PROJECT 2145:
WALNEY 2 OFFSHORE WINDFARM

VOLUME I:
DESIGN AND ENGINEERING DOCUMENTATION BOOK

CHAPTER A: CABLE DOCUMENTS

1. Data Sheets

a. Inter Connection Cable (ICC) and Platform Connection Cable (PCC)

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Document: Datasheet ICC and PCC

Customer: Walney (UK) Offshore Windfarms Ltd.

Project: Walney II Offshore Windfarm

Cable Type: Inter Connection Cables (ICC) and Platform Connection Cables (PCC):
3 x 150 mm² 19/33(36) kV + 2 x 24 SM OF
3 x 500 mm² 19/33(36) kV + 3 x 24 SM OF

1	25.10.10	---	JEL	FR.	---		Issued for approval
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Reason for Revising

Rev	Date implemented	Published / Distributed	Reason for Revising
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Distribution List

Rev	Function / Position	Names
1	WoW II Project Engineer (WoW) WoW II Engineer (WoW) WoW II Project Manager (Draka)	Karsten Kabel Soeren Moeller Erik Furseth

1. Introduction

This document is the technical datasheet for composite submarine wind turbine interconnection cables (ICC) and platform connection cables (PCC) being supplied by Draka for the Walney II Offshore Windfarm project. Specified in the datasheet are design details, mechanical properties, electrical properties and transmission properties of the complete cables, and of the individual power cores, optical fibre cores and optical fibres within the cable.

2. Standards and specifications

[1]	IEC 60502-2:	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV) – Part 2: Cables for rated voltages from 6 kV (U_m = 7,2 kV) up to 30 kV (U_m = 36 kV)
[2]	IEC 60038:	IEC standard voltages
[3]	IEC 60228:	Conductors of insulated cables
[4]	IEC60287-1-1:	Calculation of the Current Rating - Current Rating Equations (100% load Factor) and Calculation of Losses - General
[5]	IEC60287-2-1:	Calculation of the Current Rating - Thermal Resistance
[6]	IEC 60793-2-50:	Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres
[7]	ITU-T G.652:	Characteristics of a single-mode optical fibre and cable
[8]	EN 10257-2:	Zinc or zinc alloy coated non-alloy steel wire for armouring either power cables or telecommunication cables – Part 2: Submarine cables
[9]	EN 10244-2:	Steel wire and wire products. Non-ferrous metallic coatings on steel wire – Part 2: Zinc or zinc alloy coatings

33 kV Power Core Design Details

	Unit	***Platform Connection cables – (PCC) 3x500mm² + 72OF***	***Inter Connection cables – (ICC) 3x500mm² + 72OF***	***Inter Connection cables – (ICC) 3x150mm² + 48OF***
Governing standard		IEC 60502-2	IEC 60502-2	IEC 60502-2
Manufacturer		Draka	Draka	Draka
Conductor cross section and material	mm^2	3x 500mm^2 Plain copper	3x 500mm^2 Plain copper	3x 150mm^2 Plain copper
Conductor construction		Copper, stranded and compacted, IEC 60228 class 2	Copper, stranded and compacted, IEC 60228 class 2	Copper, stranded and compacted, IEC 60228 class 2
Longitudinal water tightening material		Combination of waterswellable tapes and waterswellable powder	Combination of waterswellable tapes and waterswellable powder	Waterswellable powder
Conductor, number of wires		59	59	19
Conductor, nominal diameter	mm	26.5	26.5	14.2
Insulation system		Conductor screen, Insulation and insulation screen extruded in same operation (triple extruded)	Conductor screen, Insulation and insulation screen extruded in same operation (triple extruded)	Conductor screen, Insulation and insulation screen extruded in same operation (triple extruded)
Conductor screen material		Extruded semi-conductive polymer	Extruded semi-conductive polymer	Extruded semi-conductive polymer
Conductor screen thickness Nominal / minimum	mm	0.7 / 0.5	0.7 / 0.5	0.7 / 0.5
Conductor screen nominal outer diameter	mm	27.9	27.9	15.6
Insulation material	mm	XLPE	XLPE	XLPE
Insulation thickness, Nominal / minimum	mm	8.0 / 7.10	8.0 / 7.10	8.0 / 7.10

	Unit	***Platform Connection cables – (PCC) 3x500mm² + 72OF***	***Inter Connection cables – (ICC) 3x500mm² + 72OF***	***Inter Connection cables – (ICC) 3x150mm² + 48OF***
Insulation nominal outer diameter	mm	43.9	43.9	31.6
Insulation screen material		Extruded semi-conductive polymer, bonded to the insulation	Extruded semi-conductive polymer, bonded to the insulation	Extruded semi-conductive polymer, bonded to the insulation
Insulation screen thickness Nominal / minimum	mm	0.7 / 0.5	0.7 / 0.5	0.7 / 0.5
Insulation screen nominal outer diameter	mm	45.3	45.3	33.0
Metallic screen bedding tape		Waterswellable semiconductive tape longitudinally applied over the insulation screen with minimum 5 mm overlap.	Waterswellable semiconductive tape longitudinally applied over the insulation screen with minimum 5 mm overlap.	Waterswellable semiconductive tape longitudinally applied over the insulation screen with minimum 5 mm overlap.
Metallic screen		2 layers of 0.1 mm thick, plain annealed copper tape applied in open spiral. Minimum overlap 30%	2 layers of 0.1 mm thick, plain annealed copper tape applied in open spiral. Minimum overlap 30%	2 layers of 0,1 mm thick, plain annealed copper tape applied in open spiral. Minimum overlap 30%
Power core sheath material		Extruded Polyethylene with semiconductive skin bonded to the sheath.	Extruded Polyethylene with semiconductive skin bonded to the sheath.	Extruded Polyethylene with semiconductive skin bonded to the sheath.
Power core sheath nominal thickness, PE layer / skin	mm	1.5 / 0.2	1.5 / 0.2	1.5 / 0.2
Power core sheath outer diameter	mm	50.1 ± 1.0	50.1 ± 1.0	37.8 ± 1.0

Power core marking

Phase identification

A thin coloured marking tape longitudinally applied between the metallic screen bedding tape and the metallic screen: Yellow, blue or red.

Marking on power core sheath

Printing on the sheath, repeated every metre:

DRAKA 11 "item no." "description" "phase colour" –"batch number" "year"-"month" "metre"

Optical Fibre Core Design Details

	Unit	*Platform- and Inter Connection Cables, 3x500mm² + 72OF (3x24OF)*	*Inter Connection Cables, 3x150mm²+48OF (2x24OF)*
Cable type (designation)		SM-ME	SM-ME
Manufacturer		DRAKA	DRAKA
Number of cores in cable		3	2
Optical fibre type		Single mode (SM), type ITU-T G.652D	Single mode (SM), type ITU-T G.652D
Number of fibers in core		24	24
Number of fibers in cable		72 (3 x 24)	48 (2 x 24)
Longitudinal water tightening material		Water repellent filling compound	Water repellent filling compound
Type of material for radial water tightness barrier		Laser welded Stainless steel tube	Laser welded Stainless steel tube
Steel tube thickness / diameter	mm	0.3 / 3.4	0.3 / 3.4
Optical fibre core outer sheath material		Polyethylene (PE), black	Polyethylene (PE), black
Outer sheath thickness / diameter	mm	2.8 / 9.0	2.8 / 9.0

	Unit	*Platform- and Inter Connection Cables, 3x500mm² + 72OF (3x24OF)*	*Inter Connection Cables, 3x150mm²+48OF (2x24OF)*
Optical fibre core weight in air	kg/km	105	80
Maximum allowed short term pulling force	N	2000	2000
Minimum static bending radius	mm	180	180
Minimum repeated bending radius	mm	225	225

Optical fibre core marking

Optical fibre identification

The 24 fibres in the optical fibre core are grouped into 2 bundles of 12 fibres in each. The bundle is defined using a coloured binder yarn. Each fibre in the group is uniquely identified by a fibre colour.

Binder Yarn Colours (bundle)

No.	1	2
Color	blue	Orange

Fiber Colours/Type for bundle 1 and 2

No.	1	2	3	4	5	6	7	8	9	10	11	12
Color	blue	Orange	Green	Brown	Grey	White	Red	Black	Yellow	Violet	Turquoise	Rose
Fibre type	G652D	G652D	G652D	G652D	G652D	G652D	G652D	G652D	G652D	G652D	G652D	G652D

Marking on optical fibre core sheath

Printing on the sheath, repeated every metre:

DRAKA COMTEQ TELECOM "year" 24 x G652D OPTICAL CABLE "metre"

Optical fibre properties

Information of the optical fibre properties is found in datasheet MS-ME TB090206, re. appendix A.

33 kV ICC and PCC Design Details

	Unit	***Platform Connection cables – (PCC) 3x500mm² + 72OF***	***Inter Connection cables – (ICC) 3x500mm² + 72OF***	***Inter Connection cables – (ICC) 3x150mm² + 48OF***
Governing standards		Cigré Electra 189 combined with IEC 60502-2	Cigré Electra 189 combined with IEC 60502-2	Cigré Electra 189 combined with IEC 60502-2
Manufacturer		Draka	Draka	Draka
Conductor cross section and material	mm^2	3x 500mm^2 Plain copper	3x 500mm^2 Plain copper	3x 150mm^2 Plain copper
Lay-up		3 off power cores 3 off OF cores	3 off power cores 3 off OF cores	3 off power cores 3 off OF cores
Filling material between cores		Fibrillated PP-yarns, loose	Fibrillated PP-yarns, loose	Fibrillated PP-yarns, loose
Nominal diameter over laid-up and taped cores	mm	109	109	82
Bedding material		One layer of bitumenised woven Hessian tape applied with 50% overlap + one layer of fibrillated PP yarns	One layer of bitumenised woven Hessian tape applied with 50% overlap + one layer of fibrillated PP yarns	One layer of bitumenised woven Hessian tape applied with 50% overlap + one layer of fibrillated PP yarns
Bedding nominal, thickness / diameter	mm	1.6 + 2.4 / 117	1.6 + 2.4 / 117	1.6 + 2.4 / 90
Armour type		Single layer galvanized steel wire armour	Single layer galvanized steel wire armour	Single layer galvanized steel wire armour
Armour wire nominal diameter	mm	5.0	5.0	5.0
Armour wire minimum tensile strength	MPa	340	340	340
Armour corrosive protection		Armour flooded with bitumen	Armour flooded with bitumen	Armour flooded with bitumen
Nominal diameter over taped armour	mm	127	127	100

	Unit	*Platform Connection cables – (PCC) 3x500mm² + 72OF*	*Inter Connection cables – (ICC) 3x500mm² + 72OF*	*Inter Connection cables – (ICC) 3x150mm² + 48OF*
Outer protection		PP yarn serving, fixed to PET taped armour by spray glue	PP yarn serving, fixed to PET taped armour by spray glue	PP yarn serving, fixed to PET taped armour by spray glue
Outer serving colour		Black - Orange	Black - Orange	Black – Yellow
Overall nominal diameter	mm	133	133	106

33 kV ICC and PCC Mechanical Properties

	Unit	*Platform Connection cables – (PCC) 3x500mm² + 72OF*	*Inter Connection cables – (ICC) 3x500mm² + 72OF*	*Inter Connection cables – (ICC) 3x150mm² + 48OF*
Cable nominal weight in air	kg/m	33	33	19
Cable nominal weight in sea water	kg/m	22	22	11
Maximum safe axial pulling force	kN (tons)	60 (6)	60 (6)	30 (3)
Ultimate tensile strength	kN	350	350	275
Minimum bending radius, @ < 10 kN pulling force	mm	1330	1330	1060
Minimum bending radius, @ > 10 kN pulling force	mm	1990	1990	1600
Minimum static bending radius of single power core	mm	500	500	380
Minimum static bending radius of optical fibre core	mm	220	220	180
Maximum allowed free cable length hanging from the hang off, in air	m	150	150	150
Axial stiffness, (calculated guiding value)	[MN]	130	130	105

	Unit	*Platform Connection cables – (PCC) 3x500mm² + 72OF*	*Inter Connection cables – (ICC) 3x500mm² + 72OF*	*Inter Connection cables – (ICC) 3x150mm² + 48OF*
Torsional rigidity (calculated guiding value)	[kN·m²]	280	280	130
Bending stiffness (calculated guiding value)	[kN·m²]	1035	1035	480

33 kV ICC and PCC Electrical Data

	Unit	*Platform Connection cables – (PCC) 3x500mm² + 72OF*	*Inter Connection cables – (ICC) 3x500mm² + 72OF*	*Inter Connection cables – (ICC) 3x150mm² + 48OF*
Conductor DC resistance @ 20°C	Ω/km	0.0366	0.0366	0.124
Conductor AC resistance @ 90°C	Ω/km	0.0503	0.0503	0.159
Screen DC resistance (calculated guiding value)	Ω/km	0.037	0.037	1.609
Inductance per phase	mH/km	0.316	0.316	0.384
Capacitance per phase	μF/km	0.307	0.307	0.197
Positive sequence impedance	Ω/km	0.037 + j 0.099	0.037 + j 0.099	0.124 + j 0.121
Negative sequence impedance	Ω/km	0.037 + j 0.099	0.037 + j 0.099	0.124 + j 0.121
Zero-sequence impedance (not grounded)	Ω/km	0.406 + j 0.051	0.406 + j 0.051	0.578 + j 0.071
Zero-sequence impedance (grounded both ends)	Ω/km	0.661 + j 1.062	0.661 + j 1.062	0.870 + j 1.210

	Unit	*Platform Connection cables – (PCC) 3x500mm² + 72OF*	*Inter Connection cables – (ICC) 3x500mm² + 72OF*	*Inter Connection cables – (ICC) 3x150mm² + 48OF*
Current rating: - 2 m burial - Ambient soil temperature 15°C - Soil thermal conductivity 0.7 K·m/W	A	738	738	421
Current rating: - Air - Air temperature 20°C - Directly exposed to sun	A	830	830	441
Current rating: - Water - Water temperature 15°C	A	1313	1313	666
Current rating: - Inside monopile (J-tubeless solution) - Ambient air temperature 30°C - Directly exposed to sun	A	822	822	437
Conductor short circuit current: - Initial temperature 90°C - Final temperature 250°C - Duration 1 s	kA	71.54	71.54	21.46
Screen short circuit current: - Initial temperature 72°C - Final temperature 250°C - Duration 1 s	kA	2.23	2.23	1.66
Total losses at 25% of buried cable current rating	kW/km	6.34	6.34	5.78
Total losses at 50% of buried cable current rating	kW/km	24.11	24.11	22.32
Total losses at 75% of buried cable current rating	kW/km	53.72	53.72	49.89
Total losses at 100% of buried cable current rating	kW/km	95.17	95.17	88.48