



High Voltage Systems

System Solutions and Innovation

Prysmian is the world leader in the energy cable systems market thanks to its innovative technological approach and to its capability in maintaining cost leadership, together with a strong commitment to Research and Development. Extensive research has been conducted by Prysmian to provide solutions, which fully meet customers' requirements, with a strong focus on the development of competitive and reliable underground systems.

Prysmian dominates the technology scenario in all phases of power circuits development: engineering, design, production, installation and maintenance, a turnkey approach, that covers the asset's entire lifetime and provides customers with the benefits of a lower total cost of ownership of the system.

Major Utilities are currently installing Prysmian power transmission solutions and exploiting their benefits.

> AIR BAG™ Cable System

Prysmian has patented an innovative polymeric mechanical protection system for cables, which, with accessories and installation aspects, has been developed into a full system approach.

The totally polymeric protection employed in the **Air Bag™** cables absorbs impacts and reduces the risk of permanent deformations and damage, thus protecting the sensitive underlying cable layers.

Air Bag™ cable designs generally have reduced weights and dimensions, which provide for significant economic advantages in terms of total system cost, allowing easier handling and longer delivery lengths, with a subsequent reduced need for cable joints.

> Real Time Monitoring Systems (RTMS)

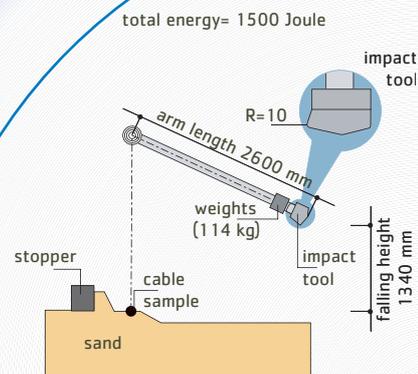
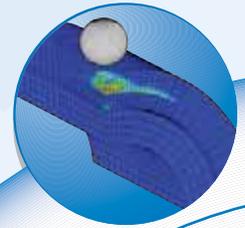
Performance management systems are a key part of the full system approach offered by Prysmian, which enable the acquiring of the maximum knowledge and optimised use of installed cable systems. RTMS allow real time management of cable systems with the monitoring of the circuit and its environment, which after necessary data processing, enables the status and predicted behaviour of the circuit to be determined. There are four base modules:

RTTR, for measuring and evaluation of circuit conditions in real time with indication on optimisation of cable loading.

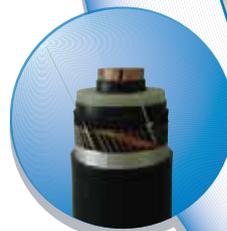
Fault Location for the localisation of faults' position using either temperature increase (RTTR) or Water Penetration Monitoring.

Circuit Diagnostics for monitoring of various circuit parameters such as partial discharges or TanDelta variation, valuable for optimisation of system use.

RTMM, for monitoring and evaluating mechanical stresses for prediction of cable fatigue life.



UNDERGR



OUNDING

> Dry Design Terminations

The most recent technological innovation developed by Prysmian for HV outdoor terminations is a new type of filling medium that replaces the traditional silicon fluid.

The new patented medium is a special environmentally friendly silicone-based compound that becomes partially "solid" - but still "flexible" - within a short time after the filling of the termination. The compound proves to be leak-proof, does not require maintenance nor fluid monitoring and remains sufficiently elastic to withstand even the highest difference in temperature, thus guaranteeing its full reliability.

> Speed line joints

As part of its continuous commitment to innovation Prysmian has developed a new generation of HV joints following the "MV joints" approach, with both industrial and jointing operations simplified.

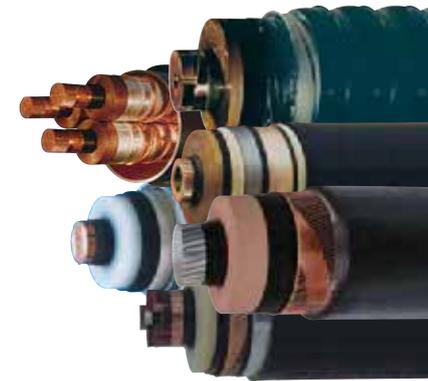
The new cold-shrink design "Speed" joints, available for 60 kV and 110 kV voltage classes, are delivered to the final customers with the rubber mouldings already expanded (in the factory) over the carrier tubes. This guarantees the full reliability of the product, plus several extra advantages, most of all an easier and faster installation as no specific tool is required for the installation.

> Installation Techniques

One of the key advantages of the **Air Bag™** Cable System is related to installation: **Air Bag™** cables can be laid in compact trenches with no special backfill requirements or alternatively directly with micro-tunnelling or fully mechanised laying techniques, all of which allows a quicker, easier and more cost effective installation.

> Zero Electro Magnetic (Zem) Shielding

Prysmian can provide support on the requirements on the management of electromagnetic fields with proprietary shielding solutions, which reduce levels to values very close to Zero.



About us

Prysmian Cables & Systems is a world-class multinational company. Founded in 1872 as "Ditta Pirelli & C.", it has achieved a leading position for more than a century of operations in its two key international markets - "Energy Cables & Systems" and "Telecom Cables & Systems".

Prysmian Cables and Systems is the world's largest manufacturer of power and telecommunications cables, with 52 manufacturing facilities in 21 countries in five continents and a market share in excess of 10%.

Prysmian Energy Cables and Systems is a global solutions provider, offering a wide range of integrated solutions, such as cable systems, system design and engineering, project management, installation and post-sale services.

Prysmian Energy Cables and Systems concentrates on continuous product innovation and on achieving a competitive edge by focusing on research and development. This is done through Prysmian's own R&D centres and by co-operating with universities, scientific institutions and above all, our customers. Prysmian's world-wide organisation makes and delivers advanced technological solutions to customers anywhere in the world.



Global Solutions Provider

The energy market has been changing dramatically, in recent years, as a result of deregulation and privatisation. To face the challenge of competition, energy transmission and distribution operators are driven towards an optimum use of their existing resources and new investments.

To support its customers, Prysmian has evolved over the years from the traditional role of cable manufacturer to that of a **Global Solution Provider**. Prysmian focuses on a total system approach, to give its customers the lowest cost of ownership of their new and installed cable networks.

This "Total System" approach is, at all voltages, the ultimate solution to provide power utilities with real advantages in terms of asset optimisation. Besides an increasing activity on product innovation to lower investment costs, Prysmian is developing additional pre and post sales services for its customers – e.g. network services, enhanced logistics, engineering studies – to optimise asset management and give the best possible exploitation of transmission and distribution networks.



Product Range

High Voltage cable systems form an integral part of electricity transmission and distribution networks throughout the world. Such systems, which have been traditionally installed in built-up areas in places with restricted space or in regions of natural beauty or ecological value where the use of overhead lines is

not appropriate, are today becoming more widely adopted. Prysmian, with its long and highly experienced history, continues to maintain and provide the complete range of products and services required for all fluid-filled and extruded High Voltage cable systems.

> Extruded Cable Systems

Prysmian produces extruded cables with either XLPE or EPR insulation material, using design and process technologies, which ensure continued service reliability and long term performance. Such cables can operate at elevated temperatures and under considerable electrical stress. Internationally, extruded cable systems operate up to U_m 525 kV. Extruded cables are usually lighter and easier to handle and extruded cable systems are generally designed to be maintenance-free. Dependent on the system requirements, these features present significant benefits in terms of total installed system cost.

Prysmian also offers a wide range of accessories for extruded cable systems, which ensures a consistent technological approach to the complete cable system. The range includes:

- Outdoor terminations with porcelain or composite insulators
- SF6 and oil immersed cable terminations (both dry and wet designs)
- Pre-moulded joints suitable for all installation environments and all cable designs
- **CLICK-FIT**® joints for factory-prepared cable heads and asymmetrical jointing
- Link boxes
- Further installation materials (cable cleats, earthing leads, etc.)
- Transition joints for interfacing extruded cable systems with both fluid filled and gas pressure systems

Prysmian also provides innovative cable solutions, for example the **Air Bag**™ Cable System, which optimise all stages of the system design, installation and services and provide considerable potential for reducing the overall system cost.

> Cable Design Main Features

| | |
|-------------------------------|---|
| Conductor | Cross Section: up to 4000 mm ² Copper: stranded, Milliken Aluminium: stranded, solid, Milliken |
| Insulation | XLPE SuperClean (dry curing and cooling) or EPR |
| Insulation technology | VCV (vertical line) CCV (catenary line) MDVC (horizontal line) |
| Metallic Screen/Sheath | Extruded (corrugated aluminium or lead alloy) Laminate (copper, glued or welded aluminium) Composite (copper wires + laminate/extruded) |
| Oversheath | MDPe, HDPe, PVC, LSOH |

> Turnkey Projects and System Management Services

The energy market has changed dramatically over the last years as a consequence of deregulation, privatisation and unbundling of generation and transmission. The new network owners mainly focus on the cost-effectiveness of their assets. This applies to new network investments but, certainly, also includes the optimisation of usage of the existing underground network.

The design of a High Voltage underground system is extremely important and requires an in-depth knowledge of cables, accessories, methods of installation and impact on the electrical network. Prysmian specialises in providing total management of major projects and offers to its customers a complete turnkey approach, from system planning to final testing and post-sale services.

Installation design and methods, co-ordination and scheduling of installation activities, are as crucial as the manufacture of cables and accessories to achieve a reliable and satisfactory connection. Prysmian operates to the highest accreditation and safety standards to meet the





> Fluid Filled Cable Systems

The Prysmian name has been synonymous with fluid filled High Voltage cable systems since it invented and introduced its range of products into service in the 1920s. With their proven electrical performance, life expectancy and excellent reliability record, these type of cable systems continue to meet the ever increasing demands of the world-wide transmission and distribution systems up to 1100 kV AC.

Prysmian supplies cables, accessories and services for all types of fluid filled cable systems, including the standard self-contained fluid filled cable designs (SCFF), which consist of a fluid impregnated paper dielectric contained within an extruded lead or corrugated aluminium sheath and finished to requirements, as well as the high pressure pipe type systems, both fluid-filled (HPFF) or gas-filled (HPGF), internally or externally pressurised.

With its long experience in the design and production Prysmian offers its own comprehensive range of High Voltage accessories for all fluid-filled cable systems, including transformer and switchgear terminations, outdoor terminations with porcelain insulators of various creepage distance, straight and stop joints - sectionalised or non-sectionalised - oil tanks, pressure monitoring and alarm equipment.

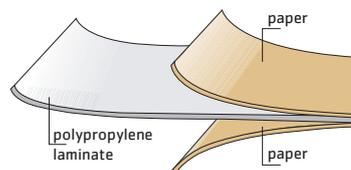
Prysmian also manufactures and supplies Polypropylene Paper Laminate (PPL) insulated cables to fulfil the latest specifications for higher capacity cables. These cables are based on the traditional fluid filled cable technology using a PP tape sandwiched within a conventional paper insulation tape. Such designs significantly increase the electrical and thermal performance of the cable and open new technological and economical possibilities to the system design process.

Services

demands of the most complex project environments. Turnkey approach, worldwide experience, top class customers references and strong focus on innovation represent the winning recipe that makes Prysmian the world leader in HV systems.

The effective management of the existing networks requires different knowledge and experience, as they are often of hybrid nature (fluid filled, gas insulated and XLPE extruded cables). Prysmian has been the first cable manufacturer to fully understand these changing needs of its customers and develop tailor-made service and product packages: from a full-proven range of transition joints to new tools for real-time network diagnostics, from the creation of a reference database to advise on cables' lifetime expectancy to new emergency service concepts.

Prysmian is committed to retain its traditional cable systems know-how, train and pass it on to its new generation of engineers and further develop products and services that assist its customers in managing their most precious asset: the existing cable network.



Total Quality Commitment



The Prysmian High Voltage Systems business unit is characterised by a competent and experienced approach to global turnkey solutions with improved research, engineering and manufacturing resources. Within the Prysmian Group, there are manufacturing facilities dedicated to the production of HV cables and accessories systems in 15 countries in all five continents and a single business unit, which gathers all critical functions in a co-ordinated management structure with common operative policies. The main advantages this organisation can offer are: great manufacturing flexibility, strong engineering capabilities to solve, develop and even anticipate the most innovative and demanding needs of the market, installation services with extensive experience, and total quality commitment.

The Prysmian brand has always been a guarantee for the supply of products and services based on worldwide common quality standards. Prysmian has a built-in multi-step quality assurance program, which covers the entire production process from cable design and raw materials purchasing, to final inspection and testing documentation. Prysmian business locations and manufacturing sites as well as operation units are certified according to **ISO 9001 and ISO 14001 Quality Management System standards** for their specific activities and products, and environmental quality standards.



Standards and recommendations

High Voltage cable constructions are not fully covered by national or international standards; Prysmian products are designed to meet the projected service duty and to comply with national and international testing requirements. Type approval references are given against each product type available.

Most High Voltage cable systems are custom designed to suit the specific environmental parameters and operating requirements of a particular route and loading conditions, taking into account the thermal, thermo-mechanical, electrical and hydraulic performance necessary to ensure reliable system operation throughout service life, which naturally will vary considerable between different applications and locations.

Besides, international scientific bodies – like IEC and Cigré – develop relevant standards, technical recommendations and guidelines within their activities in the field of High Voltage. Prysmian relies on a long-standing tradition of participation and on a strong presence within such bodies, acquired thanks to its undisputed expertise developed over scores of projects accomplished anywhere in the world.

References Track Record

| | | U _m (kV) | | | | |
|----------------------|---|---------------------|-------|------|------|--------------------|
| | | 72.5 | 170 | 300 | 420 | 525 (and above) |
| Fluid Filled Systems | • Cables (Total Km in excess of) | 7000 | 15200 | 4000 | 2000 | 25 |
| | • Accessories* (Total units in excess of) | 7000 | 35000 | 9000 | 600 | - |
| Extruded Systems | • Cables (Total Km in excess of) | 11000 | 13500 | 3750 | 250 | - |
| | • Accessories* (Total units in excess of) | 7000 | 35000 | 9000 | 600 | - |

* Accessories include joints and terminations

In addition, Prysmian relies on a track record of more than 8000 Km of HV Submarine Energy Systems.



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