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### Technical advancements in the underground medium voltage cable specifications of the USA largest investor owned utilities

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#### Abstract

This paper discusses the technical advancements in medium voltage (15-35kV) underground insulated power cable specifications for the largest investor-owned utilities (IOU's) in the USA. The data was obtained by analyzing current and past technical specifications of forty-five of the largest IOU's. The utilities were selected on the basis of the number of customers served. Special consideration was given to specification preferences for solid or filled conductors, insulation and conductor shield, extrusion and curing methods, metallic shield type and jacket type and material. The analysis provides meaningful information that will enable electrical utilities to evaluate their medium voltage underground cable specifications and practices in comparison with those of the largest utilities in the USA.

#### Résumé

Cet article fait état des progrès techniques accomplis sur les spécifications des câbles moyenne tension souterrains (15-35 kV) par les plus importantes compagnies d'électricité aux États-Unis (IOU's). Les données furent obtenues en analysant les spécifications techniques actuelles et passées de quarante cinq des plus grandes IOU's sélectionnées sur la base du nombre de client desservi. Une attention particulière a été accordée pour les spécifications basées sur les âmes conductrices bourrées ou solides, les composés d'écran de l'isolant et de l'âme, les méthodes d'extrusion et de réticulation, le type de neutre en cuivre et, le type et matériau de gaine. Les informations présentées fournissent des résultats significatifs qui permettront à toutes les compagnies d'électricité d'évaluer leur propre spécification sur les câbles moyenne tension souterrains et leurs pratiques d'exploitation comparativement à celles des plus grandes compagnies aux États-Unis.

#### Introduction

High molecular weight polyethylene (HMWPE) was first introduced in the USA as a commercial insulating material for medium voltage (15-35kV) underground power cables more than thirty-five years ago. The low cost of HMWPE, combined with outstanding dielectric properties for use in insulated conductors, generated a dramatic expansion of underground

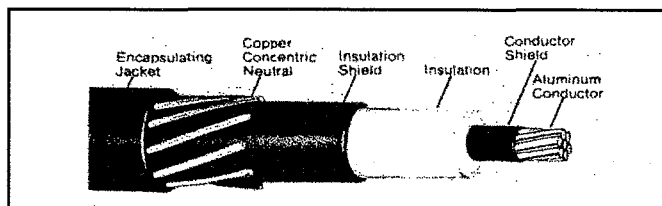


Fig 1. Typical Medium Voltage Underground Cable

utility installations that has lead to the installation of more than one million miles of underground distribution cables by the nearly 1500 utility companies across America. Fig. 1 shows the construction of a typical medium voltage cable design used for distribution circuits in the USA.

When early cables began failing prematurely, the cable manufacturing industry was challenged to diagnose the causes and find corrective solutions that would give utilities the confidence to continue their commitment to underground cable. During the past 35 years, there has been constant improvement in underground cable material and design, and in cable manufacturing and installation practices. Throughout this period, utility industry cable specifications have been revised to take advantage of this progress. This has led to today's highly reliable medium voltage (15-35kV) underground distribution electrical cable systems.

The underground insulated power cable specifications of the largest USA investor-owned utilities (IOU's) were analyzed to determine the technical trends for the design, installation and use of 15kV to 35kV underground power cables. It was felt that this information would be useful in assisting all electrical utilities to evaluate their medium voltage underground cable specifications and practices in comparison with the largest USA utilities. The results are discussed in this paper.

#### Utility Selection And Data Acquisition

Approximately one-third of the one hundred eighty-five total investor-owned utilities listed in the Edison Electrical Institute 1998 Catalogue of Investor-Owned Utilities [1] were surveyed. Since each of these utilities serves a large customer base, has significant quantities of underground cable miles installed, and are most likely to have representatives on industry standards making organizations, it was felt that they would most likely be the first to incorporate new technical advancements into their purchase specifications.

Each utility was requested to furnish specification data for design, materials, and processing parameters used for 15 to 35kV underground distribution power cables. Data was requested in nine specific areas. These included: (1) use of filled strand and solid conductors, (2) conductor shield materials, (3) insulation materials, (4) cable extrusion method, (5) cable curing method, (6) metallic shield design, (7) jacket type and material, (8) use of water blocking filler or tape and (9) cable acceptance reports and tests.

Since utility specifications could differ between cables operated at 200 A (4/0 and smaller conductors) and those energized at 600 A (4/0 and larger conductors), companies were asked to