Reducing Transformer Insurance Premiums through Condition Monitoring

by **Bhaba P. Das**

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Introduction

Insurance coverage for power transformers is an essential component of risk management in utility and industrial power systems. Premiums for these transformers can be substantial, particularly for aged or high-rated units. Traditionally, insurance underwriting relies heavily on static parameters such as asset age, location, and historical incident rates [1]. However, the adoption of real-time online condition monitoring (OCM) offers a paradigm shift in how transformer risk is evaluated.

This paper explores how OCM data can be integrated into insurer risk assessments, reducing uncertainty and enabling performance-based insurance models. The structure of the paper is as follows:

- Section 2 outlines the basic component of premium calculation and the drivers for premiums. It further establishes the linkage between OCM and insurance.
- Section 3 presents the calculations for a 30 MVA, 35-year-old transformer.
- Section 4 present engagement strategies, standards, and digital integration.
- Section 5 concludes with an outlook.

Base Calculation for Insurance Premium

Calculating insurance premiums, especially for high-value assets like power transformers, involves several components. A simple computation formula for premium is shown below:

Component	Formula/Impact
Base Premium	Base Rate × Insured Value
Risk Adjustment	Multiplier (1 ± Total Risk Factor)
Final Premium	Base Premium × Risk Adjustment

Table 1: Premium Calculation

Where:

- Insured Value: Replacement cost of the transformer
- Base Rate: A rate per unit of the Insured Value
- Risk Factor: Multiplier based on operational, environmental, and transformer-specific risks including adjustments such as discounts or surcharges based on claims history, monitoring, maintenance, etc. Some common factors are included in Table 2.

The insured value of a transformer is the amount for which the asset is covered under an insurance policy. It typically includes:

- Replacement costs: new transformer cost, transportation to site, installation & commissioning, custom duties & tax (if imported), disposal of old unit, engineering/ project costs and added contingency (10–15%).
- Collateral damage costs: environmental liability, direct failure costs such as fire/explosions
- Business interruption costs: loss of income, additional rental transformers if spare not available.

For a 30MVA, 132/33kV, an estimated approximate cost is listed in Table 3. These values will vary depending on – country of origin, design specifications, delivery lead times & manufacturer location etc. The total insured value is calculated considering replacement costs, collateral damage at 300% of new transformer costs. Business interruption cost is excluded in Table 3.

The base rate of insurance premiums for power transformers is usually calculated as a percentage of the insured value (sum insured). If the risk profile is standard, base rate should

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be 0.2-0.35%, with elevated risk around 0.4-0.65% while with high risk 0.7-1%. For a 35-year-old transformer, it could be perceived as high risk.

Risk Factor/Adjustments	Impact on Premium
Age (>25–30 yrs)	Increases premium or leads to coverage denial.
History of failure or gas events (Past Claims)	Major premium increase (up to 50%)
Load Profile	High stress loading increases risk
Geographic zone (seismic, flood)	Increases base premium rate
Oil type (PCB legacy, ester, etc.)	Affects environmental liability coverage
Lack of CM or diagnostics	Viewed as high risk by underwriters
Use of fire suppression/protection systems	May lower premium by 5–15%
Protection Equipment in place – Bucholz relay, Differential protection, UMZ relays, Breathers etc	Usually lowers premium by 5-10%
Maintenance practices – Monthly, Annually, 5 yearly tests	Typically reduces premium by 10-30%
Online Condition monitoring in place	Often reduces premium by 20–50%

Table 2: Typical Factors influencing Premium

Transformer Rating	Estimated New Cost (USD)	Total Insured Value (USD)	Base Premium (USD)
30 MVA, 132/33 kV	$600k–$1M	$2.7M - $4.5M	$19k - $32K

Table 3: Base Annual Premium Estimate (Current Year)

Linking Condition Monitoring with Insurance Premiums

Modern transformer OCM systems encompasses a range of diagnostic tools. These OCM systems enable end users to implement predictive and risk-informed maintenance, a cornerstone of insurance reduction strategy by:

- Risk Transparency and Quantification - Insurers respond positively to validated data. A continuously updated health index (HI) [2] or remaining life estimation (RLE) [3] provides a factual foundation for premium negotiation.
- Predictive Maintenance and Event Reduction – End users equipped with OCM systems observe significantly fewer catastrophic events. A CIGRE study has shown that transformer monitoring can reduce the risk of catastrophic failures by 50% [4].
- Usage-Based and Performance-Based Premium Models - Progressive insurers offer pricing schemes

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based on transformer behaviour rather than nominal rating and age, provided sufficient operational transparency is demonstrated.

The key online parameters which enable detection of incipient faults and long-term degradation trends, creating a continuous health index are listed in Table 4.

These OCM shift the evaluation from age-based estimation to real-time condition assessment.

Quantifying Premium Reduction

Using the base premium = $19,000 from Table 3. Using a +20% adjustment for age without OCM while with OCM (20% age – 50% comprehensive monitoring) results in -30% adjustment. Comprehensive monitoring is defined in Section 3.1.

This net savings can be an additional benefit to the already quantified benefits explained in [5] such as:

- Reduced inspection and maintenance costs
- Reduced failure-related repair or replacement costs
- Improved real-time transformer loading capability
- Deferred upgrade capital costs due to load growth
- Deferred replacement capital costs due equipment age or condition

Apart from the above, there are other strategic benefits of OCM for insurance purposes:

- Documentation: Monitoring reports support underwriting reviews.
- Improved Risk Profile: Real-time data reduces perceived uncertainty.
- Negotiation Power: End users can present data to negotiate lower premiums.
- Failure Prevention: Early warnings reduce likelihood of claims.

Quantifying Monitoring Levels for Premium Reduction

Transformer condition monitoring is typically implemented in three to four levels (Table 6), depending on the depth of diagnostics, data acquisition, and automation involved. These levels help end users select the right monitoring strategy based on asset criticality, budget, and risk exposure. The fault detection probability of these levels is calculated based on the method described in [6]. The corresponding premium reduction adjustments are also listed in Table 6.

Parameter	Purpose
Oil Temperature & Load	Thermal stress, overloading detection
Fibre-Optic Hot Spot Sensing	Direct winding temperature for life estimation
Dissolved Gas Analysis (DGA)	Detection of arcing, overheating, and insulation decay
Moisture in Oil	Dielectric performance degradation, life estimation
Cooling System Performance	Ensures thermal stability
Bushing Monitoring	Predictive insights into bushing degradation
OLTC Monitoring	Predictive insights into OLTC status
Partial Discharge	Early failure detection in insulation

Table 4: Common OCM Measurements

Scenario	Adjustment	Final Premium
No OCM, Age Risk	+20%	$22,900
OCM Installed, Maintained, Verified	- 30%	$13,300
Net Savings (Annual)	—	$9,600/year

Table 5

Moving Ahead

Insurer Engagement Strategies

To translate condition monitoring data into premium reductions, end users must proactively engage with insurers. The following strategies can facilitate this transition:

Develop a Monitoring-to-Insurance Framework

End users should implement a structured framework that links monitoring metrics to risk indicators recognized by insurers. This includes:

- Health Index Scoring (based CIGRÉ method [2])
- Real-time Fault Alert Systems

Risk-Based Asset Classification

End users should segment transformers by criticality and health condition as listed in Table 7.

Insurer Workshops

Most insurance companies, however, will want evidence of a maintenance regime to show that this expensive asset has had care and attention throughout its working life to minimise the risk of failure. If such reports are not available, there is a risk that the insurance company could seek to minimise its liability. Hence, there is a need to establish joint risk reviews with insurers to build trust and confidence in the data from OCM systems by:

- Demonstrate efficacy of predictive alerts.
- Review historical asset behaviour.
- Justify longer maintenance intervals based on OCM trends.

Standards & Certifications

Standards

By aligning monitoring practices with

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Sensor Type	Basic	Standard	Advanced	Comprehensive
Load Measurements	✔	✔	✔	✔
Temperatures – Top Oil, Radiators, Ambient	✔	✔	✔	✔
Key Gas & Moisture in Oil	✔	✔	✔	✔
Cooler Status	✔	✔	✔	✔
Fibre optic winding temp	✘	✔	✔	✔
OLTC Monitoring	✘	✔	✔	✔
Bushing Monitoring	✘	Optional	✔	✔
Smart cooling control	✘	✘	Optional	✔
Dissolved gas Analyzer (Multigas)	✘	✘	✔	✔
Partial discharge Monitoring	✘	✘	✔	✔
Auxiliary Devices Monitoring	✘	✘	✔	✔
Advanced Assessments- Through faults, Harmonics	✘	✘	✘	✔
Condition Assessment Algorithms	✘	✘	✘	✔
Fault Detection Probability	30%	44%	57%	65%
Premium Adjustments	-10%	-30%	-40%	-50%

Table 6: Levels of Condition Monitoring with Fault Detection Probability

Category	Monitoring Level	Insurance Adjustment
Critical & Aging	Comprehensive	Max Premium Discount ~50%
Moderate Risk	Standard or Advanced	Moderate Discount ~30-40%
Low Risk	Basic	Minimal Discount ~10%

Table 7: Transformer classification for Insurance Adjustment

global standards (IEC, IEEE or CIGRE), end users increase credibility and audit acceptance with insurers. Some examples of the many standards/ guides are presented in Table 8.

Transformer Assessment Index Certification

Independent certification of the transformer's condition (by OEMs or third-party labs) can serve as a verified input to insurance pricing. Some insurers may accept:

- Transformer health certificates
- DGA diagnostic certifications
- Remaining Life Estimations (RLE)

Digital Integration

OCM systems when integrated into enterprise digital platforms, enhance their value in insurance negotiations. Monitoring systems integrated with platforms like DynamicMetrix from Dynamic Ratings enable centralized risk profiling, automated maintenance triggers and historical data-backed analytics.

For insurers to trust digital data, cybersecurity of OCM infrastructure is critical. Cyber-secure systems reassure insurers that data is reliable and tamper-proof. Compliance with ISO 27001 [7] is required.

Conclusion

OCM goes beyond maintenance: it is an asset risk management tool with direct financial implications. End users that strategically integrate monitoring with insurance negotiation can:

- Lower premiums
- Improve asset reliability
- Extend transformer life economically

By following best practices in data transparency, standards compliance, and risk engagement, end users can position themselves as low-risk clients in the eyes of insurers.

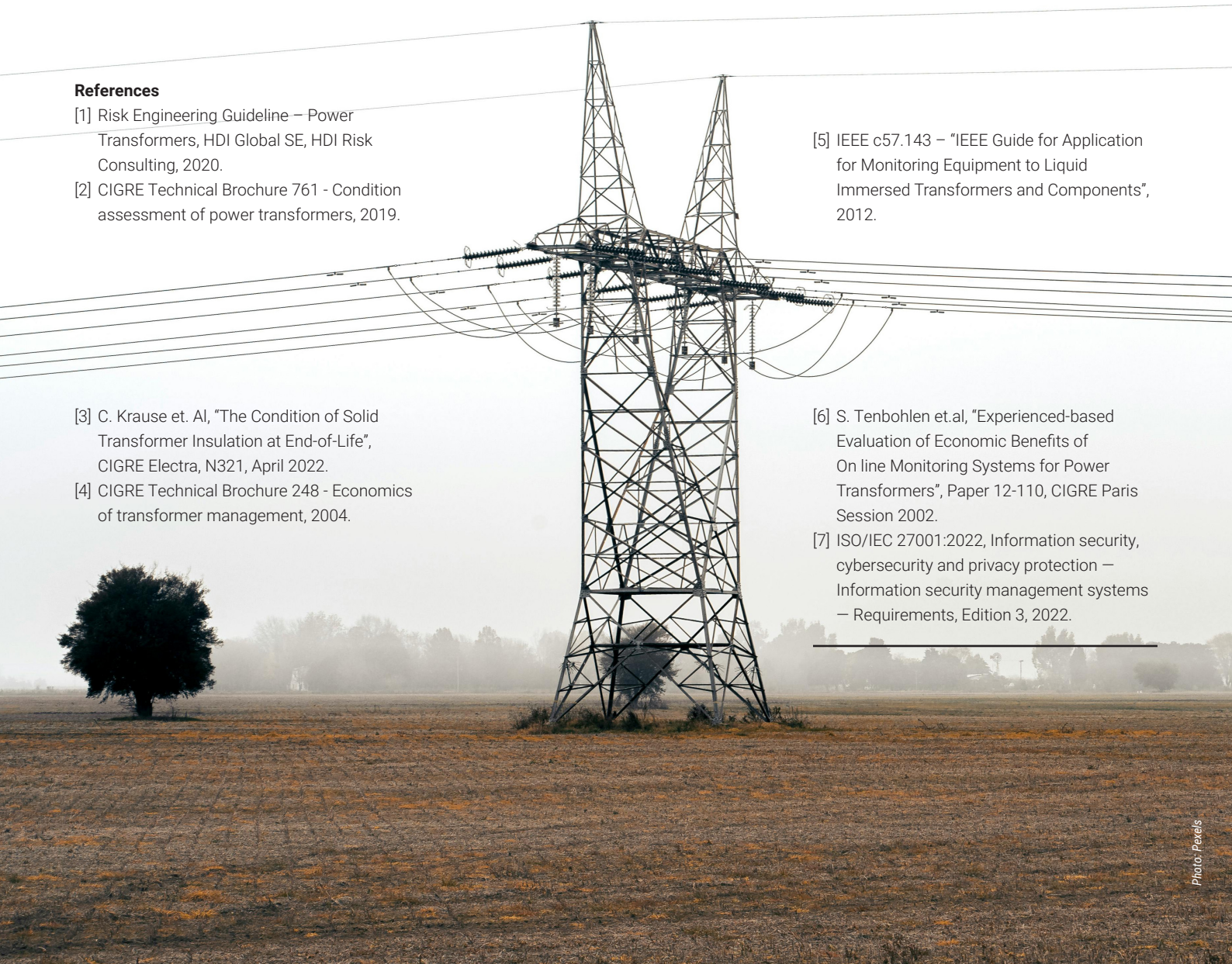
This paper demonstrates that financial returns through insurance

optimization can be an additional benefit which will help to improve the IRR and payback period for OCM systems. Furthermore, the integration of OCM with international standards, digital asset management platforms, and emerging insurer frameworks (e.g., usage-based insurance) places early adopters at a distinct advantage. As insurers evolve toward dynamic, data-centric pricing models, end users equipped with robust OCM capabilities will not only reduce premiums but also shape how transformer risk is defined in the insurance sector.

Ultimately, OCM creates a new alignment between technical reliability and financial performance ensuring that well-maintained, healthy transformers are recognized and rewarded accordingly in the insurance marketplace.

Ref #	Document Kind, Title	Document No
1	IEEE Guide for Application for Monitoring Equipment to Liquid-Immersed Transformers and Components	C57.143
2	IEEE Guide for Monitoring Distribution Transformers	C57.167
3	CIGRE TB - Recommendations for Condition Monitoring and Condition Assessment Facilities for Transformers	343
4	CIGRE TB - Guide on Transformer Intelligent Condition Monitoring (TICM) Systems	630
5	CIGRE TB – Life Management Techniques for Power Transformers	227
6	CIGRE TB – Guide for Transformer Maintenance	445
7	CIGRE TB – Transformer Reliability Survey	642
8	CIGRE TB – Condition Assessment of Power Transformers	761
9	CIGRE TB – DGA Monitoring Systems	783
10	CIGRE TB – Advances in DGA Interpretation	771
11	CIGRE TB – Life Extension of oil filled transformers	887

Table 8



References

[1] Risk Engineering Guideline – Power Transformers, HDI Global SE, HDI Risk Consulting, 2020.

[2] CIGRE Technical Brochure 761 - Condition assessment of power transformers, 2019.

[3] C. Krause et. Al, "The Condition of Solid Transformer Insulation at End-of-Life", CIGRE Electra, N321, April 2022.

[4] CIGRE Technical Brochure 248 - Economics of transformer management, 2004.

[5] IEEE c57.143 – "IEEE Guide for Application for Monitoring Equipment to Liquid Immersed Transformers and Components", 2012.

[6] S. Tenbohlen et.al, "Experienced-based Evaluation of Economic Benefits of On line Monitoring Systems for Power Transformers", Paper 12-110, CIGRE Paris Session 2002.

[7] ISO/IEC 27001:2022, Information security, cybersecurity and privacy protection — Information security management systems — Requirements, Edition 3, 2022.

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