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A.6.1. Effets des essais sous tension continue sur les câbles à isolation polyéthylène réticulé

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A.6.1. Effect of DC testing on XLPE insulated cables

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Abstract—The effect of dc testing on the life of crosslinked polyethylene (XLPE) insulated cables is discussed in this paper. The cables were aged in the laboratory under accelerated conditions until failure. The effect of dc testing on cable life prior to aging, during aging, and after aging to failure was investigated. Results infer that dc testing at 40 kV has a deleterious effect on the life of aged XLPE insulated cables. A hypothesis is presented which explains the effect of dc testing on XLPE insulated cables. It states that the effect of dc will depend upon the dielectric strength of the cable after aging, at the time of dc application.

Abstrait—Cet article traite de l'effet du test c.c. sur l'espérance de vie de câbles isolés au polyéthylène réticulé chimiquement (PRC). Les câbles furant vieillis de façon accélérée, en laboratoire, jusqu'au claquage. L'influence du test c.c. sur la vie des câbles avant et après vieillissement, et aussi après vieillissement jusqu'au claquage a été étudié. Les résultats indiquent que le test c.c. à 40 kV a une influence néfaste sur la vie de câbles PRC vieillis. Une hypothèse est avancée pour expliquer l'effet du test c.c. sur les câbles PRC. Elle établit que l'effet du test c.c. dépend de la rigidité diélectrique du câble après vieillissement au moment de son application.

I. INTRODUCTION

Electrical tests are performed on freshly manufactured cables to gain confidence that such cables will perform reliably under normal load conditions. The three main types of tests that are applicable in the industry are: ac voltage testing - to assure satisfactory service performance; partial discharge testing - to detect gross imperfections such as blisters and voids; and dc voltage testing - which is sensitive to damage due to knife cuts and punctures in the insulation. The dc voltage method is effective because it causes a high stress at the point of damage. Although this test method has several advantages, there are limitations to adopting this procedure universally, particularly on aged crosslinked polyethylene cables. The advantages and disadvantages, as well as the history of dc testing has been presented in detail (1). It has been shown that ac breakdown strength as measured via a 10 minute step rise test on laboratory-aged cables could not be used to definitively determine the effect of dc testing on crosslinked polyethylene cables. The results showed that some samples subjected to dc testing started to fail sooner (during ac aging) than the control samples being aged without dc application.

To seek to understand why dc testing was affecting the life of accelerated aged XLPE-insulated cables without having any clear effect on the 10 minute step rise ac breakdown strength, a program was initiated which involved samples aged to failure in the laboratory under accelerated conditions followed by splicing of the aged sections (after removal of the failure region) to unaged cable. The initial results of this effort (2) are highly suggestive of dc causing a latent problem, influencing the life of the spliced system upon continued accelerated aging.

Additional spliced cable aging tests have been performed and results are reported in this paper. Statistical analysis of the results obtained on samples subjected to dc testing during aging are also discussed here. The work was performed by Detroit Edison Company under a research contract from Electric Power Research Institute, project RP 2436-01.

II. EXPERIMENTAL CABLE MANUFACTURE AND SAMPLE SELECTION

The cable construction was a typical underground residential design (URD): 1/0 AWG stranded aluminum conductor, .43 mm (17 mil) average wall semiconducting thermosetting strand shield compound, 4.4 mm (175 mil) average wall crosslinkable polyethylene insulation compound, .75 mm (30 mil) average wall black semiconducting thermosetting insulation compound, 6 #14 concentric neutral wires equally spaced. The cable manufacture, sample selection, and initial characterization are described in [1]. The samples came from a single extrusion run and specimens for individual tests were selected from a large population which was devoid of any large protrusions and contaminations. The cable passed the tests done at the factory according to AEIC 5-82 requirements [4]. Also, the initial characterization tests performed in the laboratory showed the cable to be of good quality [1]. The manufactured cable was not tested with dc at the factory.

III. AGING PROTOCOL TEMPERATURE PROFILE

Aging was performed in the laboratory under accelerated conditions: 60 Hz power frequency, 6 kV/mm (150 V/mil) voltage stress, and conductor temperature load cycled with 8 hours on and 16 hours off. Local tap water was maintained at the conductor and the outside of the samples. Aging was performed in a PVC pipe having an inner diameter of 76 mm (3 inches). A 90° C temperature was sought at the conductor of the cable portion which was outside of the pipe by passing current through the conductor. (The temperature measured was 89° C.)

IV. AGING PROTOCOL/SPLICING

This test program is an attempt to simulate what occurs under the field conditions: When a cable fails in service, the failed section is removed and in its place a new cable piece is spliced to the remaining old aged section. Before the system is returned to service, the normal practice is to proof test the cable