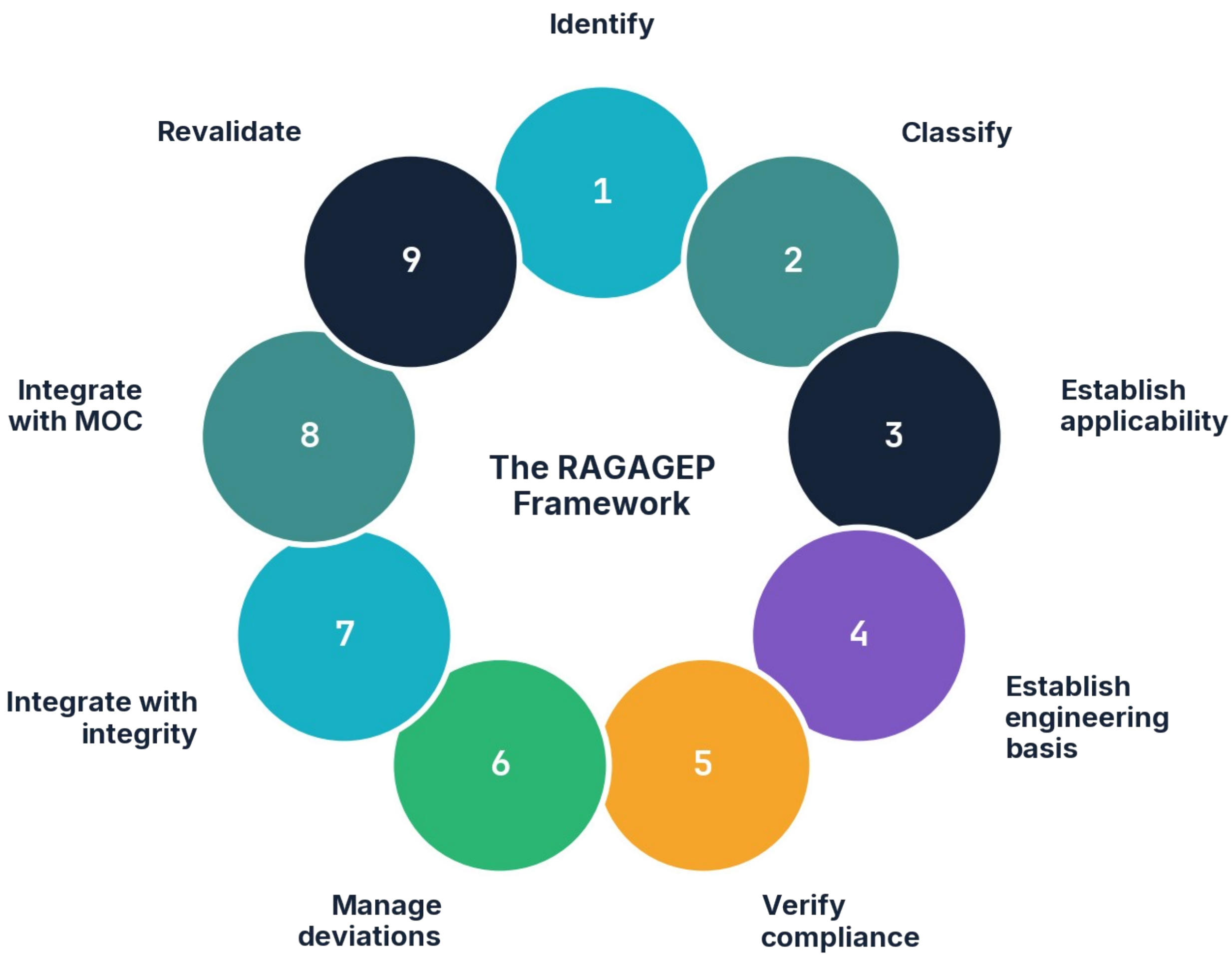

Figure 1. *The nine-stage RAGAGEP framework as a continuous governance cycle. Stage 9, Revalidate, feeds back into Stage 1, Identify, so the register never goes stale.*

THE MOST IMPORTANT APPLICATION

RAGAGEP and Mechanical Integrity

RAGAGEP defines the engineering expectation; mechanical integrity verifies whether the physical asset continues to meet that expectation.

Mechanical integrity is arguably the most consequential implementation area for RAGAGEP. The engineering practice defines the expectation. Inspection and testing provide evidence of actual condition. Engineering assessment determines whether that condition remains acceptable.

For safety-critical equipment, the RAGAGEP record should connect design basis, material, operating envelope, credible degradation mechanism, inspection method, inspection interval, acceptance criteria and engineering decision, as a single traceable chain rather than as separate documents held by separate departments.

FROM STANDARD TO DECISION

Damage Mechanisms, Risk-Based Inspection and Fitness-for-Service

Inspection should begin with the question 'What degradation mechanism is credible?' rather than 'Which NDT method is available?' A technically sound integrity programme connects material, process conditions and service history to damage mechanisms per API RP 571, and only then to the appropriate inspection and assessment strategy.

Risk-based inspection then converts that engineering understanding into inspection priorities under API RP 580/581, while fitness-for-service under API 579-1/ASME FFS-1 provides the defensible route from an observed condition to a continued-service, repair, rerating or replacement decision.

THE GOVERNING SEQUENCE

RAGAGEP → Damage Mechanism → Inspection → RBI → FFS/RLA → Operating Decision. Each arrow in this chain must be documented and auditable; an integrity programme that can show the equipment but not the reasoning behind its inspection interval has not implemented RAGAGEP, whatever its inspection records show.

Figure 2. *The governing sequence from applicable practice to operating decision. Each step is a documented, auditable handoff, not an informal judgement call.*

MAKING IT STICK

Governance, MOC and Deviation Management

A mature RAGAGEP programme requires governance. Deviations should be technically evaluated rather than hidden inside inspection reports or informal correspondence. Every significant change should also trigger a review of the applicable engineering basis, not only a process-safety review of the change itself.

GOVERNANCE ELEMENT	MINIMUM EXPECTATION
RAGAGEP register	Controlled list of applicable practices and editions
Applicability matrix	Equipment-level mapping with technical rationale
Deviation register	Requirement, deviation, risk, safeguard and closure
MOC linkage	Review of standards, damage mechanisms and integrity basis
Competency	Defined technical authority for interpretation and approval
Periodic review	Standards revisions, incidents, experience and new knowledge
Audit	Evidence that practice is implemented, not merely documented

FROM DOCUMENTS TO DATA

Digital Transformation

Traditional RAGAGEP management is document-centric: standards stored as disconnected PDFs, applicability held in someone's memory, deviations buried in email threads. A modern system should be asset-centric instead. The digital architecture should connect each engineering requirement directly to the equipment, and to the evidence supporting the integrity decision made against it.

THE GOVERNING CHAIN, DIGITISED

Standard → Requirement → Equipment → Operating Condition → Damage Mechanism → Inspection → Finding → Risk → Decision. Every link in this chain is a query a plant integrity engineer should be able to answer in minutes, not a reconstruction exercise that takes weeks after an incident.

Figure 3. *The RAGAGEP data chain as AiOM executes it, from the applicable standard through to the equipment and its operating condition (top), and from inspection evidence through to the operating decision (bottom).*

FIELD EVIDENCE TO ENGINEERING SCIENCE

TCR Advanced Engineering Perspective

TCR Advanced Engineering's combination of failure investigation, metallurgical assessment, damage-mechanism expertise, remaining-life assessment, API 579-1/ASME FFS-1 fitness-for-service, risk-based inspection and advanced NDT provides a practical foundation for implementing RAGAGEP as an engineering methodology, not as a document-control exercise.

The advantage this combination brings is the ability to connect field observation with engineering science, end to end, under one technical authority and one signature.

THE EVIDENCE CHAIN

Field observation → Metallurgy → Damage mechanism → Engineering assessment → Risk → Integrity decision. This is the same chain that underlies TCR Advanced Engineering's failure investigations, and it is the chain RAGAGEP formalises at the programme level.

AIOM (ASSET INTEGRITY OPTIMIZATION AND MANAGEMENT)

AiOM as the Digital Execution Layer

AiOM gives the RAGAGEP framework a single asset-centric environment instead of nine disconnected document sets.

AiOM, TCR Advanced Engineering's Asset Integrity Optimization and Management platform, provides a natural digital architecture for operationalising the framework proposed in this paper. AiOM brings asset data, engineering basis, damage mechanisms, inspection, RBI, integrity operating windows, FFS/RLA, maintenance history, failure history and management of change into one common asset-integrity environment, so that a RAGAGEP decision at equipment level is never more than a few clicks from its supporting engineering evidence.

This is deliberate architecture, not a software feature added after the fact. Each of the nine framework stages set out in Section 05 has a direct AiOM equivalent, so a plant adopting the framework is, in practice, adopting AiOM's data model.

AIOM / RAGAGEP COMPONENT	MECHANICAL-INTEGRITY OUTCOME
RAGAGEP library and applicability	Controlled engineering basis
Asset master and design data	Equipment-specific context
Damage-mechanism library	Mechanism-driven inspection
Risk-based inspection	Risk-based inspection prioritisation
Inspection data	Actual condition evidence
FFS / RLA	Continued-service decision
Integrity operating windows	Control of the operating envelope
MOC	Revalidation after change
Failure / RCA knowledge	Learning and prevention
Analytics	Early warning and decision support

WHY THIS MATTERS TO A PLANT MANAGER

A RAGAGEP framework that lives only in documents cannot answer 'is this vessel still fit for service' in real time. A RAGAGEP framework built on AiOM can, because the applicable standard, the damage mechanism, the last inspection finding and the current FFS position sit against the same asset record.

WHERE THIS LEADS

Conclusions and Strategic Proposition

RAGAGEP should not be viewed as another compliance requirement. It should be viewed as an engineering-governance framework that ensures decisions are based on recognized technical knowledge, and that this knowledge remains applicable throughout the asset lifecycle.

For Indian industries, the opportunity is not to create another collection of standards. It is to create a controlled, equipment-level engineering-governance system that continuously connects applicable standards, operating conditions, damage mechanisms, inspection, risk and engineering decisions, with AiOM as the digital layer that makes the connection queryable rather than aspirational.

STRATEGIC PROPOSITION

Move Indian asset integrity from inspection and compliance toward knowledge-based, continuously governed engineering integrity, built on a documented RAGAGEP basis and executed through a single digital asset-integrity environment.

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