

Cable Lore

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CABLE EXCELLENCE

A long time ago Publius Syrus stated that "it is a bad plan that admits no modification." He added that "it takes a long time to bring excellence to maturity." These philosophical quotations offer a cable engineer both challenge and encouragement.

A challenge because a perfect cable does not exist—no individual or group claims total knowledge of cable application parameters and concepts.

Encouragement because excellence is possible and can grow in degree. Excellence in this instance would be a cable having or approaching characteristics considered ideal according to the latest cable technology.

Reflection on the flow of research and development during the past half century, will put into perspective this quest for excellence. We will use medium voltage solid dielectric power cable as an example.

Historical Reflections—A Case Study

Cable engineers involved with solid dielectric medium voltage power cable in the 1930's were deeply engaged in obtaining insulations which by today's standards offered only a limited degree of ozone resistance, modest thermal properties, and only adequate electrical characteristics. Cable designs were relatively unsophisticated and bulky and generally limited to relatively low voltages.

The next decade bore fruitful results. Synthetic polymers with a more favorable chemistry than natural rubber yielded, for the first time, compounds with inherent ozone resistance. Thermal characteristics at both low and high extremes were much improved, physical properties were advanced and electrical properties improved.

The new compounds, for the most part, were introduced into cable concepts prevalent during the previous decade. Solid dielectric medium voltage power cables were underway.

The promise of new and better synthetic polymers spurred R&D activity in the '50's. Properties of compounds were optimized. Design concepts included the use of semi-conducting tapes for conductor and insulation shields. Attention was given to the detrimental effect of voids in power cable insulation; corona discharge measuring techniques were introduced to determine their presence. The utilization voltage of solid dielectric cables was increasing. The decade from 1960 to 1970 was an extremely busy period in medium voltage power cable development. Factors that accelerated this development were many:

- The trend from overhead to underground distribution.
- Customer demands for maximum reliability.
- New materials with excellent electrical properties.
- Advances in the art of processing.
- A need for reduced cable dimensions.

New cable concepts and materials were introduced during the 1960's. Two outstanding features in cable design were Anaconda's UniBlend concept and URD (underground residential distribution) cables. The UniBlend concept offered a smooth round electrode, with special attention to homogenous and clean insulations and improved processing techniques. URD cables provided a new look in shielding systems and utilized extruded semi-conducting extrusions in intimate

contact with the insulation and copper drain wires.

Utilization of the UniBlend and URD concepts in medium voltage cable design contributed significantly to:

- Maximum performance of a specific insulation.
- Improvement in corona levels.
- Streamlined and simplified cable designs.
- Reduction in cable dimensions.

In Pursuit of Cable Excellence

A review of medium voltage power cable design and performance over the past half century brings into focus cable characteristics, concepts, materials and evaluation techniques that provide reference points for cable excellence.

Quantitative evaluation of resources available in the 1960's indicated that these goals were within reach, for example:

- Ethylene propylene rubber (EPR) insulation offered unprecedented ozone resistance.
- EPR insulation exhibited electrical properties in line with those exhibited by paper-oil combinations.
- The UniBlend concept contributed a round smooth electrode.
- EPR insulation was excellent in both low and high temperature properties.

- The UniBlend concept introduced a new era of compound cleanliness.
- Highly sensitive corona detection equipment became available for sophisticated evaluation of cables.

In the mid-1960's, an imaginative combination of these resources provided a new power cable concept called "UniShield"—cable core excellence combined with excellence in the shielding system.

Over 5 years of cable development covering a broad spectrum of activity, as well as test and manufacturing equipment design, made UniShield cable a commercial reality in 1970.

Since its introduction, UniShield medium voltage power cable has proved to be a good example of Publius Syrus's philosophy on excellence.

In the years since 1970, UniShield and its method of manufacture have been continually refined to improve UniShield's reliability, cost effectiveness and safety. For example, an optional jacket was developed that provides additional flame retardant properties. This jacket enables UniShield to pass IEEE's 383 vertical tray flame test at the 210,000 btu level.

UniShield is but one example of the continuing effort required to reach and to maintain excellence in all types of cable in the face of rapidly changing technology. ≡