Range of Approval for HVDC Cable System above 320 kV up to 525 kV and its accessories

The requirements for the Range of Approval are divided into four tables:

- Modification on the CABLE SYSTEM,
- Modification on the CABLE,
- Modification on the ACCESSORIES,
- Modification on the SUBMARINE CABLE SYSTEM specific aspects

These tables are non-exhaustive. The statements made in the tables regarding equality of requirements compared to CIGRE TB 852 and (DIN) IEC 62895 are to be understood for information only. The requirements stated in the tables prevail in case of inconsistency to Standards and Brochures. Changes not stated in the tables shall be considered “undefined” with regards to qualification requirements. In such a case the required tests for qualification shall be based on the detailed FMECA provided by the Contractor and shall be agreed by the Employer.

All changes shall be supplemented by a detailed description of the change, by a comparison of the changed object (usually the offered cable system) with the referenced object (usually the qualified cable system) and by a detailed FMECA incl. proposed tests (if any). The Contractor shall submit a detailed comparison of the qualified cable system and the offered cable system to provide proof that the range of approval requirements are met. These includes at least:

- a table that includes all parameters of the qualified and offered cable systems side-by-side;
- a list of the Range of Approval criteria incl. the respective parameter of the qualified and offered cable systems side-by-side and the assessment of the Supplier on the accordance to the requirements of the Range of Approval;
- a detailed FMECA for the change. If not agreed otherwise the FMECA shall be performed in accordance with IEC 60812;
- List of tests to be performed acc. to this Range of Approval and additional tests propose by the Supplier.

The conditions for range of approval in this document do not involve considerations of DC electrical fields. In the design of DC cable systems, the DC electrical fields are critical design criteria. The Contractor must therefore have detailed knowledge of the DC electrical fields in the cable system (cable and accessories) under all operating conditions. The Contractor shall state and present to the Employer a comparison of all DC electrical fields in all operating conditions of the offered cable system (cable and all accessories) compared to the qualified cable system and shall highlight changes of the DC electrical field(s). The Contractor shall provide a proposal for the qualification to cover the changed DC electrical fields to the Employer. The acceptance of the proposal is on the sole discretion of the Employer.

This range of approval table does not give guidance (yet) on how to deal with modified or new extrusion lines. The working group excluded this from the scope as there is a CIGRE taskforce (TF B1.97) working on this topic and has the relevant experts available in that group.

With regards to submarine cable system range of approval, the table focusses only on items that are specifically relevant for submarine application, such as armour, factory joint and submarine rigid (repair) joint. Items discussed in other RoA tables apply to both EHVDC underground and submarine cable systems.

Modification on the CABLE SYSTEM		Equal[1] to..? [E]qual [C]hanged [A]dditional		Qualification tests to be performed :							Comment
	Modification / Change	CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
Electrical	Increase of rated voltage U_0 by not more than 10%.	E	E			x			x[A]	x[4]	[A] In line with CIGRE TB 852 chapter 6.1.
	Increase of rated voltage U_0 by more than 10% or U_0 higher than U_M of the qualified cable system.	E	E			x		x	x[A]	x[4]	[A] In line with CIGRE TB 852 chapter 6.1.
	Increase of any of the service voltages[3] U_M, U_{P1}, $U_{P2,S}$ and $U_{P2.O}$.	E	E			x				x[4]	In deviation to CIGRE TB 852 and DIN IEC 62895 the rated voltage U_0 is not stated here, but handled in the two lines above.
	Change from VSC to LCC.	E	E			x		x		x[4]	
	Change from LCC to VSC.	E	E			(x[A])					[A] With prerequisite as per CIGRE TB 852 ch.5.1 i) and DIN IEC 62895 ch. 12.2 h).
	Increase in short-circuit requirements (e.g. increase of Joule-Integral, peak current, …)	A	A								Supplier to provide detailed FMECA for conductor, screen and connectors. Short-circuit test may be required. For connectors CIGRE TB758 chapter 8.3.9 applies.
Mechanical	Bending radius during installation is smaller than the bending radius used during preconditioning of the qualified cable.	A	A			x					
	Bending radius during production or transportation is smaller than the bending radius used during preconditioning of the qualified cable.	A	A			x					

Table footnotes:

[1] Equality to CIGRE TB 852 or DIN IEC 62895 to be understood without considering Thermal Stability Test and STr Test and for information only. However the detailed test program of the specific tests (PQ, EQ, TT, ..) may differ from the standards. In case of inconsistency this specification and table prevail.

[2] Objects subjected to PQ Test, EQ Test, Type Test, Thermal Stability Test or STr Test shall pass Routine Test (on cables and accessories) and Sample test (on cables only) in advance, although not separately stated here. If the Employer accepts previously passed Tests, this requirement is not mandatory.

[3] Service voltages as per chapter 3.1.

[4] A new DC–LTrOV Test is not needed if the capacitive electrical stress at the outer insulation interface corresponding to the peak value U_1 is less than or equal to those of the tested cable system and if the average DC electrical stress corresponding to nominal voltage U_0 is less than or equal to those of the tested cable system. A new DOTrV Test is not needed if the electrical stress at the outer insulation interface corresponding to the first opposite oscillation peak value U_4 is less than or equal to those of the tested cable system.

[A...Z] Refer to comment column of specific row.

Modification on the CABLE		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
	Modification / Change	CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
Conductor	Increase of maximum permissible conductor temperature $T_{cond,max}$	E	E			x		x	x[A]	x	[A] In line with CIGRE TB 852 chapter 6.1.
	Same material, cross section increase ≤20%	E	A			x[A]					[A] Type Test without the non-electrical tests.
	Same material, cross section increase of 20% < x ≤30%	C	A			x	x				In addition, a new qualification acc. to CIGRE TB 758 is mandatory, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3.
	Same material, cross section increase > 30%	C	A			x		x			In addition, a new qualification acc. to CIGRE TB 758 is mandatory, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3.
	Same material, cross section between two qualified cross sections.[A]	E	A	x[B]	x[B]						[A] Only applicable if the following requirements are all met: - Laplace inner electric stress lower or equal compared to the smaller cross section. - Laplace outer electric stress lower or equal compared to the larger cross section. - The average electric stress is lower or equal compared to the higher one of the qualified cables. - No other modification as per Range of Approval tables in this document is present. [B] Only tests as per IEC 62895, chapter 10.12. In addition, a new qualification acc. to CIGRE TB 758 may be mandatory, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3.
	Change of material: Copper to Aluminium	C	A		x[A]		x				In addition, a new qualification acc. to CIGRE TB 758 is mandatory. *Comment CIGRE TB 852: "Larger expansion coefficient, but mechanical stresses remain at a low level."* [A] Only tests as per IEC 62895 chapters 10.4 and 10.5 (only for conductor) and 10.12 and 10.13. In addition water penetration test on the conductor acc. to IEC 62067, Annex F shall be performed.

Modification on the CABLE		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
Modification / Change		CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
Conductor	Change of material: Aluminium to Copper	E	A		x[A]	x					In addition, a new qualification acc. to CIGRE TB 758 is mandatory. [A] Only tests as per IEC 62895 chapters 10.4 and 10.5 (only for conductor) and 10.12 and 10.13. In addition water penetration test on the conductor acc. to IEC 62067, Annex F shall be performed.
	Other changes of the conductor design, as e.g. change in type of conductor (Stranded, Milliken, Keystone, …) and/or wire size and/or number of wires and/or wire shape and/or lay length and/or laying direction and/or …	C	A	x	x[A]						In addition, a new qualification acc. to CIGRE TB 758 may be necessary, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3. [A] Only tests as per IEC 62895 chapters 10.4 and 10.5 (only for conductor) and 10.12 and 10.13. In addition water penetration test on the conductor acc. to IEC 62067, Annex F shall be performed.
	Change from non-watertight to watertight conductor, using swellable yarns and/or tapes, excluding the layer of tapes in contact with insulation system[5].	E	A	x	x[A]						[A] Only test as per IEC 62895 chapters 10.4 and 10.5 (only for conductor) and 10.12 and 10.13. In addition water penetration test on the conductor acc. to IEC 62067, Annex F shall be performed. In addition, a new qualification acc. to CIGRE TB 758 may be necessary, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3. *Comment CIGRE TB 852: "No risk of interaction with insulation system."*
	Change from non-watertight to watertight conductor using solid compound.	C	A	x	x[A]		x			x[B]	[A] Only test as per IEC 62895 chapters 10.4 and 10.5 (only for conductor) and 10.13. In addition water penetration test on the conductor acc. to IEC 62067, Annex F shall be performed. [B] Depending on FMECA test may be omitted. As part of FMECA, small scale tests investigating the changes to the conductivity characteristics of the insulation in comparison to the limit values of manufacturers shall be performed. In addition, a new qualification acc. to CIGRE TB 758 may be necessary, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3. *Comment CIGRE TB 852: "Check of interaction of Low Molecular Weight components of the solid compound with insulation system."*

Modification on the CABLE		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed :							Comment
	Modification / Change	CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
Conductor	Change from watertight conductor using solid compound to watertight conductor using swellable tapes and yarns, excluding the layer of tapes in contact with insulation system[5].	E	A	x	x[A]						[A] Only test as per IEC 62895 chapters 10.4 and 10.5 (only for conductor) and 10.12 and 10.13. In addition water penetration test on the conductor acc. to IEC 62067, Annex F shall be performed. In addition, a new qualification acc. to CIGRE TB 758 may be necessary, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3. *Comment CIGRE TB 852: "No risk of interaction with insulation system."*
	Change from watertight conductor using swellable tapes and yarns to watertight conductor using solid compound.	C	A	x	x[A]		x			x[B]	[A] Only test as per IEC 62895 chapters 10.4 and 10.5 (only for conductor) and 10.13. In addition water penetration test on the conductor acc. to IEC 62067, Annex F shall be performed. [B] Depending on FMECA test may be omitted. As part of FMECA, small scale tests investigating the changes to the conductivity characteristics of the insulation in comparison to the limit values of manufacturers shall be performed. In addition, a new qualification acc. to CIGRE TB 758 may be necessary, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3. *Comment CIGRE TB 852: "Check of interaction of Low Molecular Weight components of the solid compound with insulation system."*
	Change of swellable yarns and tapes, excluding the layer of tapes in contact with the insulation system[5].	E	A	x	x[A]						[A] Only test as per IEC 62895 chapters 10.4 and 10.5 (only for conductor) and 10.12. and 10.13. In addition water penetration test on the conductor acc. to IEC 62067, Annex F shall be performed. In addition, a new qualification acc. to CIGRE TB 758 may be necessary, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3. *Comment CIGRE TB 852: "No risk of interaction with insulation system."*

Modification on the CABLE		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed :							Comment
	Modification / Change	CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
	Change of tapes that are in contact with the insulation system[5].	C	A	x	x[A]		x			x[B]	[A] Only test as per IEC 62895 chapters 10.4 and 10.5 (only for conductor) and 10.13. In addition water penetration test on the conductor acc. to IEC 62067, Annex F shall be performed. [B] Depending on FMECA test may be omitted. As part of FMECA, small scale tests investigating the changes to the conductivity characteristics of the insulation in comparison to the limit values of manufacturers shall be performed. In addition, a new qualification acc. to CIGRE TB 758 may be necessary, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3.
	Change of solid compound (material, formulation, supplier) of water-tight conductor.	C	A	x	x[A]		x			x[B]	[A] Only test as per IEC 62895 chapters 10.4 and 10.5 (only for conductor) and 10.13. In addition water penetration test on the conductor acc. to IEC 62067, Annex F shall be performed. [B] Depending on FMECA test may be omitted. As part of FMECA, small scale tests investigating the changes to the conductivity characteristics of the insulation in comparison to the limit values of manufacturers shall be performed. In addition, a new qualification acc. to CIGRE TB 758 may be necessary, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3. *Comment CIGRE TB 852: "Check of interaction of Low Molecular Weight components of the solid compound with insulation system."*
	Change of origin (factory, or different type of line in the same factory) of the conductor, with same specification (same, design, tapes and fillers, if any).	E	A	x	x[A]						[A] Only test as per IEC 62895 chapters 10.4 and 10.5 (only for conductor) and 10.12 and 10.13. In addition water penetration test on the conductor acc. to IEC 62067, Annex F shall be performed. In addition TGA as per CIGRE TB 852 Appendix G.1 shall be performed. *Comment CIGRE TB 852: "Check of interaction of Low Molecular Weight components of the solid compound with insulation system."*

Modification on the CABLE		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
	Modification / Change	CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
Semi-conductive screens	Change of supplier of compound or fillers	C	A			x		x	x	x	*Comment CIGRE TB 852: "Risk of new LMW products in the semicon."*
	Change of production plant of compound or fillers, with identical compound and identical supplier	C	A	x	x		x			x	
	Change of base resin or formulation	E	A			x		x	x	x	
	Change of nominal thickness of the semi-conductive screen	A	A								No test required. Minimum specified value shall be complied in any case.
Insulation	Change of supplier of base resin	A	A			x		x	x	x	
	Change of production location of insulation material	E	A			x		x	x	x	*Comment CIGRE TB 852: "New material."*
	Change of polymer / base resin	E	A			x		x	x	x	*Comment CIGRE TB 852: "New material."*
	Change of formulation (peroxide, filler, any material and its rate)	E	A			x		x	x	x	*Comment CIGRE TB 852: "New material."*
	Change in insulation grade, from higher cleanliness grade to lower cleanliness grade	E	A			x		x	x	x	For EHVDC the Employer only accepts insulation compound of highest grade for the respective voltage class, provided by the insulation compound supplier. Compliance with this requirement shall be proven by the Contractor.
	Change in insulation grade, from lower cleanliness grade to higher cleanliness grade	C	A	x	x						

Modification on the CABLE		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
	Modification / Change	CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
	Higher calculated average electrical stress[6] in insulation	E	E			x		x	x[A]	x[4]	[A] In line with CIGRE TB 852 chapter 6.1.
	Higher calculated Laplace electrical stress at the outer semi-conductive layer (insulation screen)	E	E			x		x		x[4]	
	Higher calculated Laplace electrical stress at the inner semi-conductive screen (inner field, conductor screen)	E	E			x				x[4]	*Comment CIGRE TB 852 ch.10: "Validation of the inner higher stress."*
	Increase of the maximum temperature drop ΔT_{max} across the insulation (excl. semi-conductive layers)	E	A			x		x		x	
	Decrease of the minimum temperature drop ΔT_{min} across the insulation (excl. semi-conductive layers)	E	A						x[A]		[A] In line with CIGRE TB 852 chapter 6.1.
Bedding[7]	Change of the supplier of the material	C	A	x			x				Test can be performed on cable only, without accessories. Same reasoning for EQ test as for the change of tapes over conductor that are in contact with the insulation system (see above). *Comment CIGRE TB 852: "Check of the mechanical, electrical and chemical compatibility of materials. AC test of the routine test checks the resistivity of the bedding."*
	Change of the material	C	A	x			x				Test can be performed on cable only, without accessories. Same reasoning for EQ test as for the change of tapes over conductor that are in contact with the insulation system (see above). *Comment CIGRE TB 852: "Check of the mechanical, electrical and chemical compatibility of materials. AC test of the routine test checks the resistivity of the bedding."*
	Change of the thickness	E	A	x		x					Test can be performed on cable only, without accessories. *Comment CIGRE TB 852: "Check of the mechanical, electrical and chemical compatibility of materials. AC test of the routine test checks the resistivity of the bedding."*

Modification on the CABLE		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
	Modification / Change	CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
	Change of the lapping pattern or laying design	E	A	x		x					Test can be performed on cable only, without accessories. *Comment CIGRE TB 852: "Check of the mechanical, electrical and chemical compatibility of materials. AC test of the routine test checks the resistivity of the bedding."*
Metallic screen	Change of geometry of WSAF[8] screen incl. lay length or laying direction of the wires	C	A	x	x	x[A]					[A] Only bending test, heating cycles without voltage, visual inspection and non-electrical type tests may be required. Short circuit test may be required. (with focus on cable metal sheath)
	Change from Copper to Aluminium WSAF[8]	A	A	x	x	x[A]					[A] Only, bending test, heating cycles without voltage, visual inspection and non-electrical type tests may be required. Short circuit test may be required. (with focus on cable metal sheath)
	Change from Aluminium to Copper WSAF[8]	A	A	x	x	x[A]					[A] Only, bending test, heating cycles without voltage, visual inspection and non-electrical type tests may be required. Short circuit test may be required. (with focus on cable metal sheath)
	Change of geometry of SWAS[9] screen	C	A	x	x	x[A]					[A] Only, bending test, heating cycles without voltage, visual inspection and non-electrical type tests may be required. Short circuit test may be required. (with focus on cable metal sheath) Additionally, development tests according to TB446 chapter 2.1.1.
	Change welding technology and process (TIG, Laser)	A	A	x	x	x[A]					[A] Only, bending test, heating cycles without voltage, AC test on insulation with PD, LI test, visual inspection and non-electrical type tests may be required. Short circuit test may be required. (with focus on cable metal sheath) Additionally, development tests according to TB446 chapter 2.1.1.
	Change from WSAF[8] to SWAS[9] or vice versa	C	A	x	x	x[A]					[A] Only, bending test, heating cycles without voltage, visual inspection and non-electrical type tests may be required. Short circuit test may be required. (with focus on cable metal sheath) Additionally, development tests according to TB446 chapter 2.1.1.

Modification on the CABLE		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
	Modification / Change	CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
	New screening line	A	A	x	x	x[A]					[A] based on FMECA requirement for type test might be lower.
	Change of the supplier of metallic screen (wires)	A	A								To be discussed between Supplier and Employer.
	Change of the supplier of metallic screen (foil)	A	A	x	x						For sample test: according to IEC 62895 chapter 10.5, 10,7, 10.14, In addition development test as per TB446 chapter 2.1.1.
	Change from cable without optical fibers (FIMT) to cable with optical fibers (FIMT)	A	A	x	x		x[A]				[A] Only mechanical preconditioning and heating cycles without voltage (from EQ test) and non-electrical type tests, visual inspection and OTDR tests are required. In addition a specific installation test might be required. Visual inspection is required after the LI test in the Sample test.
	Change of the design/number/supplier of the FIMT incl. lay length of FIMT.	A	A	x	x		x[A]				[A] Mechanical preconditioning and heating cycles without voltage (from EQ test) and non-electrical type tests, visual inspection and OTDR tests are required. In addition a specific installation test might be required. Visual inspection is required after the LI test in the Sample test.
	Change of fiber type(s) and/or increase of number of fibers per tube.	A	A								To be discussed between Supplier and Employer.

Modification on the CABLE		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
Modification / Change		CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
Oversheath	Change of type of material and/or supplier	C	A			x[A]					[A] Non-electrical TT and electrical test of the sheath, when applicable. In addition a bending test according to TB852 chapter 5.4.1 is required. Depending on the change and FMECA, additional tests may be required, such as: corrosion test as per TB446 chapter 2.1.1.4, additional tests for accessories as per TB852 annex J, reaction to fire test as per Employer specification and classification.
	Change of production processes	C	A			x[A]					[A] Non-electrical TT, and electrical test of the sheath, when applicable. In addition a bending test according to TB852 chapter 5.4.1 is required. Based on FMECA, additional test may be required e.g. corrosion test as per TB446 chapter 2.1.1.4,
	Change of glue/adhesion material or application process.	C	A			x[A]					[A] Non-electrical TT, corrosion test as per TB446 chapter 2.1.1.4, and electrical test of the sheath, when applicable. In addition a bending test according to TB852 chapter 5.4.1 is required.
	New production line (and no change in process).	A	A			x[A]					[A] Non-electrical TT and electrical test of the sheath, when applicable. In addition a bending test according to TB852 chapter 5.4.1 is required.

Table footnotes:

[1] Equality to CIGRE TB 852 or DIN IEC 62895 to be understood without considering Thermal Stability Test and STr Test and for information only. However the detailed test program of the specific tests (PQ, EQ, TT, ..) may differ from the standards. In case of inconsistency this specification and table prevail.

[2] Objects subjected to PQ Test, EQ Test, Type Test, Thermal Stability Test or STr Test shall pass Routine Test (on cables and accessories) and Sample test (on cables only) in advance, although not separately stated here. If the Employer accepts previously passed Tests, this requirement is not mandatory.

[3] Service voltages as per chapter 3.1.

[4] A new DC–LTrOV Test is not needed if the capacitive electrical stress at the outer insulation interface corresponding to the peak value $U1$ is less than or equal to those of the tested cable system and if the average DC electrical stress corresponding to nominal voltage $U0$ is less than or equal to those of the tested cable system. A new DOTrV Test is not needed if the electrical stress at the outer insulation interface corresponding to the first opposite oscillation peak value $U4$ is less than or equal to those of the tested cable system.

[5] Insulation system includes insulation and semi-conductive layers around the insulation.

[6] Calculated average stress is given by $U0$ divided by the nominal insulation thickness.

[7] Bedding is the layer over the outer extruded semi-conductive screen (insulation screen) and beneath the metallic screen.

[8] WSAF: Wire Screen with Aluminium Foil.

[9] SWAS: Smooth Welded Aluminium Sheath.

[A...Z] Refer to comment column of specific row.

Modification on the ACCESSORIES		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed :							Comment
Modification / Change		CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
Connector	Change in technology of connector (e.g. from welded to crimped, screwed etc.) or change in supplier	A	A			x^A	x_A	x_A			[A] Required tests to be decided based on detailed FMECA, e.g. if no experience is existing with the new technology, PQ+TT is required. If experience is existing then an EQ including mechanical preconditioning and non-electrical type tests might be sufficient. In addition, a new qualification acc. to CIGRE TB 758 may be necessary, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3.
	Change in connector design (e.g. material, amount or position of screws, contact pressure, current density at the contact areas, etc.)	A	A			x^A					[A] Required tests to be decided based on detailed FMECA.In addition, a new qualification acc. to CIGRE TB 758 may be necessary, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3.
	From joints with same conductor material (e.g. Cu-Cu) to bi-metallic factory joints (Cu-Al)	A	A			x	x				In addition, a new qualification acc. to CIGRE TB 758 may be necessary, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3.
	Change in fixation of insulation.	A	A				x^A				[A] Required tests to be decided based on detailed FMECA. Type Test might be sufficient. In addition, a new qualification acc. to CIGRE TB 758 may be necessary, taken into account the Range of Applicability as per CIGRE TB 758 chapter 8.3.
Prefabricated joints	Higher maximum calculated electrical stress (Laplace field)	C	A			x		x		x^4	Different from CIGRE TB 852, PQ+TT also required for increases below 10% as this is consistent with the requirements for the cable itself.
	Change in electric field distribution inside insulation	A	A								Required tests to be decided based on detailed FMECA considering all operating conditions.
	Change of the geometry of the prefabricated body	A	A			x^A		x^A		x^A	[A] Requirement might be adapted depending on specific change and FMECA.
	Decrease of mechanical interface (cable to joint insulation) pressure	A	A			x					
	Change in manufacturing technology of the prefabricated bodies	A	A			x		x^A		x^A	[A] Requirement might be adapted depending on specific change and FMECA.. Change in manufacturing technology may lead to change in properties of compound.

Modification on the ACCESSORIES		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed :							Comment
Modification / Change		CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
Prefabricated joints	Change in manufacturing process parameters	A	A			x		x^A		x^A	[A] Requirement might be adapted depending on specific change and FMECA..
	Change in compound of main insulation body (same base resin) or material of semi-conductive electrodes	E	A			x		x		x	
	Change in supplier of compound/material of main insulation or semi-conductive electrodes or field grading materials	A	A			x		x		x	
	Change in nature of polymer	E	A			x		x		x	
	Change of the factory for prefabricated parts	E	A			x		x			
	Change of/in the fixation of cable ends on either side of the joint, same cross-section (e.g. change of support frame)	E	A				x^A				[A] Thermomechanical part only including visual inspection.

Modification on the ACCESSORIES		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
	Modification / Change	CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
	Change of the screen interruption design of a joint with screen separation.	E	A	x	x[A]	x[B]					For same design (geometry, materials, outer protection etc.) except screen separation and unchanged electric field inside insulation. [A] Only tests as per IEC 62895, chapter 11.1 [B] Tests only according to TB852 annex J.
	Change of the outer screen and protection design (filling / water tightness), outlet of grounding leads or FIMTs, …	E	A	x	x[A]	x[B]					[A] Only tests as per IEC 62895, chapter 11.1 [B] Tests only according to TB852 annex J.
	Change from Joint with screen separation to joint without screen separation	A	A	x	x[A]						For same design (geometry, materials, outer protection etc.) except screen separation and unchanged electric field inside insulation. [A] Only tests as per IEC 62895, chapter 11.1
	Change from Joint without screen separation to joint with screen separation.	A	A	x	x[A]	x[B]					For same design (geometry, materials, outer protection etc.) except screen separation and unchanged electric field inside insulation. [A] Only tests as per IEC 62895, chapter 11.1 [B] Tests only according to TB852 annex J.
	Change from symmetric to asymmetric joint	A	A								On this point TSO follow different approaches, either TT, EQT or PQT is required. Alignment within CIGRE TF B1.97 is necessary.

Modification on the ACCESSORIES		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
	Modification / Change	CIGRE TB 852	IEC 62895	Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
Indoor or Outdoor or GIS termination	Higher maximum calculated electrical stress (Laplace field) in stress cone or cable insulation	C[A]	A			x		x		x[4]	[A] Different from CIGRE TB 852, PQ+TT also required for increases below 10% as this is consistent with the requirements for the cable itself.
	Change in electric field distribution inside insulation	A	A								Required tests to be decided based on detailed FMECA considering all operating conditions.
	Decrease of mechanical pressure at interface (stress cone to cable insulation)	A	A			x					
	Nature of filling medium (e.g. oil to gas or the opposite)	E	A			x		x		x	Internal fault withstand (arc) test as specified by the Employer shall be performed.
	Change of formulation of filling medium (e.g. change of type or formulation of gas or oil or solid)	A	A			x		x[A]		x[A]	[A] Requirement might be adapted depending on specific change and FMECA. Internal fault withstand (arc) test as specified by the employer might be required.
	Decrease of minimum permitted operational gas pressure	A	A			x					
	Change of the insulator design of outdoor terminations (e.g. creepage distance, flashover distance, inner and/or outer diameter, thickness of layers, etc.)	A	A			x[A]					[A] Requirement might be adapted depending on specific change and FMECA. Internal fault withstand (arc) test asspecified by employer shall be performed. In addition test to be performed after change in construction as per EN IEC 61462 chapter 6.1 are mandatory.

	Change in cast resin of insulator for outdoor terminations	E	A				x				Internal fault withstand (arc) test as specified by employer shall be performed. In addition test to be performed after change in construction as per EN IEC 61462 chapter 6.1 are mandatory.
	Change in internal arc protection system	A	A								Internal fault withstand (arc) test as specified by employer shall be performed. Further tests may be required depending on output of FMECA.
	Increase of internal arc energy	A	A								Internal fault withstand (arc) test as specified by employer shall be performed.
	Change in metallic screen earthing system, outlet of grounding leads	A	A			x[A]					[A] Requirement might be adapted depending on specific change and FMECA. Short-circuit withstand test may be required.
	Change of the gas type or formulation in the GIS compartment (GIS termination)	A	A			x[A]		x[B]		x[B]	[A] Testing as per CIGRE TB 957 chapter 4.7.1. [B] Requirement might be adapted depending on specific change and FMECA.
	Increase of pressure in the GIS compartment.	A	A								Required tests to be decided based on detailed FMECA.
	Change of the formulation of the resin of the insulator/socket (GIS termination)	E	A				x				
	Change of the insulator/socket design (GIS termination)	E	A				x				
	Change to termination with metal screen/sheath sectionalizing insulation or change in the design of the metal screen/sheath sectionalizing insulation	E	A								Range of approval according to TB852, appendix J.2.4. Tests according to TB852 appendix J.4 might be required.
	Change of the manufacturer of the insulator/socket design	E	A				x				
	Change of the manufacturer of the insulator/socket design	E	A				x				

Table footnotes:

[1] Equality to CIGRE TB 852 or DIN IEC 62895 to be understood without considering Thermal Stability Test and STr Test and for information only. However the detailed test program of the specific tests (PQ, EQ, TT, ..) may differ from the standards. In case of inconsistency this specification and table prevail.

[2] Objects subjected to PQ Test, EQ Test, Type Test, Thermal Stability Test or STr Test shall pass Routine Test (on cables and accessories) and Sample test (on cables only) in advance, although not separately stated here. If the Employer accepts previously passed Tests, this requirement is not mandatory.

[3] Service voltages as per chapter 3.1.

[4] A new DC–LTrOV Test is not needed if the capacitive electrical stress at the outer insulation interface corresponding to the peak value U_1 is less than or equal to those of the tested cable system and if the average DC electrical stress corresponding to nominal voltage U_0 is less than or equal to those of the tested cable system. A new DOTrV Test is not needed if the electrical stress at the outer insulation interface corresponding to the first opposite oscillation peak value U_4 is less than or equal to those of the tested cable system.

[A...Z] Refer to comment column of specific row.

Modification on the Submarine cable systems		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
	Modification / Change	CIGRE TB 852		Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
Armour and outer serving	From armoured cable to unarmoured cable	C				x					Different thermo-mechanical conditions, especially for cable to joint connections
	From unarmoured cable (with factory joint) to armoured cable	C				x		x			Different thermo-mechanical conditions, especially for cable to joint connections.
	Change in armour design (e.g. number, dimensions of wires, shape of wires, wire material)	A				x					
	Change in design and/or material of outer serving	A									Required tests to be decided based on detailed FMECA.
	Mechanical stress for intended application is higher than the tested mechanical stress, or other types of mechanical stress is expected for the intended application (e.g. coiling)	A				x					Type test and special mechanical tests as per TB623 are required to verify the cable system performance at higher mechanical stress.

Modification on the Submarine cable systems		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
	Modification / Change	CIGRE TB852		Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
Factory joint	Change of factory joint design geometry (e.g. length, interface to cable insulation)	A				x		x[A]	x[A]	x[A]	[A] Requirement might be adapted depending on specific change and FMECA.
	Change of factory joint manufacturing technology (e.g. from taping to extruding insulation)	A				x		x	x	x	
	Change of factory joint manufacturing methodology for taping (from manual to automated/machine taping)	A				x	x				
	Change of factory joint manufacturing methodology for taping (from automated/machine to manual taping)	A				x		x			
	Change of factory joint manufacturing process parameters (e.g. vulcanisation and degassing durations and temperatures)	A				x	x				Requirement might be adapted depending on specific change and FMECA.
	Change to larger conductor cross section ≤10%	C				x					
	Change to larger conductor cross section ≤20%	A				x	x				
	Change to larger conductor cross section >20%	A				x		x			
	From symmetric factory joints to asymmetric factory joints ≤20% lowest to highest cross sectional step	A				x	x				

Modification on the Submarine cable systems		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
Modification / Change		CIGRE TB852		Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
	From symmetric factory joints to asymmetric factory joints >20% lowest to highest cross sectional step	A				x		x			
	From factory joints with same conductor material (e.g. Cu-Cu) to bi-metallic factory joints (Cu-Al)	A				x		x			In addition, a qualification following CIGRE TB 758 or similar may be necessary.
	From wire by wire welding to massive welding	E				x					In addition, a qualification following CIGRE TB 758 or similar may be necessary.
	Change in conductor connecting technology (e.g. from welding to brazing)	A				x					In addition, a qualification following CIGRE TB 758 or similar may be necessary.
	Change in conductor connecting process parameters	A				x					In addition, a qualification following CIGRE TB 758 or similar may be necessary.
	Change in metal sheath/screen connecting process parameters	A				x[A]					Radial water penetration test as per CIGRE TB 623 chapter 5.4.2 to be performed in addition. [A] Requirement might be adapted depending on specific change and FMECA.
	Change in metal sheath/screen connecting technology or design	A				x[A]					Radial water penetration test as per CIGRE TB 623 chapter 5.4.2 to be performed in addition. [A] Requirement might be adapted depending on specific change and FMECA.

Modification on the Submarine cable systems		Equal[1] to..? [E]qual [C]hanged [A]dditional		Tests to be performed:							Comment
Modification / Change		CIGRE TB 852		Routine Test[2]	Sample Test[2]	Type Test[2]	EQ Test[2]	PQ Test[2]	TS Test[2]	STr Test[2]	
Rigid sea joint	Change in bend restrictor (or stiffener) design	A				x					Full type test including handling test for Rigid Joint as per TB623 chapter 6.8
	Change in anchoring of the armour design	A				x					Full type test including tensile test as per TB623 chapter 5.5
	Change in outer protection casing (e.g. material, design)	A									Depending on specific change and FMECA.
	Change in protection against corrosion	A									Depending on specific change and FMECA.