HIGH VOLTAGE & EXTRA HIGH VOLTAGE SYSTEMS

HALLEY POWER SYSTEMS

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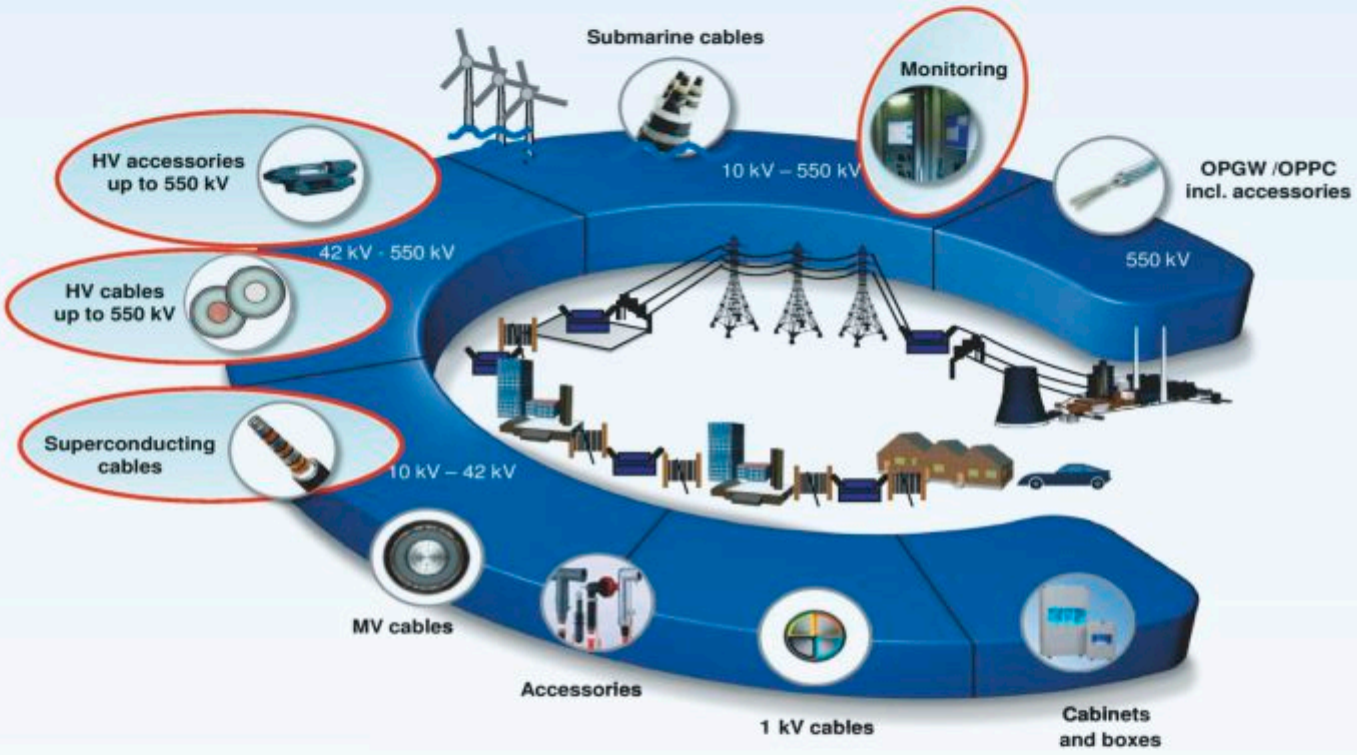


High Voltage cable systems are the the highways of the electric power supply. We have extensive experience of cable projects, encompassing every aspect from planning to commissioning, including engineering, subcontracting, route surveys, cable laying, installation, commisioning tests and maintenance services. But there are no shortcuts to success. Maintaining our position calls for motivation of our employees, innovative research and development, backed up by the wealth of know-how we have accumulated over the years. One of the main driving forces for us is to meet the new and constantly increasing requirements from the power industry and a deregulated market.

Today we aim to develop the solutions our customers will need tomorrow

WHO WE ARE

Halley Cables, Estralin High Voltage Cables and Estralin Power Systems is a top-ranking group specialized in High Voltage and Extra High Voltage Cable Projects.

Our extensive knowledge is supported by years of highly skilled experience in the field which enables us to to provide state of art consulting regarding Design, Planning, Installation, Testing and Service of High Voltage Cable and Extra High Voltage Cable Systems.

Are you planning the extension or modernization of your HV cable system and are looking for the best solution in terms of technology and operating economy?

We have the solution to your needs, we are the partner (as we prefer to regard ourselves) in terms of growth in efficiency, reliability, availability and innovation.

MISSION, VISION & VALUES

To be the first choice strategical partner for Utilities and EPC Contractors throughout the whole project engineering and implementation, service life, maintenance of the High Voltage or Extra High Voltage Cable Projects.

Our company`s evolution has been founded on the premises that the key to success in business is taking our job the most serious way possible, and the tight collaborations with the most prestigious companies stand to support this statement and ballance between price and performance.

Professionalism, efficiency, reliability, positive attitude and determination are the key traits for our group, guiding us in our daily work - how we relate to people, various cultures and how we do business, all over the world.

YOUR BENEFITS

- Benefit from our competence, collaboration with international contractors, efficient project management and documentation
- Benefit from our longtime experience in developing complex engineering solutions
- Handling of turnkey projects, by certified project managers
- You can rely on short reaction times for clearing faults
- You will receive a technically and commercially optimized vendor solution
- You will receive professional advice on technical and financial questions

PLANNING

We design and develop HV and EHV cable systems according to our customers' particular requirements. Our experience and know-how stand at the core of professional planning, especially in the early stages:

- In finding the most cost-efficient solution
- Developing customised designs
- Specifying an efficient cooling system, suggesting the correct embedding material or use of appropriate earthing procedures, e.g. single-point screen earthing or cross-bonding
- Designing the optimum route
- Designing of secondary systems, e. g. earthing systems screen earthing, temperature monitoring of the cable route or partial discharge monitoring

PROJECT MANAGEMENT

Halley Cables offers complete project management consultation concerning the installation of High and Extra High Voltage cable systems. Implementing a detailed project planning mainly consists of:

- Coordination, of all internal and external participants in the project
- Consulting, preparation of tender documents and project-based specifications, clarification of interfaces
- Procurement of the necessary materials from a large selection of goods from our own factories, partners and suppliers are available for us in best time possible, for the high voltage sector (cables, joints, terminals)
- Carrying our measurements as a basis for optimum layouts
- Logistics.

LAYING

Laying cables of the highest voltage levels requires the use of special laying methods and equipment, plus meticulous preparation. We calculate the cable pull for each individual case, and minimise the pulling forces involved by using state of the art cable pulling equipment.

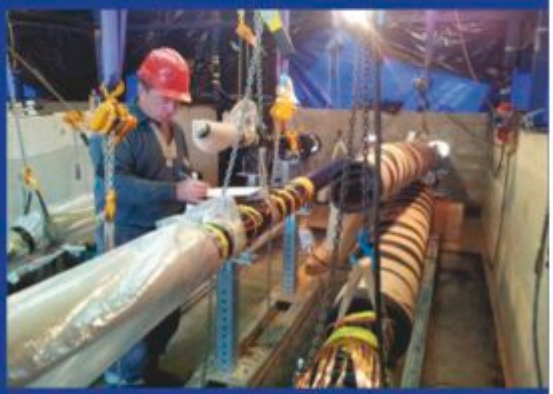
The length of the individual laying sections will depend on a multitude of factors, such as the laying conditions in the cable route, the maximum delivery length, restrictions on transportation by land or sea, and the design of the protection against transient over-voltages, using cross-bonding or single-point earthing of the cable screens.

INSTALLATION

Our accessories are installed by our specially trained fitters, with many years of experience behind them.

All our fitters benefit from intensive training programmes regarding all relevant electrical and mechanical jobs that a project involves, so that our customers can be certain that the cables and accessories will be safely and efficiently installed using the latest methods and state of art equipment.

- Route planning and pulling force calculations
- Vertical installation in shafts and tunnel installation
- Fault diagnosis on existing cable installations, for example, through temperature measurement using thermal imaging camera, TE measurement, or cable oil inspections
- Maintenance, fault location, fault clearance, inspections, modernization, and dismantling of old installations.



COMMISSIONING

Before an installed cable system is commissioned, it is usually tested in accordance with the relevant test specifications for high and extra-high voltage XLPE-insulated cable systems. These include DC voltage tests on the cable sheath and/or AC voltage tests on the main insulation. For extra-high voltage systems, particularly, they may be supplemented by partial discharge tests on the accessories installed.

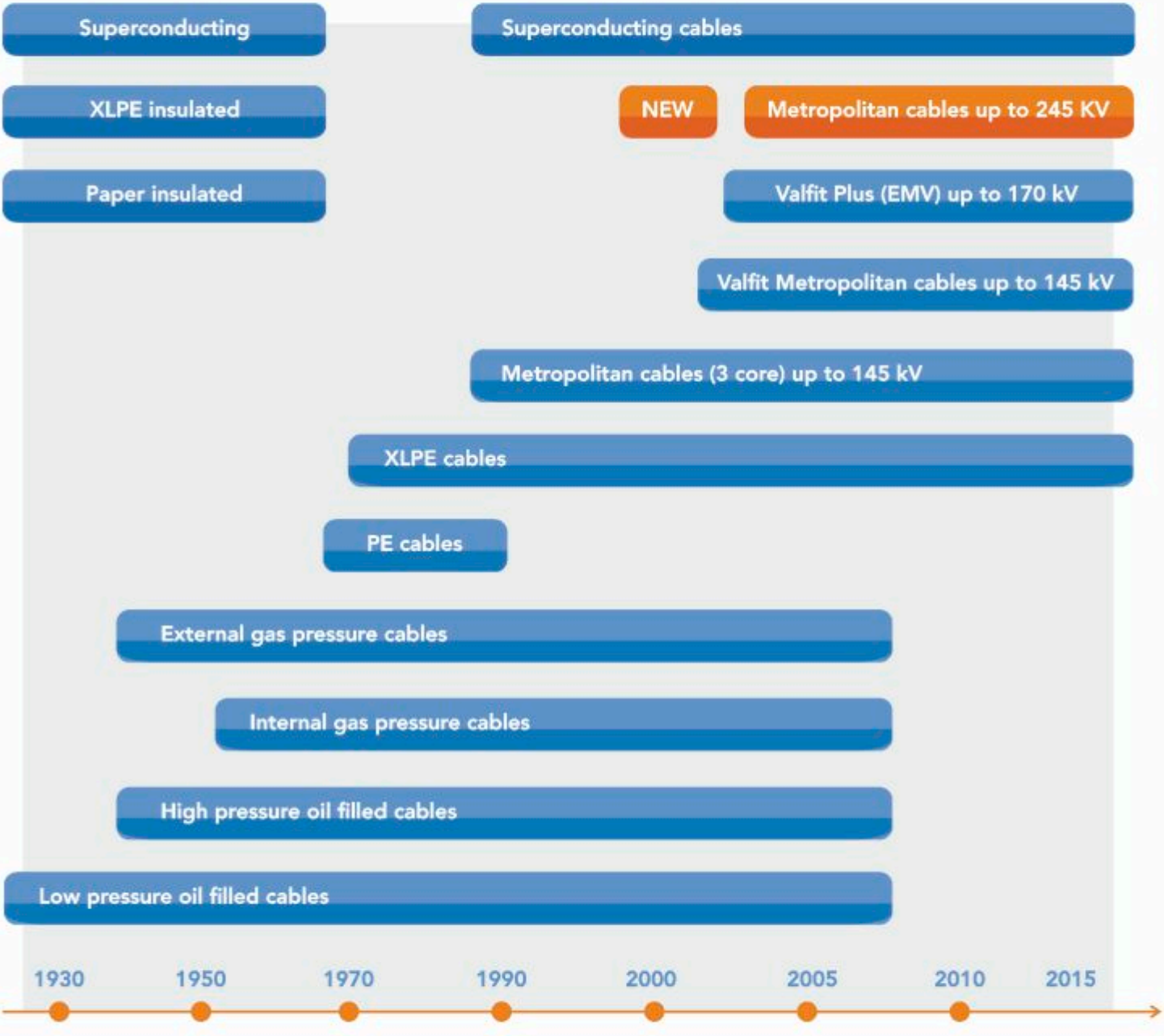
DEFINITION OF SYSTEM VOLTAGE RANGE HV & EHV

Halley Cables is covering the whole voltage range from 50 kV up to 550 kV

	HIGH VOLTAGE				EXTRA HIGH VOLTAGE			
Um /kV	72,5	123	145	170	245	362	420	550
	↑	↑	↑	↑	↑	↑	↑	↑
U0 /kV	50	110	132	150	220	330	380	500
U0 /kV	60	115	138	161	230	345	400	
U0 /kV	66							

Typical operating voltage in various markets

THE DRIVER OF INNOVATION DEVELOPMENTS



SCOPE FOR HV & EHV CABLES

Single Core Cables

Design:
- 50 kV – 550 kV
- Various cable designs available

Properties:
- Up to highest ampacities
- Flat or trefoil configuration

Three Core Cables

Design:
- 50 kV – 245 kV
- Very compact design
- Cable protected by pipe

Properties:
- Integrated EMF shielding as an option

VOLTAGE RANGE AND CABLE TYPE (Cu/Al)

550 kV	Single Core XLPE cables
420 kV	Single Core XLPE cables
362 kV	Single Core XLPE cables
300 kV	Single Core XLPE cables
245 kV	Single Core XLPE cables Metropolitan cables / ValFit / ValFit Plus
170 kV	Single Core XLPE cables Metropolitan cables / ValFit / ValFit Plus
145 kV	Single Core XLPE cables Metropolitan cables / ValFit / ValFit Plus
72,5 kV	Single Core XLPE cables Metropolitan cables / ValFit / ValFit Plus

XLPE UNDERGROUNG CABLE SYSTEMS
DESIGN, INSTALLATION AND TESTING

XLPE cables consist of the following components:

Conductor

- Copper (Cu) or Aluminium (Al) stranded compacted conductor or
- Cu segmental conductor or
- Cu/Al conductor with key-stone shaped profiles
- Longitudinal water sealing of conductor

Triple extruded and dry cured XLPE insulation system

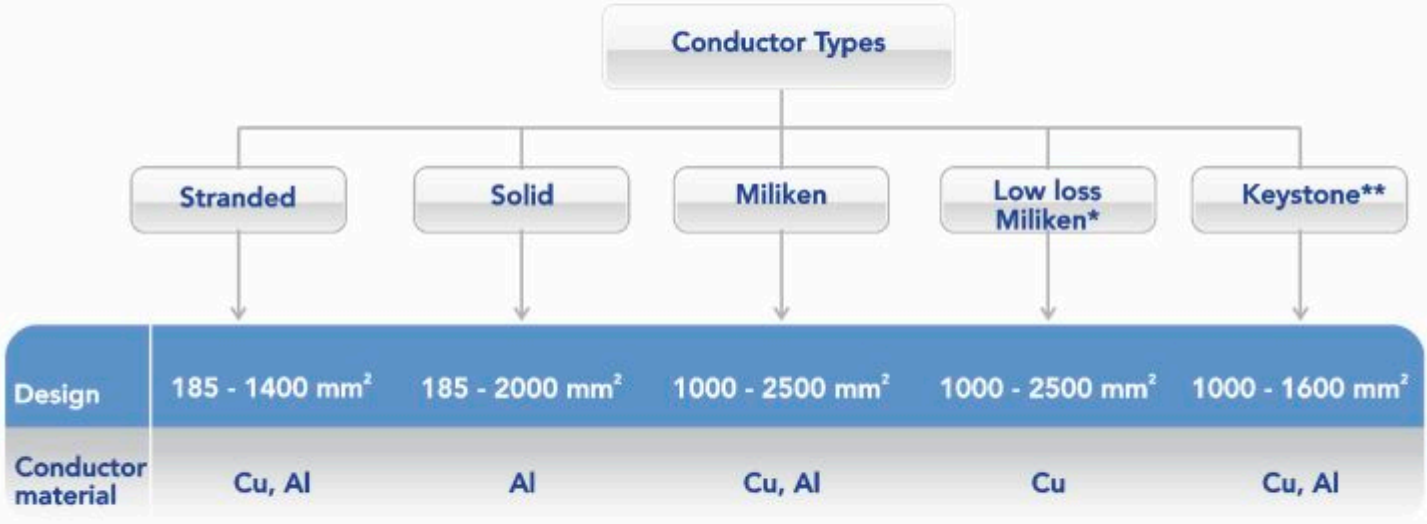
- Metallic screen
- Copper wire screen
- Copper tape screen
- Radial water sealing
- Al or Cu laminate solidly bonded to outer polyethylene sheath or
- Lead sheath
- Longitudinal water sealing of metallic screen

Non-metallic outer sheath

- PE
- PVC
- Halogen free flame retardant
- Co-extruded conductive layer over the sheath for special sheath testing

GENERAL CONDUCTOR TYPES

In high voltage XLPE-insulated cables, round, compacted, stranded conductors made of copper or aluminium are used. In order to reduce the skin effect, a segmented conductor design is provided in case of conductor cross-sectional areas as from 1.200 sqmm and above. To maximize the transmission capacity specially designed segmented conductors can be used.



*passivated wires (enemalled wired under development)

** phased out in 2010

INSULATION SYSTEM

For optimised manufacture of the XLPE insulation and the field-limiting inner and outer semi-conductive layers, the cable core is extruded in a triple extrusion head, thus ensuring the smooth interfacing between insulation and semi-conductive layers required for high operating field strength.
The subsequent continuous cross-linking and cooling operation is performed in a tube connected directly to the triple head. The "dry" cross-linking process and the high pressure inside the tube assure a homogeneous insulation structure for the cable core, without any voids.
High quality material-handling systems, triple extrusion, dry curring and super-clean XLPE materials guarantee high quality products.

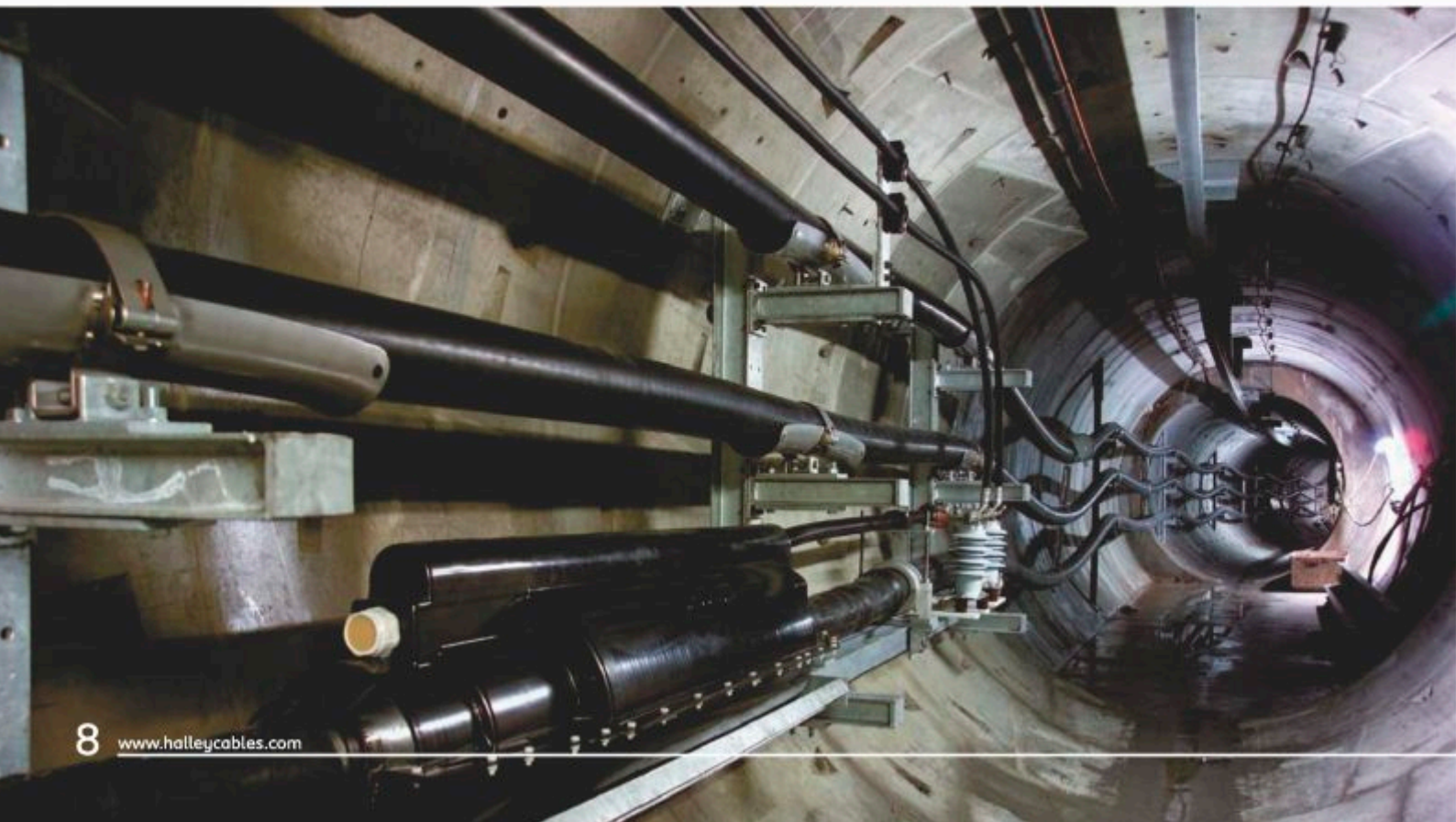
Standard solution

- Standard thickness
- Conservative design

Optimized solution

- Optimized thickness
- Compact design
- Longer lenghts
- Technical & economic benefits

The raw material used for the insulation is low-density polyethylene (LDPE). By virtue of its homopolar character, polyethylene has a low relative permittivity, a very low power loss factor and very high dielectric strength.
The cross-linking process provides improved mechanical characteristics while not affecting the dielectric properties at all. Besides the excellent electrical properties, the mechanical characteristics remain also very good even at high temperatures.
Even at high short-circuit temperatures, XLPE retains good dimensional stability and in this crucial point it is definitely superior to thermoplastic PE. Thanks to XLPE's high thermal stability, thermal ageing plays practically no role at all, provided the permissible operating conditions are complied with.
Results from extensive long-term studies show that with the technologies available nowadays the material can be relied upon to cope with very high operating field strengths.



GENERAL TYPES & CAPABILITIES OF METAL SHEATH

Non-metallic outer sheath

PE or PVC are normally used for the non-metallic outer sheath. IEC 60502 recommends a thickness of $t = 0.035 \times D + 1.0$ mm, where D is the diameter under the sheath.
For heavy installations a larger thickness is recommended. PE is the first choice for most applications. PVC is used when there are high requirements on fire retardation behaviour.

Conductive outer layer

A conductive outer layer facilitates testing of the non-metallic outer sheath. This testing is important to ensure the physical integrity of the cable from time to time, either in factory, after transportation, directly after laying, upon completion of the installation or periodically thereafter.
A conductive outer layer obtained by simultaneous extrusion with the non-conductive outer sheath presents superior electrical and structural properties.

Flame retardant outer layer

For PE-sheathed cables a halogen free and flame retardant layer can be applied in order to limit the fire spread in buildings and tunnel installations.

Fire behavior

This relates to cables in buildings and tunnels. Several serious fire accidents have focused attention on the fire behaviour of cables. Experience shows that cables seldom initiate fires. However, in some cases cable installations have influenced the extent of a fire, as a propagator of flames and/or as a source of intense aggressive smoke. Cables having a PVC sheath are considered as flame retardant. However, once PVC is on fire, it generates hydrochloric acid fumes (HCl) acid. This gas is highly corrosive and irritating to inhale. Cables with a standard PE outersheath do not generate any corrosive HCl but are not flame retardant. Special polyolefines with flame retardant properties but without chlorine or any other halogenes are optional for the outer sheat.

GENERAL TYPES & CAPABILITIES OF METAL SHEATH

Over sheath for XLPE cables

PE

(Polyethylene material for HDPE sheath)
-Extruded type
-In different colours available

Flame retardant

(Special mixture based on PE properties)
-Extruded type
-Testing passed

Fire retardant

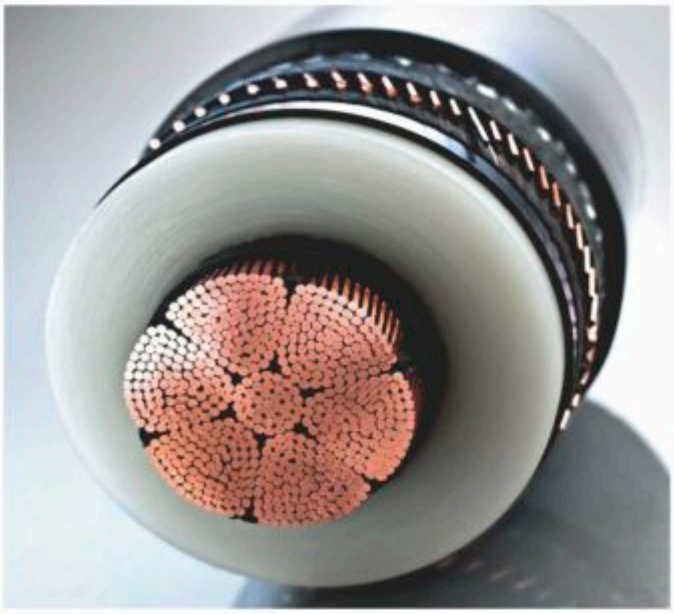
(Special mixture based on PE properties)
-Extruded type

Termite proof Designs with nylon layer

Extruded hybrid construction with three layers

To ensure reliable protection against mechanical effects from outside, the high and extra-high voltage XLPE-insulated cables are given an outer sheath made of high-density polyethylene (HDPE), which possesses excellent mechanical properties.

With a transversely watertight cable design, protection against ingress of humidity is provided by a laminated sheath, comprising a longitudinally applied coated aluminium tape, firmly welded to the polyethylene sheath extruded over it. While the polyethylene provides mechanical protection for the cable, the aluminium tape prevents radial water-vapour diffusion and thus any penetration of moisture into the cable. As an optional extra, additional flame-retardant and/or semi-conductive layers can be extruded together with the PE outer sheath. Besides the cable construction described above, other cable designs can also be provided on request.



Single Core XLPE Cables
with Copper Wire Screen and APL Sheath

1. A - aluminium conductor
2. 2X - XLPE insulation
4. (F - watertight design
3. S - copper wire screen
5. L) - radial water barrier (Al type)
6. 2Y - poliethylene sheath

Single Core XLPE Cables
with Solid Aluminium Conductor

1. A - solid aluminium conductor
2. 2X - XLPE insulation
3. (F) - waterlight design
4. K - lead sheath
5. 2Y – polyethylene sheath with extruded condictive layer

Large sized solid aluminium conductors provide an economic solution for power transmission

Single Core XLPE Cables
with Lead Sheath

1. A - aluminium conductor
2. 2X - XLPE insulation
3. (F) - waterlight design
4. K - lead sheath
5. 2Y - polyethylene sheath

Instead of copper wire screen and APL sheath, the XLPE insulated cables can also be aquipped with a lead sheath, a design which has proven its suitabillity on power cables for more than a century

Single Core XLPE Cables
with Copper Wire Screen and Lead Sheath

1. Copper conductor
2. 2X - XLPE insulation
3. (F) - watertight design
4. S - copper wire screen
5. K - lead sheath
6. 2Y – polyethylene sheath

To improve the fault current carrying capability of the lead sheathed cable, an additional Cu wire screen may be applied.

These cables can be supplied in the standard design, i.e with insulation thickness as used already for several decades.
Due to improvements in material and manufacture it was possible not only to develop XLPE cables for extra high voltage, but also to reduce the insulation thickness of the established high voltage cable.

The efects are smaller dimensions and weights, both enabling longer supply lengths on standard drums, resulting in a smaller number of joints which in turn means less installation work and less disturbance due to open joint bays. Overall, a significant cost saving is achieved with XLPE cables of advanced design.

Single Core XLPE Cables
with Aluminium Sheath

1. Segmental copper conductor
2. 2X - XLPE insulation
3. (F) - watertight design
4. KL - aluminium sheath
5. 2Y - polyethylene sheath

These are cables with low dielectric losses used in energy networks. Laid in residential or industrial areas, underground or in ducts.
If the cable gets water inside due to the mechanical damages, the watertight sign prevents the movement of the water inside the cable.
A considerable number of installations with the cable type is in service today. These cables have proven their reliability in many decades. thousands of kilometers are in satisafactory service in high voltage networks.

External Gas Pressure Cable

NP - external gas pressure cable according to VDE standard

1. Copper conductor
2. Paper insulation
3. K - lead sheath
4. D- reinforcing tapes
5. V - laid-up cable cores
6. F - flat steel wire armour
7. ST - steel pipe
8. 2Y - polyethylene covering

The conductors are insulated with lapped mass impregnated paper insulation. Each insulated core is separatly lead sheathed. Three cores are cabled together. Over a suitable bedding an armour cable is pulled into a steel pipe which is filled with nitrogen gas at 15 bar overpressure. With the gas pressure acting on the oval shappede cable cores, formation of voids is prevented, giving the cables the required electrical strength.

Emergency Cables
110 kV ... 300 kV

S - special cable

1. Copper conductor
2. 2X - XLPE insulation
3. S - copper wire screen
4. 2Y - polyethylene sheath

The so-called emergency cables have been developed for use in high voltage networks up to 300 kV. The cables are lightweight and flexible type to permit easiest transport, installation and operation. Maintaining power supply via an overhead line or within a switchyard can be of high importance. While it would be necessary to switch off because of working in the vicinity of the overhead conductors, the relevant sections can be bridged using the emergency cables. The emergency cables have demonstraded their advantages connections in outdoor switchyards.

Internal Gas Pressure Cable

NI- internal gas prressure cable according to VDE standard

1. Copper conductor
2. Paper insulation
3. V - laid-up cable cores
4. F - flat steel wire armour
5. ST - steel pipe
6. 2Y – polyethylene covering

Similar to external gas pressure cables service experience with the internal gas pressure cables is also very satisafactory. In deviation to the external gas pressure the nitrogen gas forms part of the cable insulation. As there is no metal sheath, the gas penetrates into the voids present in the mass impregnated insulation and prevents electrical discharges. A considerable number of installations with the cable type is in service today.
Similar to external gas pressure cables service experience with the internal gas pressure cables is also very satisafactory.

Three Cores XLPE Cables in Steel Pipe

The advantages of pipe tye cables and XLPE cables are combined. The cable has been developed especially for use in urban cable networks for retrofitting and new installation. Major design details have been determined to take account of the use of existing cable pipe lines. This cables concept allows the cheap reconstruction of old pipe type cable circuits and the economical and safe installation of new cable connections in crowded city areas.

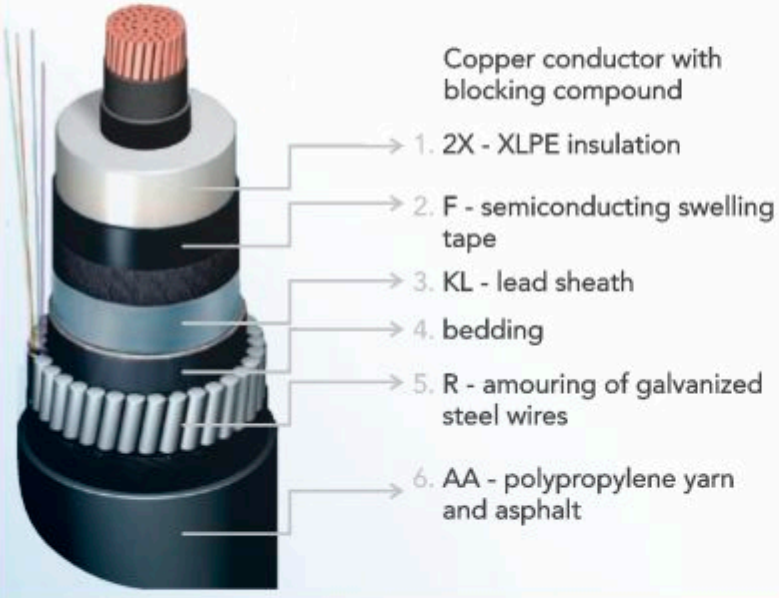
This provides:

- fast and cheap cable replacement by pulling the cable into existing pipe
- compact and strong three core design
- maintenance-free service
- no risk of environmental pollution
- the possibility of pipe monitoring

In many cases the steel pipes are well protected against corrosion and thus suitable for further use.

Also, the ability to leverage the installed steel pipe from the existing cable system for installation of new, modern cross-linked polyethylene (XLPE) cables drastically reduces overall project costs. Civil construction costs for installation of a duct bank for a new XLPE cable circuit can account for as much as 50% of the total project.

Single Core XLPE Submarine Cable with integrated Optical Fibres



Although much of the investment in submarine cables has been directed toward developed markets such as the transatlantic and transpacific routes, in recent years there has been an increased effort to expand the submarine cable network to serve the developing world.
The cable design is determined by a variety of requirements and environmental conditions - with conformance to national and international standards always to be kept in mind. Since requirements and environmental conditions for each project differ greatly, submarine power cables design are always project-specific.
The optical submarine cable is an underwater optical fibre cable designed to be suitable for shallow and deep water use, which is required to ensure protection of optical fibres against water pressure, longitudinal water propagation, chemical aggression and the effect of hydrogen contamination throughout the cable design life.

HV & EHV ACCESSORIES

For our cables with XLPE-insulation, all commonly used cable accessories are available: outdoor terminations, transformer and SF6 GIS terminations and joints.
Accessories for XLPE-insulated high and extra-high voltage cables require customised compatibility, so HALLEY CABLES develops and manufactures these accessories inhouse – thus providing a maximum of safety under all operating conditions in our customers' power transmission networks.

Um /kV	72,52	145	170	245	420	550
Outdoor termination						
Fluid filled	X/O	X/O	X/O	X/O	X/O	X/O
Fry type	X	X				
Switchgear / transformer termination						
Fluid filled	X/O	X/O	X/O	X/O	X/O	X/O
Fry type	X	X	X	X (<1600 mm²)		
Joint						
1 piece RTV	X	X (<1200 mm²)	X (<1000 mm²)	(*)		
1 piece LSR			(*)	(*)		
1 piece silicone	X	X	X	X	X	X
Stop joint						
Transition joint	X/O	X/O	X/O			

X - XLPE cables O - Oil filled cables * - under development

Halley Cables' line-up of cable accessories for XLPE cable systems includes:

- Straight joints and joints with integrated screen separation for cross bonding
- Transition joints for connection of XLPE to fluid filled cables
- Outdoor terminations with porcelain or composite insulators
- Sealing ends
- Screened separable connectors for switchgears and transformers
- Cable terminations for transformers and Gas Insulated Switchgears (GIS)
- Link boxes for earthing and cross-bonding
- Sheath bonding
- Distributed Temperature Sensing (DTS) Systems with integrated optical fibre in metallic tube (FIMT).

OUTDOOR TERMINATIONS

The outdoor terminations are installed with porcelain or composite insulator. The length of the insulator's creepage path is specified to suit the requirements of the particular application concerned. It is usually installed on to a steel support structure, using additional post-insulators where required, providing the necessary potential isolation between the termination's base plate and the earthed supporting structure during sheath testing.

Termination with composite insulator

Design:
- Pre-moulded stress control
- Body made of silicone rubber
- Composite insulator with insulating fluid
- Including connection bolt for Al or Cu conductor
- Stress control body routine tested
- Termination type tested according to IEC 60840

Properties:
- Excellent hydrophobical properties
- High mechanical strength
- Low weight
- Various shrinkable distances available

Operation voltage (Um (kV)	Lightning impulse voltage (kV)	Max. cross section	Ø Over peeled insulation
72,5	325	2500 mm^2	34,5 - 97 mm
145	650	2500 mm^2	34,5 - 108 mm
170	750	2500 mm^2	34,5 - 108 mm
245	1050	2500 mm^2	... 120 mm
300	1050	2500 mm^2	... 120 mm
420	1425	2500 mm^2	... 120 mm

Termination with porcelain insulator

Design:
- Pre-moulded stress control body made of silicone rubber
- Porcelain insulator with insulating fluid
- Including connection bolt for Al or Cu conductor
- Stress control body routine tested
- Termination type tested according to IEC 60840

Properties:
- High chemical resistance
- High resistance against surface leakage
- High mechanical strength
- Various shrinkable distances available

Operation voltage (Um (kV)	Lightning impulse voltage (kV)	Max. cross section	Ø Over peeled insulation
72,5	325	2500 mm^2	34,5 - 97 mm
145	650	2500 mm^2	34,5 - 108 mm
170	750	2500 mm^2	34,5 - 108 mm
245	1050	2500 mm^2	... 120 mm
300	1050	2500 mm^2	... 120 mm
420	1425	2500 mm^2	... 120 mm

Slip on termination

Design:
- Pre-moulded stress control body made of silicone rubber
- Silicone rubber slip on sheds
- Including connection bolt for Al or Cu conductor
- Stress control body routine tested
- Termination type tested

Properties:
- Quick and easy to install
- No insulation fluid necessary
- Various shrinkable distances available
- Very low weight

Operation voltage (Um (kV))	Lightning impulse voltage (kV)	Max. cross section	Ø Over peeled insulation
72,5	325	1200 mm^2	40 - 76 mm
123	550	1000 mm^2	56 - 76 mm
145	550	1000 mm^2	56 - 76 mm

Dry type termination

Design:
- Pre-moulded stress control body made of silicone rubber
- Composite insulator according to pollution level IV
- Including connection bolt for Al or Cu conductor
- Stress control body routine tested
- Termination type tested in accordance to IEC 60840

Properties:
- Excellent hydrophobical properties
- High mechanical strength
- Low weight
- No insulting fluid necessary

Operation voltage (Um (kV))	Lightning impulse voltage (kV)	Max. cross section	Ø Over peeled insulation
145	650	1200 mm^2	34,5 - 74 mm

GIS / TRANSFORMER TERMINATIONS

The terminations for gas-insulated switchgears (GIS) are installed with an epoxy resin insulator, including an integrated insulating clearance for potential isolation between the switchgear housing and the cable screen/sheath. The interface dimensions conform to IEC 62271-209 or are agreed upon between the switchgear and cable system suppliers for the particular application concerned. Both conventional terminations with a fluid filling in the insulator and plug-in "dry" terminations are available.
The advantage of the plug-in-terminations is that the insulator socket can be installed in advance at the switchgear manufacturer's plant, thus avoiding additional work with gas during cable installation on site.

The transformer terminations feature an insulator made of epoxy resin, with an integrated insulating clearance for potential isolation between the transformer housing and the cable screen/sheath. The interface dimensions conform to DIN EN 50299 or as agreed upon between the transformer and cable suppliers concerned in the particular case involved. As with the switchgear terminations, both conventional fluid-filled and "dry" plug-in terminations are available using the plug-in terminations in transformers offers comparable advantages to those obtained with the switchgear.

GIS / transformer termination, dry type

Design:
- Pre-moulded stress control body made of silicone rubber
- Dimensions according top IEC 62271-209
- Including connection bolt for Al or Cu conductor
- Stress control body routine tested
- Termination type tested in accordance to IEC 60840ed
- Termination type tested

Properties:
- Installation in any position possible
- Pre-installation of insulator possible
- Available for asset-inlets with dimensions of fluid filled terminations
- With corona shield for transformer application

Operation voltage (Um (kV)	Lightning impulse voltage (kV)	Max. cross section	Ø Over peeled insulation
72,5	325	1000 mm^2	38,5-74 mm
145	650	2500 mm^2	38 - 97 mm
170	750	2500 mm^2	38 - 97 mm
245	1050	2000 mm^2	....97 mm

GIS / transformer termination, fluid filled

Design:
- Pre-moulded stress control body made of silicone rubber
- Dimensions according to IEC 62271-209
- Including connection bolt for Al or Cu conductor
- Stress control body routine tested
- Termination type tested according to IEC 60840

Properties:
- Expansion vessel for horizontal installation available
- Excellent reliability for many decades
- With corona shield for transformer application

Operation voltage (Um (kV)	Lightning impulse voltage (kV)	Max. cross section	Ø Over peeled insulation
72.5	325	1200 mm^2	40 - 73 mm
145	650	2500 mm^2	...108 mm
170	750	2500 mm^2	...108 mm
245	1050	2500 mm^2	...120 mm
300	1050	2500 mm^2	...120 mm
420	1425	2500 mm^2	...120 mm

JOINTS

HALLEY CABLES offers an extensive program of joints for high and extra-high voltage XLPE-insulated cables. The joints are completely maintenance-free, since they contain no gaseous or liquid constituents ("solid joints"). Both straight-through joints with through connections of the screen as well as sectionalising joints with potential insulation of the cable screen at both sides of the joint are used. Insulating joints are designed for cross-bonding of the cable screen or for applications with single bonded cable screens.

One piece slip on joint

Design:
- Pre-moulded stress control body made of silicone rubber
- Straight through or cross bonding type available
- Including connector for Al or Cu conductor
- Joint body routine tested
- Joint type tested according to IEC 60840

Properties:
- Cable connection with crimping- or screwing connectors
- Different coverings available
- Quick and easy to install

Operation voltage (Um (kV)	Lightning impulse voltage (kV)	Max. cross section	Ø Over peeled insulation
72,5	325	630 mm²	40 - 58 mm
145	650	1200 mm²	55 - 85 mm
170	750	1000 mm²	55 - 85 mm

Three piece slip on joint

Design:
- Pre-moulded stress control body made of silicone rubber
- Straight through or cross bonding type available
- Including connector for Al or Cu conductor
- Joint body routine tested
- Joint type tested according to IEC 60840

Properties:
- Very compact design
- Different coverings available
- Possibility to connect different cross-sections
- Quick and easy to install

Operation voltage (Um (kV)	Lightning impulse voltage (kV)	Max. cross section	Ø Over peeled insulation
72,5	325	1600 mm²	...79 mm
145	650	2500 mm²	...101 mm
170	750	2500mm²	...101 mm
245	1050	2500 mm²	...108 mm
300	1050	2500mm²	...108 mm
420	1425	2500mm²	...124 mm

Transition joint, oil filled cable to XLPE cable

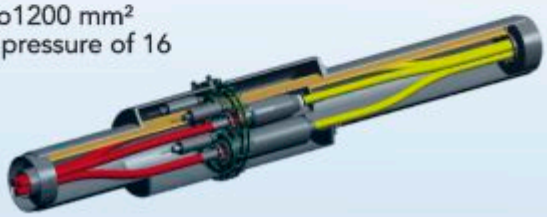
Design:
- XLPE-side using GIS-termination technology
- Oil-side with epoxy resin stress cone and/or paper wrapping
- Including corrosion protection
- Optional oil piping available
- Optional expansion vessel available
- Optional pressure monitoring available

Properties:
- Solutions up to 400kV available
- Covering cross sections up to 1600 mm²
- For systems with max. static pressure of 6,5 bar

Transition joint, pipe type cable to XLPE cable

Design:
For internal or external gas pressure cables
- For 3/C oil-filled cable
- Including silicone joint bodies
- Including expansion vessel
- Including corrosion protection
- Optional pressure piping available
- Optional pressure monitoring available

Properties:
Solutions up to 145kV available
- Covering cross sections up to1200 mm²
- For systems with max. static pressure of 16 bar



3 pieces vs. 1 piece joint

Criteria	3/p joint	1/p joint
Overall length	Very short	Longer
Connection of different cross section/designs	Very short, just for adapter lenght	Very limited to similar cables
Length of removal of outersheath	Easy possible, high flexibility, easy stock man	Long parking area -> rebuilding of sheath and metal sheath required
Parking position	W/O expansion	With expansion and on semicon layer
Tools for push on	By hand(w/o 300 and 420 kV)	Tools required
Space for conductor connection	Comfortable	Limited (thickenss insulation)
Interface	Main joint sleeve/ adapter/cable	Main joint sleeve/cable
Installation time	Short	Longer (especially for metal sheathed cables)
Acceptance on market	In specific markets	Worldwide
Number of competitors	Limited(tyco etc)	Large

Earthing and cross bonding boxes

Design:
- Boxes with removable links
- Boxes with SVL for protection against induced voltages
- Boxes for cross bonding systems

Properties:
- Different protection classes available
- Different housings available
- Overground or underground applications
- SVL up to 10kV available

Trefoil and flat formation

The three cables in a 3-phase circuit can be placed in different formations. Typical formations include trefoil (triangular) and flat formations. The choice depends on several factors like screen bonding method, conductor area and available space for installation.

Bonding of the metallic screens

The electric power losses in a cable circuit are dependent on the currents flowing in the metallic sheaths of the cables. Therefore, by reducing or eliminating the metallic sheath currents through different methods of bonding, it is possible to increase the load current carrying capacity (ampacity) of the cable circuit. The usual bonding methods are described below:

Both-ends bonding

A system is both ends bonded if the arrangements are such that the cable sheaths provide path for circulating currents at normal conditions. This will cause losses in the screen, which reduce the cable current carrying capacity. These losses are smaller for cables in trefoil formation than in flat formation with separation.

Single-point bonding

A system is single point bonded if the arrangements are such that the cable sheaths provide no path for the flow of circulating currents or external fault currents. In such case, a voltage will be induced between screens of adjacent phases of the cable circuit and between screen and earth, but no current will flow. This induced voltage is proportional to the cable length and current. Single-point bonding can only be used for limited route lengths, but in general the accepted screen voltage potential limits the length.

Cross-bonding

A system is crossbonded if the arrangements are such that the circuit provides electrically continuous sheath runs from earthed termination to earthed termination but with the sheaths so sectionalized and cross-connected in order to eliminate the sheath circulating currents. In such case, a voltage will be induced between screen and earth, but no significant current will flow. The maximum induced voltage will appear at the link boxes for crossbonding. This method permits a cable currentcarrying capacity as high as with single-point bonding but longer route lengths than the latter. It requires screen separation and additional link boxes.

INSTALLATION OF XLPE CABLE SYSTEMS

Installation of cable systems includes trenching, cable pulling, clamping of cable, cable splicing as well as mounting of accessories. High quality installation work performed by Halley Cables certified field personnel is essential for achieving the low failure rates and reliability performance that is expected from modern underground transmission and distribution circuits.

Halley Cables has long and extensive experience from different types of cable installations including direct burial, duct, shaft, trough, tunnel and submarine installations, but also trenchless technologies like directional drilling, pipe jacking and others.

EXPERIENCE
you can rely on

EUROPE

AUSTRIA
2008: **115 kV** Hartberg Project: 10 km of HV cable and HV accessories;

ENGLAND
2008: **132 kV** Palm Kings Lynn and 132 kV Black Fandata: 30 km of HV cable and HV accessories;
2009: **232 kV** EDF Centrum: 57 km of HV cable and HV accessories;

GERMANY
2008: **115 kV** Flamming Project, DB Lehrte, Drewag Tolkewitz Project, HKW Klingenberg Ost Vattenfall, EnBW Project: 40 km of HV cable and HV accessories;
2009: **115 kV** Lager Peters Project, Karlsruhe Project, VW Wolsburg Project: 36 km of HV cable and HV accessories;

ITALY
2008: **154 kV** Imola Ortigonala Project and Morasco&Regloedo Project: 5 km of HV cable and HV accessories;
225 kV Tireno Power Napoli Project: 630 m of HV cable and HV accessories;

LATVIA
2008: **115 kV** Latvenergo Project: 40 km of HV cable and HV accessories;

MACEDONIA
2009: **115 kV** Macedonia Project: 23 km of HV cable and HV accessories;

SLOVENIA
2008: **115 kV** Moste Project and Brestenika project: 15 km of HV cable and HV accessories;

TURKEY
2008: **380 kV** TEIAS Project: 19 km of HV cable and HV accessories;
2009: **115 kV** Best Trafo: 320 m of HV cable and HV accessories;

ROMANIA
2008: The most important project we conducted in Romania in 2008 was in Constanta, at **110 kV** Tabacarie Station, where we used 6 HV repair joints.
2009: We provided expertise during CESI investigation of fault for **110 kV** Tabacarie Station in Constanta.
2010: Another milestone of our activity in Romania was in 2010, in Tulcea District, at **110 kV** Sarinasuf Station, where we used 12 HV joints and 6 outdoor sealing ends.
2011: We brought a major contribution to the development of wind farms in Romania in 2011, with a voltage range from **110 kV** up to **420 kV**.
110 kV: Babadag Wind Farm (12 HV accessories and 13 km of HV cables), Mireasa Wind Farm (8 HV accessories and 5.6 km of HV cables), Casimcea Wind Farm (57 HV accessories), Fantanele Wind Farm (12 HV accessories), Rahmanu Wind Farm (18 HV accessories), Poiana Brasov Wind Farm (9 HV accessories and 8.6 km of HV cables).
420 kV: Stupina Wind Farm, where we supplied and installed 360 meters of HV cable and 12 HV terminations.
2012: Stupina **110 kV** Wind Farm, where we supplied and installed 540 meters of HV cable and 12 HV accessories.

ASIA

RUSSIA

In 2008 we took a strong position on the Russian market and we have established as a trustworthy provider of expertise in HV cable systems. Our success is based on strategic partnerships with reputable cable and accessories manufacturers and highly skilled personnel with long operational experience with HV cable systems.

2008

220 kV: Ochakovo 220 kV Substation in Moscow: 154 km of HV cable and HV accessories;
Strogino-Krasnogoskaya in Moscow: 45 km of HV cable and HV accessories;
550 kV: Vezkudnikovo 550 kV Substation in Moscow: 2 km of HV cable and HV accessories;

2009

110 kV: Ugo Zapadnaya 110 kV Station in Sankt Petersburg: 69 km of HV cable and HV accessories;
Krasnopolyanskiy Poselkoviy Okrug: 55 km of HV cable and HV accessories;
Izmaylovo 110 kV Station in Moscow: 17 km of HV cable and HV accessories;
220 kV: Taneko 220 kV Station: 62 km of HV cable and 30 HV accessories;

2010

110 kV: Kirishiorgsintez 110 kV Station in Sankt Petersburg: 50 km of HV cable and HV accessories;
Kollontay 110 kV Substation in Sankt Petersburg: 24 km of HV cable and HV accessories;
Ryabina 110 kV Substation in Ekaterinburg: 40 km of HV cable and 120 HV accessories;
220 kV: Ochakovo-Mnevniki 220 kV Substation in Moscow: 81 km of HV cable and 212 HV accessories;
330 kV: Yuzhnaya 330 kV Station in Sankt Petersburg: 5 km of HV cable and 24 HV accessories;
550 kV: Skolkovo Innovation Center: 72 km of HV cable (2 parallel cable circuits), 138 joints and 19 sealing ends;

2011

110 kV: Ugresha-Novospasskaya 110 kV Station in Moscow: 11 km of HV cable and 39 HV accessories;
Sinopskaya 110 kV Sbstation in Sankt Petersburg: 15 km of HV cable and HV accessories;
220 kV: Omega-Radishchevo 220 kV Substation: 98 km of HV cable and 233 HV accessories;
Babyushkin 220 kV Substation in Moscow: 34 km HV cable and 66 HV accessories;
550 kV: Kalyuzhskaya 750 kV Substation in Maloyaroslavec: 2 parallel HV cable circuits, 12 sealing ends;

2012

110 kV: Imeretimskaya 110 kV Station in Sochi: 44 km of HV cable and HV accessories;
Sportivnaya 110 kV Substation in Sochi: 39 km of HV cable and HV accessories;
Cable air-line (110 kV) from Sochinskaya TPS till Substation Verechaginskaya from Substation Verechaginskaya till Substation Dragomis, in Sochi: 43 km of HV cable and HV accessories.
220 kV: Ochakovo-Presnya 220 kV Station in Moscow: 8 km of HV cable and 36 HV accessories;

Since 2008 and up to 2012, we have delivered and installed in Russia as turnkey projects over 1000 km of 110 kV cables, over 400 km of 220 kV cables, around 20 km of 330 kV cables and almost 100 km of 550 kV cables.

MIDDLE-EAST

QATAR

2008: Kahramaa GTC Project: 85 km of **132 kV**, HV cable and HV accessories, as well as 95 km of 225 km of HV cable and HV accessories;
2009: **66 kV**, Kahramaa GTC Project: 379 km of HV cable and HV accessories;

BAHRAIN

2008: **225 kV**, Ministery of Electricity and Water and EWA Bahrain cable diversion Works at Sitra: 60 km of HV cable and HV accessories;

IRAQ

2009: **132 kV** Al Mousawy Co. Project: 100 km of HV cable and HV accessories;

SAUDI ARABIA

2008: **225 kV** Worley Parsons: 33 km of HV cable and HV accessories;

UNITED ARAB EMIRATES

2009: **132 kV** DEWA Horse Race Project: 6 km of HV cable and HV accessories.

TESTING OF XLPE CABLE SYSTEMS

Standard routine tests, sample tests, type tests and after laying tests are normally performed according to IEC standards. Other international or national standards may be followed upon agreement between contractor and purchaser.

Factory testing:
- According to all standards and customer requirements
- Latest technology

Site testing:
- Complete service scope for testing
- Own resonant test sets on trailers for commissioning test for HV & EHV cable systems

Routine tests of XLPE cables and accessories:
- PD-measurement test
- High-voltage test of main insulation
- Electrical test of oversheath
- Visual inspection

Sample tests are carried out with a frequency according to applicable IEC standards:
- Conductor examination
- Electrical resistance of conductor
- Check of dimensions
- Capacitance test
- Hot set test
- Electrical tests

After laying tests:
- DC voltage test of oversheath
- AC voltage test of main insulation

Halley Cables understands the challenges and increasing complexity of nowadays High Voltage projects and supports all its customers from system planning, engineering and project management to final testing and post-project maintenance. Underground transmission systems represent a considerable investment, requiring a long-term partner that has in-depth knowledge of the cables, accessories and installation methods – Halley Cables is the partner that you need.
Our solutions are customer-driven and designed to satisfy the industry's continuously evolving demands for higher technical performance. They can be found in the most challenging HV and EHV cable applications. In answer to the need for production, installation and cable-system lifetime enhancements, we create the innovation links that secure world-class, step-changing solutions and benefit the whole wire and cable value chain.
Our team is committed to finding the best solutions and to transforming your needs into concrete proposals. The HV& EHV Products Service Line consists of experienced engineers at your service, who will carry out consultancy, technical and economical optimization directly on site, at your plants.