

INSULATION STATE ANALYSIS AND UPGRADING FEASIBILITY STUDY OF EXISTING AC 10KV XLPE DISTRIBUTION CABLES IN JIANGSU GRID OF CHINA

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ABSTRACT

This paper assesses the insulation state of existing AC 10kV XLPE distribution cables in Jiangsu province and analyzes the feasibility of 10kV grid to be upgraded to 20kV. Score system is established mainly based on the breakdown voltages of sample existing cables, also on dielectric loss angle tangent and aging factor. This system is then used to assess and grade the insulation state of existing 10kV XLPE cables in Jiangsu area. By voltage endurance coefficient and breakdown field strength measurement, remaining life expectancies of 10kV cables are checked before they are upgraded to 20kV. Besides, new and old 10kV cables are tested by 20kV voltage class criteria. At present, several 10kV power circuits have put into test run under 20kV.

KEYWORDS

Existing AC 10kV XLPE cable, Insulation state assessment, Upgrade feasibility analysis, Score system, Remaining life expectancy, test run

1 INTRODUCTION

In recent years, China economy has kept developing rapidly. Urban expansion, industrial zone establishment and demand growth require enhancement of the reliability and capability of power supply in metropolis. There are about 85,000 circuits of AC 10kV XLPE distribution cables in China Jiangsu province, and the total length is approximately 22,000km. For existing cable grid it is essential to analyze its insulation state and assess remaining life to learn its operational reliability. When the requirements are not met, it is needed to reform an existing circuit or build a new one, but this means a vast investment, and it is hard to carry out infrastructure work in the densely populated city zone. A feasible approach is to change parameters of existing circuits to enhance their capabilities, that is, to transmit more power by increasing the voltage grade of distribution grids.

If it is feasible to upgrade existing distribution cables in large-scale depends on several issues, including the use margin of cables, the improvement of insulation quality, the design level of cable structure, the installation and operation condition of cables and etc. All these issues need to be researched systematically to study the operational status of existing cables, and to predict the remaining life under certain circumstances.

Draft report of WG B1-09 "Remaining Life of Existing AC Underground Lines" and draft report of WG B1-11 "Upgrading and Upgrading of Existing Cable Systems" are outcomes of CIGRE SC B1 after systematical research on remaining life assessment and upgrading and uprating techniques of existing extruded insulation cables, which provide basis and reference program for cables condition assessment and analysis [1-2]. But it is needed to be researched according to reality in Jiangsu power system if these programs are applicable or not to 10kV cable grids, and in application which specific issues should be

considered.

Cable design life depends mainly on the characteristics of insulation material used. It is the basis for existing cable state assessment to obtain corresponding checking parameters. Breakdown tests are used to explore the influence of material, technology and environment on cable electrical life, and to gain voltage endurance coefficient and breakdown field strength.

Existing cables have different run length, operating environment, failure and load history and etc. Quantifiable non-destructive evaluation parameters and classification standards are essential to carry out cable remaining life assessment in large scale. Referring to the research outcomes of CIGRE SC B1 on remaining life assessment of existing AC underground lines, and combining the operation and maintenance experience in Jiangsu province and elsewhere with test data in this research, score system for cable status evaluation is established to carry out general survey on existing cables in representative regions. Based on survey results, cables are assessed and classified on their insulation states, and the distribution is presented.

According to the research results of existing cable insulation state, this paper analyzes the feasibility of existing 10kV cables to be upgraded to 20kV, and gives the remaining life expectancies of cables when the circuits are grounded in different ways. In following study, 10kV new and existing cables pass the tests of 20kV voltage class criteria. Based on the researches above, several 10kV circuits are put into test run under 20kV, and this will provide useful experience for distribution cable systems to be upgraded.

2 INSULATION STATE EVALUATION AND CLASSIFICATION OF EXISTING DISTRIBUTION CABLES

In researches on insulation state of existing AC 10kV XLPE distribution cables in Jiangsu power grid, 410 samples are taken from 91 random pieces of cables, among which 23 pieces are new cables, and the rest are old ones. These cable samples, from power circuits in different laying condition and operation environment, represent overall status of cables in Jiangsu power grid.

A series of electrical tests, including breakdown voltage, insulation resistance, dielectric loss angle tangent, isothermal relaxation current and water tree aging measurements are carried out to check cable electrical insulation performance, and to explore the potential insulation margins.

2.1 Comprehensive Analysis on Sample Appearance Features, Laying Conditions and Electrical Performances

Data of 10 samples are listed in Table 1, including cable types, run lengths, dielectric loss angle tangents under