

Designing for Insight at the Outset

Modern engineering practices demand asset management begins at the very first stage of the asset lifecycle, the acquire phase. Decisions made during this early stage determine the long-term performance, reliability, and maintainability of an asset.

By Clayton Ross, Electrical Engineer at EA Technology.

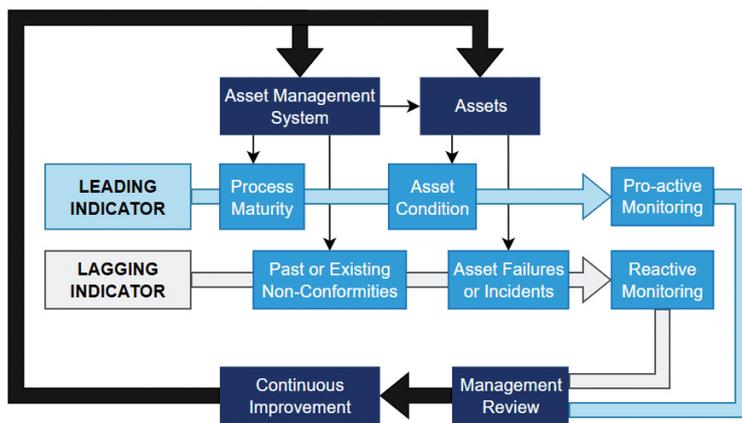


Figure 1 Leading and Lagging Indicators

By embedding condition monitoring capabilities into the design and commissioning of assets, a powerful shift from reactive maintenance strategies based on lagging indicators to proactive maintenance strategies based on leading indicators can be achieved.

FUNDAMENTALS OF ASSET MANAGEMENT

Lagging indicators, such as asset failures or past non-conformities, only reveal problems after they've occurred. In contrast, leading indicators provide early warnings by tracking asset condition in real-time. Leading indicators enable predictive maintenance, anticipating failures before they occur. Transitioning to a leading indicator framework requires far greater visibility into an asset's condition. In some cases, this may not be achievable given a lack of foresight in the asset's planning stages.

This transition begins with planning at the acquire stage of the lifecycle. During the initial stages of a project, engineers must consider how condition data will be collected throughout the asset's life. Only after this step can engineers begin designing and integrating systems that facilitate monitoring. The goal is to ensure that once the asset is operational, it can be continuously and thoroughly assessed providing highly detailed data that will inform superior decision-making. With a

clearer picture of asset health, engineers can prioritise interventions and optimise maintenance schedules, thus extending asset life. For workers and the public, a much deeper understanding of potential risks result in a significantly safer environment.

CASE FOR CABLES

High-voltage (HV) cables provide one of the clearest demonstrations of why foresight at the acquire stage is essential. These assets are critical, yet they remain among the most difficult to monitor once installed. Condition data is scarce, and the cost of

failure is high. Partial Discharge (PD), most often linked to workmanship issues in joints and terminations, is the dominant cause of unexpected failures, making it the most critical condition to detect and trend.

Engineers can apply techniques such as Very Low Frequency (VLF) testing to obtain condition data or retrofit High Frequency Current Transformers (HFCTs) within switchgear to enable continuous monitoring (Figure 3). Both approaches provide valuable insight, but they also illustrate the constraints of relying on retrofit solutions for assets that were not designed with monitoring access in mind.

DESIGN-STAGE CHALLENGE

Consider a newly commissioned very long HV cable circuit (>16 km), installed without intermediate switching points or accessible test locations. Current testing methods cannot cover its full length, leaving large sections invisible until a failure occurs. This reliance on lagging indicators forces a reactive maintenance approach, raising risk and reducing reliability. Had the project been designed with monitoring in mind, sectionalising points or other forms of access could have been introduced to facilitate testing, enabling proactive monitoring throughout the cable's service life.

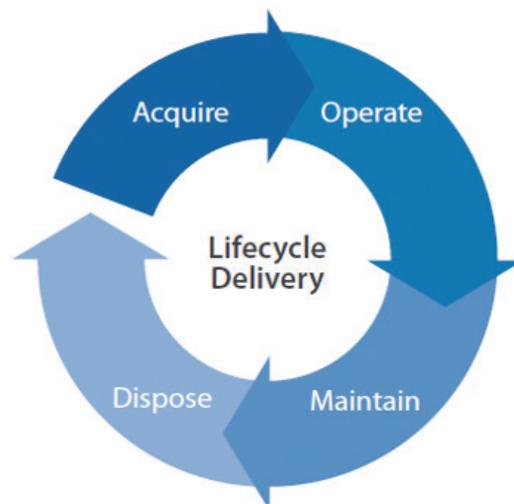


Figure 2 Institute of Asset Management Model



Figure 3 HFCT installed within switchgear

COMMISSIONING-STAGE CHALLENGE

A further limitation arises at the commissioning stage. In many installations, earth screens are terminated within sealed enclosures. Once the system is operational, this makes it impossible to attach HFCTs without a shutdown. As a result, continuous monitoring, or periodic testing, can only be introduced later through disruptive retrofits. By contrast, installing HFCTs during commissioning, or externalising earth screens for safe future access, allows operators to enable online monitoring from day one.

These two scenarios highlight a consistent principle: foresight during both design and commissioning determines whether cables can be effectively monitored over their operational life. Embedding monitoring capability early transforms cables from opaque, high-risk assets into transparent, manageable ones.

SUMMARY

The lesson from cables extends across all network assets: foresight at the acquire stage is decisive. Without designing and commissioning with monitoring in mind, operators are forced to rely on lagging indicators such as failures, outages, or reactive investigations. By contrast, embedding access points, externalising earth screens, and installing sensors during commissioning enables condition data to be gathered throughout the asset's life.

Partial Discharge remains the most critical aspect of condition to manage. Workmanship issues at joints and terminations are responsible for the majority of premature failures, and PD is the earliest and most reliable indicator of these defects. If monitoring is considered from the outset, PD can be detected, trended, and acted upon long before it escalates into catastrophic failure.

Designing for insight at the outset is therefore not just sound engineering practice; it is the foundation of safer, more reliable, and more cost-effective networks. By shifting from lagging to leading indicators, utilities can reduce risk, extend asset life, and deliver resilience at the lowest overall cost. **T&D**

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Supply Security

ea
technology

New Zealand | +64 21 663 491
 greg.linton@hvds.co.nz
www.hvds.co.nz

Australia | +61 7 3256 0534
 neil.davies@eatechnology.com
www.eatechnology.com.au

