

# Analysis of a Practical Study for Under-Ground Cable Faults Causes

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**Abstract**—The underground cables are widely used for the transmission and distribution of the electrical energy over a wide range of voltages due to their merits. On the other hand, there are limitations for using the underground cables because the fault location is very difficult and consuming long time to be detected. In order to achieve a reliable operation of the electrical network and minimize the rate of the cable faults, accurate and effective fault causes analysis has to be carried out as we aim to prevent faults from happening rather than to restore the system after fault occurrence. This paper discussed the different underground cable faults and their causes through the analysis of a practical statistical study carried out for Dokky underground cable distribution networks in the Egyptian ministry of electricity to show the rate of occurrence of the different cable fault types during the previous twelve years, a practical study results were statistically analyzed and correlated to the cable faults causes analysis. It is noted that the underground cable faults are mainly due to cable insulation failure or joint insulation failure as a direct result of different partial discharge forms inside the cable or the joint.

**Keywords**— *Cables faults, cable fault causes*

## I. INTRODUCTION

Since the first cable installations by Thomas Edison's in the 1870s in New York city [1], the underground cables become the best choice for the electrical energy transmission, distribution and utilization, due to rugged construction, greater service reliability, increased safety, better appearance, it is not affected by the climatic conditions (storm, ice, tree or lightning), it require lesser right of-way, it is also more suitable for areas where it is impractical to use overhead lines (transmission lines through sea – air field crossing). Therefor the underground cables increasingly replaced the overhead lines especially inside towns and near densely populated areas up to 500 kV [2]. On the other hand, the cost of installation of underground cable is nearly about from 10 to 15 times that cost of overhead transmission line for the same voltage, moreover the cable fault location and repairing is very difficult and has a long time-consuming process; where it takes 3–5 times longer than that time required for an overhead line [3]. All these factors represent limitations for the use of the underground cables and require great effort from researchers to overcome these limitations. In this paper, firstly a practical statistical study is conducted to Dokky underground cable distribution networks in the Egyptian

ministry of electricity to conclude a real indication of the rate of occurrence of each cable fault type over the year for ten years from 2009 to 2020 with practical analysis of the causes and mechanism of each fault, accordingly the most suitable and the right precaution is introduced to avoid fault repeating in the future and to prevent faults from happening rather than to restore the system after fault occurrence.

A practical study of the underground cables different fault location techniques is carried out on practical feeders on Dokky underground cable distribution networks in the Egyptian ministry of electricity to conclude the suitable technique for each fault case to facilitate the fault location process and save the time. The aim of all these efforts is to create a reliable and stable power system capable of delivering a high-quality service to the consumer with minimum electricity cut off times and have economic benefits for the power utility companies.

## II. CLASSIFICATION OF UNDERGROUND CABLES FAULTS AND THEIR CAUSES FOR CASE STUDY

The experience in the operation of electrical networks has shown that the underground cable faults may have several forms; accordingly, it can be classified into

### A. Cable Faults due to Cable Insulation Failure

This type is a commonly occurred and it is due to the insulation breakdown between phases to earth or between phase to phase, this breakdown may be due to different causes which summarized into:

- Insulation defects during cable manufacturing: The defects may be due to existence of air voids or impurities inside the insulating material, unsymmetrical insulation layer thickness or unsymmetrical semi-conducting material layer thickness. This resulting in a non-uniform electric field distribution inside or at the insulation surface, creating high stressed points leading to partial discharge (PD) activity, creating channels of carbonization with branch-like structure resembling a tree. Once an electrical tree grows big enough and bridges the electrodes of the cable system, the cable insulation will break [4] as shown in (Fig.1).
- Conductor defects during cable manufacturing: The cable conductor may have a bad welding during its manufacturing process which leading to a bad contact resulting arcing and raising the temperature at the