B.2.4. Dimensionnement et installation de câbles 22 kV pour le métro de Londres

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Résumé

London Underground Ltd a mis en route un certain nombre de projets importants visant à améliorer et étendre son réseau électrique y compris l'installation de nouveaux câbles 22 kV.
Le présent document décrit l'étude du système, les considérations de sécurité incendie, la conception des câbles et l'expérience relative à la réalisation d'un grand projet. Etant donné les difficultés d'accès aux tunnels, facilité et rapidité de montage ont été un facteur déterminant pour le choix d'un câble unipolaire à isolation EPR.
La conception du câble, qui n'intègre pas de barrière d'étanchéité, tient compte des résultats d'essais de court-circuit pour garantir la sécurité du câble suspendu en trèfle dans des conditions sévères de court-circuit.
En final, la fourniture de jonctions capables de donner les mêmes garanties de résistance au feu a été nécessaire.
Cette expérience, faite sur une installation de plus de 100 km de câbles, montre que les paramètres relatifs à la conception des câbles sont conformes aux exigences souhaitées à savoir facilité et rapidité d'installation des câbles unipolaires.

B.2.4. Design and installation of 22kV power cables for LUL

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Abstract

London Underground Ltd. are carrying out a number of major projects to upgrade and extend their electrical supply including installation of new 22 kV supplies.

This paper describes the system design, fire safety considerations, cable designs and installation experience on one major project. Due to limited access in the underground tunnels, ease and speed of installation has been a major factor leading to the choice of single core EPR insulated cables.

Type testing of the designs which do not include a water barrier is discussed together with the results of short circuit tests to prove the safety of a cable hanger installation of trefoil groups under onerous short circuit conditions.

To complete the cable system, supply of joints able to meet similar fire performance requirements was necessary.

Actual experience based upon the installation of over 100km of cable shows that cable system design parameters have been met and that the predicted advantages in ease and speed of installation of the single core cables have been achieved.

Introduction

London Underground's power distribution system consists of a primary 22kV distribution ring, fed from its own power station inputs at Lots Road and Greenwich and bulk supply points fed from the local electricity company at Neasden, Old Oak Common and Mansell Street. Transformation is then made at a number of main switch houses from 22kV to 11kV for secondary distribution and at further substations from 11kV to 415 volt 3 phase for local supplies or by transformation and rectification to 650 volts DC for traction power supplies. The total circuit length of 22kV cable is approximately 560 kilometres of which approximately 100 kilometres are within the tunnel sections of the underground railway system. All cabling within the tunnel sections of London Underground system must meet stringent fire safety requirements to ensure the safety of customers and staff.

System Design

The design of the 22kV cable distribution system, its extension or renewal, must take into account cable loadings, voltage regulation, short-circuit ratings, and reliability indices. The railway operations requires that the design shall provide secure supplies within a voltage tolerance of +6% and -10% under full load within the range of rated generation voltage and with any single circuit outage. In addition a complete sub-station outage must be able to be tolerated in the HV distribution system under maximum load assuming that sharing of its load will be via adjacent substations. Because of the physical proximity of double circuits in some locations on the railway, the design has to take account of the design voltage drop of less than 10% occurring if both double circuits fail at the same time.

The feeding arrangements from either the bulk supply points or LUL's own power stations result in maximum through fault levels of the order of 25 KA rms and the system must withstand these short-circuit levels. Typically, load and short-circuit levels require cables of between 95 mm^2 and 300 mm^2 cross section to be used. The system design includes neutral earthing resistance arrangements that produce a maximum earth fault current of 4.5KA for 1 second duration.

The cable route configuration is very complex in the London Underground railway system which consists of both small bore deep tube tunnels, cut and cover sections and surface sections. The surface sections of the cable route represent the least onerous constraints on design. Although complex, in that the route has sections where the cable will be ducted, directly buried, supported on wall brackets, or supported on a purpose-built post and rail system, the additional constraints of the underground sections do not exist. It is of note that in bracket mounted cable runs within London Underground the brackets are traditionally cast iron, now becoming fabricated steel, provided with plain or slightly curved supports approximately 120 mm wide with centre to centre spacing of between 1.2 and 2.4 metres. On straight, level runs the cables are not fixed to any of these supports and cleating only occurs at joint positions or at significant curves or changes of direction within the run.