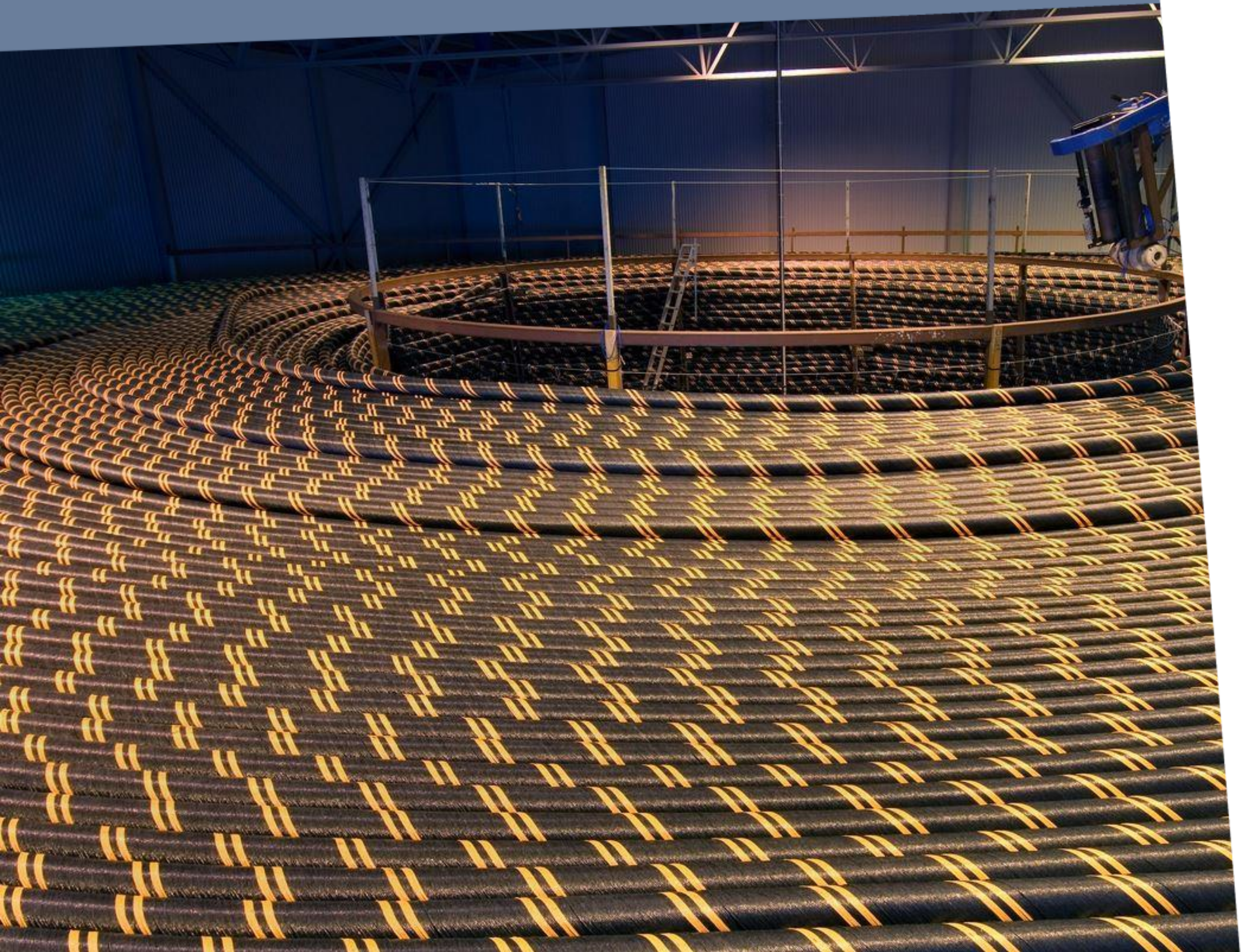
Welke kabel moet ik gebruiken?

RICCARDO BODEGA



Prysmian Group

PRYSMIAN

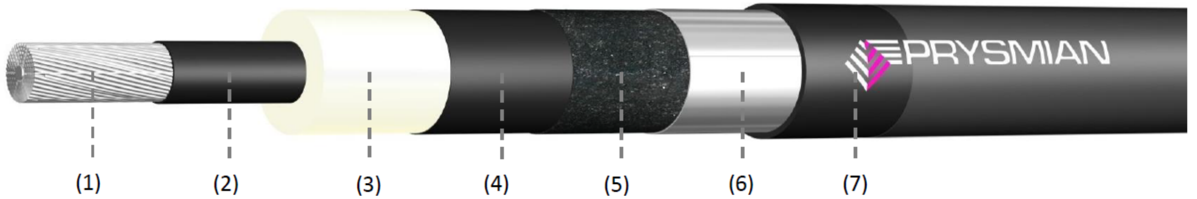
Draka

Hoe selecteer ik de beste kabeloplossing voor mijn project?

- *Technische aspecten*
- *Economische aspecten*
- *Project-gerelateerde aspecten*
- *MVO aspecten*

Voorbeeld van kabel (1)

Cable type	:	**EYAKrvlwd 87/150 kV 1x2500 Alu**	***Cable data sheet***
Article number	:	20159215 [520.14.0043.838]	
Standard	:	NEN-HD632 S2:2011	*1-dec-2017*



Cable construction

Conductor	:	(1)	Milliken compacted aluminium wires, water blocked
Conductorscreen	:	(2)	semi-conducting tape, semi-conducting compound
Insulation	:	(3)	XLPE
Insulationscreen	:	(4)	semi-conducting compound
Bedding	:	(5)	semi-conducting swellable tape
Metallic sheath	:	(6)	Welded Aluminium Sheath
Outer sheath	:	(7)	black polyethylene jacket + extruded semi-conductive coating
Identification	:		Prysmian - year - cable type - length identification

Main dimensions and weight				Nominal thickness	Diameter
Conductor	:	(1)			61,3 mm
Conductorscreen	:	(2)			63,7 mm
Insulation	:	(3)		17,9 mm	101,1 mm
Insulationscreen	:	(4)			103,5 mm
Metallic sheath	:	(6)		1,0 mm	108 mm
Outer sheath	:	(7)		4,0 mm	116 mm
Cable weight	:		appr.	14,8 kg/m	

Electrical data

Rated voltages U_0/U (U_m)		:	87/150 (170) kV
Conductor			
Maximum DC resistance at 20° C		:	0,0119 Ω/km
Maximum temperature under normal conditions		:	90 °C
Maximum temperature under short circuit conditions		:	250 °C
Permissible short circuit current during 1 sec (adiabatic 90-250°C)		:	>50 kA
Insulation			
Capacitance		:	0,29 µF/km
Charging current per core at Uo		:	3,8 A/km
Dielectric stress on conductor screen at Uo		:	6,1 kV/mm
Dielectric stress under insulation screen at Uo		:	3,9 kV/mm
Dielectric loss angle at Uo		:	$<10 * 10^{-4}$
Metallic sheath			
Maximum temperature in case of short circuit		:	250 °C
Permissible short circuit current (non-adiabatic 45-250°C)	1s	:	42,7 kA

(* = according IEC 61443-1999)

Cable laying data

Maximum pulling force on cable with cable grip	:	13,5 kN
Maximum pulling force on conductor with pulling head	:	75,0 kN
Minimum bending radius during laying	:	2,90 m
Minimum bending radius when installed	:	2,32 m
Minimum temperature of cable during laying	:	-10 °C

Voorbeeld van kabel (2)

DRAFT - WINDFLEX-S - DRAFT (N)TSCGEHXOEU /3 36/60-69(72,5) kV

Number of cores x cross section	Part number	Conductor diameter max. mm	Insulation thickness nom. mm	Outer Sheath Thickness nom. mm	Outer diameter min. mm	Outer diameter max. mm	Bending radius free moving min. mm	Weight (approx.) kg/km	Conductor resistance at 20°C max. Ω/km	Nominal operating capacitance µF/km	Current carrying capacity (1) A	Short Circuit Current (conductor) kA	Torsional stress +/- °/m
3x95+3x95/3	20181086	12.5	10.5	4.5	92.6	96.5	579	10905	0.21	0.244	298	13.6	80
3x120+3x120/3		14.4	10.5	5	97	103	618	13015	0.153		346	17.4	70
3x150+3x150/3	20198294	16	10	5	97	104	624	13875	0.126	0.292	399	21.5	70
3x240+3x240/3		21.5	10	5	105	114	684	18555	0.0785	0.642	538	34.4	70

Current carrying capacity free in air at 30°C acc. to IEC 60364-5-52T B52.12

Electrical parameters

Rated voltage	36/60-69 (72,5) kV
Max. permissible operating voltage AC	42/72.5 kV
Max. permissible operating voltage DC	54/108 kV
AC test voltage - main cores	90 kV (5 Min.)

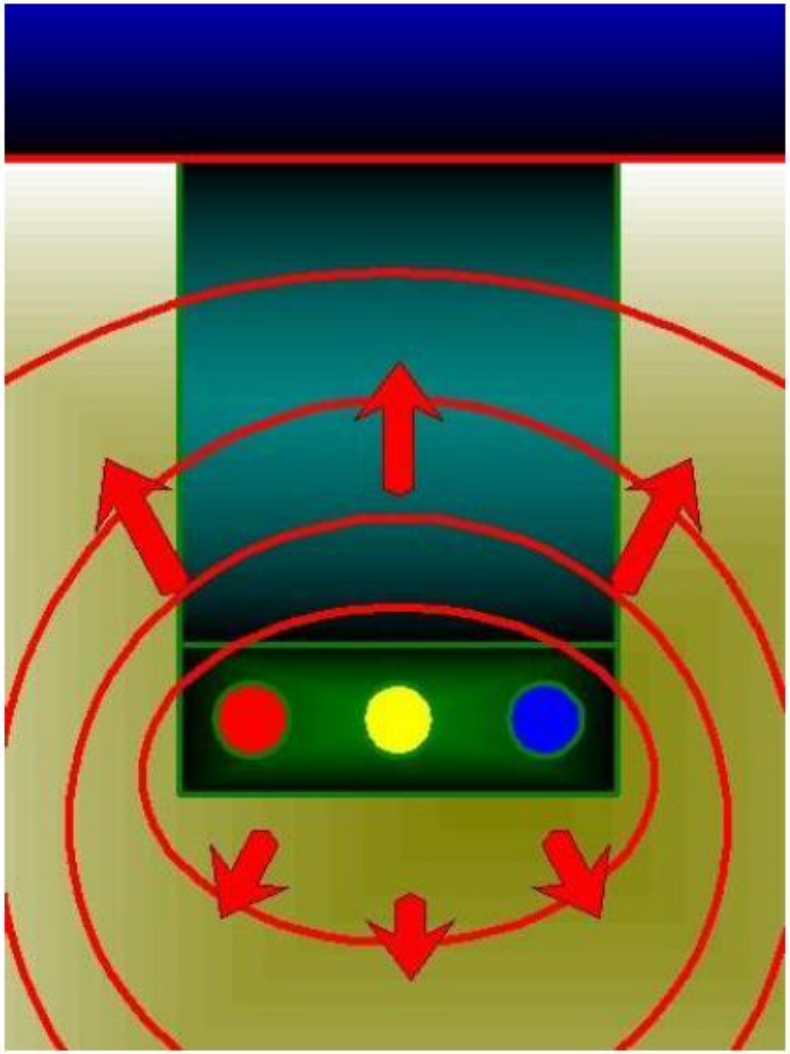
Chemical parameters

resistance to cooling fluid	acc. to IEC 60811-404 24h at 60°C - Dowcal 10 (50% Ethylenglycol) - Havoline XLC +B -40 (50% Ethylenglycol
Zero halogene	IEC 60754-2
Smoke emission	IEC 61034-2
Flame propagation	IEC 60332-1-2
Resistance to oil	acc. to IEC 60811-404 24h at 100°C - IRM 902 - Cognis Breox SL 320 - Mobilgear SHC XMP 320 - Shell Tivela SC 320 - Texaco Meropa 320 - Texaco Pinnacle WM 320 - Tribol 1710/320 - Mobil SHC 524 - Mobil Aero HF(A) 32 - Texaco Rando HDZ LT 32 - Texaco Rando WM 32 - Shell Transaxle 75W-90
UV-resistance	Cable is UV-resistant
Ozone resistance	EN 50396 clause 8.1.3

Thermal parameters

Max. permissible temperature at conductor	90 °C
Max. short circuit temperature of the conductor	250 °C
Ambient temperature for fix installation min.	-40 °C
Ambient temperature for fix installation max.	80 °C
Ambient temp. in fully flex. operation min.	-40 °C
Ambient temp. in fully flex. operation max.	80 °C

Stroom is geen eigenschap van een kabel!



Stroom berekening: via gestandardiseerde tabellen

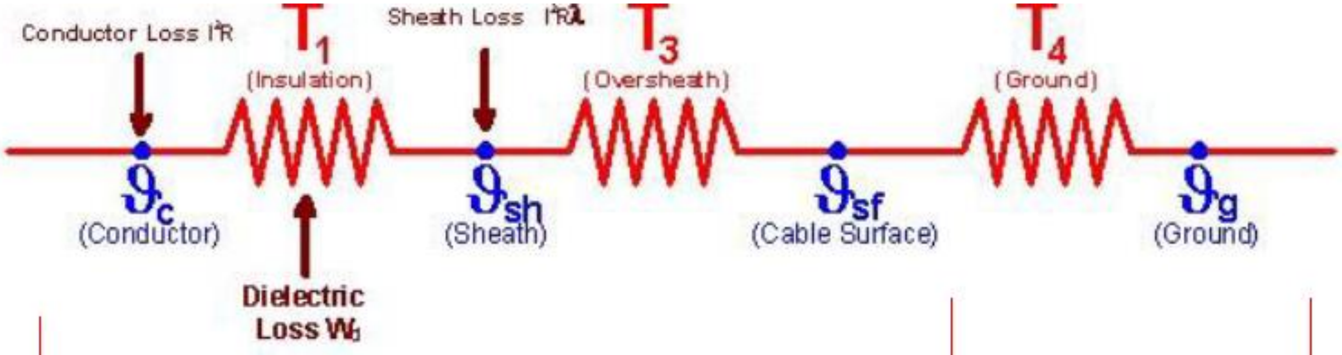
Nominal area of conductor	Buried direct in the ground		In single-way ducts		In air		
	Trefoil	Flat spaced	Trefoil ducts	Flat touching ducts	Trefoil	Flat touching	Flat spaced
							
mm^2	A	A	A	A	A	A	A
16	82	84	77	78	90	92	107
25	105	109	99	100	119	121	141
35	126	130	118	120	144	147	171
50	149	153	140	142	174	178	207
70	182	188	172	174	218	223	259
95	217	224	206	208	266	273	317
120	247	256	235	238	309	317	368
150	277	287	264	267	352	361	419
185	314	325	300	303	406	417	484
240	364	377	350	354	483	495	575
300	411	426	397	401	556	570	659
400	471	487	456	462	651	667	770

Maximum conductor temperature	90 °C
Ambient air temperature	30 °C
Ground temperature	20 °C
Depth of laying	0,8 m
Thermal resistivity of soil	1,5 K·m/W
Thermal resistivity of earthenware ducts	1,2 K·m/W

Screens bonded at both ends.

* Current rating calculated for cables having a rated voltage of 6/10 kV.

Stroom berekening: via formules en modellen



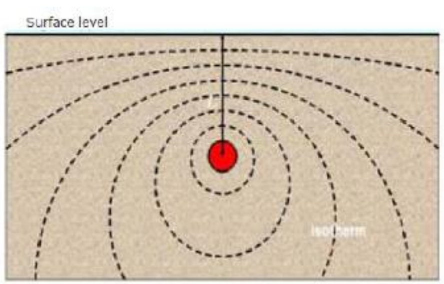
HS-kabel

Warmte bronnen

- *Geleider*
- *Isolatie*
- *Metaalmantel*
- *Bewapening*

Thermische weerstanden

- *Isolatie*
- *Buitenmantel*
- *Omgeving*

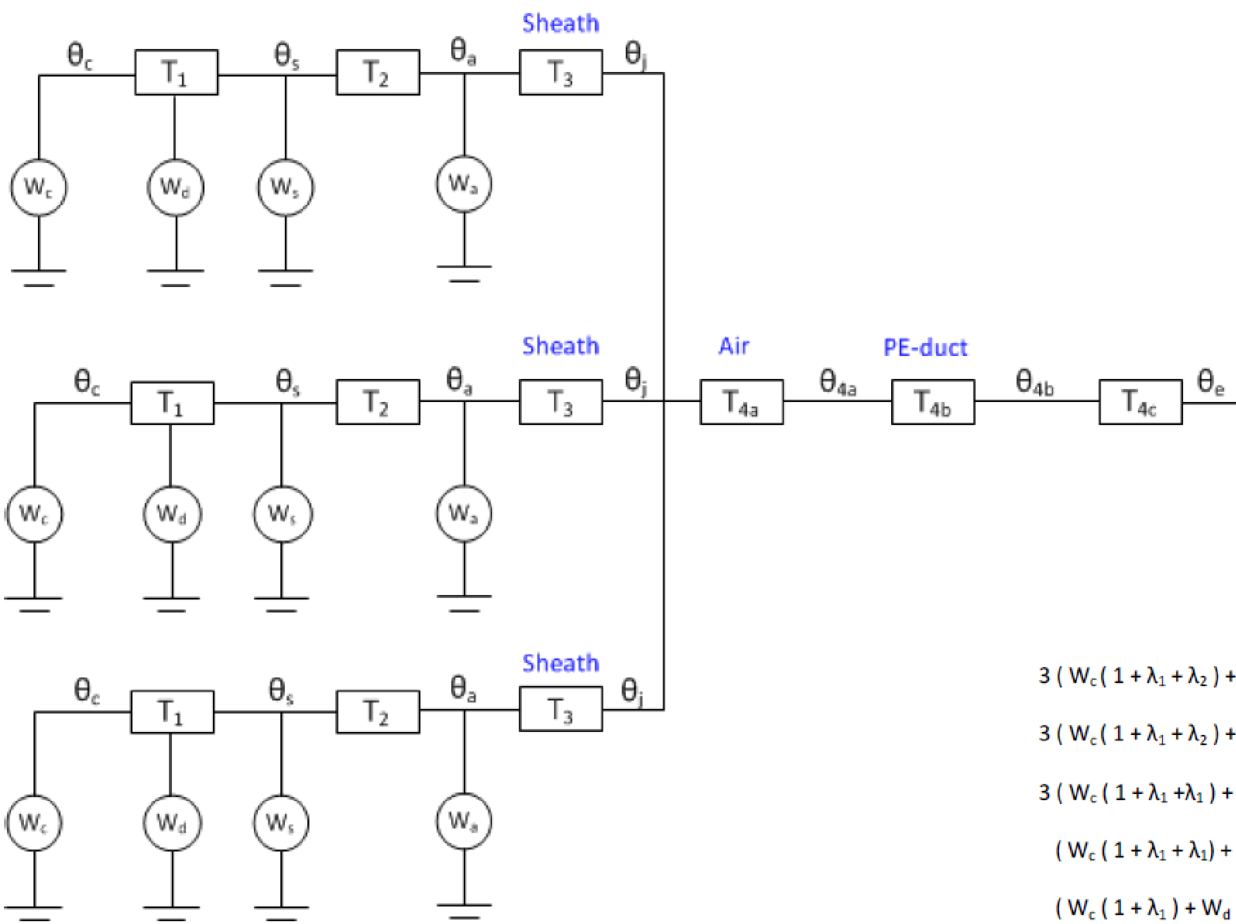


Warmtestroom kabel naar omgeving

Thermisch evenwicht

Stroom berekening: via formules en modellen (2)

$$I = \left[\frac{\sqrt{\Delta\theta - W_d \cdot \left[0.5\,T1 + n \cdot \left(T2 + T3 + T_4\right)\right]}}{\sqrt{Rc_{ac} \cdot T1 + n \cdot Rc_{ac} \cdot \left(1 + \lambda_1 + \lambda_2\right) \cdot T2 + n \cdot Rc_{ac} \cdot \left[\left[1 + \left(\lambda_1 + \lambda_2\right)\right] \cdot \left(T3 + T_4\right)\right]}} \right]$$



$3\,(\,W_c\,(\,1 + \lambda_1 + \lambda_2\,) + W_d\,)\,T_{4c} = \theta_{4b} - \theta_e$

$3\,(\,W_c\,(\,1 + \lambda_1 + \lambda_2\,) + W_d\,)\,T_{4b} = \theta_{4a} - \theta_{4b}$

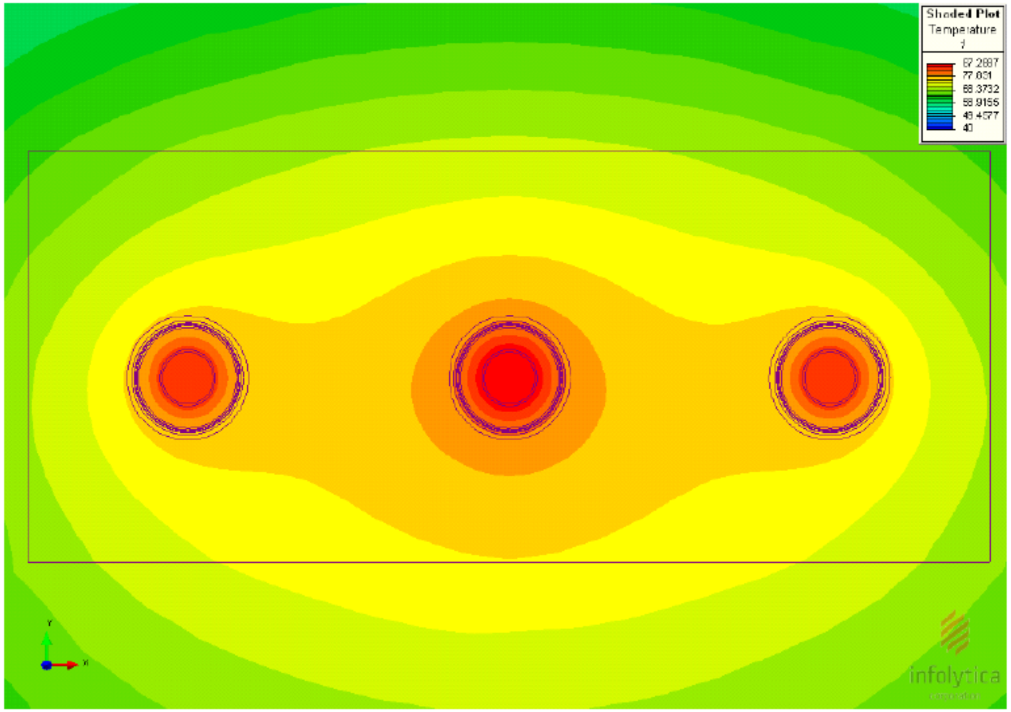
$3\,(\,W_c\,(\,1 + \lambda_1 + \lambda_1\,) + W_d\,)\,T_{4a} = \theta_j - \theta_{4a}$

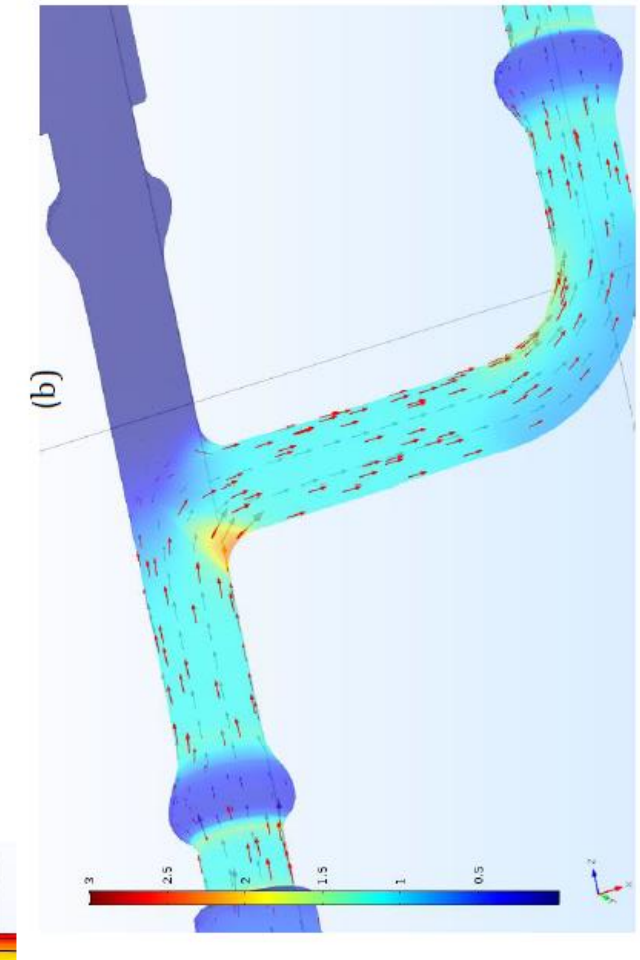
$(\,W_c\,(\,1 + \lambda_1 + \lambda_1) + W_d\,)\,T_3 = \theta_a - \theta_j$

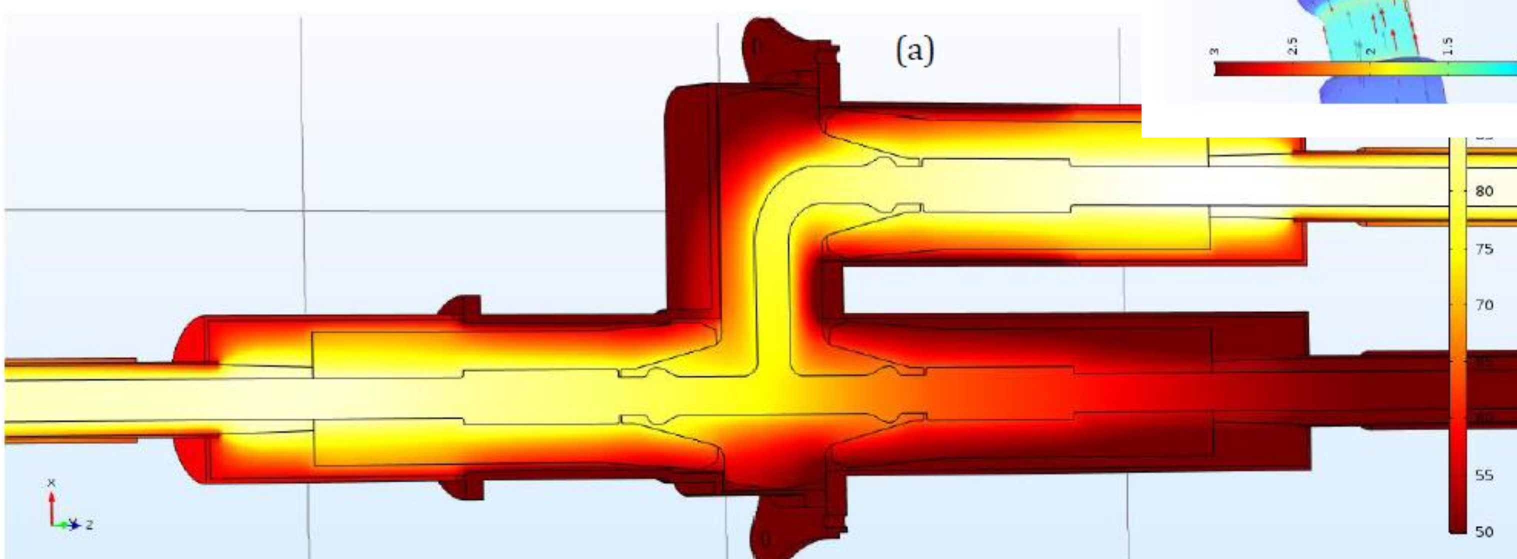
$(\,W_c\,(\,1 + \lambda_1\,) + W_d\,)\,T_2 = \theta_s - \theta_a$

$(\,W_c + \tfrac{1}{2}\,W_d\,)\,T_1 = \theta_c - \theta_s$

Stroom berekening: via FEM analyse

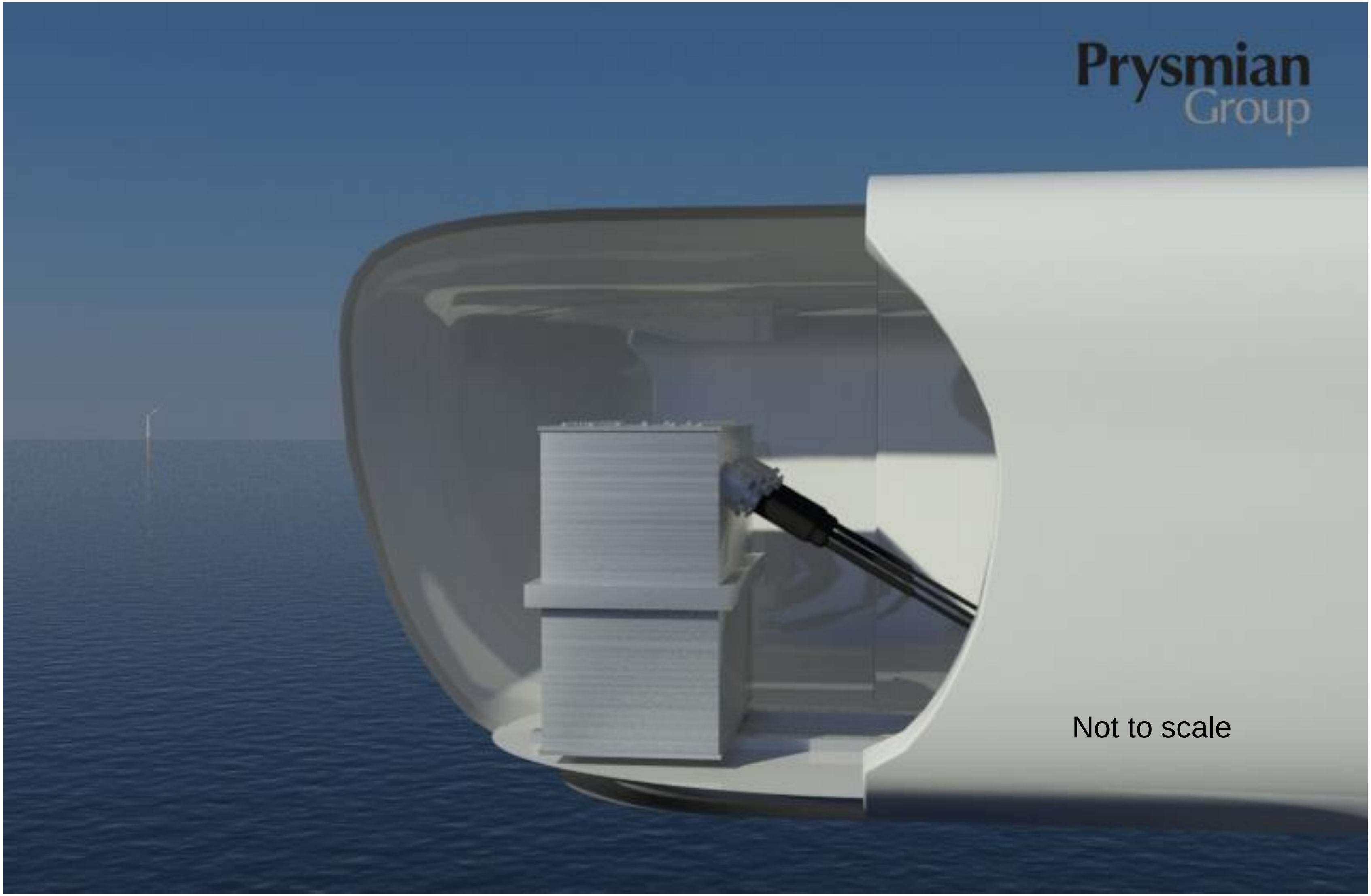






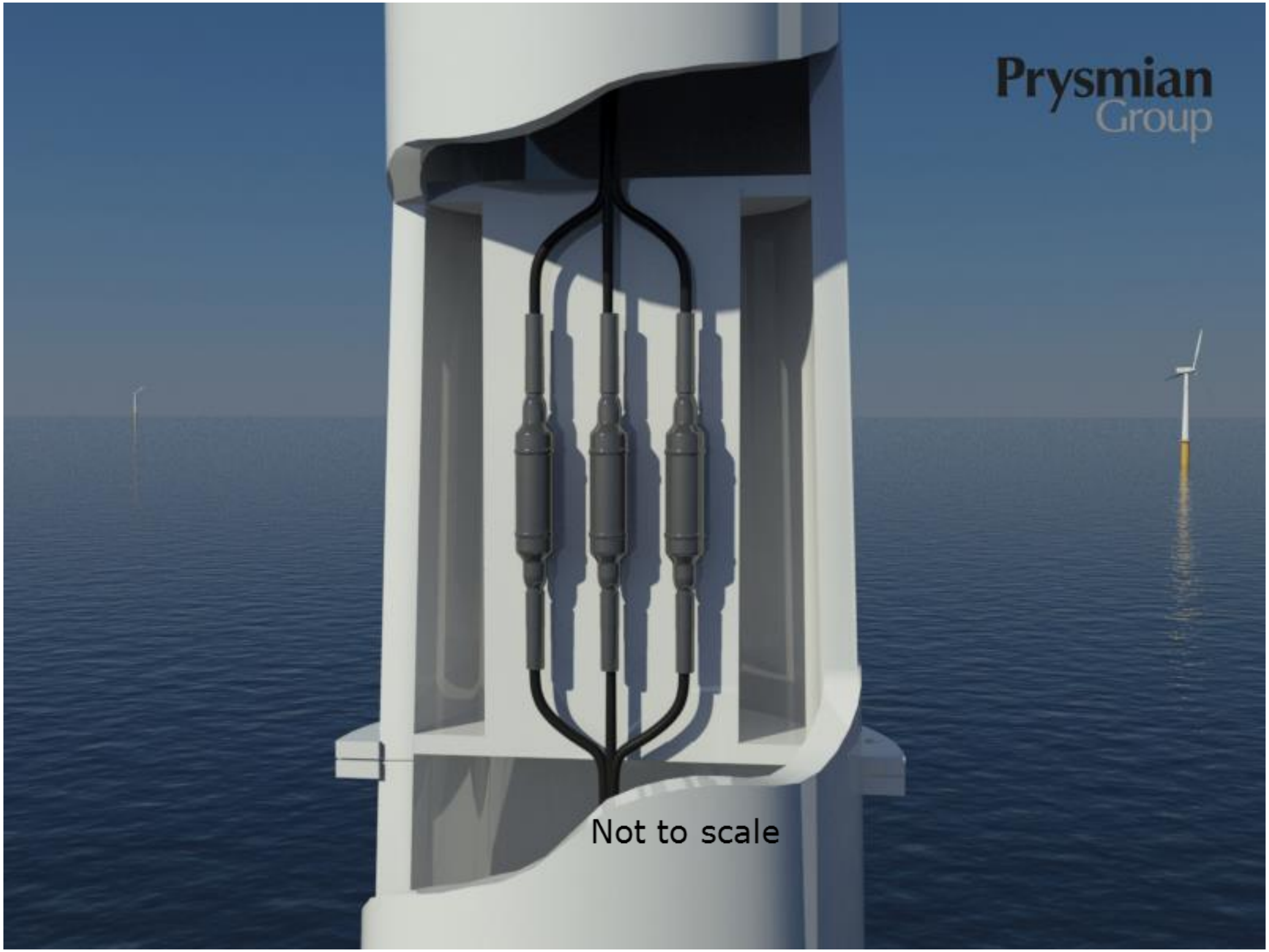
Kabelsysteem = kabel + garnituren (moffen en eindsluitingen)

Trafo / GIS eindsluiting



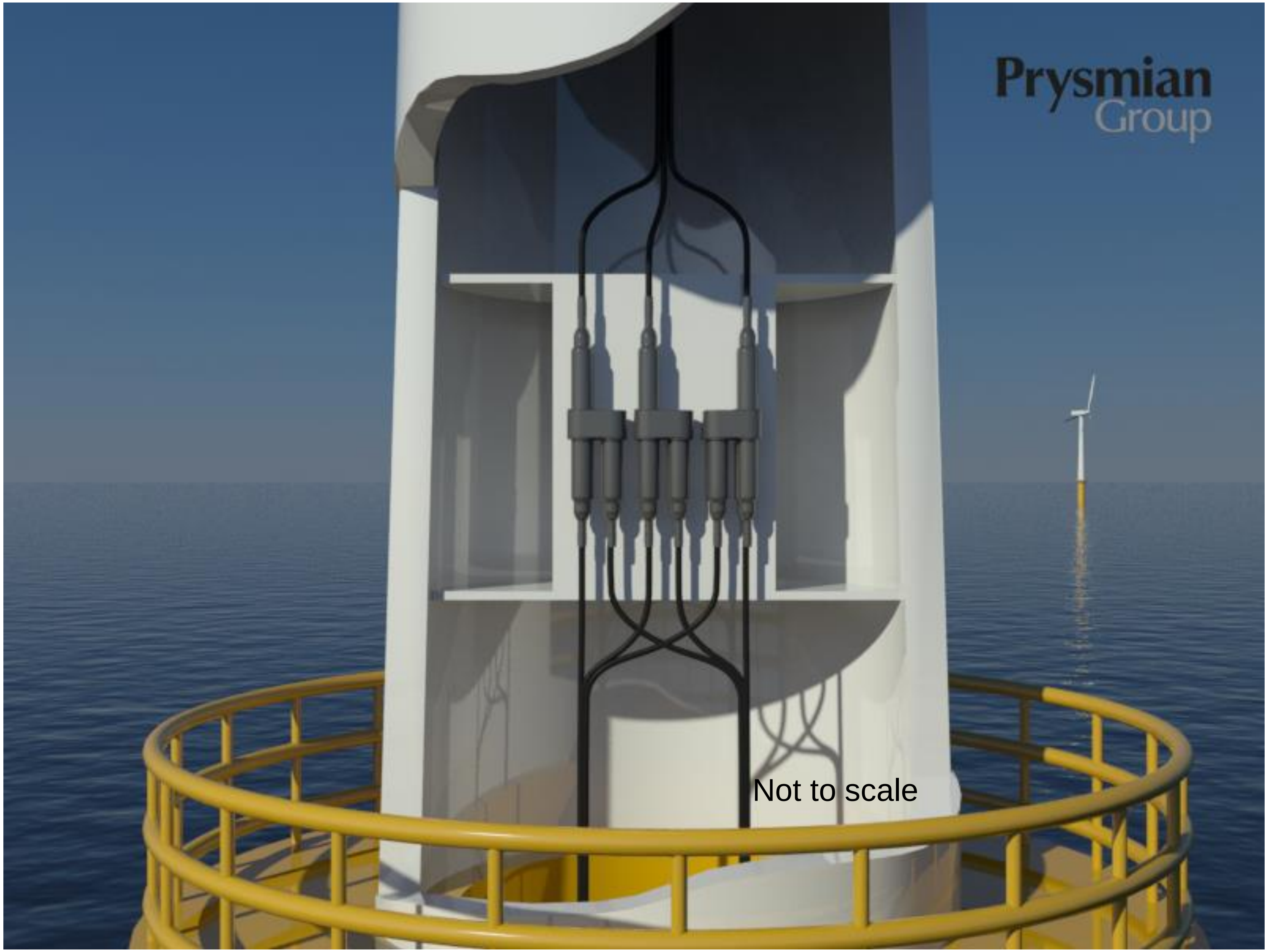
Voorbeeld van Prysmian GIS/Trafo plug-in eindsluiting

Mof

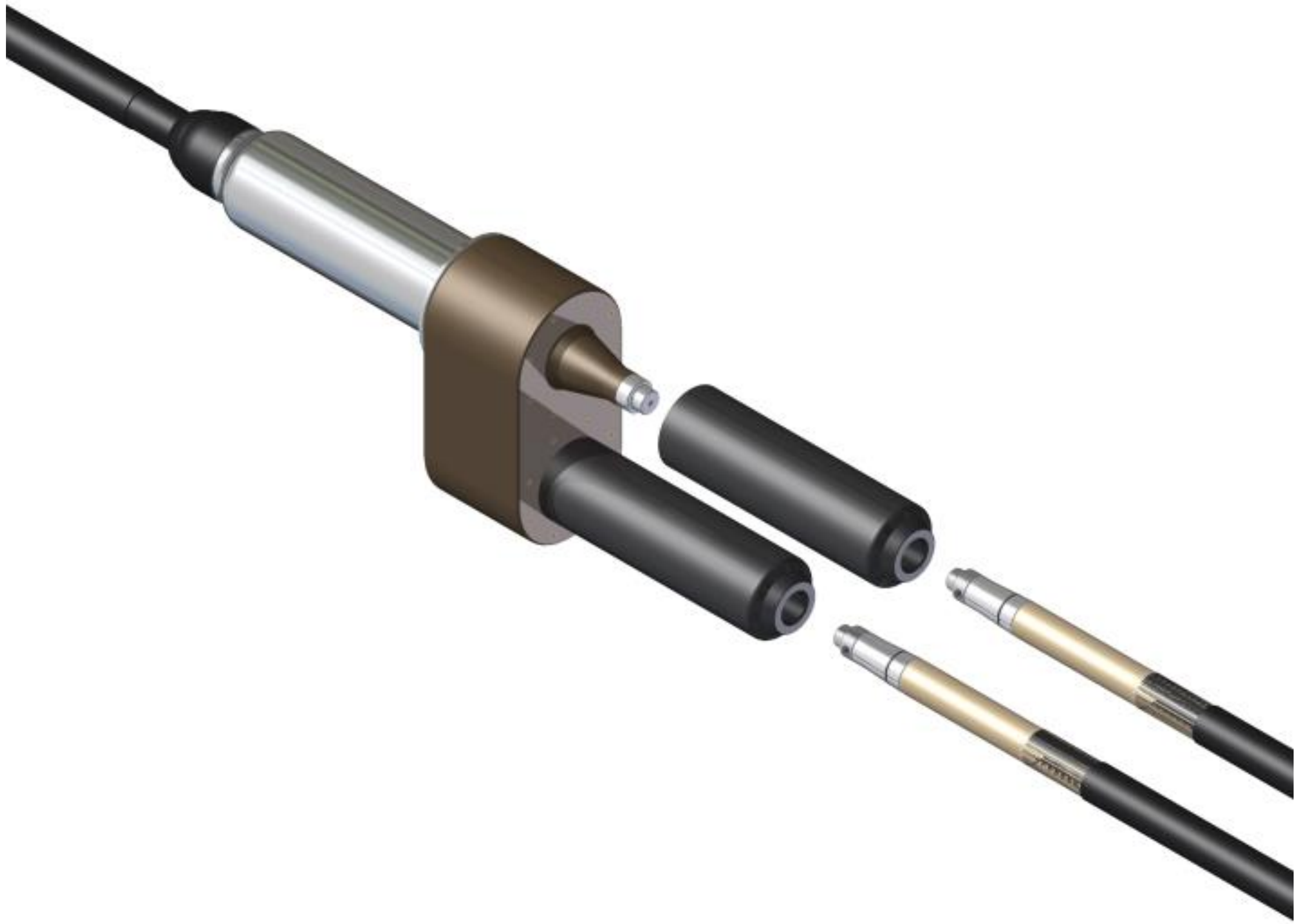


Voorbeeld van Prysmian plug-in mof

Branch joint - Mof tussen drie (3) kabels



Voorbeeld van Prysmian plug-in branch joint



Montage

Testen

Economische aspecten

- *Product kost: kost van het product op zich*
- *Totale oplossing kost: kost voor het totale kabelsysteem (kabel - garnituren – montage – testen)*
- *TCO: total cost of ownership, inclusief kosten voor energie verliezen tijdens gebruik*

Project gerelateerde aspecten

- *Risico beheersing: welke oplossing minimaliseert de project risico's?*
- *Contractuele afspraken (LD's, aansprakelijkheid, garantie)*
- *Logistiek*

MVO aspecten

- *Milieu: project CO2 footprint, recycling van gebruikte materialen, milieu-friendelijke producten*
- *Elektromagnetische impact van kabelverbindingen,*
- *Imago*

Thank you

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