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New HD 629.1 CENELEC Standard

(*test requirements for MV extruded cable accessories qualification*)

Comparison between the previous Standard and the 2019 version

April 2019

1. Introduction

Test requirements and performances of Medium Voltage accessories for extruded cables are specified on CENELEC Standard HD 629.1. After several years of work, a new revision of this standard has been prepared by CENELEC Working Group 11.

Why is this Standard so important? Because the majority of M.V. power grids in Europe is built by using extruded cables and properly performing cable accessories (joints and terminations) are key-components for a reliable power distribution service.

Guide lines for the revision of HD 629.1 have been defined starting from market needs and taking into consideration technological trends.

Experts of accessories, following modern working methods, have identified critical aspects of existing products and consequently defined new test requirements and performances able to guarantee their highest reliability.

2. List of main changes introduced on new version of HD 629.1

- A new type of accessory is considered: «range-taking» joints and terminations. For these accessories, able to cover a size range of cables, a new test sequence has been defined, testing both the minimum and the maximum cable size of the declared rang.
- DC test has been removed.
- Short circuit tests can be carried on a separate test loop or combined with the main test sequence.
- For extending the qualification to the smallest cross-section, an increased number of thermal cycles is required on relevant «additional tests», while for the extension to largest cross-section it is necessary to carry out the main test sequence (only the repetition of short-circuit tests and special tests are excluded).
- More severe criteria and additional tests are introduced for extending the qualification to connectors different from those included in the accessory type test.
- Compliance for a three-core accessory can be extended to a single-core accessory of the same family by only carrying out a list of tests able to verify the single-core accessory sealing performances against water or moisture penetration.

Details of changes and explanation of improvements introduced in the new version of the standard are presented in the following pages.

3. HD 629.1: comparison between the previous standard and the new version

a) Range-taking and non-range-taking accessories

Most popular accessories currently used in the European market are designed for covering more than one cable size. This type of MV joints and terminations are identified as range-taking cable accessories. Cold-shrinkable factory-expanded components molded with SILICONE or EPR compounds are typically range-taking accessories but also heat-shrinkable and slip-on components can be used this way.

On the previous version of HD 629.1 Standard no differentiations were considered for range-taking and non-range-taking MV accessories. There was only one test protocol and for the main test sequence only one cable size was prescribed. Tested cable size was to be chosen inside the range of the «most popular cables» (i.e. MV extruded cables with cross-section from 95 mm2 up to 300 mm2 included).

This approach is also present on the new version but limited to non-range-taking accessories. In fact, for range-taking accessories it is important to verify their performances when installed on the minimum and the maximum cable size of the declared range of application. At least one of the two tested sizes shall be within the range of the most popular cables.

On the following page Qualification Tables applicable to non-range-taking and range-taking joints are compared.

«A» in one case and «A+B» on the other one are the cables for the main test sequence, while «C» is the cable for short circuit testing.

Test cables for the extension of qualification to the smallest and the largest cable sizes are also reported (respectively size «E» and «F»).

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Qualification Tables: Example of non range-taking accessories vs range-taking ones

Non range-taking joints:

Cable Cross Section	Size	Min Size	Sample tested	Short Circuit	Max Size Range
25					
35	1	E			
50	2				
70	3				
95	4				
120	5				
150	6		A	C	
185	7				
240	8				
300	9				
400	10				
500	11				
630	12				
800	13				F
1000					
1200					

Cross sections covered without testing

Range-taking joints:

Cable Cross Section (mm2)	Size	Min Size Range	Inter-mediate Size Range	Min and Max of application range	Short Circuit	Inter-mediate Size Range	Max Size Range
25							
35	1	E					
50							
70	2						
95							
120				A			
150							
185	3						
240							
300				B	C		
400	4						
500							
630	5						
800							F
1000							
1200							

Cross sections covered without testing

TYPE OF ACCESSORY	SAMPLES FOR THE MAIN TEST SEQUENCE	SHORT CIRCUIT TESTS
Non range-taking	One test cable “A” inside the range of the most popular cables (95-300 mm2) and 1 accessory size	Same test cable C = A
Range-taking	Two test cables “A” + “B” at the limits of the declared range of application for the accessory. At least 1 of the 2 cables must be within the most popular cables. 1 accessory size (e.g. Size 3)	Bigger test cable C = B

b) Innovations introduced on the test sequence

1. DC test was removed; after installation DC tests are considered dangerous for MV extruded cable systems.
2. Sequence B2 of short circuit tests can be carried out on separated test loop or combined with sequence B1.
3. Partial discharges measurements are to be carried out at 2 Uo voltage, previously, 1.73 Uo was also acceptable.
4. Visual examination procedure is well detailed in ANNEX C, even if final visual examination remains «informative only».

New test sequence for joints qualification is shown as example.

Tests on new HD 629.1		Sequence			Test requirements
		B1		B2	
		Joints types			
		I	II	I-II	
1	AC voltage withstand test dry	x	x	x	5 min at 4,5 U_0, no breakdown
2	Partial discharge at ambient temperature	x	x		max. 10 pC at 2 U_0
3	Impact at ambient temperature		x		Insulation resistance - Conductor to screen 10^3 MΩ minimum - Screen to water 50 MΩ minimum
4	Impulse voltage at elevated temperature	x	x		10 impulses of each polarity, no breakdown
5	Heating cycle voltage in air	x	x		63 cycles at 2,5 U_0, no breakdown
6	Heating cycle voltage in water (without oversheath damage)	x	x		9 cycles at 2,5 U_0, no breakdown Insulation resistance [c] - Conductor to screen 10^3 MΩ minimum - Screen to water 50 MΩ minimum
7	Heating cycle voltage in water (with oversheath damage for non-waterblocked cables)	x	x		54 cycles at 2,5 U_0 no breakdown Insulation resistance [d] - Conductor to screen 10^3 MΩ minimum - Screen to water 50 MΩ minimum
8	Partial discharge at elevated and ambient temperature	x	x		max. 10 pC at 2 U_0
9	Thermal short circuit (screen)			x	2 short circuits at I_{sc}, no breakdown
10	Thermal short circuit (conductor)			x	2 short circuits to raise conductor to θ_{sc} of the cable, no breakdown
11	Dynamic short circuit [e]			x	1 short circuit at I_d [f], no breakdown
12	Impulse voltage at ambient temperature	x	x	x	10 impulses of each polarity, no breakdown
13	AC voltage withstand test dry	x	x	x	5 min at 4,5 U_0, no breakdown
14	Partial discharge at ambient temperature	x	x		max. 10 pC at 2 U_0
15	Visual examination according to Annex C	x	x	x	Shall be documented in the report

(a) Type I: Type test without impact test;
Type II: Type test with impact test at ambient temperature.
(b) In order to reduce the number of test loops, test sequence B1 can be combined with test sequence B2 (perform test 1 to 8 then test 9 to 15). For range taking accessories a third sample shall be added for test sequence B2.
(c) Insulation resistance applicable to non-water blocked cable only
(d) Insulation resistance applicable to water blocked cable only
(e) This test can be combined with the thermal short circuit on the conductor.
(f) Applies to 3-core cables only. For the value of the current I_d, see 7.2.

c) Heating cycling of joints immersed in water

Compared to the previous HD 629.1 (2005), some changes are introduced for improving thermal cycles test on joints immersed in water.

Heating cycle voltage test in water is divided into 2 parts:

- Preliminary 9 cycles at 2.5 Uo are carried out, without any outer sheath damage on the test cable. Internal and external insulation resistances are measured after that. In case the measured resistance does not comply with the requirement, for example because water is penetrated in the joint already at the initial stage, the test is interrupted without waiting the end of the complete test.
- 54 cycles at 2.5 Uo are then carried out.

For non-water-blocked cables, a damage on the cable outer sheath is simulated before carrying out these cycles, in such a way to verify the joint water-proofing design when no sealing fillers or hygroscopic tapes are present in the cable outer sheath. At the end of the test, insulation resistance measurements are repeated (both conductor to screen and screen to water).

d) Other changes introduced on the test sequences

Qualification severity has increased for improving both products quality and reliability.
E.g. in the new version the extension of qualification to the largest cable size requires the same tests included in the main test sequence (only the repetition of short circuit tests can be avoided) while on the previous version a reduced number of tests was considered for this application (additional tests). This improvement has been introduced because large cable cross-sections are generally more critical in service, due to the thermo-mechanical forces generated in the cables during thermal cycles, that are proportional to the conductor size.

For this reason, compliance for largest cable cross-section will require withstanding Impulse, AC Voltage test and Partial Discharges measurement after the complete sequence of thermal cycles.

However, also the extension of qualification to smallest cable cross-section has improved, increasing the number of thermal cycles from 10 to 21 cycles, implemented in the Table for Additional Tests, where also AC voltage test, P.D. measurement and Impulse test are present.

e) Connectors

One critical aspect in M.V. accessories is to verify the compatibility of “variable components” inside joints and terminations. Joint connectors and terminal lugs are typical “variable components” because they are chosen according to the cable conductor size and sometime supplied separately from the accessory kit. Both connectors types are covered by IEC Standard 61238-1, where test methods and requirements are specified - but electrical and thermal compatibility of connectors with the accessories where they will be installed can be only verified testing the complete accessory assembled on relevant cable.

On the previous version of HD 629.1 it was possible to qualify one accessory/connector combination and to extend to any other connector type the qualification validity, without other verifications. This approach did not take into consideration the electrical and thermal influence the different connectors could have on the accessory performances.

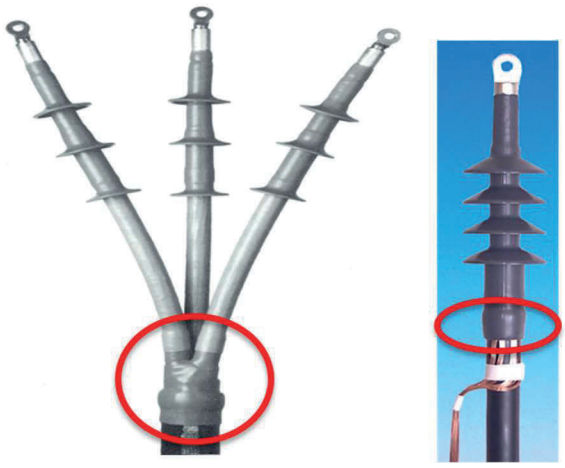
Detailed compliance rules for connectors are introduced in the new version:

- qualification can be extended to other connectors than those included in the accessories type test, only passing additional tests on the accessories with new connectors.
- furthermore, new connectors must be of the same “technology family” of the qualified one (e.g. shear-bolts mechanical connectors or punched or compressed…) without exceeding some critical dimensions and characteristics specified on new HD 629.1 Standard.

e) Three-core and single core accessories

In the previous version of HD 629.1, compliance for a three-core accessory could be extended to single-core accessory of the same design, while the converse could not be applied. This approach did not consider some important differences that are present in the design.

For example, the sealing of a 3-core outdoor termination needs a specific component, called trifurcation glove, to be applied where the three cores are opened before entering into the three terminations. This component is not present on single-core terminations, so the sealing against moisture and water penetration is substantially different between the two accessories of the same family. For this reason, on the new HD 629.1 version, compliance can be extended to single-core accessories, only after positively performing following additional tests involving the accessory sealing:



- Immersion and salt fog tests for outdoor terminations (followed by relevant verification tests)
- Humidity test for indoor terminations (followed by relevant verification test)
- Heating cycle voltage in water for joints and separable connectors (+ verification tests).

4. Conclusions

Evolution of European power cables market and availability of innovative solutions for MV cable accessories have been the guide lines for the revision of HD 629.1 standard.

Aluminum conductors have largely replaced Copper ones and larger cross-sections are now used. On big size cables, thermo-mechanical effects are more important and for this reason the extension of qualification to largest cross-section will require a more severe test protocol respect to the past.

Accessories designed for covering a range of cables are becoming very popular in the last years, therefore a new test approach was specifically defined for such family of joints and terminations, testing the most popular accessory size assembled on both the minimum and the maximum cable of the declared range of application. In this way electrical performances can be verified both with the lowest pressure applied at the accessory/cable interface (e.g. minimum cable size), that is critical for the longitudinal stress, as well as with the highest external radial stress i.e. maximum cable size.

For improving MV accessories reliability, more stringent rules are introduced for the extension of qualification to other connectors than those included in the accessory type test and the compliance granted for a three-core accessory can be extended to a single-core accessory of the same family only after additional tests have verified the sealing performance of the single-core accessory.

All above changes will improve MV accessories quality and consequently the reliability of European MV power distribution grid.
