

## Combined Application of Diagnostics Tools for MV Underground Cables

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### ABSTRACT

This paper presents the advantages of the application of the combination of offline and online diagnostic tools for underground medium voltage cables. Partial Discharge (PD) online measurement is a useful tool to identify PD activities without the shutdown of a cable circuit. Advantages and challenges of PD online diagnostics combined with the advantages and strengths of offline VLF tan delta and VLF PD measurement are demonstrated by practical case studies. The combination of advanced diagnostic tools allows asset owners to implement condition based maintenance measures most cost and time efficient.

### KEYWORDS

Online PD, Offline VLF TD, VLF PD, MWT

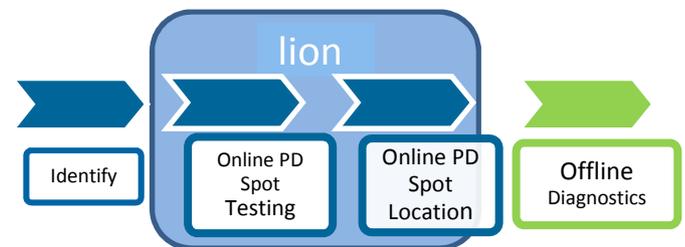
### 1. INTRODUCTION

More and more network operators of Medium and High Voltage Underground (MVUG) cable networks are facing the challenge of ensuring highest power supply reliability and at minimizing the costs for maintenance at the same time.

For cost efficient management of assets and maintenance of MVUG cables, condition based preventive maintenance is the key for modern power utilities. Based on condition evaluation of MVUG cables, service aged cables and accessories can be prioritized for maintenance according to their condition. Condition evaluation is also getting more and more important for commissioning tests of new cable installations. The combination of VLF testing and PD monitoring and localization allows to identify installation weaknesses already at the stage of commissioning. Accordingly, long term problems can be prevented in an early stage.

In order to make best use of modern condition assessment, diagnostic tests are used to understand the cable condition. As for all diagnostic investigations, only the right mix of applied technologies can ensure to discover all kind of degradations along new and service aged cables. Especially old installed cables which may consist of hybrid arrangements can present numerous degradation effects in one single cable.

Combined diagnostic methods in MVUG cables have proven to cover all aging characteristics. Different diagnostic tools are expected to deliver highly informative results that allow improving the condition of cables with a minimum of effort in time and costs. In the following chapters, the applied technologies for combined diagnostics are explained in detail. In general online and offline diagnostic techniques can be combined in order to work in a most efficient way, when power shutdowns are critical and request for fundamental justification.



### 2. PD ONLINE - DIAGNOSTICS

The portable device “liona” is used for measuring and localizing PD online, i.e. while the power circuit remains in operation. With “liona”, medium- and high-voltage cables as well as switching stations can be tested quickly for PD without major expense and without the effort of disconnection of the cable circuit. Special high-frequency current sensors (HFCT, High Frequency Current Transformers) are used to perform measurements on a connected power cable. The sensors enable to measure the PD signal at the cable screen in the substation as well as link-boxes in transmission circuits (see Fig. 1 and Fig. 2).

To acquire meaningful information in spite of the active mains operation, it is essential that the device software is able to differentiate between interference signals and the PD activities. One of the strongest tools to differentiate between noise and PD activities is the algorithm called DeCIFer<sup>®</sup> invented and registered by IPEC Ltd. (IPEC, 2014), the core of the software. The algorithm is the result of many years of expertise and experience acquired by IPEC. The algorithm automatically identifies the PD activities out of the interference signals (Fig. 4). Noise is the major difficulty to be overcome in online diagnostics.



Fig. 1 PD online spot testing equipment, liona