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MVAC cable condition assessment and PD measurement capability maturity model

Partial Discharge measurements, analysis and monitoring are increasingly used in New Zealand on MVAC cables. PD measurements as diagnostics, condition assessment (CA) and condition monitoring (CM) are recognised as valuable tools to manage cables as long-life assets with a wide range of economic life of their components.

However, there is a broad range of skill and experience on PD measurement application in the New Zealand power cable industry, resulting in an inconsistent experience for the stakeholders and unreliable ROI. Therefore, I present an (incomplete) Cable Condition Assessment Capability Maturity Model (CCA-CMM) that enables organisations to measure and improve the value of cable condition assessment (CCA).

The process of cable diagnostics (selecting cables for diagnostics through to maintaining the assets) must be effective and efficient to be valuable for managing these assets. The process must be effective (by providing results that are true and actionable) and efficient (by gathering the results at lowest cost and greatest benefit).

The Asset Management Maturity Scale and Guidance¹, [IAM AMM guide] summarises a maturity scale for asset management as “a scale of capabilities and maturity against which organisation can identify their strengths and areas for improvement.”

A quote from the [IAM-AMM] summarises the value of such a maturity scale as the scale “serves to diagnose and prioritise the development of new capabilities, benchmarking and demonstrating progress, competency or excellence to stakeholders. It also serves to establish processes and habits of continual improvement with an objective basis of evidence”. These maturity scales can be applied to elements used to manage assets, such as condition assessment. In a similar manner, in the software industry, “The Capability Maturity Model (CMM) is a methodology used to develop and refine an organization's software development process.” [CMM]²

The cable condition assessment capability maturity model (CCA-CMM) is constructed with five levels of maturity (as per [IAM AMM] as well as [CMM]) and four high level stages of the CCA process, namely Plan-Do-Check-Act (PDCA).

The five maturity levels are Aware, Developing, Competent, Optimizing and Excellent as follows:

1. Aware: the organisation is “aware” of cable diagnostics, which means it is considered “interesting” and applied sporadically.
2. Developing: in the “Developing” stage cable diagnostics tools have been tested and certain methods have been chosen. The measurements are an “option” to be applied

¹ [IAM AMM] [IAM - Asset Management Maturity Scale and Guidance \(PDF\) \(theiam.org\)](https://www.theiam.org/shop/products/20690)
<https://www.theiam.org/shop/products/20690>

² [CMM] [What is Capability Maturity Model \(CMM\)? \(techtarget.com\)](https://www.techtarget.com/searchsoftwarequality/definition/Capability-Maturity-Model)
<https://www.techtarget.com/searchsoftwarequality/definition/Capability-Maturity-Model>

when considered necessary. A scheduled program has not yet been established. Some cable condition assessment testing methods have been established.

3. Competent: the “value” of cable diagnostics is becoming recognized across the organisation. Their cost & benefit is clear, although not yet optimised. Formal processes, quality measures, interfaces between teams, and training programs have been established. Technology is used effectively and with purpose.
4. Optimizing: a complete set of cable diagnostics tools is embedded in cable condition assessment and has become the “main guidance” of the organisations’ maintenance and renewal program for individual assets as well as extrapolated to the fleet to direct CAPEX and OPEX programs.
5. Expert: cable diagnostics, condition assessment and monitoring are the “core” of the maintenance and renewal strategy, both directing lifecycle activities on individual assets, as well as informing the strategy across various sub-fleets and types. The processes and technology are tightly integrated, with minimum manual input and maximum benefit from the measurements. The effectiveness and efficiency of the program is limited only by technology and best industry knowledge rules to identify defects. There is a perfect balance between application of diagnostics, and maintenance and renewal activity.

The PDCA phases relate to the condition assessment cycle as follows:

- A. The Plan phase: selection of the cables to be assessed.
- B. The Do phase: diagnostic measurements are performed, the data is processed and interpreted, and the results are reported
- C. The Check Phase: The results and information from different measurements and sources are combined and its impact on the asset analysed
- D. The Act phase: Actions are taken on the asset based on the outcome of the analysis, i.e. replace, improve, maintain or remeasure.

Each phase is evaluated on generalised efficiency and effectiveness measures: input, output, quality of internal process and actions, technology level, level of manual vs. automation (efficiency).

Multiplying the five levels of maturity with the four phases of PDCA provides a 4 by 5 matrix containing twenty fields with maturity measures.

For example: when an organisation has reached the ‘competent’ maturity level across the organisation, the following characteristics are foreseen:

- A. Plan:
 - a. cable assets are proactively selected and scheduled for diagnostics as part of condition assessment,
 - b. the selection is based on defined characteristics (i.e. age and type of cable segments, length, number of joints, previous failures, past measurement results, etc.).
- B. Do:
 - a. Pass/Fail/Further study levels are set for each diagnostics tool
 - b. The quality of measurement processing is consistent and intermediate interpretation rules have been established.
 - c. (Sub)contractors have approved/agreed SOPs.

C. Check:

- a. Action rules have been established for typical measurement results
- b. complex measurement results are reviewed manually.
- c. The quality of the measurements is reported and being systematically improved.

CI. Act:

- a. Maintenance and renewal activities are regularly initiated based on the diagnostics.
- b. CAPEX and OPEX programs are influenced by measurement results.
- c. Learnings are systematically captured and used to improve the process as well as the rules

The CCA-CMM helps an organisation to implement and develop a cable condition assessment capability as the original CMM.

As mentioned before “This scale serves to diagnose and prioritise the development of new capabilities, benchmarking and demonstrating progress, competency or excellence to stakeholders. It also serves to establish processes and habits of continual improvement with an objective basis of evidence”.

Questions to the audience are:

1. How do you evaluate the CCA capability in your organisation?
2. Have you used such a maturity scale?
3. Would such a maturity scale be useful to develop and improve the capability of your organisation?