TNB Experienced in Monitored Withstand Test as part of the Medium Voltgae Underground Cable Maintenance Regime

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ABSTRACT

Starting in 2021, Tenaga Nasional Berhad, Malaysia has embark in Monitored Withstand Test (MWT) as complementary to Partial Discharge (PD) Measurement for medium voltage underground cable. TNB had developed the testing procedure that propose cable with no PD activity but still low in Insulation Resistance to undergo MWT. Result are analyze based on IEEE 400.2. From the results shows that 32% of cable tested with MWT were belong to 'action required' that need to undergo withstand test. Some of the joints failed were then undergo post mortem. From the post mortem of the failed joint shows that there are water residual inside the joint, corroded copper tape and electrical tracking at the joint tubing. This shows that MWT successfully detected moisture ingress inside the joint.

KEYWORDS

Monitored Withstand Test; Medium Voltage Underground Cable; Maintenance Regime

INTRODUCTION

Tenaga Nasional Berhad (TNB) is the largest power utilities company in Malaysia. It has 186,000 km of medium voltage underground cable. TNB has started condition based maintenance since 2007 which has 2 tier testing. Tier 1 testing mainly scanning purposes. Tier 2 testing is Offline Partial Discharge Mapping.

The maintenance regime that been practice has helped TNB to maintain SAIDI below 50 minutes. However from the PD Mapping data, it is found that there is 15% of medium voltage underground cable that has no partial discharge activity but still has low insulation resistance. Eventually the cables experienced breakdown. This has created dissatisfaction among the diagnostic engineer.

TNB MAINTENANCE REGIME 2007-2020

The maintenance regime for medium voltage underground cable is consist of 2 Tier. Tier 1 is targeted for the whole population and Tier 2 is for advance diagnostic testing.

Tier 1 Testing

Tier 1 testing is using online PD scanning or Insulation Resistance. By default, online PD scanning is favorable compared to Insulation Resistance (IR) due to no shutdwon requirement. Table 1 shows the recommendation of the online PD scanning.

No PD	Repeat after 24months
Suspected PD	Perform Tier 2 test

Table 1: Online PD Scanning Result Recommendation

However there is a few circuit that has difficulty to access the cable ground earth wire, therefore Insulation Resistance will be conducted. The analysis of Insulation Resistance is by calculating the Polarization Index (PI) or Dielectric Absorption Ratio (DAR) using the formula:

$$PI = \frac{IR\ @\ 10\ mins}{IR\ @\ 1\ min} \quad [1]$$

$$DAR = \frac{IR\ @\ 1\ min}{IR\ @\ 30\ sec} \quad [2]$$

Table 2 shows the recommendation of the Insulation Resistance measurement.

Results	Action
PI value ≥ 3.0 (DAR value ≥ 1.6)	Repeat after 24 months
$1.6 <$ PI value < 3.0 ($1.1 <$ DAR value < 1.5)	Repeat after 6 months.
$1.0 <$ PI value < 1.5 ($1.0 <$ DAR value < 1.1)	Repeat after 3 months.
PI value < 1.0 (DAR value < 1.0)	Perform Tier 2 tests

Table 2: Insulation Resistance Result Recommendation [1]

Tier 2 Testing

Offline Partial Discharge mapping using damped AC technique is practiced since 2007. TNB has developed in-house calculation of severity index (SI) for PD value. The formula for calculate SI is as follows [1]:

$$Severity\ Index\ (SI) = \frac{\left(\frac{Maximum\ discharge}{Average\ discharge}\right) \times \left(\frac{No\ of\ discharge\ @\ L}{Total\ no\ of\ discharge}\right)}{\left(\frac{Inception\ voltage}{Phase\ voltage}\right) \times \left(\frac{Extinction\ voltage}{Phase\ voltage}\right)} \quad [3]$$

Table 3 shows Offline PD Mapping recommendation. There are few casses when the value of SI is less than 2 but the absolute value of Insulation Resistance is very poor. This will lead into failure / breakdown in few months time.