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(HIGH PRESSURE FLUID FILLED) PIPE-TYPE CABLES

by OKONITE

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Pipe-type

The purpose of this brochure is to acquaint the reader with “Pipe Type Cables” which are by far the most common type cables utilized in the USA for underground bulk power transmission in the 69kV through 345kV voltage range. These cables have provided exceptionally reliable trouble-free service over a period of seven decades and continue this unequaled performance into the new millennium.

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introduction

Pipe-type

In 1931 Okonite pioneered and developed a new type of cable system for high voltage underground power transmission circuits. The system was so unique that it was patented and registered under the trademark Oilostatic®.

The system was based on the principle of utilizing a rugged quarter-inch thick coated steel pipe for mechanical protection and long life. Into this pipe were pulled three impregnated paper insulated cables and the system filled with a high dielectric strength insulating liquid pressurized at 200 psig.

A pilot experimental circuit 2000 feet long and operating at 69kV was installed and placed in service in 1932 at the Plymouth Meeting Substation of the Philadelphia Electric Company.

In 1935 the first commercial installation consisting of a three mile long circuit operating at 138kV was placed in service by the Pennsylvania Railroad in Baltimore, Maryland

The usage of this type of system rapidly accelerated in the 1940's, and it quickly became the system of choice for reliable underground transmission of large MVA rated power circuits at high voltage levels.

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background

In the early years, while the patent was still in effect, Okonite licensed other manufacturers to produce this type cable and it became generically known in the industry as High Pressure Oil Filled (HPOF) Pipe Type Cable. In later years this name changed slightly to High Pressure Fluid Filled (HPFF) Pipe Type Cable.

In 1941, a modified version of this system known as High Pressure Gas Filled (HPGF) Pipe Type Cable was introduced into the industry. This system utilized a pressurized gas (nitrogen) filled pipe instead of the fluid filled pipe.

In 1955, the first Oilostatic system at the 230kV level was supplied by Okonite to the Sao Paulo Light & Power Company Limited and placed in service at the Cubatao Power Plant in Brazil. In 1963 these Oilostatic type cables were supplied by Okonite and other manufacturers to Consolidated Edison Company of New York, Inc. for their underground large capacity 345kV transmission system. Okonite has supplied by far, the major portion of these 345kV cables.

Pipe-type

Throughout the years Okonite continued to further improve these pipe type cables by pioneering and developing new innovations. A premium type of polybutene impregnant was adopted in the early 1960's to provide the greatest resistance to the effects of heat and oxidation and long term stability over the life of the cable. Zinc alloy shielding and skid wires were introduced to the industry in 1969 to provide optional equivalent lower cost materials to the earlier copper and brass materials.

From the early 1930's up until 1987 the cables were all manufactured with insulation consisting of impregnated paper tapes. In 1987 Okonite supplied the first commercial pipe type cable system insulated with impregnated laminated paper (LPP) tapes to Boston Edison Company for a 6 mile long 345kV 600 MVA circuit. A new trademark Oilostatic LPP® was registered by Okonite for this new improved pipe type cable system utilizing insulating tapes each comprised of paper and polypropylene components laminated together.

From the 1930's up to the start of the new millennium, a total of over 3200 circuit miles (9600 cable miles) of pipe type cables have been installed and placed into service and are still providing reliable service today. Of this total, Okonite has been the leader and predominant supplier of all these systems.

The variety of Okonite installed systems range from short substation runs of a few hundred feet to long double circuit transmission feeders of 7 miles. Conductors and voltages of all types ranging from 250 kcmil copper at 69kV to 2750 kcmil copper at 345kV and 300 kcmil aluminum at 69kV to 3750 kcmil aluminum at 230kV have been supplied over the years.

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background

Shipping reel lengths have ranged all the way up to the massive 7300 foot lengths of 2500 kcmil copper 1.025" paper insulation thickness 4.1" diameter 345kV HPFF cables supplied in 1978 to Con Edison of New York for their underwater Sands Point to Execution Rocks crossing and the 7400 foot lengths of 2250 kcmil copper .485" paper insulation thickness 3.0" diameter 115kV HPGF cables supplied in 2004 to South Carolina Electric & Gas for their Cooper River submarine crossing.

With the new type laminated paper insulation (LPP), Okonite has supplied over 1.5 million feet of cable since 1987 at voltages of 345kV - 230kV - 138kV - 115kV. This constitutes over 75 percent of the entire industry total of laminated paper insulated pipe type cable systems in service today.

Okonite's Paterson, New Jersey plant is the most modern facility and has the largest production capacity currently available in the industry for the manufacture of pipe type cables.

Pipe-type

The pipe type cable system in both HPFF and HPGF versions has many desirable features and advantages as follows:

1. Provides a highly reliable, simple, trouble-free system with a proven long term track record for new bulk power transmission circuits in the 69kV to 500kV range, as an alternative to solid dielectric cables.

2. Impregnated paper insulated pipe type cables have proven to be almost ageless in service life. No pipe type cable systems have been decommissioned due to age or problems with the impregnated paper dielectric. Many systems are still in service after the original 40 year design life.

3. There are approximately 4100 circuit miles of underground high voltage transmission cable in service in the U.S.A. Over 80% of this total is HPFF and HPGF pipe type cable.

4. Multiple layers of insulating tapes produce a uniform laminated insulation wall, minimizing effects of any abnormalities in the insulation wall, as compared to an extruded insulation solid dielectric cable.

5. Cable can be manufactured and installed in long lengths of 4000 feet and longer which minimizes the number of manholes, splices and cost.

6. Cable insulation materials and manufacturing processes have been refined to a high degree of quality and reliability for over seven (7) decades.

7. Pipe type cable splices and terminators have proven over many years of service to be exceptionally reliable and trouble-free, as compared to the more volatile track record of these accessiories on alternate type cable systems at these voltage levels.

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8. Provides extremely low magnetic field (1 to 2 milligausses) as confirmed by industry tests and data. This is substantially lower than 1/C solid dielectric cables installed in duct banks or direct buried.

9. No metallic type moisture barrier or sheath is required over the insulation of each 1/C cable as is necessary for extruded solid dielectric cables.

10. No special bulky sheath cross-bonding arrangements are required as on 1/C solid dielectric cables. No sheath sectionalizing joints, bonding leads, link boxes or sheath voltage lmiters are required. No standing sheath voltages to ground are present.

11. Eliminates need for breaking bonding connections in order to periodically test sheath insulation. This disconnecting and testing is necessary on 1/C solid dielectric cables to assure that no unintended grounds have occurred in service which could cause considerable sheath currents to flow, resulting in higher losses and overheating of cables.

12. High overload capabilities in emergency type situations, especially the HPFF system which has the capability of fluid oscillation or circulation for temperature averaging and circuit cooling.

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13. Built in ability for voltage and MVA uprating by reconductoring the existing pipe.

14. Pipe system is totally welded from end to end including the splice joint casings in the manholes, providing an exceptionally rugged very low maintenance system. The system is subjected to a simple, fool-proof series of vacuum and pressure tests during original installation.

15. Only one 6” or 8” pipe is required for the 3 phase circuit instead of 4 individual 5” or 6” ducts in a bulky concrete encased duct bank. This small trench requirement is particularly significant when threading new circuits through congested urban streets.

16. Pipe type cable systems are very competitive, on an installed cost basis, with solid dielectric cable systems in concrete encased duct banks.

17. Pressurization at 200 psig of the dielectric fluid in HPFF systems and nitrogen gas in HPGF systems prevents ionization in service under normal and emergency operating conditions.

18. Real time monitoring of the cathodic protection system has recently been developed which even further enhances the reliability and minimizes the already low maintenance of these systems.

19. Manufacture and testing is tightly governed by the longstanding industry standard AEIC CS2-97 “Specification for Impregnated Paper and Laminated Paper Polypropylene Insulated Cable High-Pressure Pipe- Type”, 6th edition dated March, 1997.

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features & advantages

20. The laminated paper polypropylene (LPP) cables were proven by extensive Okonite testing to have exceptional reliability under extreme operating conditions that are far beyond the AEIC CS2-97 requirements. The results of these unique extended tests were presented at industry IEEE Insulated Conductor Committee meetings and are published in the Spring and Fall 1992 Minutes of the ICC.

21. These cables can be overinsulated to allow future operation at a higher system voltage. A number of circuits have been installed in this fashion and operated at a lower voltage initially for years and then later switched to the higher operating voltage when greater MVA system capacity was required of the feeder.

22. Manufactured in the U.S.A. in the largest capacity, most modern paper cable plant at Paterson, New Jersey. Engineering, installation and technical assistance are always readily available.

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Okonite has for many years manufactured and supplied numerous pipe-type cables in the 69kV through 345kV voltage range to the following customers.

AES/Warrior Run
Alabama Power
All Florida Electric
Amoco
Aramco - Saudi Arabia
Baltimore Gas & Electric
Bechtel
Black & Veatch
Boston Edison Company
Brown & Root
Bureau of Reclamation
California - Depart. of Water Resources
Canadian - Brazilian Services Limited
Capitol District Energy Center - Hartford
Cambridge Electric Light & Power
Central Electric Power Cooperative
Central Hudson Gas & Electric
Central Power & Light
Cincinnati Gas & Electric
City of Cleveland, Ohio
City of Nashville, Tennessee
City of Jacksonville, Florida
City of Palo Alto, California
City of Tallahassee, Florida
Cleveland Electric Illuminating
Cogeneration Partners LP
Colorado Springs Utilities
Columbus & Southern Ohio Electric
Commonwealth Electric
Commonwealth Edison
Con Edison of New York
Connecticut Light & Power
Croft Mullins Electric
Dallas Power & Light
Delmarva Power & Light
Detroit Edison
Dominion Resources
Duquesne Light
D.W. Close
Ebasco Constructors
Electrical Constructors
Eisenman & Elliott
Exelon
Exxon
Florida Power & Light
Fluor
Georgia Power
Gilbert Associates
Gulf States Utilities
Harada
Hoffman Electric
Houston Lighting & Power
International Transmission Company
Iowa Illinois Gas & Electric
Jacksonville Electric Authority
Kansas City Power & Light
KeySpan Energy
Korea Electric Power
Linden Cogeneration Technologies
Long Island Lighting
Lord & Mass Electric
Los Angeles Depart. of Water & Power
Louisville Gas & Electric
Lumen Alltech
Madison Gas & Electric
Massachusetts Bay Transit Authority
Massachusetts Electric
Memphis Light Gas & Water
Narragansett Electric
NASA Langley Research Center
Nashville Electric Power Board
New Bedford Gas & Edison Light
New England Electric Service
New England Power
New York Power Authority
New York State Electric & Gas
Niagara Mohawk
Niagara Power Project - N.Y.
Northeast Utilities
Northern States Power
Novatny Electric
NSTAR
Orange & Rockland Utilities
Orlando Utilities Commission
Pacific Gas & Electric
Parsons Main
Paxson Electric
PECO Energy
Pennsylvania Railroad
Philadelphia Electric
Pirelli Cable Corporation
Potomac Electric Power
Pritchard Corporation
Public Service Company of Colorado

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Public Service Company of Northern Illinois
Public Service Electric & Gas
Puerto Rico Water Resources Authority
Rio De Janiero Traction Light & Power - Brazil
Rochester Gas & Electric
Sacramento Municipal Utility District
Saint Lawrence Power Authority
Sao Paulo Light & Power - Brazil
Santee Cooper
Savannah Electric & Power
Seattle City Light
Shelby Electric
Shrewsbury Light
Southern California Edison
South Carolina Electric & Gas
Southeastern Control & Cable Testing
Southwestern Public Service
Stone & Webster
Tampa Electric
Town of Braintree, Massachusetts
Texas Utilities Electric
United Illuminating
U.S. Army Corps of Engineers
U.S. Department of Energy
U.S. Navy Aeronautical Turbine Lab
Utah Power & Light
Utec Constructors
Vermont Electric
Virginia Electric Power
W.A. Chester, LLC
Western Massachusetts Electric
Westinghouse Electric Supply
Westinghouse International - Indonesia
Wisconsin Electric Power
Wisconsin Energies

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experience record

Pipe-type

OKONITE 345kV OILOSTATIC® AND OILOSTATIC LPP® SYSTEM EXPERIENCE RECORD

Okonite has been the predominant supplier of the highly reliable HPFF and HPGF pipe type underground transmission cables. Numerous circuits are in service at many utilities throughout the United Stated totaling thousands of conductor miles at all voltage levels from 69kV through 345kV inclusive. Records of all these various installations were kept for many years through the 1960s but they became so common and voluminous at the lower voltage levels that the listing of installations was only continued for the higher voltage 230kV and 345kV systems. The Okonite record of 345kV installations is:

Customer	Linear Footage	Conductor Size kcmil	Insulation Thickness	Year
Consolidated Edison Co. of New York, Inc.	634,000	2000	1.025”	1964 to Present
Consolidated Edison Co. of New York, Inc.	63,000	2500	1.025”	1964 to Present
Duquesne Light Company, Pittsburgh, PA	282,000	2500	.920”	1979
Niagara Mohawk, Syracuse, NY	13,000	2500	.920”	1980
U. S. Department of Energy, Piketon, OH	50,688	1000 (Aluminum)	1.035”	1981
Public Service Electric & Gas Co., Newark, NJ	90,288	2500	.920”	1982
Public Service Electric & Gas Co., Newark, NJ	47,520	2000	.920”	1982
Long Island Lighting Company, Mineola, NY	60,192	2500	1.035”	1983
Boston Edison Company, Boston, MA	4,752	2500	.920”	1983
Boston Edison Company, Boston, MA	101,376	2000	.650” (LPP)	1988
Boston Edison Company, Boston, MA	71,280	2250	.600” (LPP)	1989
New York Power Authority, Long Island, NY	161,568	2500	.600” (LPP)	1990
Ebasco (Cogen Technologies), Linden, NJ	23,760	2500	.600” (LPP)	1992
Narragansett Electric Company, Providence, RI	218,592	2750	.600” (LPP)	1994
Consolidated Edison Co., of New York, Inc.	9,504	2000	.905”	1994

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Customer	Linear Footage	Conductor Size kcmil	Insulation Thickness	Year
Commonwealth Edison Company, Chicago, IL	120,384	2500	.600” (LPP)	1995
Consolidated Edison Co., of New York, Inc.	10,020	2500	.600” (LPP)	2000
Boston Edison Company, Boston, MA	63,726	2250	.600” (LPP)	2000
Boston Edison Company, Boston, MA	82,253	2500	.600” (LPP)	2001
KeySpan Energy, Hicksville, NY	127,065	2500	.600” (LPP)	2001/2002
Public Service Electric & Gas Co., Newark, NJ	36,399	2500	.600” (LPP)	2002
Consolidated Edison Co. of New York, Inc. NY	75,960	2500	.600” (LPP)	2002/2003
Detroit Edison, Detroit, MI	2,299	2500	.600” (LPP)	2003
Commonwealth Edison Company, Chicago, IL	101,070	2500	.600” (LPP)	2003/2004
International Transmission Company/ Black & Veatch, Detroit, MI	124,560	2500	.600” (LPP)	2004/2005
New York Port Authority, White Plains, NY	7,800	1000	.680” (LPP)	2004
Consolidated Edison Co. of New York, Inc., NY	6,000	2500	.600” (LPP)	2005
Northeast Utilities/W. A. Chester Bethel-Norwalk, CT	309,342	2500	.600” (LPP)	2005/2006
TOTAL LINEAR FOOTAGE	**2,898,398**			

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customers

District Offices, Manufacturing Plants & Service Centers

*Ashton, R.I.

*Orangeburg, S.C.

*Orangeburg, S.C - Compound Facility

Paterson, N.J.

*Richmond, Ky.

*Santa Maria, CA.

*Qualified to provide nuclear Products

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