RETROFITTING OF MV OVERHEAD LINES

ANTI-ELECTROCUTION BIRD PROTECTION COVERS

FOR CLASS 0 DISTRIBUTION NETWORKS: ≤30kV.

EVALUATION OF DETERMINANT FACTORS TO ENSURE

THE ENDURING PERFORMANCE OVER TIME OF THE INSTALLATIONS.

GUARANTEE AND DURABILITY REPORT.

ANALYSIS OF TEST RESULTS.

ENVERTEC®_CAON®-KORWI® Silicone Covers

1. MANUFACTURER, BRAND AND PRODUCTION FACILITY.

- Design engineering, development and supply: **ENVERTEC S.L.**
  - Address: **Polígono La Fuente , Calle Huelva, 10**
    18340 Fuente Vaqueros
    Granada - Spain.
    Tel No.: **+34 958 511 669**
    Contact Person : **Jose Luis Ruz González**
    Contact Tel. No. : **+34 678 67 50 60**
  - QMS Certification:
    - **UNE-EN-ISO 9001:2015** :
      - Scope : **Design, development and marketing of insulators, silicone covers and switchgear for use in medium and high voltage systems.**

- Brand : **ENVERTEC® _ CAON®-KORWI®**
  - Production Facility Accreditations :
    - **ISO 9001:2008**
    - **ISO 14001:2004**

Access link to corporate video showing images of the facility taken from a drone-mounted camera.

1. PRODUCT SUPPLY HIGHLIGHTS:

   - **>225,000 CAON®-KORWI®** brand Polymer Insulators supplied in Spain since **2008** (of which **>155,000 supplied to ENDESA DISTRIBUCIÓN ELECTRICA SLU** over the 2011-2017 period), and **>350,000** worldwide, all of them **with zero (0) reported incidents.**
   - **>70,000 Preformed** Bird Protection Covers and **>115,000m** of **Conductor** cover hose**, all of them made of HTV Silicone material, ENVERTEC®_CAON®-KORWI®** brand, supplied mainly to **Spain and Portugal, as well as Mexico and Nicaragua,** since 2013 **with highly satisfactory results and an excellent reception** among professionals in the industry.

1. OVERVIEW AND TECHNICAL CHARACTERISTICS OF THE ANTI-ELECTROCUTION PROTECTIVE COVERS

APPLICABLE ANTI-ELECTROCUTION BIRD PROTECTION LEGISLATION AND STANDARDS

ROYAL DECREE 1432/2008 – AENOR EA0058:2016

ENVERTEC®_CAON®-KORWI ®SILICONE COVERS FOR USE ON **15 – 45kV** MEDIUM VOLTAGE OVERHEAD LINES.

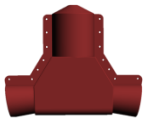
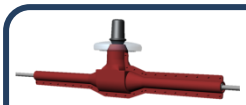
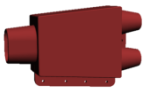
 **SWP**	PROTECTIVE COVER FOR CONDUCTORS	 **SPPL**	PROTECTIVE COVER FOR PIN-TYPE POLYMER INSULATOR WITH 2 OUTLETS.
 **STSC**	PROTECTIVE COVER FOR DEADEND CLAMPS	 **SPAV**	PROTECTIVE COVER FOR PIN-TYPE GLASS INSULATOR ARVI STYLE
 **SPSC**	PROTECTIVE COVER FOR SUSPENSION CLAMPS	 **SPSA**	PROTECTIVE COVER FOR SURGE ARRESTERS **SF6** BREAKER BUSHINGS
 SPGSA	PROTECTIVE COVER FOR **45kV** REINFORCED SUSPENSION CLAMPS	 **SPEB**	PROTECTIVE COVER FOR CABLE TERMINATIONS
 **SPP**	PROTECTIVE COVER FOR TRANSFORMER BUSHINGS	 **SAP**	PROTECTIVE COVER FOR AMPACT/GRIMPI SPLICES

Table 1

Specific solutions designed to Protect **Bird Species, Safeguard the Integrity of the Electrical System** and ensure an **Uninterrupted Power Supply**

1.1 INTRODUCTION.

The ***CAON-KORWI®*** brand Silicone Covers have been developed as a **protective device to prevent the electrocution of bird species** on **Class 0** overhead distribution power lines with a phase-to ground voltage up to **36kV/√3**.

These covers have been manufactured and tested in accordance with AENOR Specification EA0058:2016 and ENDESA Standard GE-BNA001:2017 (See AENOR Certification No. A30/000089 on pages 13-14 of this document).

These Covers are designed for retrofitting on existing lines that do not allow installation of our Bird Protection Insulator models ***C3670EBAV*** and ***C3670EBAV_AR***, the latter constituting an example of **pioneering design**.

The purpose of these Covers is to protect Bird and other Wildlife species from electrocution due to the bird or other animal making simultaneous contact with a phase conductor and the metal structure, or simultaneous contact with two phase conductors, or with a phase conductor and any other energised part. These Covers are also an effective means of **protecting overhead lines from other causes of line faults**, such as vegetation (branches), vandalism, etc, thereby **preventing fire hazards and Power Outages.**

1.2 NOMINAL CHARACTERISTICS OF THE MATERIAL USED. *GUARANTEED DURABILITY.*

- **MANUFACTURED WITH HTV SILICONE WITH A HYDROPHOBICITY LEVEL OF Hc2:** Due to their composition and nature **they repel the build-up of moisture and are permeable to Oxygen.**
- Compared with other materials, **silicones show excellent and enduring water repellency,** a property known as **hydrophobicity.** Insulating materials made of silicone rubber maintain their water-repellent properties for many years. Thus, leakage currents are minimised, **preventing flashovers due to contaminant build-up** even in case of severe surface contamination, as the hydrophobic effect migrates to the contaminant layer. This is known as hydrophobicity transfer.
- Based on the accelerated weathering tests carried out and their **excellent resistance to chemicals and UV radiation,** their service life is estimated at **more than 20 years.**
- These Covers have a **minimum silicone thickness of 3 to 3.5mm** (depending on the model), ensuring *excellent dielectric performance and resistance to UV radiation*, **with no colour degradation or crystallisation**, and they are **effective even in areas with extremely high saline pollution.**

Nominal Material Characteristics	
Name	**Silicone Rubber (White carbon black).**
Type:	**HTV. Solid high temperature vulcanising (200°C) silicone rubber component.**
Model:	**110-2 (60W to 65W molecular film)**
Hydroph. Coating:	**Water permeability level Hc2.**

Mechanical Characteristics	
Flammability :	**650ºC (UNE 60695-2-11)**
Density:	**>1.1g/cm3 (ISO-868)**
Hardness:	**>60 Shore A (ISO868)**
Tensile Strength:	**>4N/mm2(EN60811-501)**
Elasticity Modulus :	**>200% (EN-60811-501)**
Tear Resistance :	**>10N/mm (UNE-HD-605)**
Dielectric Strength :	**>18kV/mm_EN60243-1**

Tables 2 & 3. Nominal and Mechanical Characteristics of the material used in the manufacture of the various ENVERTEC® _ CAON-KORWI® brand covers.

1.3 WORKING TEMPERATURE RANGE.

The mechanical tests already performed on the covers in accordance with AENOR Specification **EA 0058:2016** Section 8.3.2, and ENDESA standard GE-BNA001 Section 7.3.2, allow us to guarantee their use at minimum temperatures of up to **-25°C.**

Moreover, the vulcanisation of the silicone material present in all the covers is carried out at a temperature of **180 to 200°C**, which allows the covers to be used at temperatures of up to **105°C.**

This last property is also endorsed by the performance of the Silicone used to manufacture these Covers **— the same as that used in the manufacture of our Polymer Insulators —** during the accelerated weathering test as per Standards ANSI C29.13 – 2000 and C29.11-1989[(1)], performed by the LAPEM independent laboratory, with test report Nº K304-150/2010 .

(1) To carry out this test, a total of 6 samples of the same silicone material used to make these covers undergo weathering for **100 hours in 0.1% sodium chloride brine at boiling temperature.** Following this conditioning, the samples underwent an electrical voltage withstand test within 3 hours from the completion of the weathering test.

1.4 CONSTRUCTION CHARACTERISTICS.

DETERMINANT FACTORS TO ENSURE ENDURING PERFORMANCE OVER TIME

The **enduring effectiveness** of the implementation of anti-electrocution measures through the use of **CAON®-KORWI®** Silicone Covers depends on **4 fundamental factors:**

1. **Qualities of the raw material used in the manufacture of the protective Covers:**
   - Safe, inert materials ensuring an enduring satisfactory performance under the existing climate and environmental conditions at the installation site: Thermal stress, UV radiation, Saline fog, Contaminant level, ….

2. **Device design and geometry:**
   - The various models have been specifically designed for each of the hardware or conductor types for which they are intended, so as to ensure that their size is as small as possible, thereby ensuring **improved aerodynamic performance** under prevailing winds, as well as good **rainwater drainage.** This design feature significantly contributes to ensure that the cover stays in its original installation position.[(2)]

3. **Cover fixing and closure securing system:**
   - A **specific fixing and closure securing system** has been designed for each different device, using certain accessories and installation techniques described in the Installation Videos and/or Manuals available for each model.

4. Installation Techniques [3]:

- Proper installation of each device is critical to ensure that it stays in its original installation position. The manuals provided in each packing unit, containing clear instructions in Spanish, complete with images **and descriptive field installation videos** (which can be accessed through the QR codes provided), directly support the installation work.

[2] The damages and consequences due to lightning and/or severe weather phenomena such as gales, hurricanes, accidents involving vegetation, fires, etc. are not contemplated.

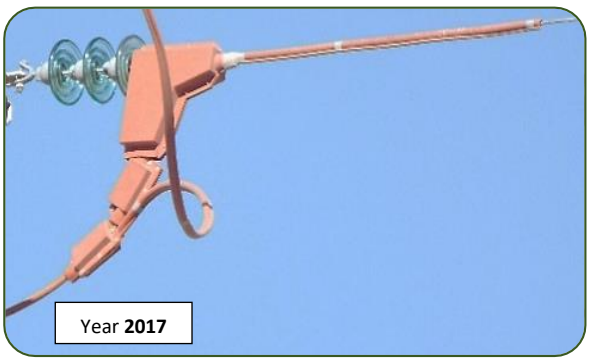
[3] The designs feature locking systems by means of **preinstalled** pins on each preformed cover model, allowing **fast, simple, manual** installation requiring no tools. The **double-cone** design of the pins allows locking and subsequent reopening for inspection or maintenance, **without impairing the effectiveness of the locking system or damaging the cover.**

The design of the preformed deadend clamp covers features **cone-shaped** coupling sections which provide the Kit with a **double safety system that prevents the conductor cover from slipping along the conductor.**
In the case of the **SWP** type conductor cover models, the properties and **flexibility** of the Silicone used to manufacture them makes the covers easy to work with, as they easily adapt to the installation requirements of each application, and are **effective even on small radius curves**, with the added advantage that they can be quickly and easily trimmed to the right length.

Preinstalled cone-shaped pins.
Clamshell opening design of the covers.

Cone-shaped sections for coupling to other cover models. Non-slipping along conductor guaranteed.

Conductor cover can adapt to small radius curves without opening up.



Images of the same line phase taken with a 2013 – 2017 time interval. The installation was carried out using the cone-shaped sections incorporated in the deadend clamp covers for coupling with the conductor cover, and the built-in locking elements (preinstalled pins) and closure securing devices (self-vulcanising silicone tape) specified in the manual, as well as well as in the assembly instructions and installation videos accessed through the QR codes provided.
The satisfactory performance of the various elements, as well as the absence of slipping from their original position, was established.

1.5 MARKING.

- Traceability of each Cover by means of Individual Marking:

  Each cover is **indelibly marked** on an external, visible place with the brand, model, Batch number, year and month of manufacture, rated voltage and 'recyclable' symbol.

2. PROCESS TRACEABILITY. *ENSURING ENDURING PERFORMANCE.*

2.1 QUALITY DOCUMENTATION.

Each batch of covers supplied to a utility or environmental agency is supplied complete with a QUALITY AND TRACEABILITY ASSESSMENT REPORT for that specific batch.

This document includes the Routine/Individual and Random Test reports for the tests carried out at the production facility on a certain number of samples, depending on the scope of the supply and according to the specifications given in the relevant Table of AENOR Specification EA 0058; it also specifies essential data such as the batch numbers of the covers, the batch numbers of the silicone raw material used for the manufacturing process, etc., to ensure the Traceability of the devices.

In addition to the above documentation, a **recycling programme** is provided – included in the installation manuals for each product reference number – describing the correct procedure for recycling the covers when they reach the end of their service life.

3 GUARANTEE.

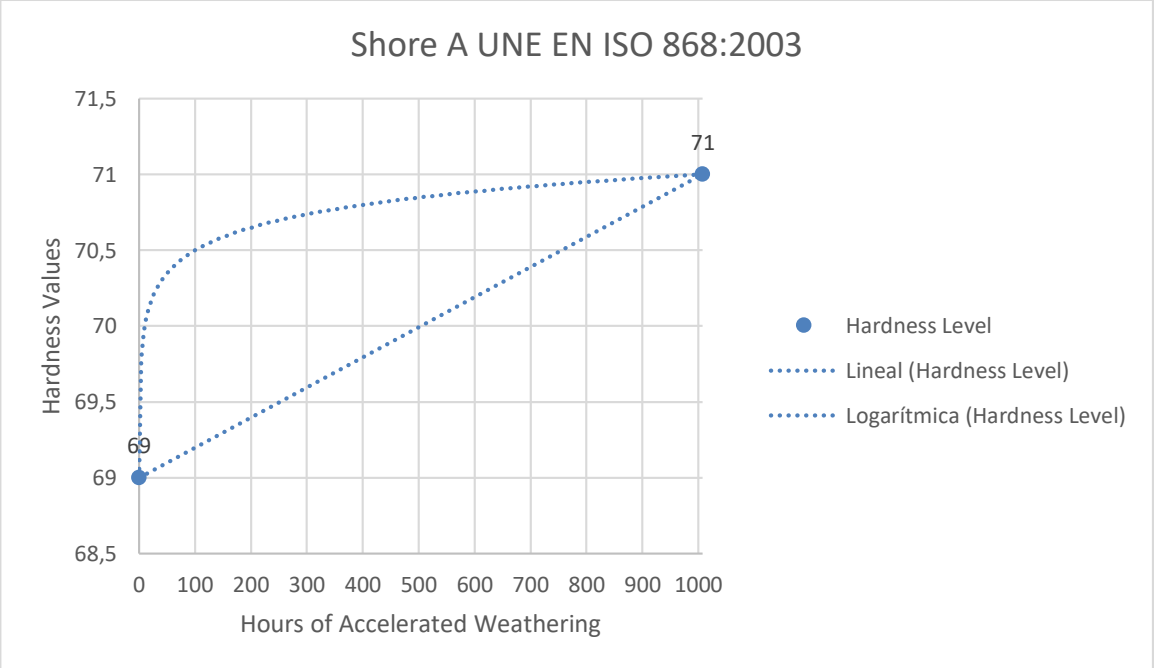
The Silicone base material used to manufacture these Covers **is the same as that used in the manufacture of our Polymer Insulators,** of which more than **205,000 units** have been supplied and installed in Spain over the past 9 years. The 5,000 hour Accelerated Weathering tests as per IEC 6119 Annex C [(4)] , carried out at the **STRI testing laboratory in Sweden**, which include the **harmful effects of Saline Fog** on the silicone used in all our products, allow us to estimate the **service life [(1)] of these Covers at more than 20 Years.**

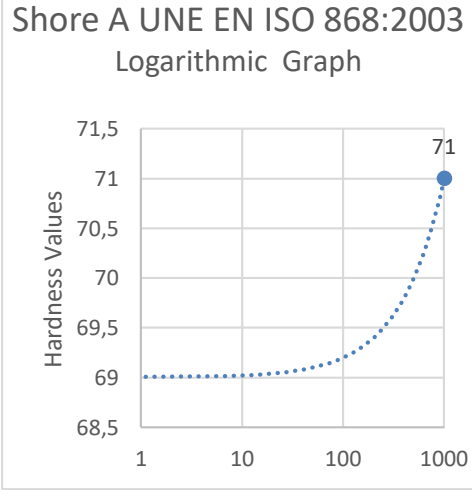
[(4)] These tests were carried out in a weathering chamber over a period of approximately 7 months. During that period, the (silicone) polymer coating of the insulators was continually subjected to an electric voltage, together with intervals of **high saline contamination fog**, artificial rain, high relative humidity atmosphere, high ambient temperature periods, and UV radiation exposure periods simulated using Xenon lamps.

Recently, the materials used to manufacture our covers underwent new, rigorous testing for certification according to AENOR Specification EA0058:2016 and ENDESA Standard BNA001:2017.
These tests were verified and/or performed by the CEIS (Centro de Ensayos Innovación y Servicios) testing facility in MADRID :
Hardness, tensile strength and elasticity modulus, tear resistance, flammability, Ozone Resistance, **Dielectric Strength** and **1000h Weathering** tests**.**
In light of the outstanding results obtained, we wish to highlight the outcome of the last two tests mentioned above:

4. Accelerated Weathering Test: UNE 211605.

"Performance of the material used for the manufacture of the covers when exposed to sunlight and the elements (humidity, water spray, cold and heat) for a prolonged period of time."
Change in Hardness level, measured in Shore A, according to ISO 868:2003

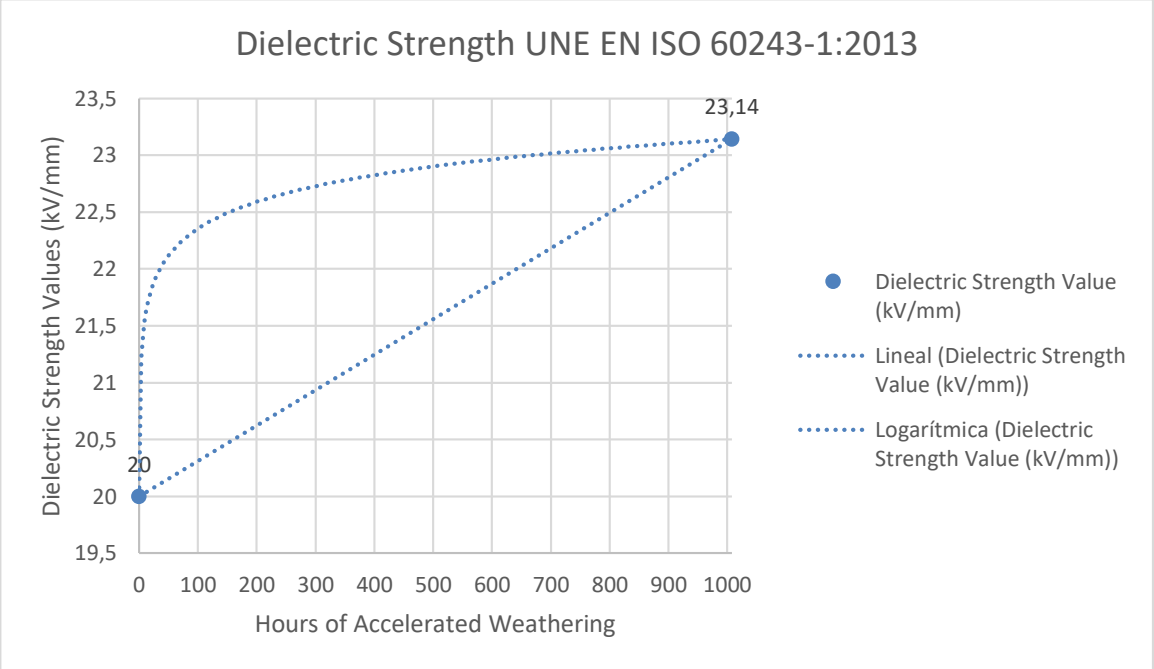




Experience has allowed us to identify a relationship between improved **hydrophobicity** and a higher Hardness level measured in Shore A.
This results in better dielectric performance under exposure to environmental pollution, **minimising leakage currents.** This allows us to guarantee that the performance of our covers is fully **satisfactory** and shows **outstanding endurance over time.**

5. 1000h Accelerated Weathering Test : UNE 211605.

Change in Dielectric Strength according to ISO:60243-1:2013



"(…)The Dielectric Strength **IMPROVES** after the weathering."

Source : Report dated April 2018 , Issued by **CENTRO DE ENSAYOS INNOVACIÓN Y SERVICIOS – CEIS**

The **Dielectric Strength** of the specially formulated silicone used in our covers initially has a value of **20kV/mm, which improves** to **23.14kV/mm after the Weathering Test.**

This results in better performance in polluted environments, which, combined with the material's excellent **Ozone Resistance — IEC EN 60811-403:2012,** allows us to guarantee that the performance of our covers is fully **satisfactory** and shows **outstanding endurance over time**.

These results are complemented with the **Constant Monitoring of the Performance of Field Installations** that we have been carrying out over the past 5 years for our Silicone Covers, as described in the appendix to this report.

6. MAINTENANCE.

Thanks to their design and conception, these Covers have minimum maintenance [5] and conservation requirements, essentially the same as those applying to the different switching and insulation devices installed on line structures or transformer stations.

- The recommended maintenance of the installed devices includes:
  Visual inspection and assessment of the integrity of the device at intervals not exceeding five years, depending on the existing pollution level and the environmental value of the location where the devices are installed.[2]

[5] Pursuant to Royal Decree 1432/2008 issued by the Government of Spain, the factors required to be considered when carrying out maintenance work include the environmental and conservation value of the area where the devices are installed.
For devices installed on overhead power lines running across areas classified as high environmental value locations, maintenance and cleaning work (if required) must be performed in such a manner as to ensure minimal environmental impact, always adhering to the prescriptions of the applicable legislation.
Such legislation prohibits maintenance work on those parts of overhead lines supporting nests, or in the vicinity of nesting areas of birds included in the List of Wild Species subject to Special Protection (Articles 53 & 54 of Law 42/2007 of 13 December, on the Natural Heritage and Biodiversity) during the mating and breeding season, subject to the exceptions provided in said law for urgent work required to ensure the quality or continuity of the power supply, in which case the scheduled work plan must be notified in advance to the competent authority of the autonomous community involved.

7. ENVIRONMENTAL IMPACT AND RECYCLING.

The polymeric material (silicone rubber) making up the Cover bodies shows excellent resistance to changing climate conditions and weathering, as it is not biodegradable. It is an inert material that maintains its characteristics and properties over its entire service life; it does not decompose, it does not react chemically and **does not give off contaminants into the surrounding environment.**

Silicone's low toxicity, its resistance to hosting microbial agents, and the precautions taken during the silicone rubber manufacturing process to prevent the presence of organisms are added value features in terms of the interaction of these Covers with the animal and plant species whose habitat is located in the natural areas for which such devices are intended (e.g., Special Bird Protection Areas - SPAs), or in terms of the introduction of undesired non-autochthonous species (predatory or parasitic) into such protected areas.

No incidents have been reported to date involving the presence of external microbial organisms, such as for example fungi, on devices made of this kind of material installed on the lines, or incidents involving the ingestion by animals of this kind of material on devices fitted on the power lines, which would also include polymer insulators.

Consequently, whether in their installed position or in the event of their falling to the ground under the effect of severe weather phenomena, these devices do not pose a risk to the environment, and can thus be considered non-hazardous waste, easy to identify and spot on account of their colour: red RAL 3031.

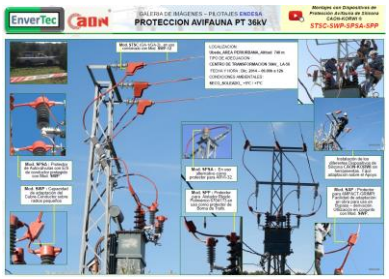
As regards recycling at the end of their service life, as specified in the installation manual for each cover, they should be dropped off at the nearest recycling collection point or approved local waste disposal facility. No contaminant agents have been found to be present in the material.

8. STANDARD SUPPLY FORMAT AND PACKAGING.

- Conductor Cover hose (Mod. **SWP)**: Cartons holding 5 to 20m.
- **Other** Preformed Silicone Protective **Covers**: Cartons holding 6 units.
- All the cartons are made of **recyclable cardboard** with no metal staples, closed with **environment-friendly** adhesive paper **tape**.
- Every carton is clearly marked with the name of the cover model it contains and **includes information on the month/year of manufacture, Batch No.** and **handling and storage** instructions.
- Inside the carton is a detailed A4 size **Instruction Manual** in Spanish, printed **double-side in colour,** describing the correct installation of the protective cover and its fitting and closure securing accessories, as well as guidelines for **proper recycling** at the end of their service life.
- Both the Installation Manuals and the cartons for each device feature a **QR Code** providing access to the relevant **Field Installation Video.**

Installation Video

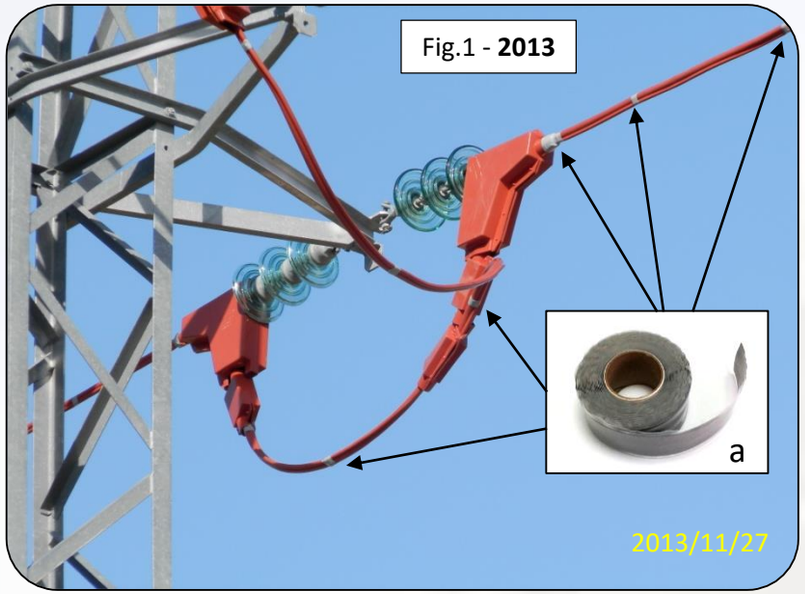
- **LINKS TO FURTHER INFORMATION: CATALOGUE DOWNLOAD, TECHNICAL DATA SHEETS, IMAGE GALLERY, AND FIELD INSTALLATION VIDEOS.**



Quick Guide. General Catalogue & Technical Data Sheets Image Gallery. Installation Videos.

THANK YOU.

EnverTec https://envertec.eu info@envertec.eu



SPECIFIC ADVANCED FORMULATION SILICONE.

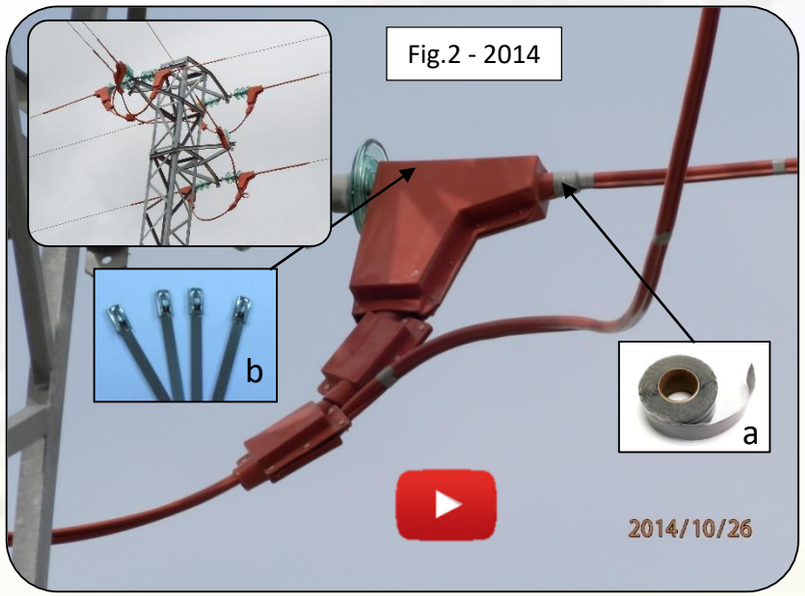
" […] the dielectric strength **improves** with ageing." (*)

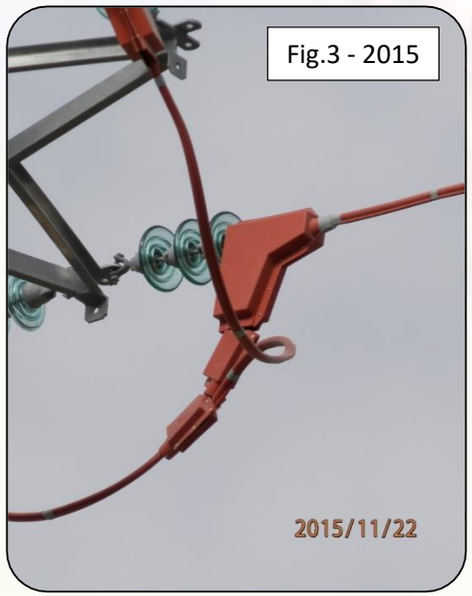
The **Ongoing Field Installation Performance Monitoring** carried out by us over the past 5 years on our CAON®-KORWI® brand Silicone covers, together with the **positive results** in the recently carried out **OZONE RESISTANCE** tests according to IEC EN 60811-403:2012, as well as the remarkable Shore A Hardness and Dielectric Strength measurements obtained **after passing** the **1000h ACCELERATED WEATHERING** test as per IEC EN 60243-1:2013(*) allow us to assure a ***Unique and Outstanding Enduring Performance of our Covers.***

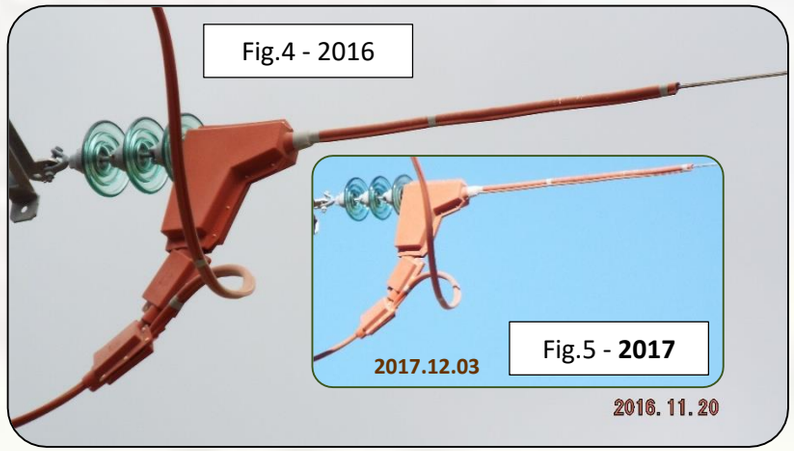
(*) The initial **Dielectric Strength** value of our silicone is **20kV/mm, which improves** up to **23.14kV/mm after the test.**

The initial Shore A hardness value is 69, which improves up to a **Shore A** value of **71** after passing the test.
Source: Report dated April 2018 – **CENTRO DE ENSAYOS INNOVACIÓN Y SERVICIOS – CEIS.**

The use of utility approved **fixing and closure securing** elements in combination with the Mod. SWP Silicone protective cover **ensures optimum performance of the installation, enduring over time.** - **Fig. 1:** Use of self-welding silicone tape (a) on deadend phase. The application points are specified in the installation manual provided with each device. **Fig. 2:** Securing of SWP cover to the cone forming part of the Mod.STC clamp cover (a). **Fig. 2:** Use of self-welding silicone tape (a) and stainless steel fixing ties (b . The application points are specified in the installation manual provided with each device.







Figs. 1, 2 , 3 , 4 & Fig. 5: Photos taken at **one-year intervals** of the same deadend phase: **2013 –** 2014 – 2015-2016-**2017.**

Total absence of incidents or signs of weather degradation.