Compare MV Cable Jointing Technologies (11 kV–33 kV)

Introduction

Medium-voltage cable joints are critical components in underground power networks. Their function is not only to connect two cable sections, but to restore electrical, mechanical and environmental performance as closely as possible to that of the original cable system (IEEE, 2022; CENELEC, 2019). In practical terms, a joint must provide reliable insulation, stable stress control, mechanical protection and long-term sealing under thermal, electrical and environmental loading (IEEE, 2022; IEC, 2023).

This whitepaper compares the main jointing technologies used in 11 kV to 33 kV systems: heat shrink, cold shrink, resin, pre-moulded and hybrid designs. The comparison is based on standards, manufacturer information and published research on cable accessories, partial discharge and material ageing (IEEE, 2022; IEC, 2023; MDPI, 2025; MDPI, 2024).

Functional requirements of an MV joint

A medium-voltage joint must satisfy three core requirements. First, it must withstand the electrical stress of the operating system without creating local field intensification. Second, it must protect the cable interface against moisture, contamination and mechanical damage. Third, it must maintain those properties over the intended service life, including during thermal cycling and fault-related stress (IEEE, 2022; CENELEC, 2019).

In practice, failures in cable systems often originate in accessories rather than in the cable core itself. This is why interface quality, installation consistency and void management are so important in MV joint design (MDPI, 2025; MDPI, 2023). Partial discharge is especially relevant because it typically begins in gas-filled voids, imperfect interfaces or contamination zones and can gradually erode the insulation system over time (MDPI, 2025; MDPI, 2023).

Standards and test framework

For MV cable accessories in the 11 kV to 33 kV range, the most relevant international reference is IEC 60502-4:2023, which specifies type test requirements for accessories for power cables rated from 3.6/6 kV up to 18/30 kV and, more broadly, up to 30 kV systems covered by the standard (IEC, 2023). For the European market, HD 629-1-S3 defines performance requirements for cable accessories for use on extruded insulation power cables in the same general voltage range (CENELEC, 2019).

These documents matter because they provide a common technical basis for evaluating joints, rather than relying only on product claims. IEEE 404-2022 likewise establishes electrical ratings and test requirements for cable joints used with extruded and laminated dielectric shielded cable, and is useful as an additional reference point for performance expectations and test discipline (IEEE, 2022).

PD testing also plays a central role in quality assurance. Industry practice uses partial-discharge testing during factory testing and commissioning to detect incipient breakdown and installation defects in MV cable systems and accessories (Megger, 2025). That makes PD performance a relevant benchmark when comparing joint technologies.

Heat shrink technology

Heat shrink joints use thermally activated materials that shrink around the prepared cable interface. They are widely used, mechanically robust and familiar to many installers (Lovink Enertech, n.d.). Their main strength is broad applicability and relatively simple material structure, especially when installation conditions are well controlled and experienced jointers are available.

The main limitation is installation sensitivity. Heat shrink systems depend on correct heating, clean surface preparation and sufficient procedural control during assembly. In environments where open flame is restricted, where permits are difficult to obtain or where space is limited, this installation method can be less practical. In short, heat shrink can be a robust solution, but it is not especially forgiving when field conditions are poor (Lovink Enertech, n.d.; IEEE, 2022).

Cold shrink technology

Cold shrink systems use elastomeric components that contract around the cable interface without external heat. This improves installation repeatability and removes the need for open-flame work, which is attractive in many industrial environments. The method also reduces one source of installer variability because the radial force is built into the accessory geometry rather than created during heating.

The key technical issue is long-term interface stability. Published research shows that interface pressure in silicone rubber cable accessories is affected by temperature and thermal ageing, and that these changes can influence long-term electrical behaviour (Xia et al., 2023; Du et al., 2024). That does not make cold shrink unsuitable; it does mean that ageing of the elastomer and retention of contact pressure are central to lifetime performance.

Resin technology

Resin-based joints encapsulate the connection in a cured compound. Their principal advantage is strong external protection: once cured, the joint offers a rigid barrier against moisture ingress, soil movement and mechanical impact (Lovink Enertech, n.d.). This makes resin especially relevant where environmental sealing and ruggedness are priorities.

The main design challenge is that rigid systems depend on void-free casting and correct internal geometry. Once the resin has cured, defects are difficult to correct, which means installation quality remains critical even though the outer protection is mechanically strong. Resin systems are therefore attractive for their sealing and robustness, but not inherently self-compensating for internal imperfections (IEEE, 2022; Lovink Enertech, n.d.).

Pre-moulded technology

Pre-moulded systems rely on factory-shaped insulation bodies with controlled geometry. Their main strength is consistency: the insulation profile and stress-control shape are produced under controlled manufacturing conditions rather than being formed fully in the field (INMR, n.d.). This can support reliable stress control if the accessory is properly matched to the cable and installed correctly.

Their limitation is that installation quality still matters. Fit, interface preparation and any additional outer protection all influence the final performance of the joint (INMR, n.d.; IEEE, 2022). In other words, pre-moulded designs reduce some variability, but they do not eliminate the importance of workmanship.

Electrical stress control

Electrical stress control is one of the central design issues in MV joints. At the point where the cable screen is cut back, the electric field becomes concentrated, and without mitigation that local stress concentration can accelerate ageing or trigger insulation failure (Power and Cables, n.d.; IEEE, 2022). Stress control is therefore achieved through a combination of geometry, field grading materials and carefully designed interfaces (IEEE, 2022; INMR, n.d.).

Material compatibility matters here as well. If the dielectric properties of the joint insulation differ strongly from those of the cable insulation, the electric field can distort at the interface. Lovink states that LoviSil is designed with dielectric behaviour similar to XLPE to reduce this effect; in the whitepaper this should be presented as a manufacturer claim unless supported by independent measurements (Lovink Enertech, n.d.). Technically, the point is sound: stable permittivity and good interface compatibility support better field grading.

Partial discharge and long-term reliability

Partial discharge is widely recognized as one of the most important degradation mechanisms in cable accessories (MDPI, 2025; MDPI, 2023; Megger, 2025). It typically starts in voids, bubbles, contamination or poorly controlled interfaces and can progressively erode insulation until failure occurs. This is why the quality of the internal electrical interface is often more important than the external appearance of the joint.

Research on silicone rubber cable accessories shows that thermal ageing and mechanical compression can change interface pressure and material behaviour over time (Xia et al., 2023; Du et al., 2024; RSC, 2026). That means long-term reliability depends not only on initial design but also on how the accessory behaves after years of thermal cycling and environmental exposure. For this reason, claims about “PD immunity” should be avoided unless they are backed by independent evidence under relevant test conditions.

Hybrid architecture

A hybrid jointing architecture separates the electrical and mechanical functions of the accessory. In the Lovink concept, liquid silicone is used for the electrical insulation and interface region, while a resin outer layer provides mechanical strength and environmental sealing (Lovink Enertech, n.d.). The design logic is attractive because it does not force one material to do both jobs equally well.

From an engineering standpoint, this is a sensible approach. The liquid silicone can support void management and field compatibility at the interface, while the resin outer layer can provide robust external protection against moisture, contamination and mechanical loading. Lovink describes this as a long-life jointing concept with field experience and standardized testing, but those statements should remain clearly identified as manufacturer claims unless supplemented by independent test data (Lovink Enertech, n.d.; IEEE, 2022; IEC, 2023).

Comparative assessment

The technologies differ most clearly in four areas: installation sensitivity, electrical interface stability, mechanical robustness and ageing behaviour. Heat shrink is a proven all-round solution, but it is more dependent on installation discipline and thermal process control (Lovink Enertech, n.d.; IEEE, 2022). Cold shrink improves installation repeatability, but long-term performance depends on elastomer ageing and interface pressure retention (Xia et al., 2023; Du et al., 2024).

Resin systems provide strong external protection and sealing, but they depend on high-quality casting and do not inherently forgive internal voids once cured (Lovink Enertech, n.d.; IEEE, 2022). Pre-moulded systems provide controlled geometry and consistent stress control, but still depend on precise fit and proper installation (INMR, n.d.; IEEE, 2022). Hybrid systems offer a balanced architecture by combining cavity management on the electrical side with rigid protection on the mechanical side (Lovink Enertech, n.d.).

Selection criteria by application

Technology choice should be based on application conditions rather than on a single generic preference. Where flame-free installation is required, non-thermal systems have a clear practical advantage. Where soil movement, moisture exposure or external mechanical loading are dominant, resin-based outer protection becomes especially relevant.

Where the main concern is long-term electrical interface quality, stress control and partial-discharge suppression, the design of the interface itself becomes the decisive factor (MDPI, 2025; MDPI, 2023; Megger, 2025). In that context, hybrid systems deserve consideration because they combine electrical interface management with robust external sealing and protection. For demanding MV applications, the best technology is usually the one that best matches the real operating environment, installation constraints and reliability target (IEEE, 2022; CENELEC, 2019).

Conclusion

No single jointing technology is best for every MV application. Heat shrink, cold shrink, resin and pre-moulded systems each have a valid place depending on the project context, installation conditions and reliability requirements (IEEE, 2022; IEC, 2023). The technical literature shows that partial discharge, interface quality and ageing behaviour are central to long-term performance, which makes void management and stress control especially important in accessory design (MDPI, 2025; MDPI, 2023; Xia et al., 2023).

A hybrid architecture based on liquid silicone and resin is technically defensible because it separates the electrical and mechanical functions of the joint. That approach can improve the balance between interface stability, sealing and ruggedness, provided the design is validated against relevant standards and supported by independent evidence where possible (Lovink Enertech, n.d.; IEEE, 2022; IEC, 2023).

Referenties

CENELEC. (2019). *HD 629-1-S3: Test requirements for accessories for use on power cables of rated voltage from 3.6/6(7.2) kV up to 20.8/36(42) kV – Part 1: Accessories for cables with extruded insulation*.

Du, B., et al. (2024). *Compression stress relaxation characteristics and failure mechanism of silicone rubber cable accessories*. *Polymer Degradation and Stability*.

IEEE. (2022). *IEEE Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2.5 kV to 500 kV (IEEE Std 404-2022)*.

IEC. (2023). *IEC 60502-4:2023 Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV – Part 4: Test requirements on accessories for cables with rated voltages from 6 kV up to 30 kV*.

INMR. (n.d.). *Material design requirements for MV cable accessories*.

Lovink Enertech. (n.d.). *LoviSil technology*.

Lovink Enertech. (n.d.). *Resin cable joint kits*.

Megger. (2025). *Partial discharge testing for MV, HV & EHV cables and accessories*.

MDPI. (2023). *A review on partial discharge diagnosis in cables*. *Sensors*.

MDPI. (2025). *Medium-voltage AC cable joints: A review of testing methods*. *Sensors*.

Power and Cables. (n.d.). *MV cables: Electric field stress control*.

RSC. (2026). *Accelerated ageing of silicone rubber and XLPE used in HV cable accessories*.

Xia, et al. (2023). *Effect of temperature and thermal ageing of cable silicone rubber accessories on interface pressure of cable joints*. *Applied Sciences*.

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