From Engineering Risk to Insurance Decisions: A Risk-Based Premium Model (RBPM) for Energy Assets

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INTRODUCTION & AIM

Background

- Insurance premiums for energy assets are typically based on historical losses and broad benchmarks.
- Asset-specific integrity information is rarely incorporated into underwriting.
- RBI generates valuable engineering evidence that can support more transparent premium decisions.

Aim

Develop a Risk-Based Premium Model (RBPM) that integrates engineering integrity information into insurance premium determination.

Research Gap

Current underwriting practices primarily rely on historical losses and generalized risk factors, while detailed engineering integrity information generated through RBI remains largely excluded from premium determination.

Engineering Domain – ✗ – Insurance Domain

METHODOLOGY

A Risk-Based Premium Model (RBPM) was developed by integrating engineering integrity data with practical insurance underwriting principles. The framework prioritizes **inspection confidence** and **integrity management quality** as the primary premium drivers, while **remaining asset life** is applied as a secondary modifier. The model was evaluated using **Aboveground Storage Tank (AST)** integrity datasets from previous studies, including inspection histories, Risk-Based Inspection (RBI) outputs, condition assessments, cathodic protection performance, and documented integrity management plans.

1. Asset Integrity Data
2. Risk Assessment
3. Inspection Confidence + Management Quality + Remaining Life
4. Risk-Based Premium Model (RBPM)
5. Insurance Premium Decision

RESULTS & DISCUSSION

1. Current vs Proposed Underwriting

Conventional underwriting primarily relies on historical loss data, regional benchmarks, and generic actuarial assumptions. In contrast, the proposed Risk-Based Premium Model (RBPM) incorporates engineering integrity information, enabling condition-based and evidence-driven premium determination.

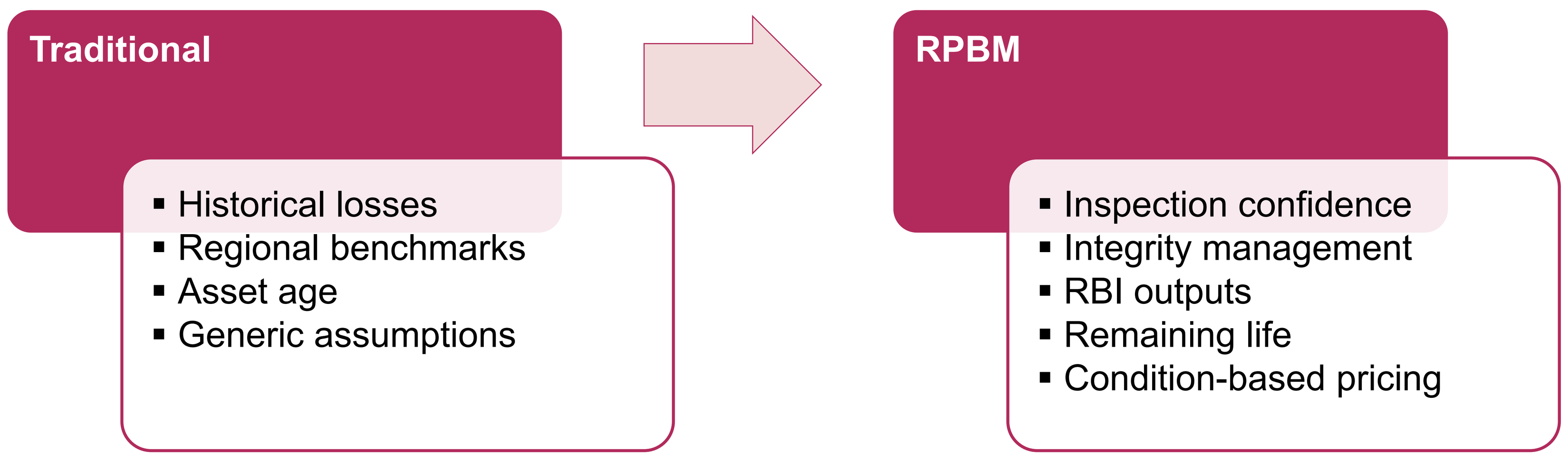

Figure 1. Comparison between traditional insurance underwriting and the proposed Risk-Based Premium Model (RBPM).

2. Premium Decision Logic

The proposed RBPM prioritizes **inspection confidence** and **integrity management quality** as the primary determinants of insurance premiums, while **remaining asset life** acts as a secondary modifier. This approach reflects practical underwriting, where uncertainty and management effectiveness influence premium decisions more than asset age alone.

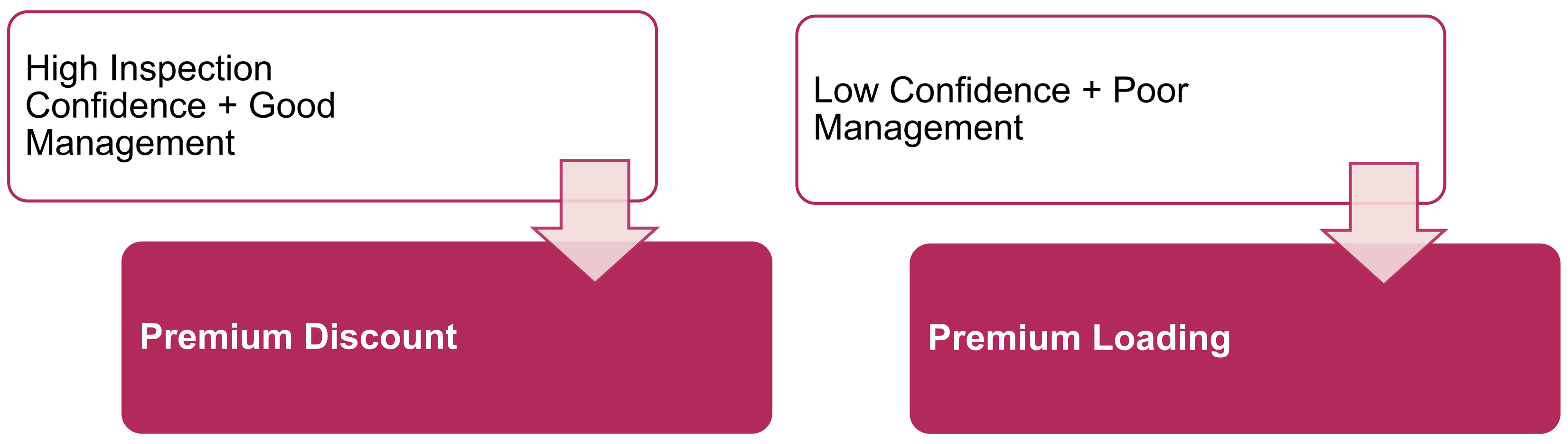

Figure 2. Premium decision logic used in the proposed RBPM.

3. Case Study Results

The RBPM framework was applied to Aboveground Storage Tank datasets obtained from previous integrity studies. The results demonstrate that assets with high inspection confidence and documented integrity management plans received lower premium loadings, even when remaining asset life was limited. Conversely, assets with unknown condition or poor management attracted higher premium adjustments.

Tank	Condition	Premium Outcome
T-01	High confidence	Discount
T-37	Short RL + Good Management	Baseline
T-25	Unknown condition	30%

Table 1. Practical application of RBPM to representative tanks showing relationship between inspection confidence, management quality, remaining life & premium adjustments.

4. Premium Distribution

The proposed framework clearly differentiates between well-managed and poorly managed assets. Compared with traditional underwriting, RBPM rewards proactive integrity management by reducing premiums for assets with high inspection confidence while applying additional premium loadings to assets with greater uncertainty.

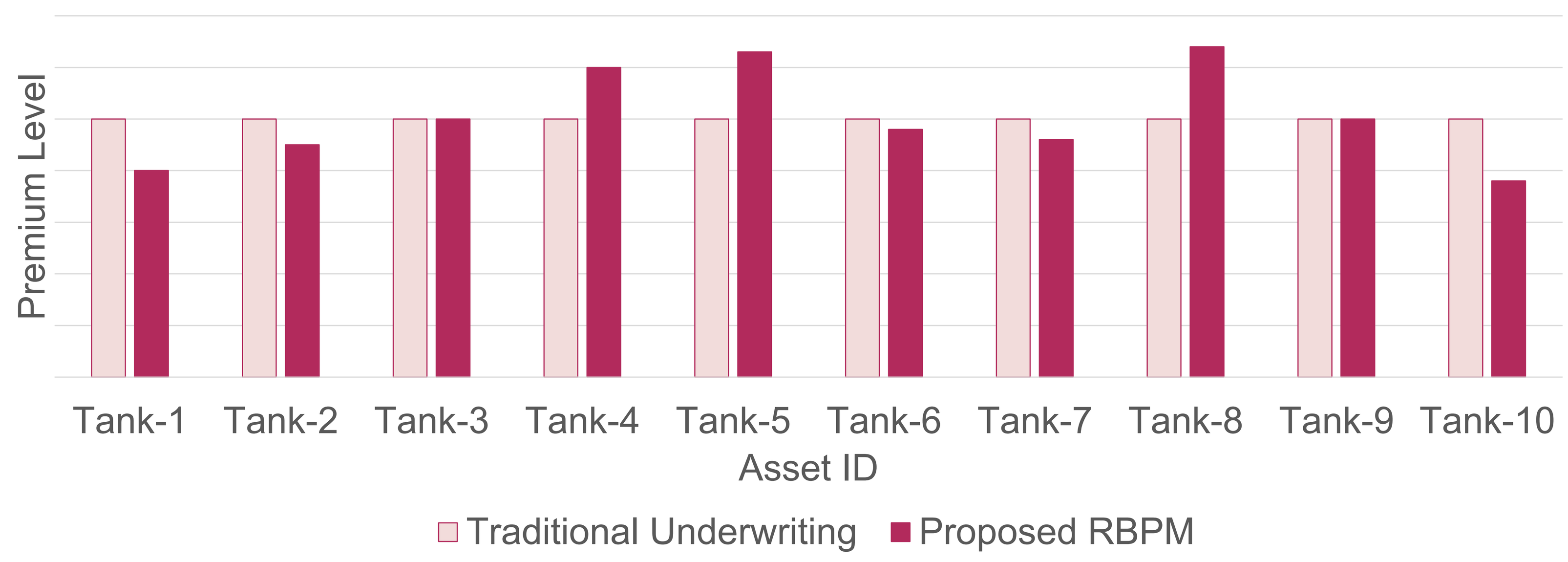

Figure 3. Comparison of premium outcomes under traditional underwriting and the proposed RBPM, demonstrating improved differentiation of asset-specific risk profiles.

CONCLUSIONS

- RBPM links engineering integrity with insurance pricing.
- Inspection confidence and management quality are the primary premium drivers.
- Remaining life acts as a secondary modifier.
- Engineering evidence reduces underwriting uncertainty.
- RBPM rewards proactive integrity management through condition-based premiums.

Key Contributions

- Proposes the first engineering-driven framework linking RBI outputs with insurance premium determination.
- Demonstrates how inspection confidence can reduce underwriting uncertainty.
- Provides a transparent methodology for condition-based premium adjustment using integrity management data.

The future of energy insurance should be driven not by asset age or historical losses, but by measurable engineering integrity.

FUTURE WORK/ REFERENCES/ACKNOWLEDGMENT

Future Work:

- Validate RBPM using insurer pricing and claims datasets.
- Expand the framework to pipelines, pressure vessels and offshore assets.
- Integrate AI, digital twins and real-time monitoring.
- Develop standardized RBI–insurance protocols.

References:

- API RP 580 – Risk-Based Inspection
- API RP 581 – RBI Methodology
- ISO 31000 – Risk Management
- Lloyd's Market Association. (2024). *Guidelines for the Conduct of Oil, Gas & Petrochemical Industries – Implications for Insurance Risk Engineering Reviews*

Acknowledgement:

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