Capital Project 966

Cable Ratings Compendium

321084AE-REP-001A

03 April 2020

EirGrid

CP966

Capital Project 966

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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
Final	03/04/2020	Final		ES	NE	FL

Contents

Executive Summary

This Document is to be read in conjunction with report "321084AE-REP-001 RevC - Cable Feasibility Report".

It has been prepared to collate and detail the numerous CYMCAP simulations that have been performed to support the EirGrid CP966 project.

Whilst there are a number of assumptions that need to be considered (as discussed in chapter 2), alongside the fact that such calculations have been performed to support a strategy for network development and not to provide a detailed design solution, there is some clear guidance:

For Option 3, where a 220kV UGC (underground cable) solution was requested, there is a, single conductor per phase, technically feasible cable solution which delivers the required winter and summer ratings, utilising readily available materials and components.

For Option 4, where a 400kV UGC solution was requested, there is no single conductor per phase cable solution which delivers the required winter and summer ratings.

The required ratings can only be achieved by utilising a 2 conductors per phase UGC solution.

Important note about your report

- This report must be read in conjunction with 321084AE-REP-001 Rev C
- The sole purpose of the report is to support EirGrid CP966 project
- Any information relied upon and presumed accurate in preparing the report (i.e. client and/or third party supplied information)
- Ratings calculations have been performed using CYME Cymcap 7.3 rel 2
- Calculations have been performed to support a strategy for network development and not to provide a detailed design solution
- Observations and findings in the report subject to the extents permitted by law
- This report shall be read in full with no excerpts to be representative of the findings
- This report has been prepared exclusively for EirGrid Project CP966 Step 3, no liability is accepted for any use or reliance on the report by third parties

1. Introduction

The outputs of the ratings calculations, as shown in the pdf attachments, are divided in the following sections:

- Study summary
- Steady State summary
- Cables input
- Electrical parameters
- Steady state report

The 220kV and 400kV 2500sqmm cables are modelled on the supplied datasheets while the 3000sqmm cable is based on a generic model.

Where design parameters have not been made available, generic values have been adopted.

2. Calculation assumptions

2.1 Environmental conditions

All calculations have been performed under the following 3 temperature/soil conditions:

Season	Ground temperature	Indigenous Soil TR	CBGM TR
Winter	10C	1.0 K.m/W	0.85 K.m/W
Spring	15C	1.2 K.m/W	1.0 K.m/W
Summer	20C	1.2 K.m/W	1.0 K.m/W
Autumn	15C	1.2 K.m/W	1.0 K.m/W

2.2 Simulation tool

CYME CYMCAP 7.3 rev 2 is the cable ratings software tool utilised for all calculations.

It addresses steady-state and transient thermal cable rating as per the analytical techniques described by Neher-McGrath and the International Standards IEC 287© and IEC 853.

2.3 About Low Thermal Resistivity materials

Several technical backfill materials with extremely low Thermal Resistivity (TR) values have recently become commercially available under different brand names.

The TR values of such materials can be as low as 0.33K.m/W in dry-out conditions.

We have assumed the above value for all our calculations utilising “low TR” specialised backfills.

2.4 About supplied cable datasheets

The cable datasheets shown in the appendices have been provided by EirGrid.

2.5 About UGC with large conductor cross-sections

Due to the recent growth of the HVDC and interconnector market, high voltage cables with enhanced conductor cross-sections has become available.

3000sqmm Cu conductors can now be supplied by many different cable manufacturers.

Because such cables are not currently type registered by EirGrid and no datasheet was made available, we have assumed a “generic” 3000sqmm Cu cable design for all the simulations.

2.6 About trench dimensions

The trench dimensions, found in the simulations below, are based on one of the following criteria:

- Provided by EirGrid as one of their standard cable trench cross-sections
- Determined by Jacobs to be suitable for Ireland's narrow roads and capable of delivering the required rating
- Requested EirGrid and determined by Jacobs, to deliver the maximum/required cable rating given a specific conductor cross-section and material

Some simulations show large quantities of technical backfill (on top, beside and below the ducts) used around the cable ducts, especially when the cable phases are very far apart. This is due to the unrefined and high-level nature of these simulations.

During detailed design, when all the design constraints are known, the exact quantity of technical backfill required for each scenario will need to be determined. Most importantly, at this next stage, it will be possible to reduce extremely wide single trenches to 3 narrower ones.

3. Summary table

The table below summarises the results from the numerous simulations completed. It shows cable ratings variations in response to the change of the following parameters:

- Cable voltage
- Cable conductor cross-section
- Trench technical backfill
- Separation between phases

Complete results can be found in the attachments

OPTIONS	WINTER	AUTUMN SPRING	SUMMER	Delivered by	
Option 3 - 220kV UGC					
REQUIRED	2377	n/a	2289		
Solution 1					
in 1.7m trench CGBM backfill	2220	2038	1968	2500mm^2	1 cond/phase
in 2.5m trench with low TR backfill	2550	2394	2313	Cu Cable	1 trench
in 4.0m trench with CGBM backfill	2454	2280	2202		
in 7.0m trench with CGBM backfill	2377	2289	2289		
Option 4 - 400kV UGC					
REQUIRED	2963	n/a	2506		
Solution 1					
in 1.7m trench CGBM backfill	2119	1937	1867	2500mm^2	1 cond/phase
in 2.5m trench with low TR backfill	2302	2157	2082	Cu Cable	1 trench
in 4.0m trench CGBM backfill	2389	2214	2135		
Solution 2					
in 1.7m trenches CGBM backfill	4238	3874	3734	2500mm^2	2 cond/phase
in 2.5m trenches with low TR backfill	4604	4314	4164	Cu Cable	2 trenches
in 4.0m trench CGBM backfill	4778	4428	4270		
Solution 3					
in 10.5m wide trench with CGBM backfill	2524	2353	2271	3000mm^2	1 cond/phase
				Cu Cable	1 trench

Appendix A. Cable Data Sheet

nkt cables

nkt document no. TDA 330 Rev. 2 / 13.03.2017
1 x 2500Cu XLPE Al PE 400 kV

TECHNICAL SCHEDULE TS – 56

400 kV XLPE Land Cable – 2,500mm² Cu XLPE **Physical Characteristics**

Note: All dimensions to be filled in where applicable.

Item	Query	Unit	Reply
1	Conductor:		
	(a) Material Grade		copper
	(b) Type e.g. round, etc.		round
	(c) Design e.g. stranded, segmental, enamelled etc.		stranded, segmental
	(d) Nominal diameter	mm	63
	(e) Cross-sectional area	mm^2	2500
	(f) Method of water blocking		swelling yarns and/or swelling tapes
2	Inner Semi-conducting Layer:		
	(a) Material Grade		XLPE
	(b) Nominal thickness	mm	1,8
	(c) Minimum thickness	mm	0,7
3	Insulation:		
	(a) Material Grade		XLPE
	(b) Nominal thickness	mm	26,2
	(c) Minimum thickness	mm	23,6
	(d) Ovality of insulation ≤ 10%		≤ 10%
4	Outer Semi-conducting Layer:		
	(a) Material Grade		
	(b) Thickness	mm	1,5
	(c) Minimum thickness	mm	0,7
5	Nominal diameter over core screen	mm	123
	Roundness of core ; maximum ovality < 0.9mm	mm	max. 0,9
6	Radial thickness of insulation incl. semi-conducting layers		
	(a) Nominal	mm	29,5
	(b) Minimum	mm	25,0
7	Bedding Layer/Water Barrier		
	(a) Material		semiconducting and swellable tapes
	(b) Thickness	mm	2,5
	(c) OD of bedding layer	mm	128
	(d) Method of electrical connection between 4 and 8 to avoid discharges		semiconducting and swellable tapes
	(e) Method of water blocking		semiconducting and swellable tapes
8	Metallic Sheath:		
	(a) Material		aluminium
	(b) Type, corrugated or smooth		smooth
	(c) Nominal thickness	mm	1,5
	(d) Mean diameter	mm	129
	(e) Cross-sectional area	mm^2	608
	(f) Diameter over crest of corrugations	mm	n. a.
	(g) OD of sheath if not corrugated	mm	131
	(h) Diameter and no. of extra copper wires required to ensure short circuit performance of cable meets Specification 18080 (if needed)		n. a.
9	Outer HDPE/MDPE Sheath :		
	(a) Material		HD PE
	(b) Nominal thickness	mm	5,0
	(c) Minimum thickness	mm	4,15
	(d) Shore D hardness		appr. 58

nkt cables

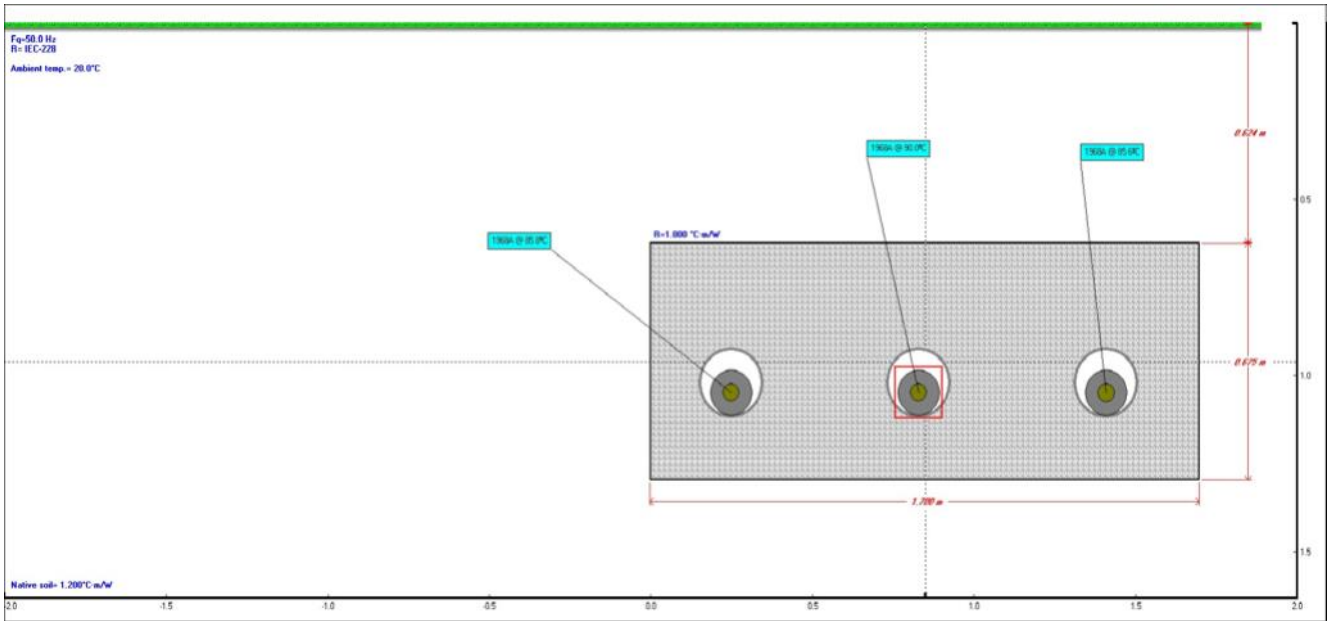
XLPE insulated Cable 220 kV 1x 2500 Cu
nkt offer 23829
ESB specification 18090

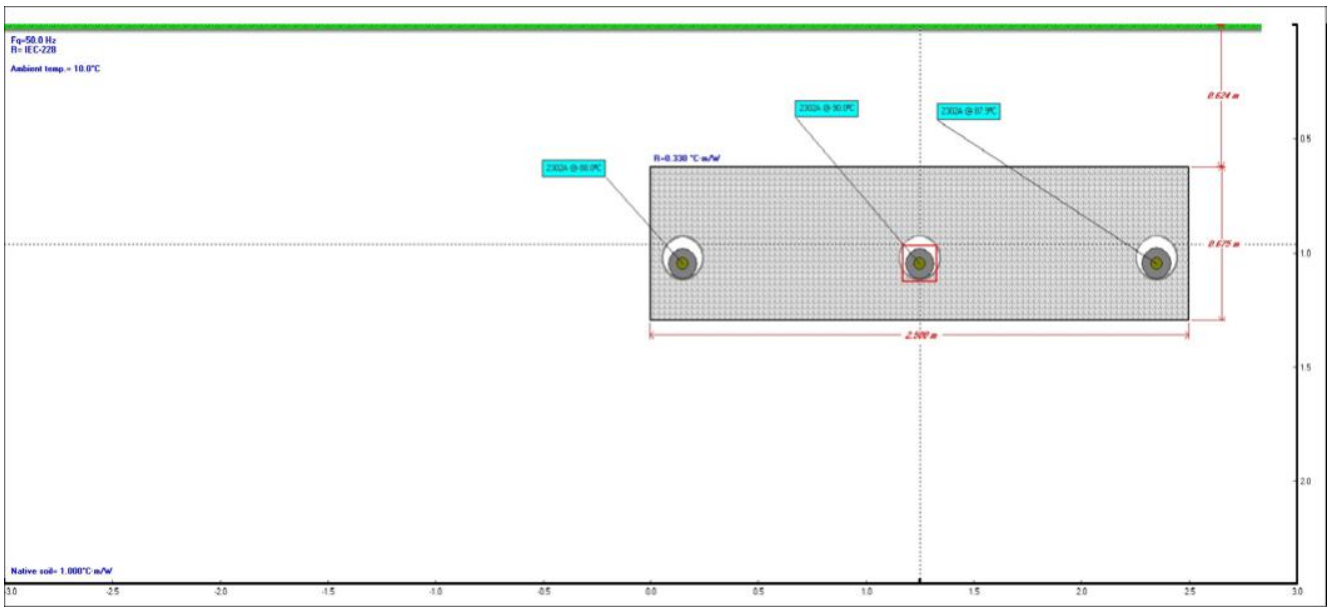
SCHEDULE A (continued)
Physical Characteristics of 220kV Crosslinked Polyethylene Cable

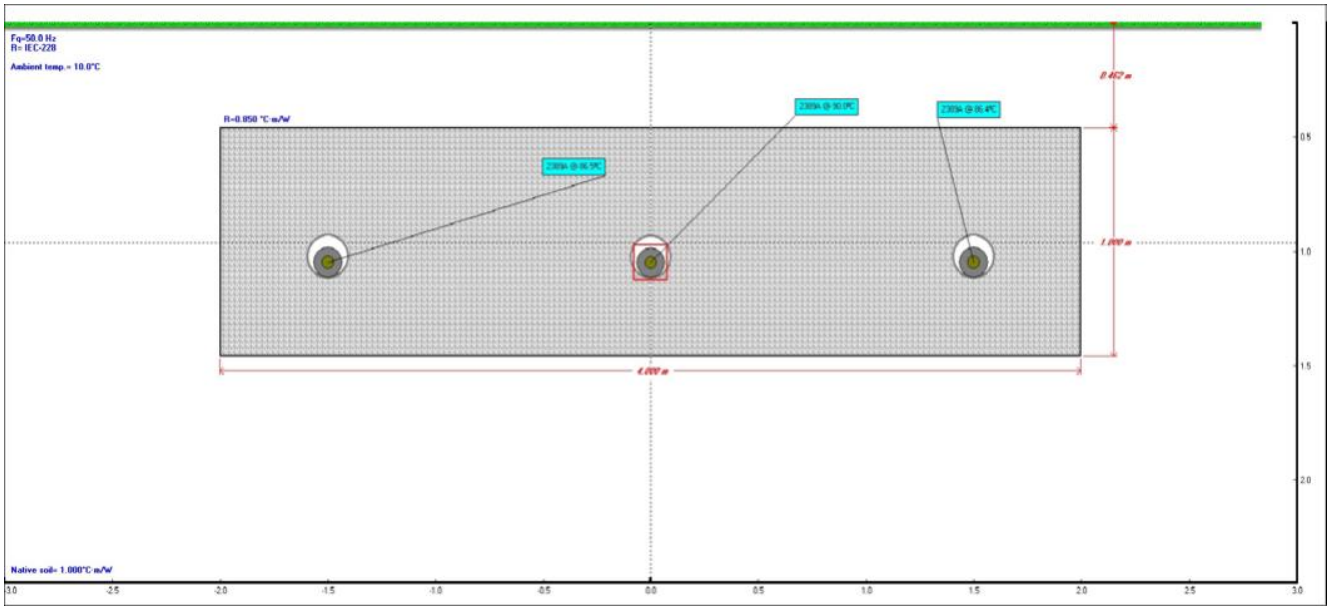
Item	Query		Reply
9	Corrosion Protection:		
	(a) Material		PE
	(b) Nominal thickness	mm	4,9
	(c) Minimum thickness	mm	4,07
	(d) Shore D hardness	approx.	58
	Height of marking with indented lettersby laser marking on the cable sheath	mm	appr. 10
	marking text 1st line: ELECTRIC CABLE 220000 V 1x2500/150 CU/XLPE/CU-PB/PE nkt cables <year> ESB <metre marking (4 digits)> 2nd line:<code number (4 digits)>		
10	Nominal diameter of completed cable	mm	135
11	Nominal weight of finished cable	kg/m	44
12	(a) Normal length per drum	m	740
	(b) Maximum length per drum	m	to be agreed upon
13	(a) Normal gross weight of loaded drum	approx. kg	36
	(b) Maximum gross weight of loaded drum	approx. kg	to be agreed upon
14	(a) Normal drum dimensions width/height	approx. m/m	3,2 /4,3
	(b) Maximum drum dimensions width/height	approx. m/m	3,7 /4,3
15	Minimum radius of bend around which cable can be pulled	m	3,4
	(a) Laid direct	m	3,4
	(b) In ducts	m	3,4
	(c) Cable placed in position with former	m	2,0
	(d) Cable placed in position without former	m	3,4
16	Permissible pulling force allowed on conductors during installation	kN	125
17	Maximum permissible sidewall forces	kN/m	10

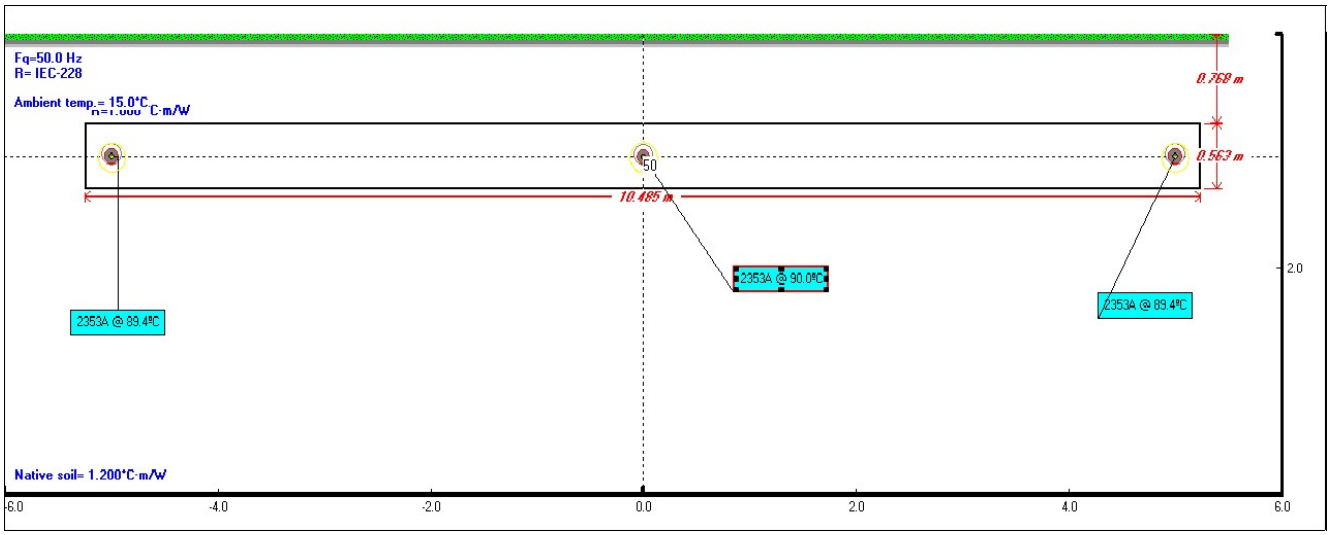
Appendix B. Simulation trench cross-sections

Following trench cross-sections and *dimensions* as per simulation output. These are outputs automatically generated by the software tool and not to be representative of the actual construction trench. Supplied here for reference only.








Fq=50.0 Hz
R= IEC-228
Ambient temp.= 15.0°C
0.768 m
0.563 m
10.485 m
2353A @ 90.0°C
2353A @ 89.4°C
2353A @ 89.4°C
Native soil= 1.200°C·m/W
2.0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0

Appendix C. Cable Ratings Calculations

400kV Cable - 4.0m Width Trench (CGBM) - Winter (10C)

400kV Cable - 4.0m Width Trench (CGBM) - Summer (20C)

400kV Cable - 4.0m Width Trench (CGBM) - Spring Autumn (15C)

400kV Cable - 2.5m Trench (low TR) - Winter (10C)

400kV Cable - 2.5m trench (low TR) - Summer (20C)

400kV Cable - 2.5m Trench (low TR) - Spring Autumn (15C)

400kV Cable - 1.7m Trench (CGBM) - Winter (10C)

400kV Cable - 1.7m Trench (CGBM) - Summer (20C)

400kV Cable - 1.7m Trench (CGBM) - Spring Autumn (15C)

220kV Cable - 4.0m Width Trench (CGBM) - Winter (10C)

220kV Cable - 4.0m Width Trench (CGBM) - Summer (20C)

220kV Cable - 4.0m Width Trench (CGBM) - Spring Autumn (15C)

220kV Cable - 2.5m Trench (low TR) - Winter (10C)

220kV Cable - 2.5m Trench (low TR) - Summer (20C)

220kV Cable - 2.5m Trench (low TR) - Spring Autumn (15C)

220kV Cable - 1.7m Trench (CGBM) - Winter (10C)

220kV Cable - 1.7m Trench (CGBM) - Summer (20C)

220kV Cable - 1.7m Trench (CGBM) - Spring Autumn (15C)

400kV 3000sqmm -10.5m trench - CGBM - Winter 10C

400kV 3000sqmm -10.5m trench - CGBM - Spring 15C

220kV Cable - 7m trench - CGBM - Winter 10C

220kV Cable - 7m trench - CGBM - Summer 20C

220kV Cable - 7m trench - CGBM - Spring 15C

Study Summary

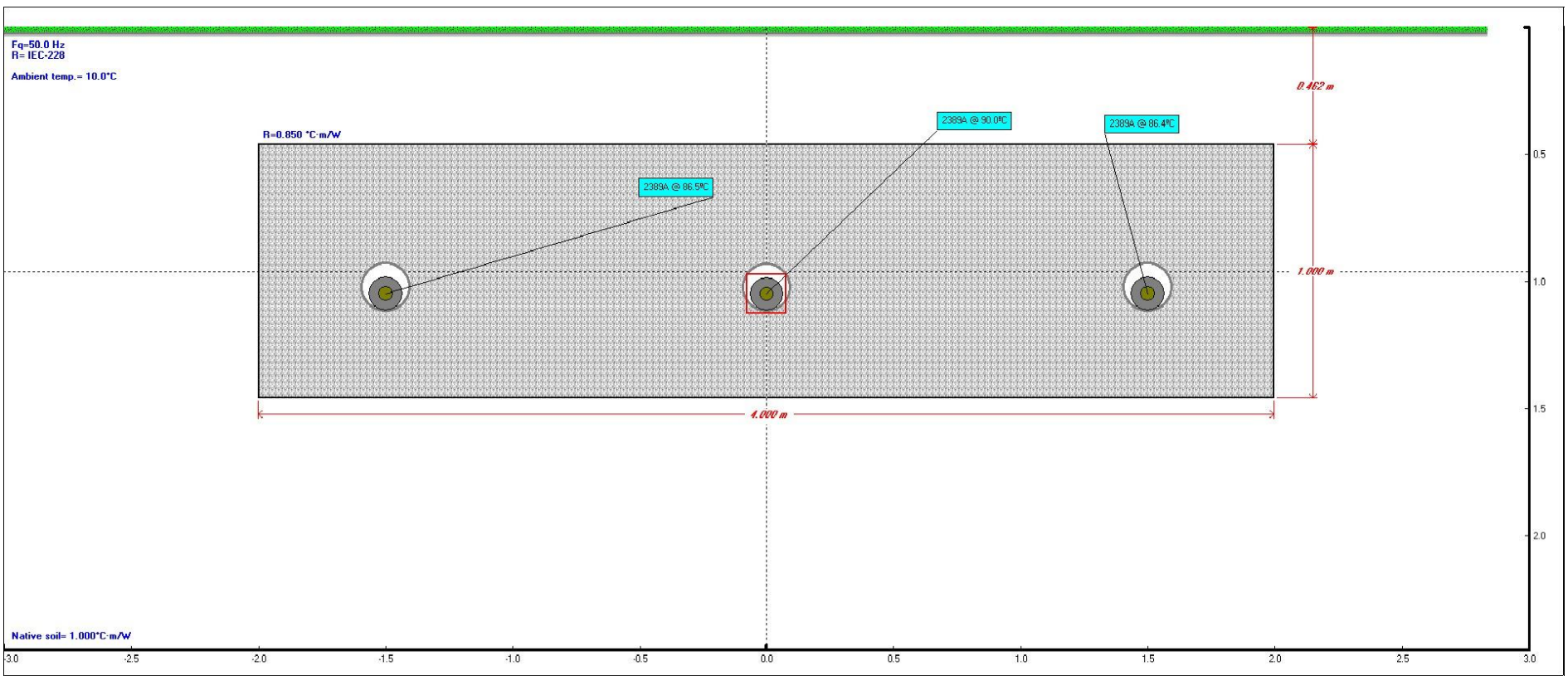
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE)
Date:	18/03/2020 11:24:45

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	10.0
Native Soil Thermal Resistivity	[K.m/W]	1.0
Thermal Resistivity of Duct Bank	[K.m/W]	0.9
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	4.0
Duct Bank Height	[m]	1.0



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	400KV.011	1		A	50.0	1.0	-1.5	1.05	86.5	2389.5
2	400KV.011	1		B	50.0	1.0	0.0	1.05	90.0	2389.5
3	400KV.011	1		C	50.0	1.0	1.5	1.05	86.4	2389.5

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE)
Date:	18/03/2020 11:24:45

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	10
Native Soil Thermal Resistivity [K.m/W]	1.0
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		400KV.011	400KV.011	400KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	-1.5	0.0	1.5
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2389.5	2389.5	2389.5
Temperatures					
θc	Conductor temperature	[°C]	86.5	90.0	86.4
θs	Sheath/Shield temperature	[°C]	64.5	67.7	64.4
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	61.5	64.7	61.4
θduct	Duct surface temperature	[°C]	44.6	47.8	44.5
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.0101	0.01018	0.01009
ys	Skin Effect Factor		0.11125	0.1091	0.11132
yp	Proximity Effect Factor		0.00026	0.00026	0.00026
Losses					
Wc	Conductor Losses	[W/m]	57.64346	58.15139	57.62698
Wd	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
Ws	Metallic Screen Losses	[W/m]	1.51482	1.99981	1.37184
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	63.16763	64.16055	63.00817
λ_1	Screen Loss Factor		0.02628	0.03439	0.02381
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.36997	0.36997	0.36997
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04684	0.04684	0.04684
T4	External thermal resistance	[K.m/W]	0.81558	0.85322	0.81612
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	150.7	144.3	142.1

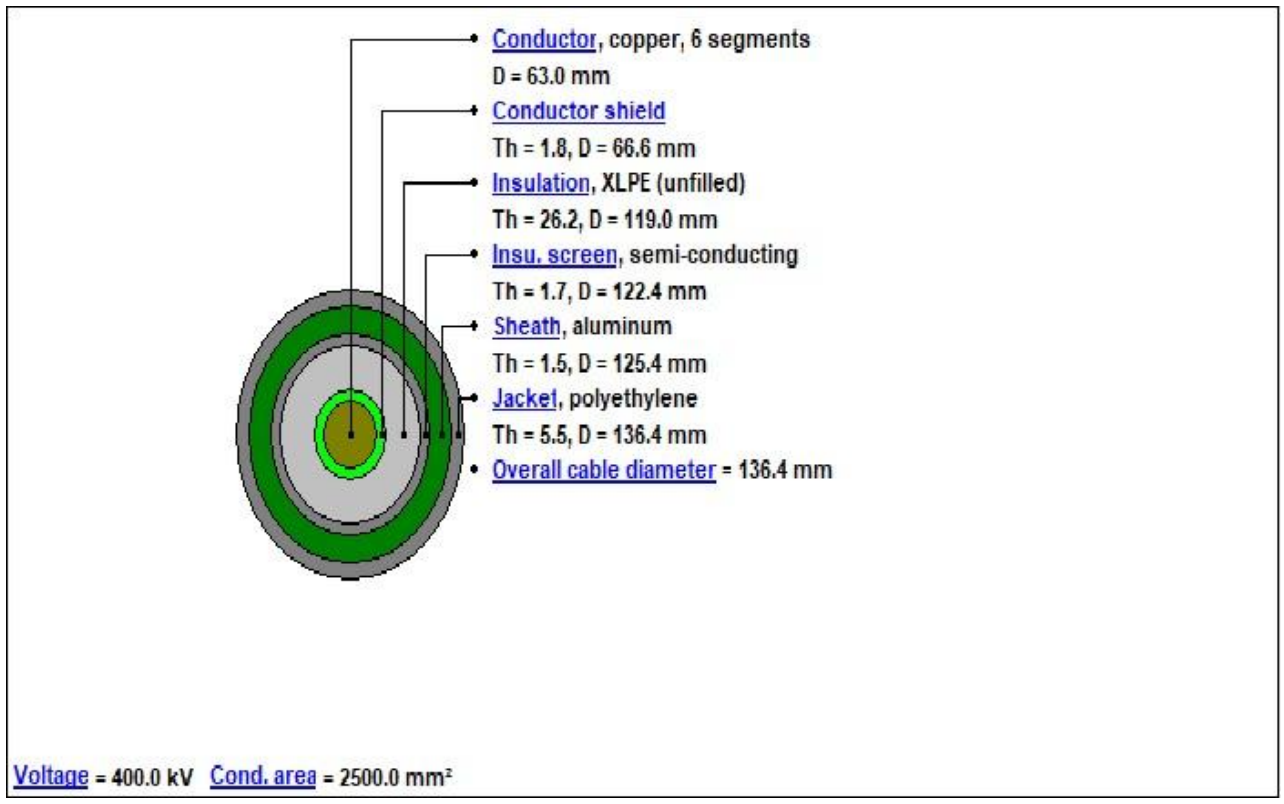
Cables Report

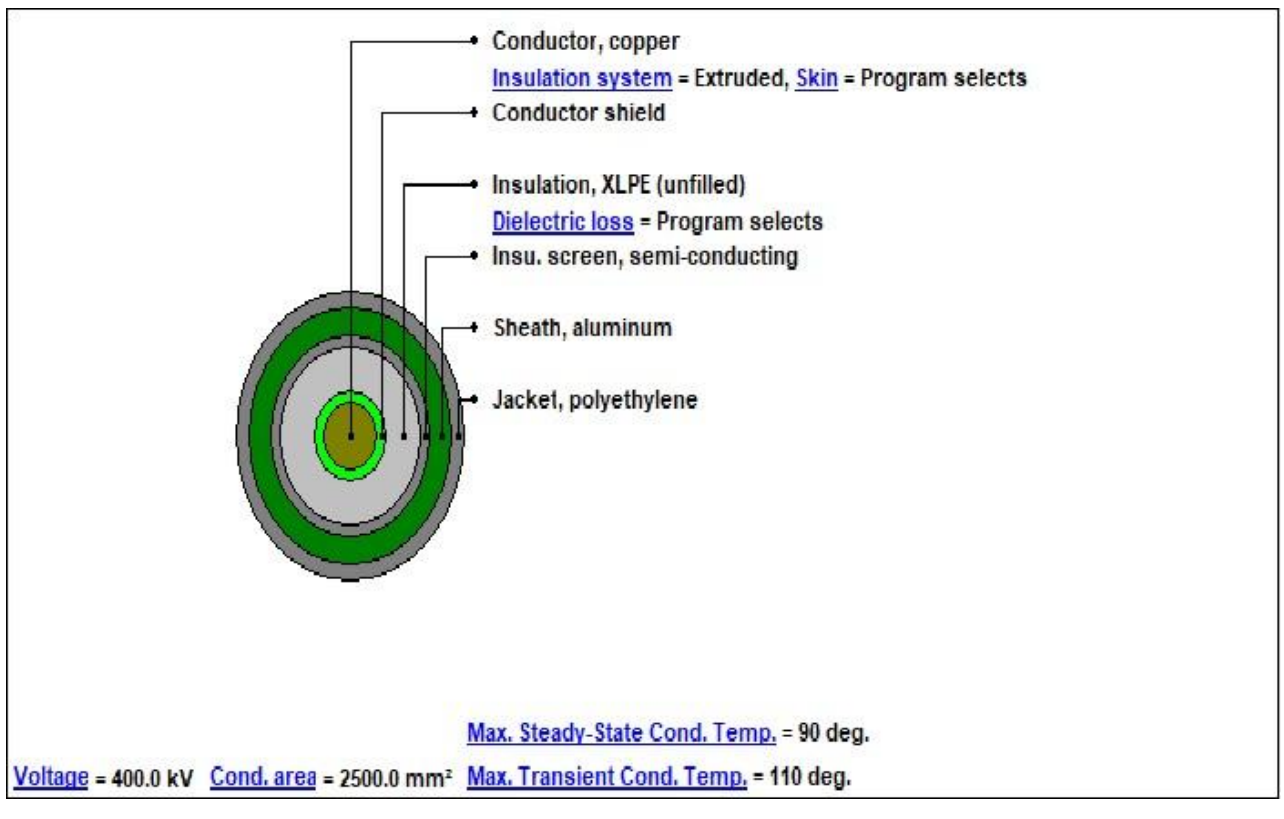
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE)
Date:	18/03/2020 11:24:45

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		400KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	400
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	136.4
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	63.0
Conductor Shield			
19	Thickness	[mm]	1.8
20	Diameter	[mm]	66.6
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	26.2
27	Diameter	[mm]	119.0
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.7
30	Diameter	[mm]	122.4
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Aluminum
33	Electrical Resistivity at 20°C	[µΩ.cm]	2.84
34	Temperature Coefficient at 20°C	[1/K]	0.00403
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	228
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	2.5
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	1.5
39	Diameter	[mm]	125.4
Jacket			
40	Material		Polyethylene
41	Thermal Resistivity	[K.m/W]	3.5
42	Thickness	[mm]	5.5
43	Diameter	[mm]	136.4

No.	Description	Unit	1
Specific Installation Data			
44	Cable Equipment ID		400KV.011
45	Cable Frequency	[Hz]	50
46	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
47	Loss Factor Constant (ALOS)		0.3
48	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
49	Duct construction		Polyethylene in Concrete
50	Duct material thermal resistivity	[K.m/W]	3.5
51	Inside Diameter of the Duct/Pipe	[mm]	188.0
52	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 400KV.011	
Cable Title	2500sqmm Cu (insulated wires)_XLPE_CAS_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE)
Date:	18/03/2020 11:24:45

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**400KV.011**	**400KV.011**	**400KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00908	0.00918	0.00908
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00841	0.00841	0.00841
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.0101	0.01018	0.01009
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.04864	0.04864	0.04864
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.05736	0.058	0.05734
Losses					
8	Conductor Losses	[W/m]	57.64346	58.15139	57.62698
9	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
10	Metallic Screen Losses	[W/m]	1.51482	1.99981	1.37184
11	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
12	Total Losses	[W/m]	63.16763	64.16055	63.00817
Capacitance, Inductance, Impedance					
13	Capacitance	[µF/km]	0.239	0.239	0.239
14	Inductance of Conductor	[mH/km]	0.82265	0.82265	0.82265
15	Reactance of Conductor	[Ω/km]	0.25844	0.25844	0.25844
16	Inductance of Metallic Sheath	[mH/km]	0.63738	0.63738	0.63738
17	Reactance of Metallic Sheath	[Ω/km]	0.20024	0.20024	0.20024
18	Positive Sequence Impedance	[Ω/km]	0.010100 + j0.258440	0.010180 + j0.258440	0.010090 + j0.258440
19	Negative Sequence Impedance	[Ω/km]	0.010100 + j0.258440	0.010180 + j0.258440	0.010090 + j0.258440
20	Zero Sequence Impedance	[Ω/km]	0.056640 + j0.200240	0.056630 + j0.200240	0.056640 + j0.200240
21	Surge Impedance	[Ω]	58.63321	58.63321	58.63321
Others					
22	Dielectric Stress at Conductor Surface	[kV/mm]	11.94851	11.94851	11.94851
23	Dielectric Stress at Insulation Surface	[kV/mm]	6.68715	6.68715	6.68715
24	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	16540.20553	16540.20553	16540.20553
25	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
26	Charging Current for One Phase	[A/km]	17.36102	17.36102	17.36102
27	Charging Capacity of three phase system at Uo	[kvar/km]	12028.06597	12028.06597	12028.06597
28	Voltage drop for Three Phase System	[V/A/km]	0.01749	0.01764	0.01748
29	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
30	Induced current on Metallic Screen	[A]	150.7	144.3	142.1

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE)
Date:	18/03/2020 11:24:45

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		400KV.011	400KV.011	400KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00908	0.00918	0.00908
4	dc	Conductor Diameter	[mm]	63.0	63.0	63.0
5	s	Distance Between Conductor Axes	[mm]	1500.0	1500.0	1500.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.20051	2.18875	2.2009
9	xp	Component of Yp Calculation (Proximity Effect)		1.66343	1.65454	1.66372
10	ys	Skin Effect Factor		0.11125	0.1091	0.11132
11	yp	Proximity Effect Factor		0.00026	0.00026	0.00026
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.0101	0.01018	0.01009
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[µF/km]	0.239	0.239	0.239
16	U_0	Voltage	[kV]	230.94011	230.94011	230.94011
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	4.00936	4.00936	4.00936
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.05736	0.058	0.05734
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	123.9	123.9	123.9
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.20024	0.20024	0.20024
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.24379	0.24379	0.24379
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.18572	0.18572	0.18572
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.02259	0.02076	0.02008
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.05736	0.058	0.05734
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	123.9	123.9	123.9
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	125.4	125.4	125.4
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	1.5	1.5	1.5
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		108.57191	107.9702	108.59161
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00543	1.0054	1.00543
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.54769	0.54164	0.54789
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00059	0.00232	0.00059
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00488	0.00125	0.00398
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00003	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00369	0.01363	0.00372
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.02628	0.03439	0.02381
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.36997	0.36997	0.36997
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	29.7	29.7	29.7
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04684	0.04684	0.04684
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.5	5.5	5.5
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	54.1	57.4	54.0
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.23412	0.2294	0.23425
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.54699	0.58936	0.5474
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	1.0	1.0	1.0
64	y	Longer Side of the Duct Bank/Backfill	[m]	4.0	4.0	4.0
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	1.19983	1.19983	1.19983
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		0.80178	0.80178	0.80178
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	0.85	0.85	0.85
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.54699	0.58936	0.5474
72	T_4	Total External Thermal Resistance	[K.m/W]	0.81558	0.85322	0.81612
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2389.5	2389.5	2389.5

Study Summary

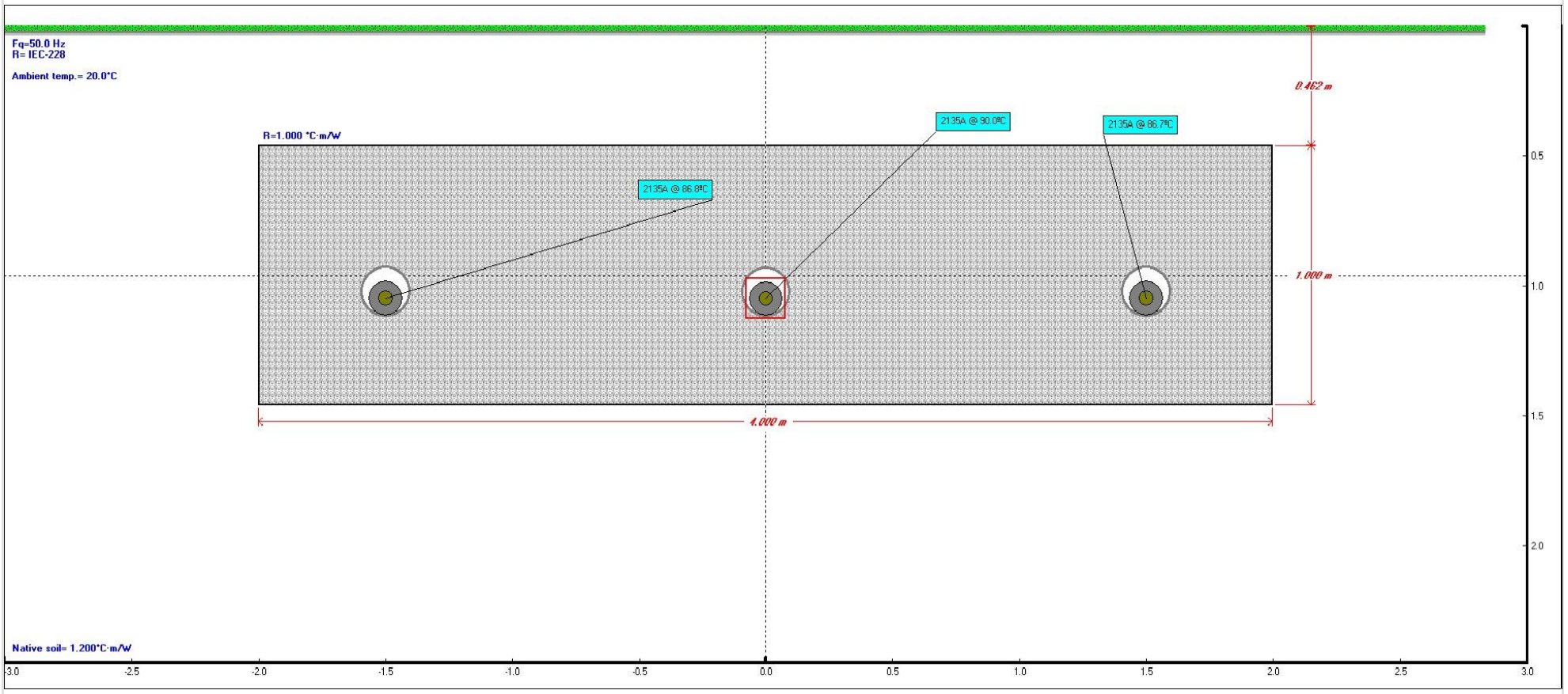
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE) - Summer (20C)
Date:	02/03/2020 16:02:32

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	20.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	1.0
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	4.0
Duct Bank Height	[m]	1.0



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	400KV.011	1		A	50.0	1.0	-1.5	1.05	86.8	2135.3
2	400KV.011	1		B	50.0	1.0	0.0	1.05	90.0	2135.3
3	400KV.011	1		C	50.0	1.0	1.5	1.05	86.7	2135.3

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE) - Summer (20C)
Date:	02/03/2020 16:02:32

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	20
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		400KV.011	400KV.011	400KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	-1.5	0.0	1.5
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2135.3	2135.3	2135.3
Temperatures					
θc	Conductor temperature	[°C]	86.8	90.0	86.7
θs	Sheath/Shield temperature	[°C]	69.0	72.1	68.9
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	66.6	69.6	66.5
θduct	Duct surface temperature	[°C]	53.3	56.4	53.2
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.0101	0.01018	0.0101
ys	Skin Effect Factor		0.11112	0.1091	0.11119
yp	Proximity Effect Factor		0.00026	0.00026	0.00026
Losses					
Wc	Conductor Losses	[W/m]	46.05738	46.43925	46.04573
Wd	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
Ws	Metallic Screen Losses	[W/m]	1.22292	1.6034	1.10571
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	51.28965	52.05201	51.16079
λ_1	Screen Loss Factor		0.02655	0.03453	0.02401
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.36997	0.36997	0.36997
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04684	0.04684	0.04684
T4	External thermal resistance	[K.m/W]	0.90787	0.95374	0.90847
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	134.6	128.7	126.8

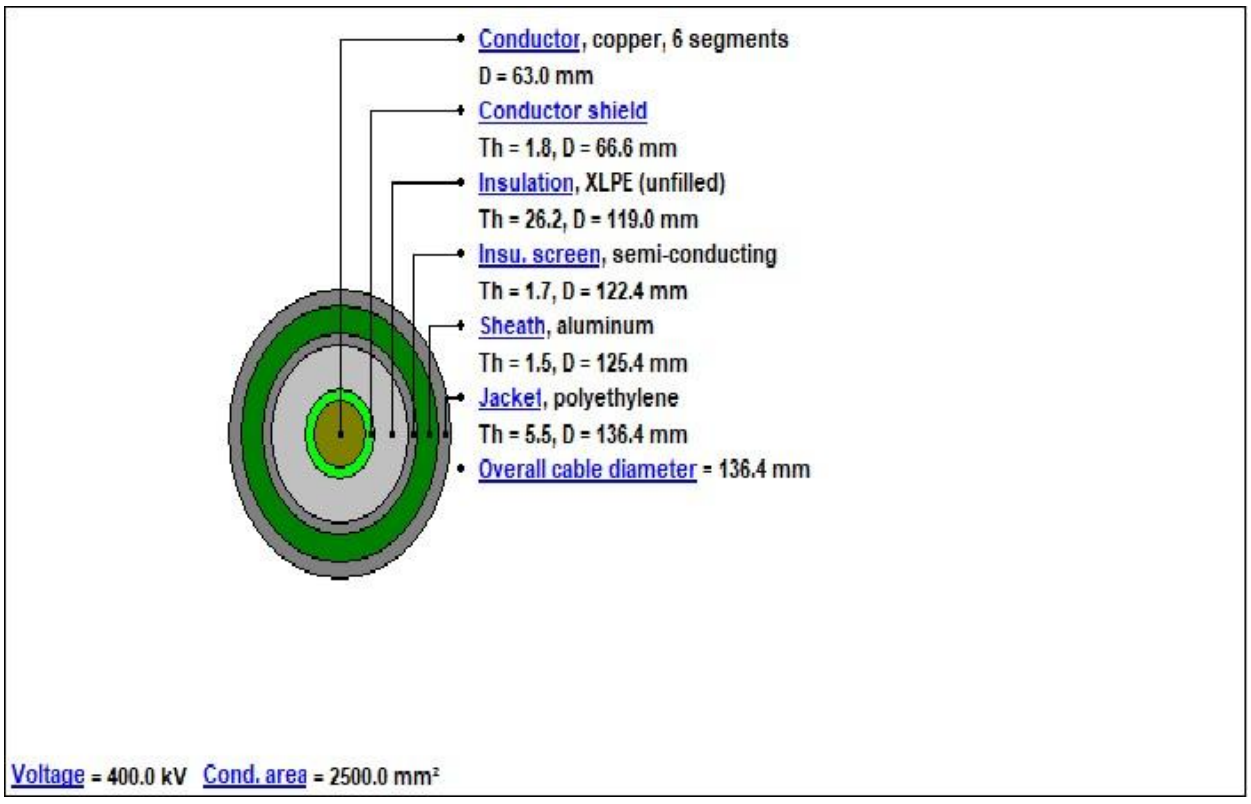
Cables Report

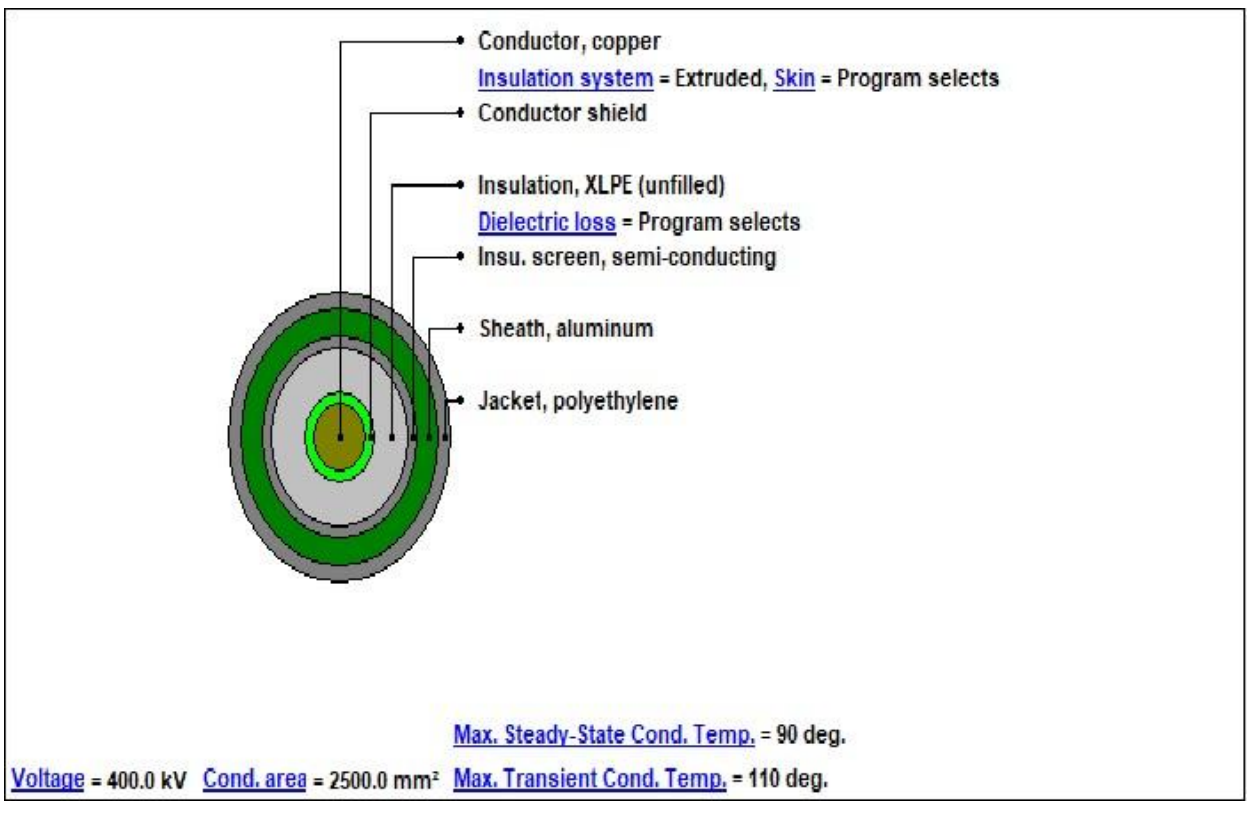
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE) - Summer (20C)
Date:	02/03/2020 16:02:32

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		400KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	400
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	136.4
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	63.0
Conductor Shield			
19	Thickness	[mm]	1.8
20	Diameter	[mm]	66.6
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	26.2
27	Diameter	[mm]	119.0
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.7
30	Diameter	[mm]	122.4
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Aluminum
33	Electrical Resistivity at 20°C	[µΩ.cm]	2.84
34	Temperature Coefficient at 20°C	[1/K]	0.00403
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	228
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	2.5
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	1.5
39	Diameter	[mm]	125.4
Jacket			
40	Material		Polyethylene
41	Thermal Resistivity	[K.m/W]	3.5
42	Thickness	[mm]	5.5
43	Diameter	[mm]	136.4

No.	Description	Unit	1
Specific Installation Data			
44	Cable Equipment ID		400KV.011
45	Cable Frequency	[Hz]	50
46	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
47	Loss Factor Constant (ALOS)		0.3
48	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
49	Duct construction		Polyethylene in Concrete
50	Duct material thermal resistivity	[K.m/W]	3.5
51	Inside Diameter of the Duct/Pipe	[mm]	188.0
52	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 400KV.011	
Cable Title	2500sqmm Cu (insulated wires)_XLPE_CAS_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE) - Summer (20C)
Date:	02/03/2020 16:02:32

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**400KV.011**	**400KV.011**	**400KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00909	0.00918	0.00909
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00841	0.00841	0.00841
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.0101	0.01018	0.0101
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.04864	0.04864	0.04864
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.05824	0.05885	0.05822
Losses					
8	Conductor Losses	[W/m]	46.05738	46.43925	46.04573
9	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
10	Metallic Screen Losses	[W/m]	1.22292	1.6034	1.10571
11	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
12	Total Losses	[W/m]	51.28965	52.05201	51.16079
Capacitance, Inductance, Impedance					
13	Capacitance	[µF/km]	0.239	0.239	0.239
14	Inductance of Conductor	[mH/km]	0.82265	0.82265	0.82265
15	Reactance of Conductor	[Ω/km]	0.25844	0.25844	0.25844
16	Inductance of Metallic Sheath	[mH/km]	0.63738	0.63738	0.63738
17	Reactance of Metallic Sheath	[Ω/km]	0.20024	0.20024	0.20024
18	Positive Sequence Impedance	[Ω/km]	0.010100 + j0.258440	0.010180 + j0.258440	0.010100 + j0.258440
19	Negative Sequence Impedance	[Ω/km]	0.010100 + j0.258440	0.010180 + j0.258440	0.010100 + j0.258440
20	Zero Sequence Impedance	[Ω/km]	0.056640 + j0.200240	0.056630 + j0.200240	0.056640 + j0.200240
21	Surge Impedance	[Ω]	58.63321	58.63321	58.63321
Others					
22	Dielectric Stress at Conductor Surface	[kV/mm]	11.94851	11.94851	11.94851
23	Dielectric Stress at Insulation Surface	[kV/mm]	6.68715	6.68715	6.68715
24	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	16540.20553	16540.20553	16540.20553
25	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
26	Charging Current for One Phase	[A/km]	17.36102	17.36102	17.36102
27	Charging Capacity of three phase system at Uo	[kvar/km]	12028.06597	12028.06597	12028.06597
28	Voltage drop for Three Phase System	[V/A/km]	0.0175	0.01764	0.01749
29	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
30	Induced current on Metallic Screen	[A]	134.6	128.7	126.8

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE) - Summer (20C)
Date:	02/03/2020 16:02:32

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		400KV.011	400KV.011	400KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00909	0.00918	0.00909
4	dc	Conductor Diameter	[mm]	63.0	63.0	63.0
5	s	Distance Between Conductor Axes	[mm]	1500.0	1500.0	1500.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.19982	2.18875	2.20016
9	xp	Component of Yp Calculation (Proximity Effect)		1.6629	1.65454	1.66316
10	ys	Skin Effect Factor		0.11112	0.1091	0.11119
11	yp	Proximity Effect Factor		0.00026	0.00026	0.00026
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.0101	0.01018	0.0101
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[µF/km]	0.239	0.239	0.239
16	U_0	Voltage	[kV]	230.94011	230.94011	230.94011
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	4.00936	4.00936	4.00936
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.05824	0.05885	0.05822
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	123.9	123.9	123.9
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.20024	0.20024	0.20024
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.24379	0.24379	0.24379
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.18572	0.18572	0.18572
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.0229	0.021	0.02033
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.05824	0.05885	0.05822
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	123.9	123.9	123.9
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	125.4	125.4	125.4
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	1.5	1.5	1.5
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		107.74839	107.18805	107.76563
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00539	1.00536	1.00539
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.53942	0.53382	0.53959
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00058	0.00227	0.00058
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00497	0.00124	0.00395
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00003	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00365	0.01352	0.00369
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.02655	0.03453	0.02401
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.36997	0.36997	0.36997
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	29.7	29.7	29.7
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04684	0.04684	0.04684
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.5	5.5	5.5
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	60.8	63.9	60.7
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.22464	0.22049	0.22474
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.64876	0.69878	0.64926
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	1.0	1.0	1.0
64	y	Longer Side of the Duct Bank/Backfill	[m]	4.0	4.0	4.0
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	1.19983	1.19983	1.19983
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		0.80178	0.80178	0.80178
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.64876	0.69878	0.64926
72	T_4	Total External Thermal Resistance	[K.m/W]	0.90787	0.95374	0.90847
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2135.3	2135.3	2135.3

Study Summary

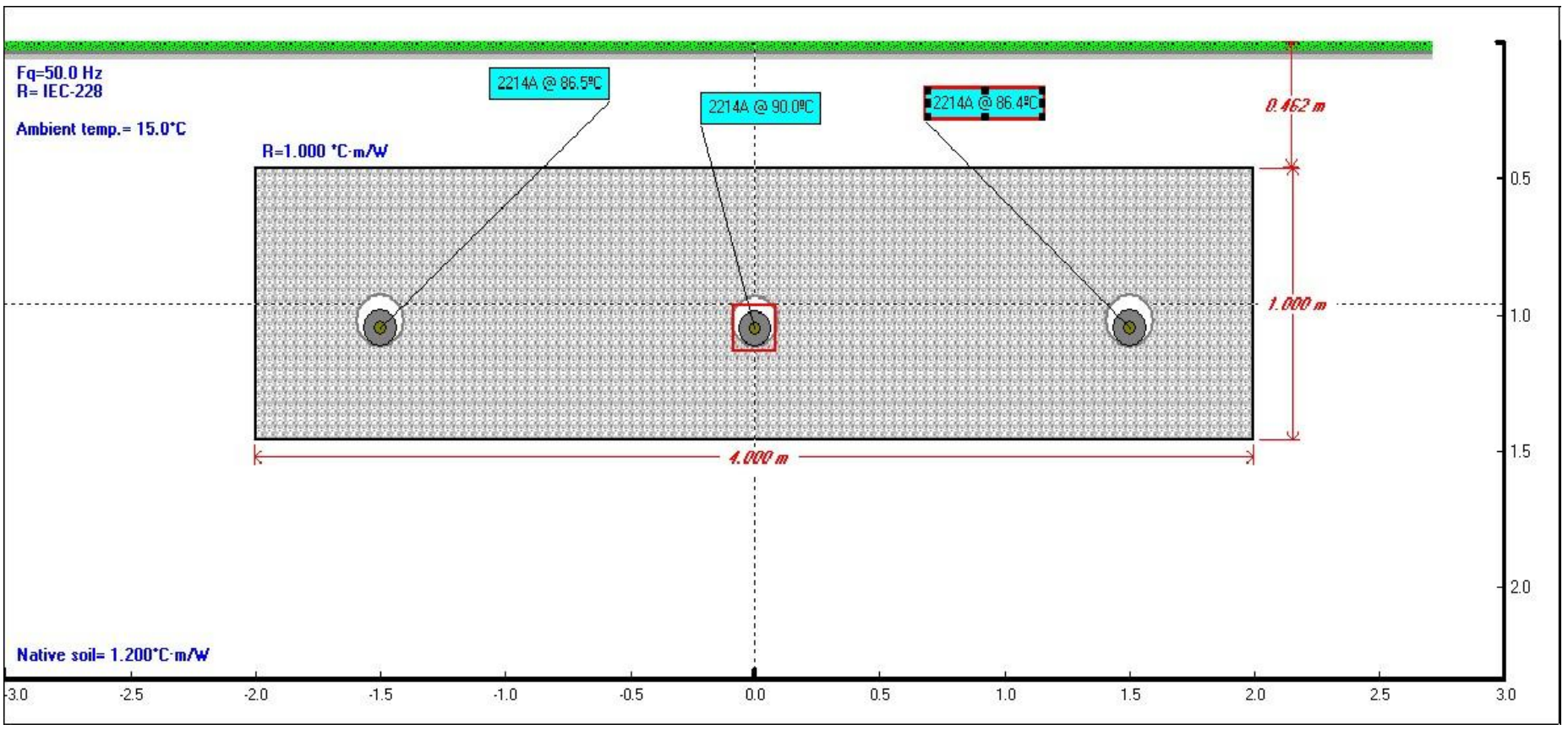
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE)
Date:	16/01/2020 13:56:02

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	15.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	1.0
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	4.0
Duct Bank Height	[m]	1.0



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	400KV.011	1		A	50.0	1.0	-1.5	1.05	86.5	2213.5
2	400KV.011	1		B	50.0	1.0	0.0	1.05	90.0	2213.5
3	400KV.011	1		C	50.0	1.0	1.5	1.05	86.4	2213.5

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE)
Date:	16/01/2020 13:56:02

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	15
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		400KV.011	400KV.011	400KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	-1.5	0.0	1.5
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2213.5	2213.5	2213.5
Temperatures					
θc	Conductor temperature	[°C]	86.5	90.0	86.4
θs	Sheath/Shield temperature	[°C]	67.5	70.8	67.4
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	64.9	68.2	64.8
θduct	Duct surface temperature	[°C]	50.5	53.9	50.5
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01009	0.01018	0.01009
ys	Skin Effect Factor		0.11128	0.1091	0.11134
yp	Proximity Effect Factor		0.00026	0.00026	0.00026
Losses					
Wc	Conductor Losses	[W/m]	49.4631	49.90372	49.44967
Wd	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
Ws	Metallic Screen Losses	[W/m]	1.30942	1.721	1.18454
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	54.78187	55.63408	54.64357
λ_1	Screen Loss Factor		0.02647	0.03449	0.02395
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.36997	0.36997	0.36997
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04684	0.04684	0.04684
T4	External thermal resistance	[K.m/W]	0.91089	0.95614	0.9115
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	139.5	133.5	131.5

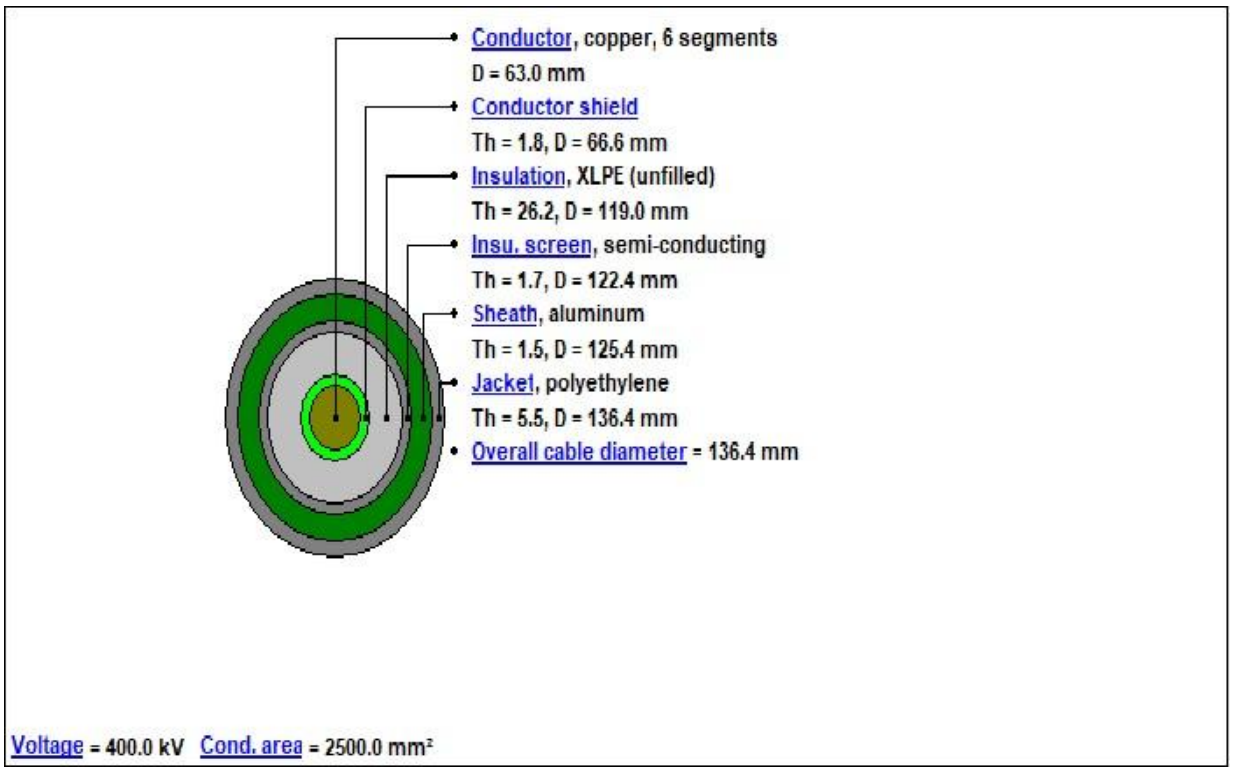
Cables Report

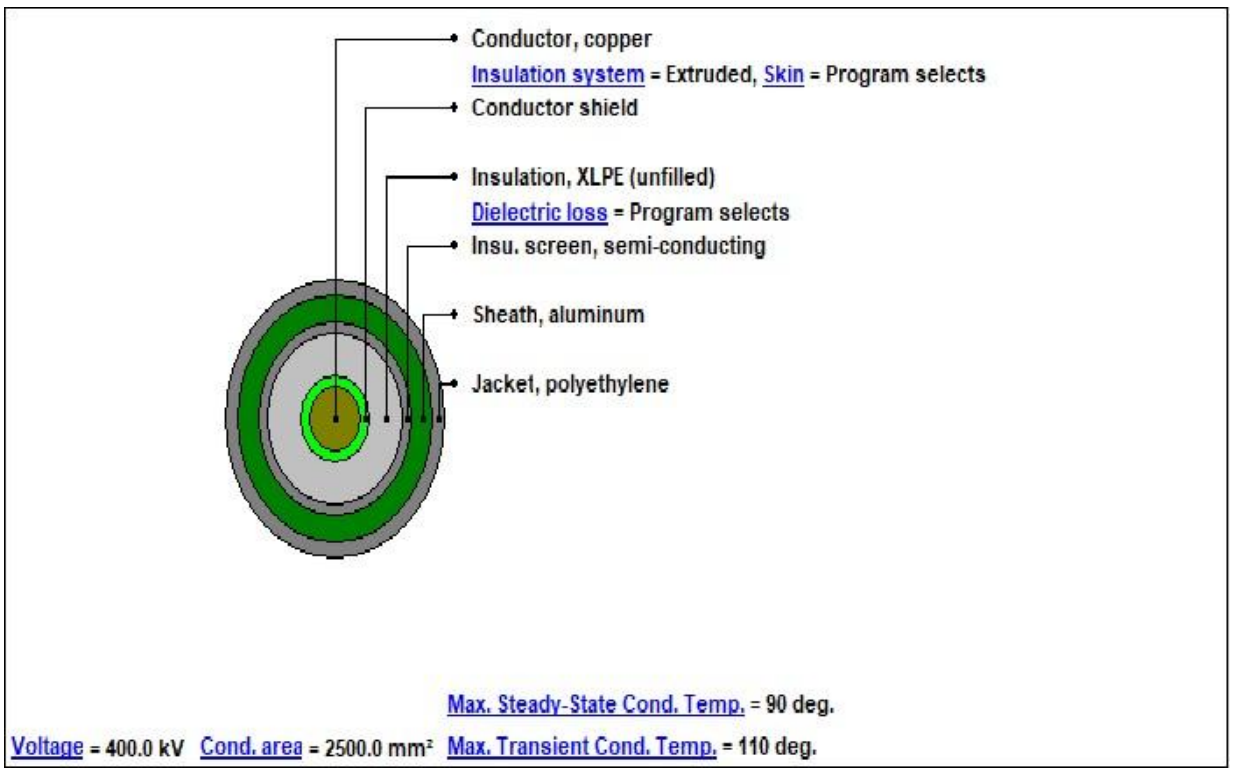
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE)
Date:	16/01/2020 13:56:02

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		400KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	400
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	136.4
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	63.0
Conductor Shield			
19	Thickness	[mm]	1.8
20	Diameter	[mm]	66.6
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	26.2
27	Diameter	[mm]	119.0
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.7
30	Diameter	[mm]	122.4
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Aluminum
33	Electrical Resistivity at 20°C	[µΩ.cm]	2.84
34	Temperature Coefficient at 20°C	[1/K]	0.00403
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	228
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	2.5
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	1.5
39	Diameter	[mm]	125.4
Jacket			
40	Material		Polyethylene
41	Thermal Resistivity	[K.m/W]	3.5
42	Thickness	[mm]	5.5
43	Diameter	[mm]	136.4

No.	Description	Unit	1
Specific Installation Data			
44	Cable Equipment ID		400KV.011
45	Cable Frequency	[Hz]	50
46	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
47	Loss Factor Constant (ALOS)		0.3
48	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
49	Duct construction		Polyethylene in Concrete
50	Duct material thermal resistivity	[K.m/W]	3.5
51	Inside Diameter of the Duct/Pipe	[mm]	188.0
52	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 400KV.011	
Cable Title	2500sqmm Cu (insulated wires)_XLPE_CAS_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE)
Date:	16/01/2020 13:56:02

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**400KV.011**	**400KV.011**	**400KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00908	0.00918	0.00908
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00841	0.00841	0.00841
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01009	0.01018	0.01009
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.04864	0.04864	0.04864
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.05795	0.0586	0.05793
Losses					
8	Conductor Losses	[W/m]	49.4631	49.90372	49.44967
9	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
10	Metallic Screen Losses	[W/m]	1.30942	1.721	1.18454
11	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
12	Total Losses	[W/m]	54.78187	55.63408	54.64357
Capacitance, Inductance, Impedance					
13	Capacitance	[µF/km]	0.239	0.239	0.239
14	Inductance of Conductor	[mH/km]	0.82265	0.82265	0.82265
15	Reactance of Conductor	[Ω/km]	0.25844	0.25844	0.25844
16	Inductance of Metallic Sheath	[mH/km]	0.63738	0.63738	0.63738
17	Reactance of Metallic Sheath	[Ω/km]	0.20024	0.20024	0.20024
18	Positive Sequence Impedance	[Ω/km]	0.010090 + j0.258440	0.010180 + j0.258440	0.010090 + j0.258440
19	Negative Sequence Impedance	[Ω/km]	0.010090 + j0.258440	0.010180 + j0.258440	0.010090 + j0.258440
20	Zero Sequence Impedance	[Ω/km]	0.056640 + j0.200240	0.056630 + j0.200240	0.056640 + j0.200240
21	Surge Impedance	[Ω]	58.63321	58.63321	58.63321
Others					
22	Dielectric Stress at Conductor Surface	[kV/mm]	11.94851	11.94851	11.94851
23	Dielectric Stress at Insulation Surface	[kV/mm]	6.68715	6.68715	6.68715
24	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	16540.20553	16540.20553	16540.20553
25	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
26	Charging Current for One Phase	[A/km]	17.36102	17.36102	17.36102
27	Charging Capacity of three phase system at Uo	[kvar/km]	12028.06597	12028.06597	12028.06597
28	Voltage drop for Three Phase System	[V/A/km]	0.01748	0.01764	0.01748
29	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
30	Induced current on Metallic Screen	[A]	139.5	133.5	131.5

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width trench (1ct 400kV CABLE)
Date:	16/01/2020 13:56:02

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		400KV.011	400KV.011	400KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00908	0.00918	0.00908
4	dc	Conductor Diameter	[mm]	63.0	63.0	63.0
5	s	Distance Between Conductor Axes	[mm]	1500.0	1500.0	1500.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.20064	2.18875	2.20101
9	xp	Component of Yp Calculation (Proximity Effect)		1.66353	1.65454	1.6638
10	ys	Skin Effect Factor		0.11128	0.1091	0.11134
11	yp	Proximity Effect Factor		0.00026	0.00026	0.00026
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01009	0.01018	0.01009
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[µF/km]	0.239	0.239	0.239
16	U_0	Voltage	[kV]	230.94011	230.94011	230.94011
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	4.00936	4.00936	4.00936
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.05795	0.0586	0.05793
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	123.9	123.9	123.9
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.20024	0.20024	0.20024
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.24379	0.24379	0.24379
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.18572	0.18572	0.18572
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.02281	0.02093	0.02026
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.05795	0.0586	0.05793
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	123.9	123.9	123.9
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	125.4	125.4	125.4
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	1.5	1.5	1.5
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		108.02153	107.41766	108.04011
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.0054	1.00537	1.0054
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.54215	0.53611	0.54234
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00058	0.00228	0.00058
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00494	0.00124	0.00396
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00003	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00367	0.01356	0.0037
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.02647	0.03449	0.02395
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.36997	0.36997	0.36997
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	29.7	29.7	29.7
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04684	0.04684	0.04684
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.5	5.5	5.5
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	58.7	62.0	58.6
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.22759	0.22304	0.2277
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.64883	0.69864	0.64933
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	1.0	1.0	1.0
64	y	Longer Side of the Duct Bank/Backfill	[m]	4.0	4.0	4.0
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	1.19983	1.19983	1.19983
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		0.80178	0.80178	0.80178
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.64883	0.69864	0.64933
72	T_4	Total External Thermal Resistance	[K.m/W]	0.91089	0.95614	0.9115
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2213.5	2213.5	2213.5

Study Summary

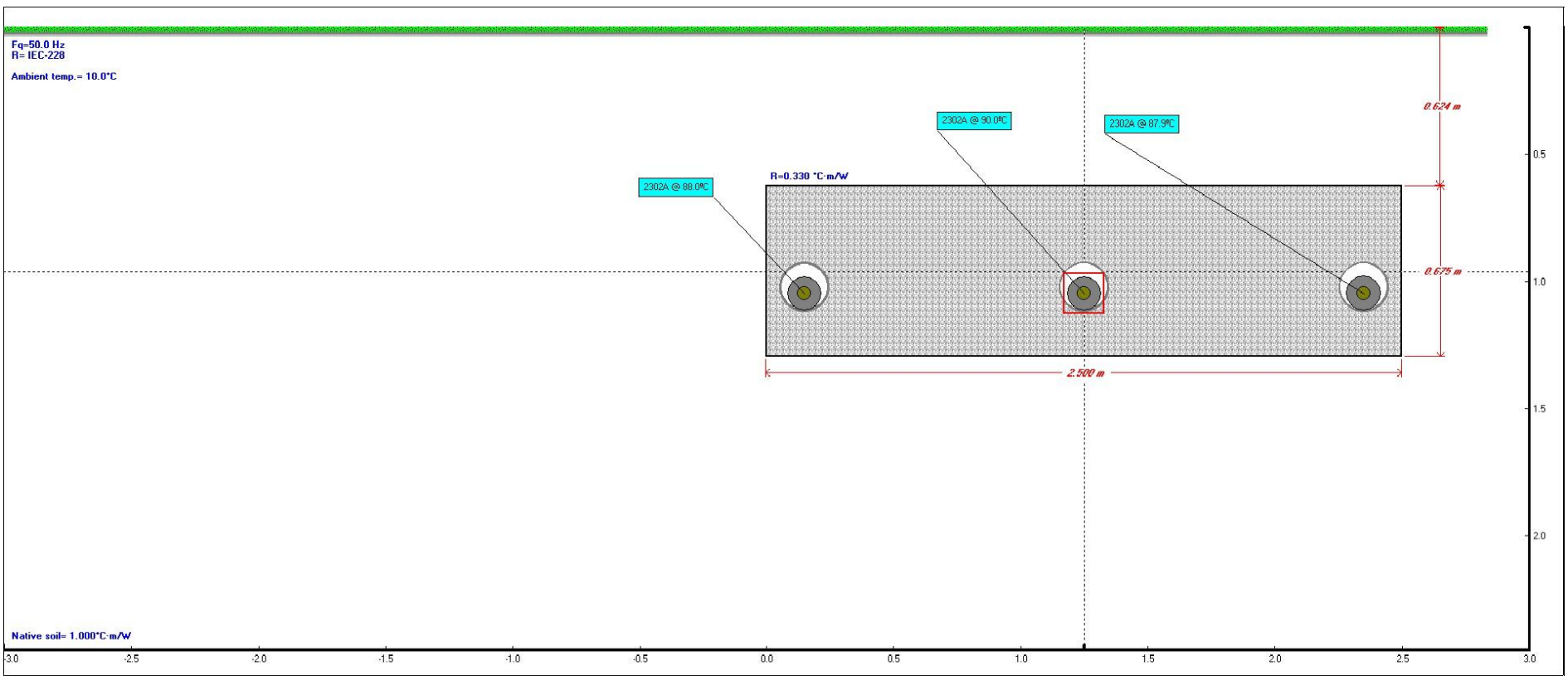
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2
Date:	18/03/2020 11:18:58

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	10.0
Native Soil Thermal Resistivity	[K.m/W]	1.0
Thermal Resistivity of Duct Bank	[K.m/W]	0.3
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	2.5
Duct Bank Height	[m]	0.68



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	400KV.010	1		A	50.0	1.0	0.15	1.05	88.0	2302.2
2	400KV.010	1		B	50.0	1.0	1.25	1.05	90.0	2302.2
3	400KV.010	1		C	50.0	1.0	2.35	1.05	87.9	2302.2

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2
Date:	18/03/2020 11:18:58

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	10
Native Soil Thermal Resistivity [K.m/W]	1.0
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		400KV.010	400KV.010	400KV.010
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	0.15	1.25	2.35
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2302.2	2302.2	2302.2
Temperatures					
θc	Conductor temperature	[°C]	88.0	90.0	87.9
θs	Sheath/Shield temperature	[°C]	64.1	66.0	64.0
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	60.9	62.8	60.9
θduct	Duct surface temperature	[°C]	42.5	44.2	42.5
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01181	0.01186	0.01181
ys	Skin Effect Factor		0.29301	0.29022	0.29312
yp	Proximity Effect Factor		0.00121	0.0012	0.00121
Losses					
Wc	Conductor Losses	[W/m]	62.58874	62.839	62.57941
Wd	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
Ws	Metallic Screen Losses	[W/m]	1.55628	2.44998	1.40382
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	68.15438	69.29833	67.99259
λ_1	Screen Loss Factor		0.02487	0.03899	0.02243
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.36997	0.36997	0.36997
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04684	0.04684	0.04684
T4	External thermal resistance	[K.m/W]	0.74712	0.76143	0.74799
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	145.0	137.6	135.2

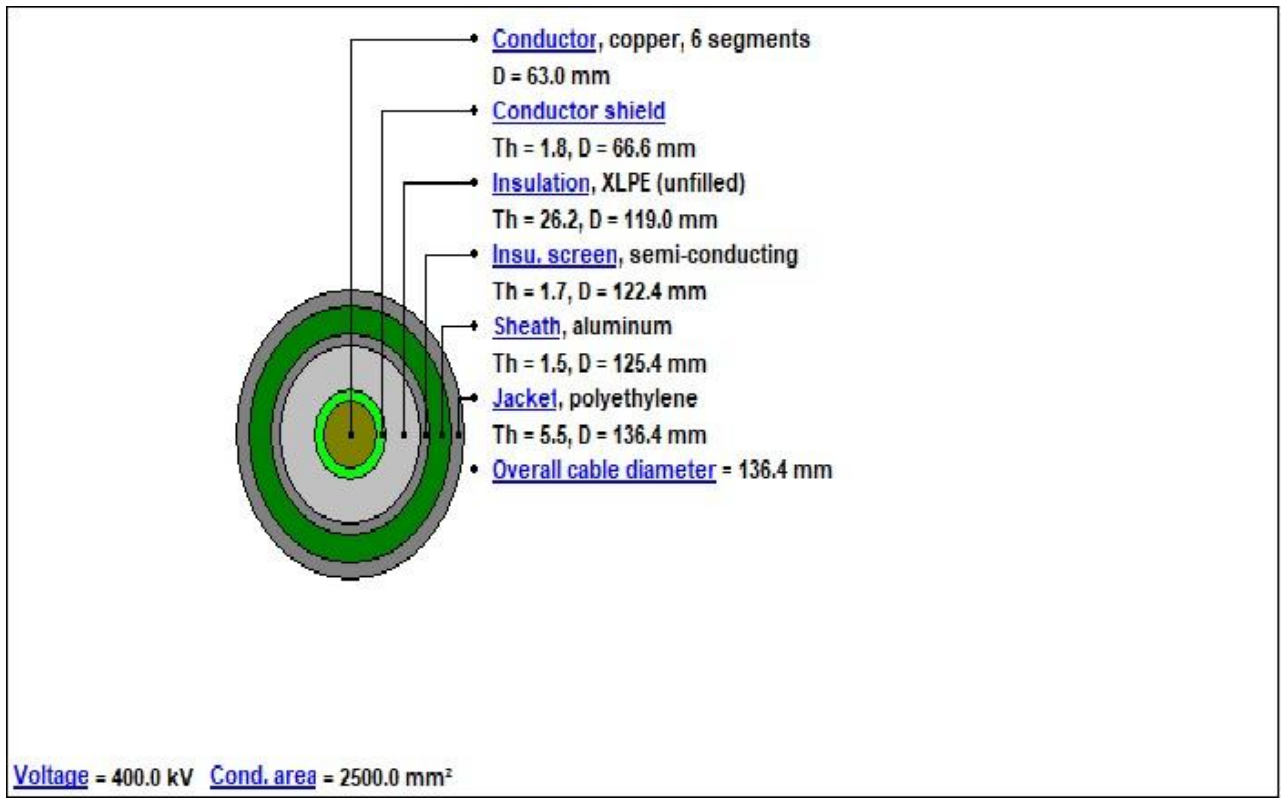
Cables Report

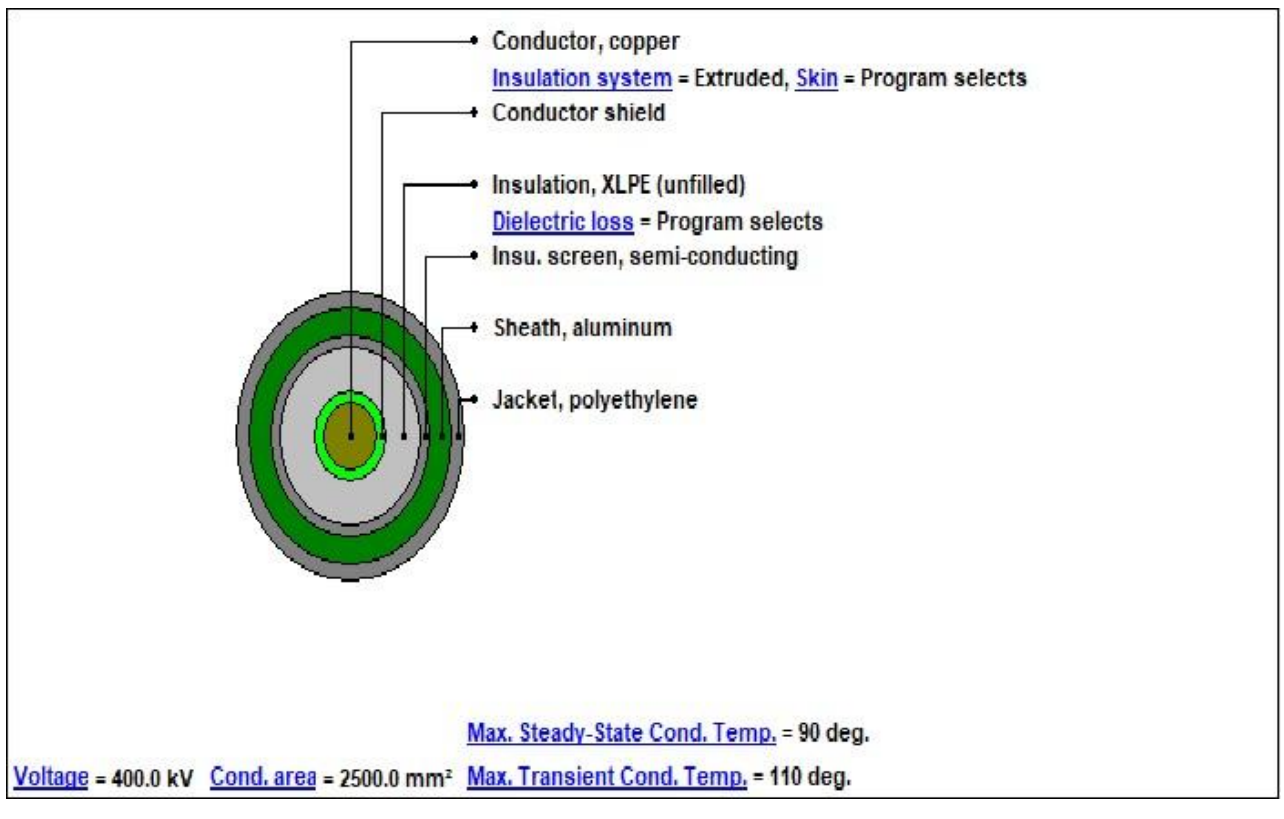
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2
Date:	18/03/2020 11:18:58

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		400KV.010
2	Number of Cores		Single Core
3	Voltage	[kV]	400
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	136.4
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Bare Unidirectional Wires
16	Ks (Skin Effect Coefficient)		0.62
17	Kp (Proximity Effect Coefficient)		0.37
18	Diameter	[mm]	63.0
Conductor Shield			
19	Thickness	[mm]	1.8
20	Diameter	[mm]	66.6
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	26.2
27	Diameter	[mm]	119.0
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.7
30	Diameter	[mm]	122.4
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Aluminum
33	Electrical Resistivity at 20°C	[µΩ.cm]	2.84
34	Temperature Coefficient at 20°C	[1/K]	0.00403
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	228
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	2.5
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	1.5
39	Diameter	[mm]	125.4
Jacket			
40	Material		Polyethylene
41	Thermal Resistivity	[K.m/W]	3.5
42	Thickness	[mm]	5.5
43	Diameter	[mm]	136.4

No.	Description	Unit	1
Specific Installation Data			
44	Cable Equipment ID		400KV.010
45	Cable Frequency	[Hz]	50
46	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
47	Loss Factor Constant (ALOS)		0.3
48	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
49	Duct construction		Polyethylene in Concrete
50	Duct material thermal resistivity	[K.m/W]	3.5
51	Inside Diameter of the Duct/Pipe	[mm]	188.0
52	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 400KV.010	
Cable Title	2500sqmm Cu_XLPE_CAS_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2
Date:	18/03/2020 11:18:58

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**400KV.010**	**400KV.010**	**400KV.010**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00912	0.00918	0.00912
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.0102	0.0102	0.0102
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01181	0.01186	0.01181
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.04864	0.04864	0.04864
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.05729	0.05766	0.05727
Losses					
8	Conductor Losses	[W/m]	62.58874	62.839	62.57941
9	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
10	Metallic Screen Losses	[W/m]	1.55628	2.44998	1.40382
11	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
12	Total Losses	[W/m]	68.15438	69.29833	67.99259
Capacitance, Inductance, Impedance					
13	Capacitance	[µF/km]	0.239	0.239	0.239
14	Inductance of Conductor	[mH/km]	0.76062	0.76062	0.76062
15	Reactance of Conductor	[Ω/km]	0.23895	0.23895	0.23895
16	Inductance of Metallic Sheath	[mH/km]	0.57535	0.57535	0.57535
17	Reactance of Metallic Sheath	[Ω/km]	0.18075	0.18075	0.18075
18	Positive Sequence Impedance	[Ω/km]	0.011810 + j0.238950	0.011860 + j0.238950	0.011810 + j0.238950
19	Negative Sequence Impedance	[Ω/km]	0.011810 + j0.238950	0.011860 + j0.238950	0.011810 + j0.238950
20	Zero Sequence Impedance	[Ω/km]	0.057950 + j0.180750	0.057930 + j0.180750	0.057950 + j0.180750
21	Surge Impedance	[Ω]	56.37929	56.37929	56.37929
Others					
22	Dielectric Stress at Conductor Surface	[kV/mm]	11.94851	11.94851	11.94851
23	Dielectric Stress at Insulation Surface	[kV/mm]	6.68715	6.68715	6.68715
24	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	16540.20553	16540.20553	16540.20553
25	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
26	Charging Current for One Phase	[A/km]	17.36102	17.36102	17.36102
27	Charging Capacity of three phase system at Uo	[kvar/km]	12028.06597	12028.06597	12028.06597
28	Voltage drop for Three Phase System	[V/A/km]	0.02045	0.02054	0.02045
29	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
30	Induced current on Metallic Screen	[A]	145.0	137.6	135.2

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2
Date:	18/03/2020 11:18:58

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		400KV.010	400KV.010	400KV.010
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00912	0.00918	0.00912
4	dc	Conductor Diameter	[mm]	63.0	63.0	63.0
5	s	Distance Between Conductor Axes	[mm]	1099.99995	1099.99995	1099.99995
6	ks	Factor Used for xs Calculation (Skin Effect)		0.62	0.62	0.62
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.37	0.37	0.37
8	xs	Component of Ys Calculation (Skin Effect)		2.92212	2.91314	2.92246
9	xp	Component of Yp Calculation (Proximity Effect)		2.25737	2.25043	2.25763
10	ys	Skin Effect Factor		0.29301	0.29022	0.29312
11	yp	Proximity Effect Factor		0.00121	0.0012	0.00121
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01181	0.01186	0.01181
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[μF/km]	0.239	0.239	0.239
16	U_0	Voltage	[kV]	230.94011	230.94011	230.94011
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	4.00936	4.00936	4.00936
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.05729	0.05766	0.05727
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	123.9	123.9	123.9
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.18075	0.18075	0.18075
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.2243	0.2243	0.2243
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.16623	0.16623	0.16623
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.01926	0.01736	0.01674
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.05729	0.05766	0.05727
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	123.9	123.9	123.9
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	125.4	125.4	125.4
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	1.5	1.5	1.5
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		108.63994	108.28869	108.6531
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00544	1.00542	1.00544
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.54838	0.54484	0.54851
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0011	0.00436	0.0011
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00788	0.00197	0.00761
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00007	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00561	0.02162	0.00569
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.02487	0.03899	0.02243
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.36997	0.36997	0.36997
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	29.7	29.7	29.7
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04684	0.04684	0.04684
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.5	5.5	5.5
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	52.9	54.7	52.8
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.23598	0.2333	0.23605
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.47667	0.49366	0.47747
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.675	0.675	0.675
64	y	Longer Side of the Duct Bank/Backfill	[m]	2.5	2.5	2.5
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	0.85977	0.85977	0.85977
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		1.1189	1.1189	1.1189
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	0.33	0.33	0.33
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.47667	0.49366	0.47747
72	T_4	Total External Thermal Resistance	[K.m/W]	0.74712	0.76143	0.74799
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2302.2	2302.2	2302.2

Study Summary

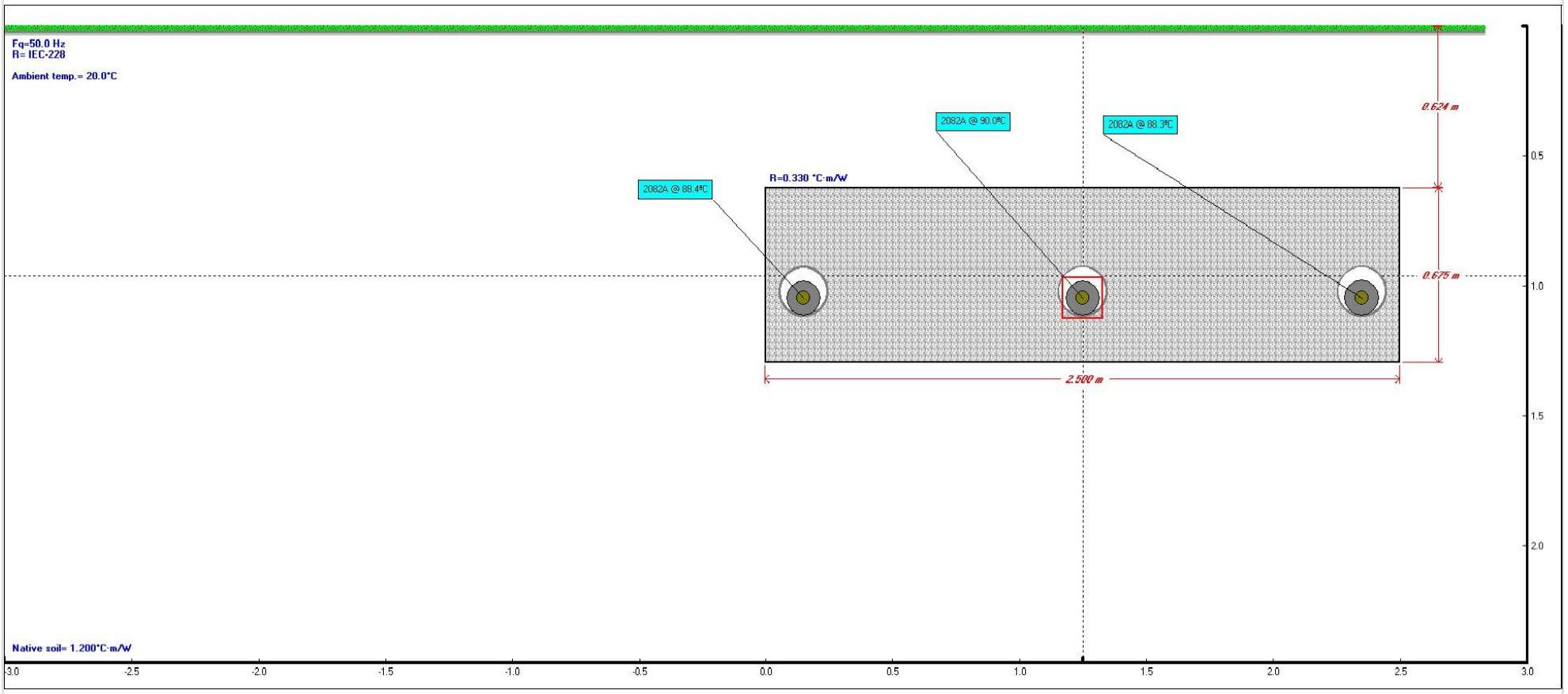
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:44:49

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	20.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	0.3
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	2.5
Duct Bank Height	[m]	0.68



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	400KV.010	1		A	50.0	1.0	0.15	1.05	88.4	2081.8
2	400KV.010	1		B	50.0	1.0	1.25	1.05	90.0	2081.8
3	400KV.010	1		C	50.0	1.0	2.35	1.05	88.3	2081.8

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:44:49

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	20
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		400KV.010	400KV.010	400KV.010
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	0.15	1.25	2.35
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2081.8	2081.8	2081.8
Temperatures					
θc	Conductor temperature	[°C]	88.4	90.0	88.3
θs	Sheath/Shield temperature	[°C]	68.7	70.3	68.6
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	66.0	67.6	66.0
θduct	Duct surface temperature	[°C]	51.3	52.7	51.3
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01182	0.01186	0.01182
ys	Skin Effect Factor		0.29252	0.29022	0.2926
yp	Proximity Effect Factor		0.0012	0.0012	0.0012
Losses					
Wc	Conductor Losses	[W/m]	51.21418	51.38255	51.20791
Wd	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
Ws	Metallic Screen Losses	[W/m]	1.28394	2.00453	1.15592
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	56.50747	57.39643	56.37319
λ_1	Screen Loss Factor		0.02507	0.03901	0.02257
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.36997	0.36997	0.36997
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04684	0.04684	0.04684
T4	External thermal resistance	[K.m/W]	0.81452	0.82865	0.81555
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	131.1	124.2	122.1

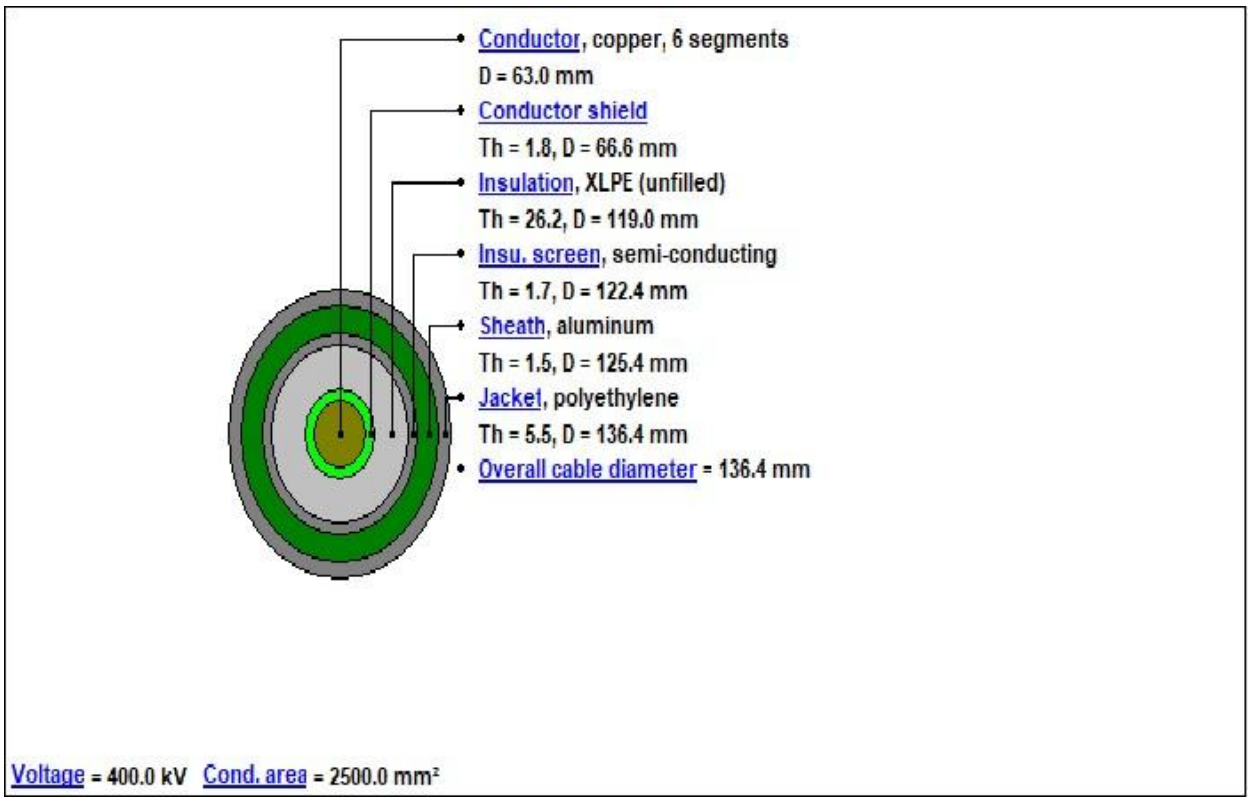
Cables Report

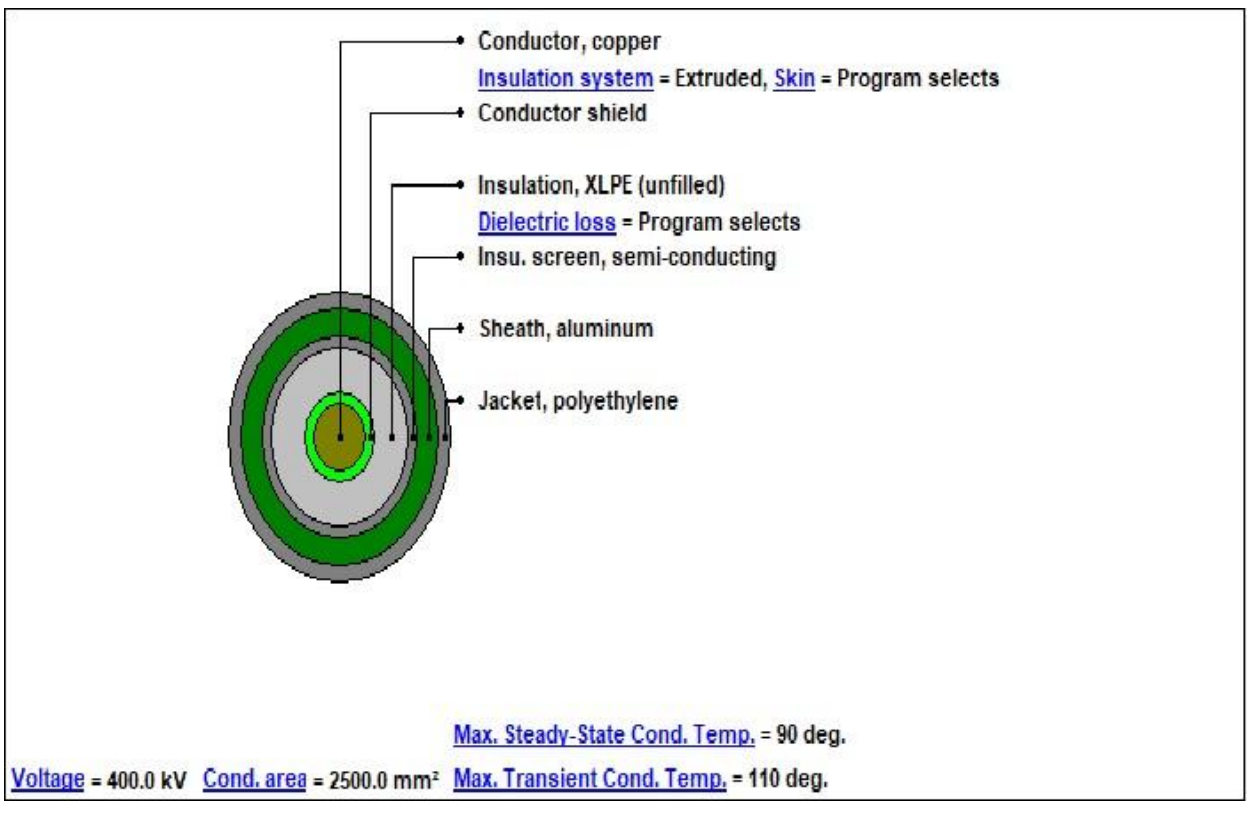
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:44:49

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		400KV.010
2	Number of Cores		Single Core
3	Voltage	[kV]	400
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	136.4
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Bare Unidirectional Wires
16	Ks (Skin Effect Coefficient)		0.62
17	Kp (Proximity Effect Coefficient)		0.37
18	Diameter	[mm]	63.0
Conductor Shield			
19	Thickness	[mm]	1.8
20	Diameter	[mm]	66.6
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	26.2
27	Diameter	[mm]	119.0
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.7
30	Diameter	[mm]	122.4
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Aluminum
33	Electrical Resistivity at 20°C	[µΩ.cm]	2.84
34	Temperature Coefficient at 20°C	[1/K]	0.00403
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	228
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	2.5
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	1.5
39	Diameter	[mm]	125.4
Jacket			
40	Material		Polyethylene
41	Thermal Resistivity	[K.m/W]	3.5
42	Thickness	[mm]	5.5
43	Diameter	[mm]	136.4

No.	Description	Unit	1
Specific Installation Data			
44	Cable Equipment ID		400KV.010
45	Cable Frequency	[Hz]	50
46	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
47	Loss Factor Constant (ALOS)		0.3
48	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
49	Duct construction		Polyethylene in Concrete
50	Duct material thermal resistivity	[K.m/W]	3.5
51	Inside Diameter of the Duct/Pipe	[mm]	188.0
52	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 400KV.010	
Cable Title	2500sqmm Cu_XLPE_CAS_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:44:49

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**400KV.010**	**400KV.010**	**400KV.010**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00913	0.00918	0.00913
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.0102	0.0102	0.0102
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01182	0.01186	0.01182
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.04864	0.04864	0.04864
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.05818	0.05849	0.05817
Losses					
8	Conductor Losses	[W/m]	51.21418	51.38255	51.20791
9	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
10	Metallic Screen Losses	[W/m]	1.28394	2.00453	1.15592
11	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
12	Total Losses	[W/m]	56.50747	57.39643	56.37319
Capacitance, Inductance, Impedance					
13	Capacitance	[µF/km]	0.239	0.239	0.239
14	Inductance of Conductor	[mH/km]	0.76062	0.76062	0.76062
15	Reactance of Conductor	[Ω/km]	0.23895	0.23895	0.23895
16	Inductance of Metallic Sheath	[mH/km]	0.57535	0.57535	0.57535
17	Reactance of Metallic Sheath	[Ω/km]	0.18075	0.18075	0.18075
18	Positive Sequence Impedance	[Ω/km]	0.011820 + j0.238950	0.011860 + j0.238950	0.011820 + j0.238950
19	Negative Sequence Impedance	[Ω/km]	0.011820 + j0.238950	0.011860 + j0.238950	0.011820 + j0.238950
20	Zero Sequence Impedance	[Ω/km]	0.057950 + j0.180750	0.057930 + j0.180750	0.057950 + j0.180750
21	Surge Impedance	[Ω]	56.37929	56.37929	56.37929
Others					
22	Dielectric Stress at Conductor Surface	[kV/mm]	11.94851	11.94851	11.94851
23	Dielectric Stress at Insulation Surface	[kV/mm]	6.68715	6.68715	6.68715
24	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	16540.20553	16540.20553	16540.20553
25	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
26	Charging Current for One Phase	[A/km]	17.36102	17.36102	17.36102
27	Charging Capacity of three phase system at Uo	[kvar/km]	12028.06597	12028.06597	12028.06597
28	Voltage drop for Three Phase System	[V/A/km]	0.02047	0.02054	0.02047
29	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
30	Induced current on Metallic Screen	[A]	131.1	124.2	122.1

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:44:49

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		400KV.010	400KV.010	400KV.010
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00913	0.00918	0.00913
4	dc	Conductor Diameter	[mm]	63.0	63.0	63.0
5	s	Distance Between Conductor Axes	[mm]	1099.99995	1099.99995	1099.99995
6	ks	Factor Used for xs Calculation (Skin Effect)		0.62	0.62	0.62
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.37	0.37	0.37
8	xs	Component of Ys Calculation (Skin Effect)		2.92052	2.91314	2.9208
9	xp	Component of Yp Calculation (Proximity Effect)		2.25614	2.25043	2.25635
10	ys	Skin Effect Factor		0.29252	0.29022	0.2926
11	yp	Proximity Effect Factor		0.0012	0.0012	0.0012
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01182	0.01186	0.01182
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[µF/km]	0.239	0.239	0.239
16	U_0	Voltage	[kV]	230.94011	230.94011	230.94011
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	4.00936	4.00936	4.00936
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.05818	0.05849	0.05817
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	123.9	123.9	123.9
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.18075	0.18075	0.18075
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.2243	0.2243	0.2243
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.16623	0.16623	0.16623
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.01952	0.01756	0.01693
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.05818	0.05849	0.05817
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	123.9	123.9	123.9
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	125.4	125.4	125.4
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	1.5	1.5	1.5
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		107.80196	107.51684	107.81262
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00539	1.00537	1.00539
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.53995	0.5371	0.54006
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00107	0.00426	0.00107
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.008	0.00195	0.00755
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00006	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00555	0.02145	0.00564
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.02507	0.03901	0.02257
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.36997	0.36997	0.36997
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	29.7	29.7	29.7
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04684	0.04684	0.04684
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.5	5.5	5.5
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	59.6	61.1	59.6
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.22625	0.2242	0.2263
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.5538	0.56998	0.55478
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.675	0.675	0.675
64	y	Longer Side of the Duct Bank/Backfill	[m]	2.5	2.5	2.5
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	0.85977	0.85977	0.85977
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		1.1189	1.1189	1.1189
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	0.33	0.33	0.33
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.5538	0.56998	0.55478
72	T_4	Total External Thermal Resistance	[K.m/W]	0.81452	0.82865	0.81555
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2081.8	2081.8	2081.8

Study Summary

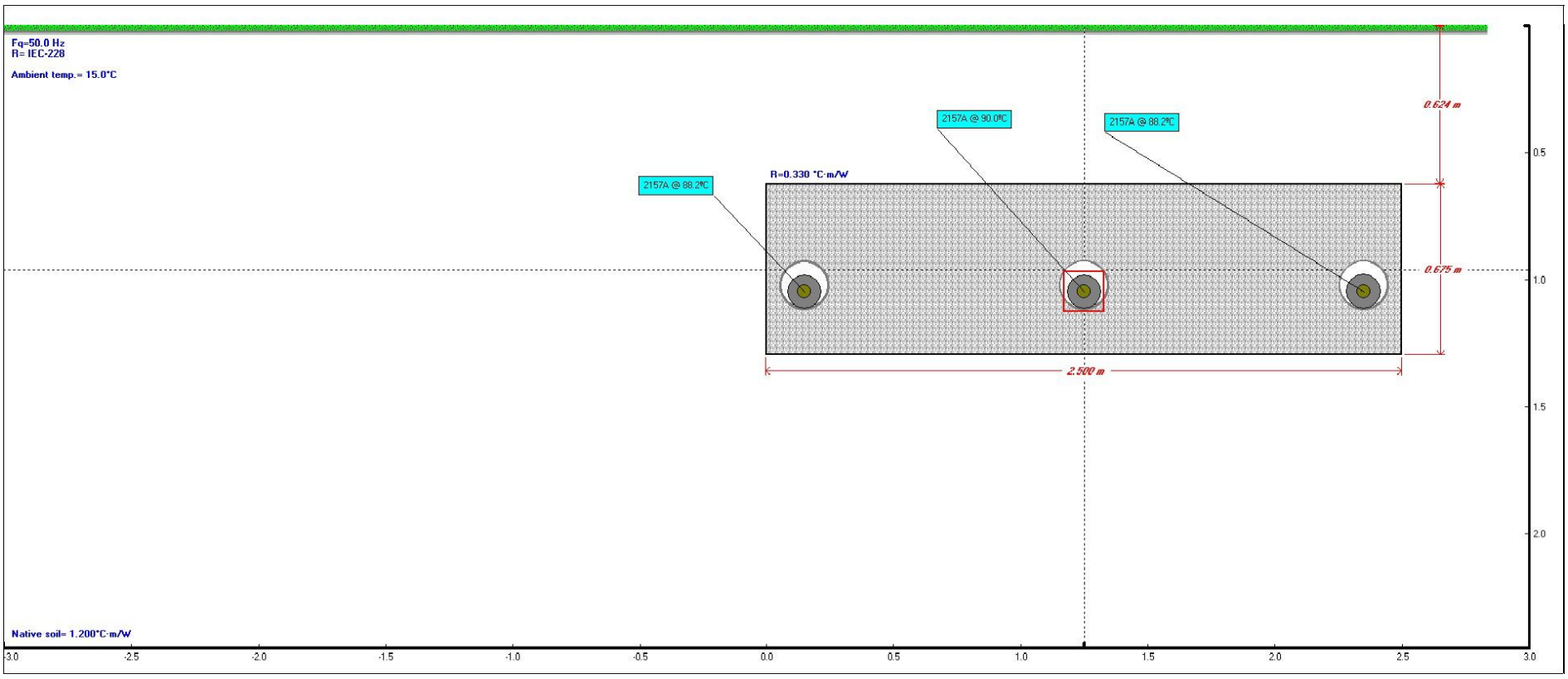
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2
Date:	17/01/2020 16:13:45

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	15.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	0.3
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	2.5
Duct Bank Height	[m]	0.68



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	400KV.010	1		A	50.0	1.0	0.15	1.05	88.2	2156.9
2	400KV.010	1		B	50.0	1.0	1.25	1.05	90.0	2156.9
3	400KV.010	1		C	50.0	1.0	2.35	1.05	88.2	2156.9

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2
Date:	17/01/2020 16:13:45

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	15
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		400KV.010	400KV.010	400KV.010
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	0.15	1.25	2.35
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2156.9	2156.9	2156.9
Temperatures					
θc	Conductor temperature	[°C]	88.2	90.0	88.2
θs	Sheath/Shield temperature	[°C]	67.2	68.9	67.1
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	64.3	66.0	64.3
θduct	Duct surface temperature	[°C]	48.4	49.9	48.4
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01181	0.01186	0.01181
ys	Skin Effect Factor		0.29268	0.29022	0.29277
yp	Proximity Effect Factor		0.0012	0.0012	0.0012
Losses					
Wc	Conductor Losses	[W/m]	54.96289	55.15645	54.95568
Wd	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
Ws	Metallic Screen Losses	[W/m]	1.37422	2.15133	1.23799
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	60.34647	61.31714	60.20302
λ_1	Screen Loss Factor		0.025	0.039	0.02253
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.36997	0.36997	0.36997
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04684	0.04684	0.04684
T4	External thermal resistance	[K.m/W]	0.81766	0.83144	0.8187
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	135.8	128.7	126.6

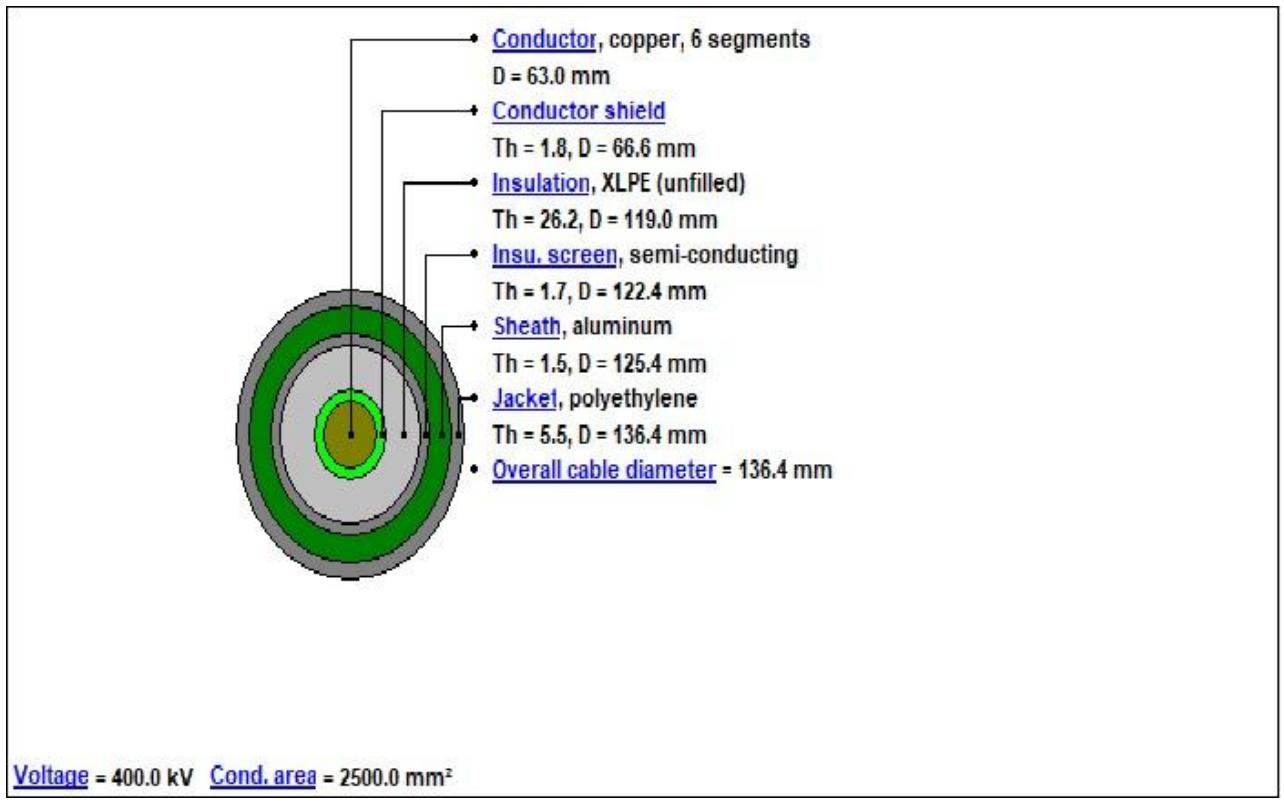
Cables Report

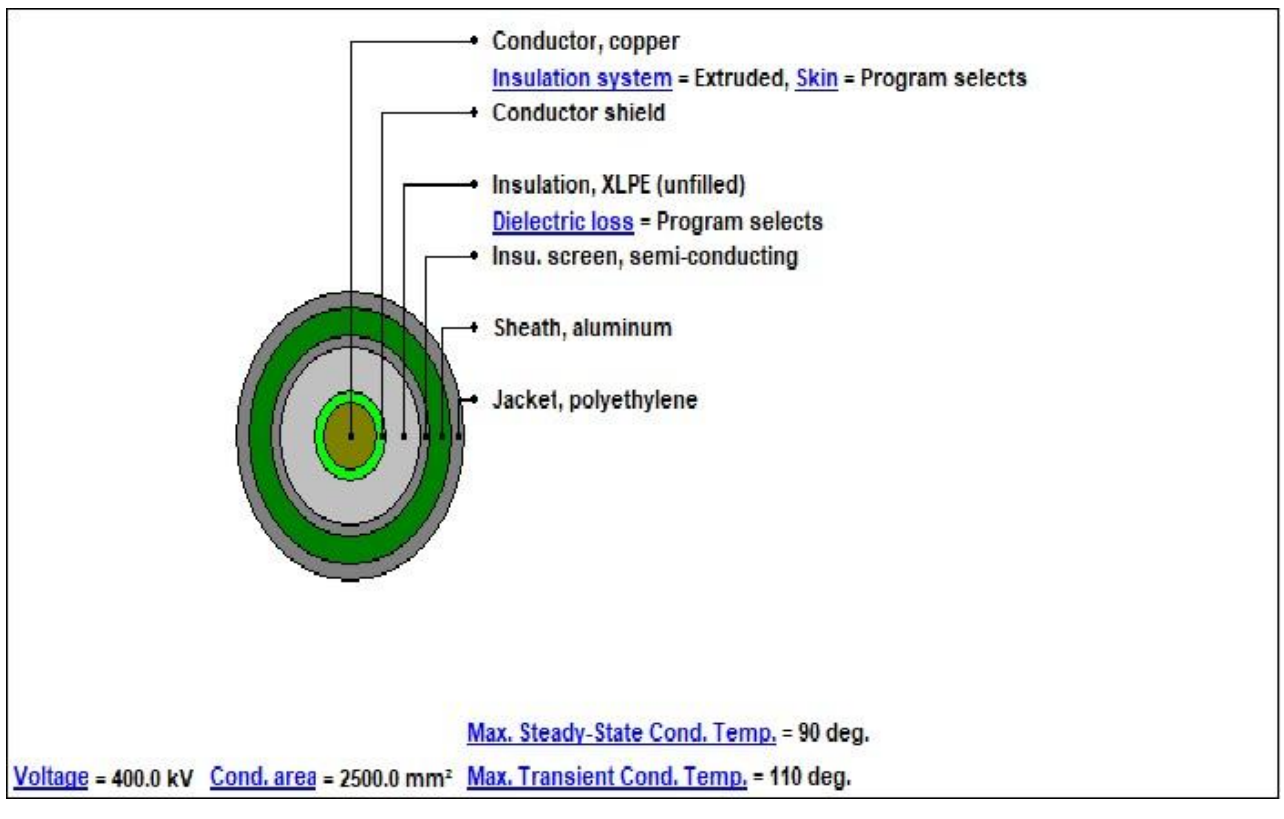
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2
Date:	17/01/2020 16:13:45

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		400KV.010
2	Number of Cores		Single Core
3	Voltage	[kV]	400
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	136.4
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Bare Unidirectional Wires
16	Ks (Skin Effect Coefficient)		0.62
17	Kp (Proximity Effect Coefficient)		0.37
18	Diameter	[mm]	63.0
Conductor Shield			
19	Thickness	[mm]	1.8
20	Diameter	[mm]	66.6
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	26.2
27	Diameter	[mm]	119.0
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.7
30	Diameter	[mm]	122.4
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Aluminum
33	Electrical Resistivity at 20°C	[µΩ.cm]	2.84
34	Temperature Coefficient at 20°C	[1/K]	0.00403
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	228
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	2.5
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	1.5
39	Diameter	[mm]	125.4
Jacket			
40	Material		Polyethylene
41	Thermal Resistivity	[K.m/W]	3.5
42	Thickness	[mm]	5.5
43	Diameter	[mm]	136.4

No.	Description	Unit	1
Specific Installation Data			
44	Cable Equipment ID		400KV.010
45	Cable Frequency	[Hz]	50
46	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
47	Loss Factor Constant (ALOS)		0.3
48	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
49	Duct construction		Polyethylene in Concrete
50	Duct material thermal resistivity	[K.m/W]	3.5
51	Inside Diameter of the Duct/Pipe	[mm]	188.0
52	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 400KV.010	
Cable Title	2500sqmm Cu_XLPE_CAS_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2
Date:	17/01/2020 16:13:45

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**400KV.010**	**400KV.010**	**400KV.010**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00913	0.00918	0.00913
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.0102	0.0102	0.0102
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01181	0.01186	0.01181
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.04864	0.04864	0.04864
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.05789	0.05822	0.05788
Losses					
8	Conductor Losses	[W/m]	54.96289	55.15645	54.95568
9	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
10	Metallic Screen Losses	[W/m]	1.37422	2.15133	1.23799
11	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
12	Total Losses	[W/m]	60.34647	61.31714	60.20302
Capacitance, Inductance, Impedance					
13	Capacitance	[µF/km]	0.239	0.239	0.239
14	Inductance of Conductor	[mH/km]	0.76062	0.76062	0.76062
15	Reactance of Conductor	[Ω/km]	0.23895	0.23895	0.23895
16	Inductance of Metallic Sheath	[mH/km]	0.57535	0.57535	0.57535
17	Reactance of Metallic Sheath	[Ω/km]	0.18075	0.18075	0.18075
18	Positive Sequence Impedance	[Ω/km]	0.011810 + j0.238950	0.011860 + j0.238950	0.011810 + j0.238950
19	Negative Sequence Impedance	[Ω/km]	0.011810 + j0.238950	0.011860 + j0.238950	0.011810 + j0.238950
20	Zero Sequence Impedance	[Ω/km]	0.057950 + j0.180750	0.057930 + j0.180750	0.057950 + j0.180750
21	Surge Impedance	[Ω]	56.37929	56.37929	56.37929
Others					
22	Dielectric Stress at Conductor Surface	[kV/mm]	11.94851	11.94851	11.94851
23	Dielectric Stress at Insulation Surface	[kV/mm]	6.68715	6.68715	6.68715
24	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	16540.20553	16540.20553	16540.20553
25	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
26	Charging Current for One Phase	[A/km]	17.36102	17.36102	17.36102
27	Charging Capacity of three phase system at Uo	[kvar/km]	12028.06597	12028.06597	12028.06597
28	Voltage drop for Three Phase System	[V/A/km]	0.02046	0.02054	0.02046
29	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
30	Induced current on Metallic Screen	[A]	135.8	128.7	126.6

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 400kV CABLE) v2
Date:	17/01/2020 16:13:45

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		400KV.010	400KV.010	400KV.010
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00913	0.00918	0.00913
4	dc	Conductor Diameter	[mm]	63.0	63.0	63.0
5	s	Distance Between Conductor Axes	[mm]	1099.99995	1099.99995	1099.99995
6	ks	Factor Used for xs Calculation (Skin Effect)		0.62	0.62	0.62
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.37	0.37	0.37
8	xs	Component of Ys Calculation (Skin Effect)		2.92105	2.91314	2.92135
9	xp	Component of Yp Calculation (Proximity Effect)		2.25654	2.25043	2.25677
10	ys	Skin Effect Factor		0.29268	0.29022	0.29277
11	yp	Proximity Effect Factor		0.0012	0.0012	0.0012
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01181	0.01186	0.01181
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[μF/km]	0.239	0.239	0.239
16	U_0	Voltage	[kV]	230.94011	230.94011	230.94011
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	4.00936	4.00936	4.00936
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.05789	0.05822	0.05788
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	123.9	123.9	123.9
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.18075	0.18075	0.18075
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.2243	0.2243	0.2243
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.16623	0.16623	0.16623
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.01943	0.0175	0.01687
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.05789	0.05822	0.05788
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	123.9	123.9	123.9
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	125.4	125.4	125.4
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	1.5	1.5	1.5
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		108.07598	107.76927	108.08747
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00541	1.00539	1.00541
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.5427	0.53963	0.54282
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00108	0.00429	0.00108
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00796	0.00195	0.00757
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00006	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00557	0.02151	0.00566
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.025	0.039	0.02253
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.36997	0.36997	0.36997
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	29.7	29.7	29.7
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04684	0.04684	0.04684
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.5	5.5	5.5
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	57.4	59.0	57.4
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.22934	0.2271	0.2294
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.55386	0.56987	0.55484
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.675	0.675	0.675
64	y	Longer Side of the Duct Bank/Backfill	[m]	2.5	2.5	2.5
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	0.85977	0.85977	0.85977
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		1.1189	1.1189	1.1189
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	0.33	0.33	0.33
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.55386	0.56987	0.55484
72	T_4	Total External Thermal Resistance	[K.m/W]	0.81766	0.83144	0.8187
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2156.9	2156.9	2156.9

Study Summary

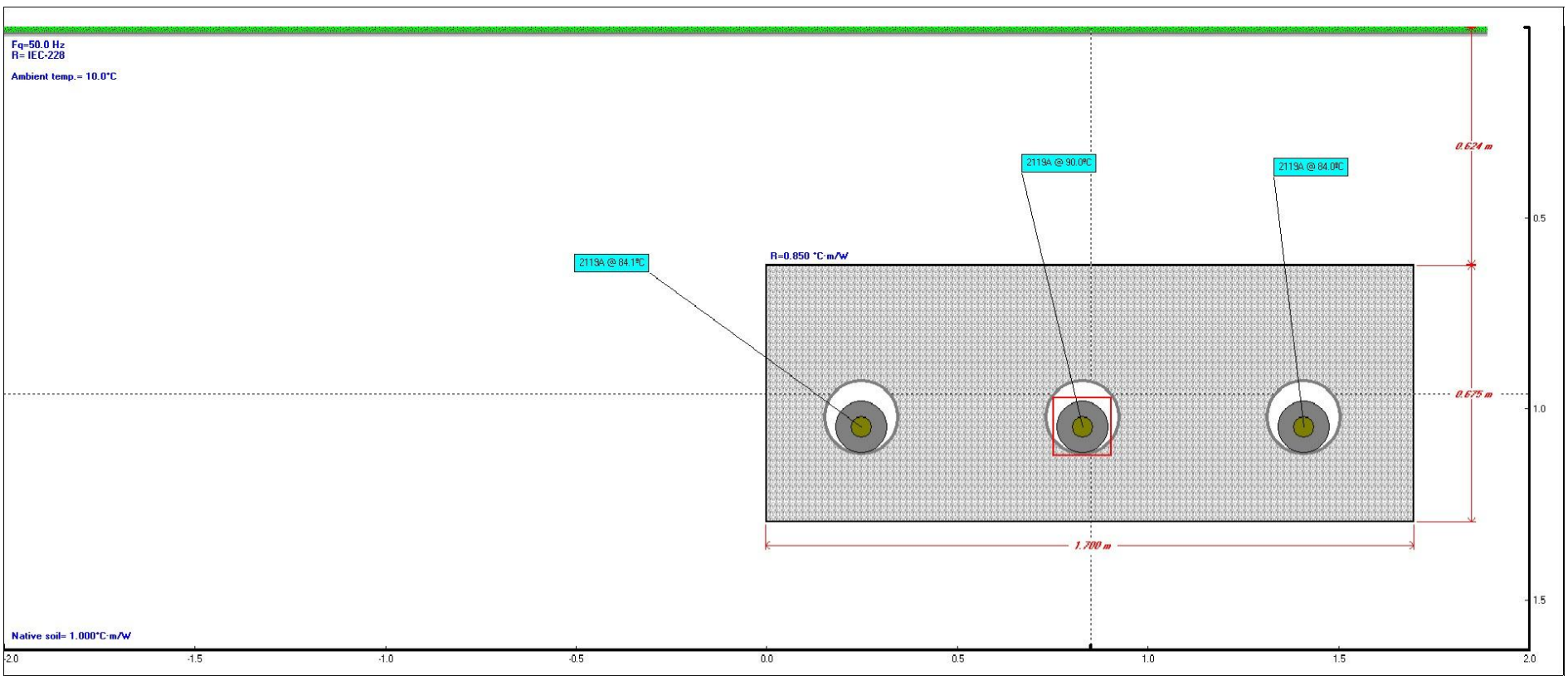
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2
Date:	18/03/2020 11:05:37

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	10.0
Native Soil Thermal Resistivity	[K.m/W]	1.0
Thermal Resistivity of Duct Bank	[K.m/W]	0.9
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	1.7
Duct Bank Height	[m]	0.68



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	400KV.011	1		A	50.0	1.0	0.25	1.05	84.1	2119.1
2	400KV.011	1		B	50.0	1.0	0.83	1.05	90.0	2119.1
3	400KV.011	1		C	50.0	1.0	1.41	1.05	84.0	2119.1

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2
Date:	18/03/2020 11:05:37

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	10
Native Soil Thermal Resistivity [K.m/W]	1.0
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		400KV.011	400KV.011	400KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	0.25	0.83	1.41
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2119.1	2119.1	2119.1
Temperatures					
θc	Conductor temperature	[°C]	84.1	90.0	84.0
θs	Sheath/Shield temperature	[°C]	66.7	72.3	66.6
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	64.3	69.8	64.2
θduct	Duct surface temperature	[°C]	50.8	55.8	50.8
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01005	0.0102	0.01004
ys	Skin Effect Factor		0.11282	0.1091	0.11288
yp	Proximity Effect Factor		0.00177	0.00171	0.00177
Losses					
Wc	Conductor Losses	[W/m]	45.11563	45.79786	45.10383
Wd	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
Ws	Metallic Screen Losses	[W/m]	2.03307	4.93426	1.88822
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	51.15806	54.74148	51.0014
λ_1	Screen Loss Factor		0.04506	0.10774	0.04186
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.36997	0.36997	0.36997
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04684	0.04684	0.04684
T4	External thermal resistance	[K.m/W]	1.06058	1.09159	1.06218
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	132.9	121.4	119.5

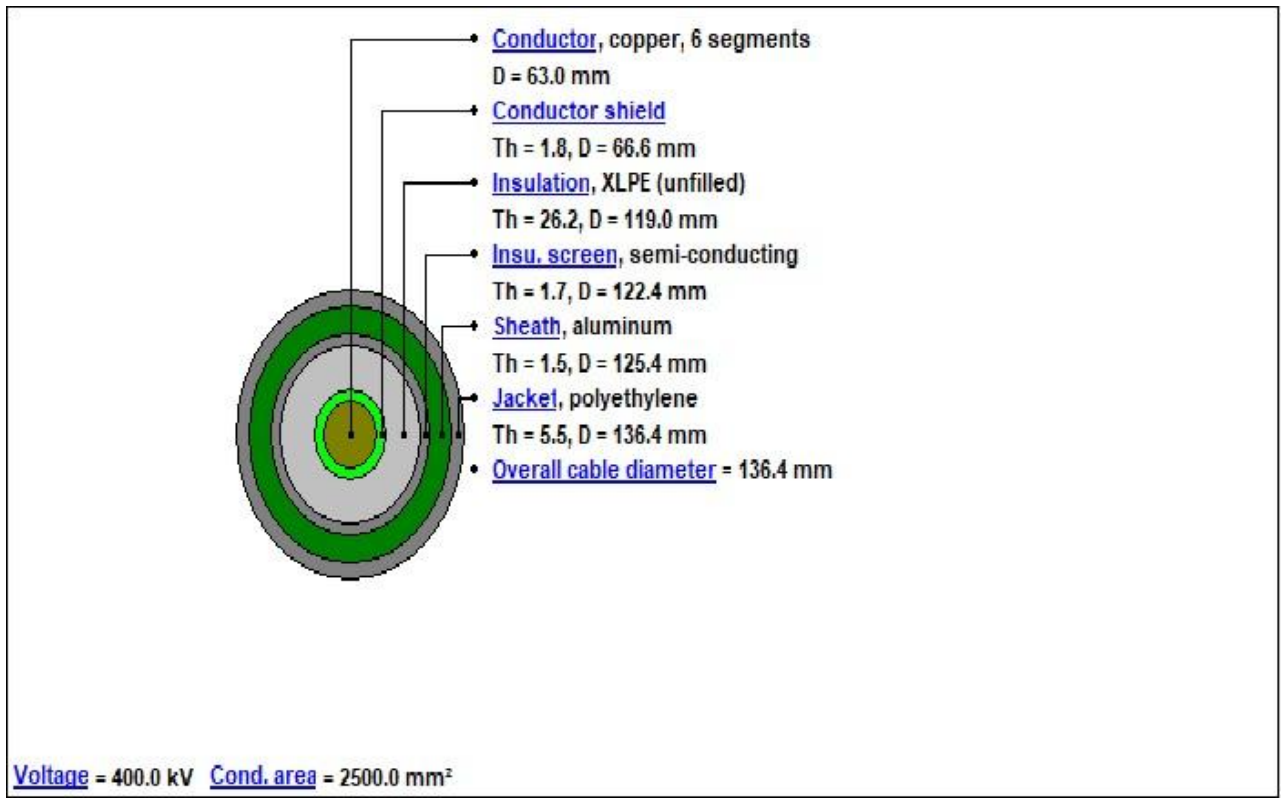
Cables Report

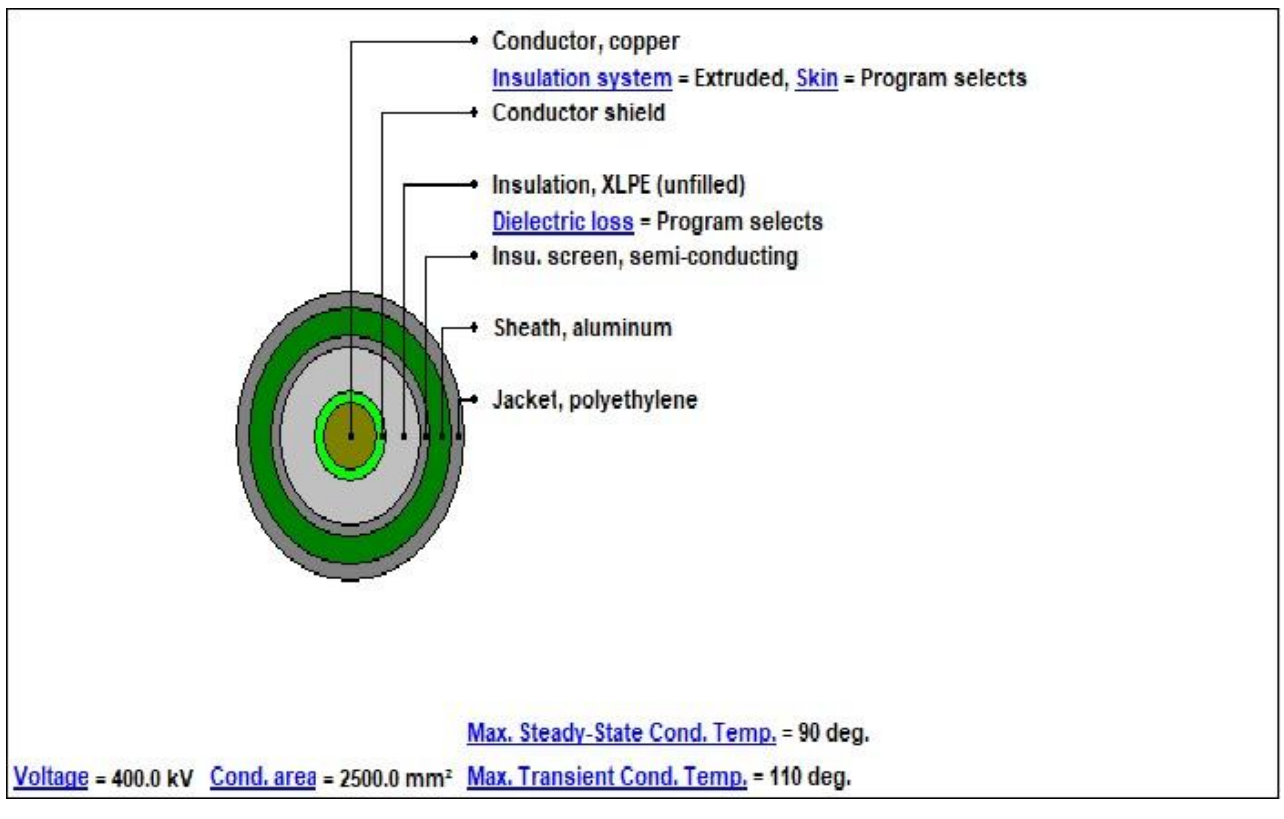
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2
Date:	18/03/2020 11:05:37

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		400KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	400
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	136.4
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	63.0
Conductor Shield			
19	Thickness	[mm]	1.8
20	Diameter	[mm]	66.6
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	26.2
27	Diameter	[mm]	119.0
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.7
30	Diameter	[mm]	122.4
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Aluminum
33	Electrical Resistivity at 20°C	[µΩ.cm]	2.84
34	Temperature Coefficient at 20°C	[1/K]	0.00403
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	228
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	2.5
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	1.5
39	Diameter	[mm]	125.4
Jacket			
40	Material		Polyethylene
41	Thermal Resistivity	[K.m/W]	3.5
42	Thickness	[mm]	5.5
43	Diameter	[mm]	136.4

No.	Description	Unit	1
Specific Installation Data			
44	Cable Equipment ID		400KV.011
45	Cable Frequency	[Hz]	50
46	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
47	Loss Factor Constant (ALOS)		0.3
48	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
49	Duct construction		Polyethylene in Concrete
50	Duct material thermal resistivity	[K.m/W]	3.5
51	Inside Diameter of the Duct/Pipe	[mm]	188.0
52	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 400KV.011	
Cable Title	2500sqmm Cu (insulated wires)_XLPE_CAS_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2
Date:	18/03/2020 11:05:37

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**400KV.011**	**400KV.011**	**400KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00901	0.00918	0.00901
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00843	0.00843	0.00843
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01005	0.0102	0.01004
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.04864	0.04864	0.04864
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.05779	0.0589	0.05777
Losses					
8	Conductor Losses	[W/m]	45.11563	45.79786	45.10383
9	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
10	Metallic Screen Losses	[W/m]	2.03307	4.93426	1.88822
11	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
12	Total Losses	[W/m]	51.15806	54.74148	51.0014
Capacitance, Inductance, Impedance					
13	Capacitance	[µF/km]	0.239	0.239	0.239
14	Inductance of Conductor	[mH/km]	0.63261	0.63261	0.63261
15	Reactance of Conductor	[Ω/km]	0.19874	0.19874	0.19874
16	Inductance of Metallic Sheath	[mH/km]	0.44734	0.44734	0.44734
17	Reactance of Metallic Sheath	[Ω/km]	0.14054	0.14054	0.14054
18	Positive Sequence Impedance	[Ω/km]	0.010050 + j0.198740	0.010200 + j0.198740	0.010040 + j0.198740
19	Negative Sequence Impedance	[Ω/km]	0.010050 + j0.198740	0.010200 + j0.198740	0.010040 + j0.198740
20	Zero Sequence Impedance	[Ω/km]	0.056650 + j0.140540	0.056630 + j0.140540	0.056650 + j0.140540
21	Surge Impedance	[Ω]	51.41672	51.41672	51.41672
Others					
22	Dielectric Stress at Conductor Surface	[kV/mm]	11.94851	11.94851	11.94851
23	Dielectric Stress at Insulation Surface	[kV/mm]	6.68715	6.68715	6.68715
24	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	16540.20553	16540.20553	16540.20553
25	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
26	Charging Current for One Phase	[A/km]	17.36102	17.36102	17.36102
27	Charging Capacity of three phase system at Uo	[kvar/km]	12028.06597	12028.06597	12028.06597
28	Voltage drop for Three Phase System	[V/A/km]	0.0174	0.01766	0.0174
29	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
30	Induced current on Metallic Screen	[A]	132.9	121.4	119.5

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2
Date:	18/03/2020 11:05:37

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		400KV.011	400KV.011	400KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00901	0.00918	0.00901
4	dc	Conductor Diameter	[mm]	63.0	63.0	63.0
5	s	Distance Between Conductor Axes	[mm]	580.0	580.0	580.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.20898	2.18874	2.20933
9	xp	Component of Yp Calculation (Proximity Effect)		1.66983	1.65454	1.6701
10	ys	Skin Effect Factor		0.11282	0.1091	0.11288
11	yp	Proximity Effect Factor		0.00177	0.00171	0.00177
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01005	0.0102	0.01004
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[μF/km]	0.239	0.239	0.239
16	U_0	Voltage	[kV]	230.94011	230.94011	230.94011
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	4.00936	4.00936	4.00936
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.05779	0.0589	0.05777
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	123.9	123.9	123.9
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.14054	0.14054	0.14054
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.18409	0.18409	0.18409
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.12602	0.12602	0.12602
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.02263	0.01896	0.01829
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.05779	0.0589	0.05777
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	123.9	123.9	123.9
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	125.4	125.4	125.4
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	1.5	1.5	1.5
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		108.16968	107.14536	108.18768
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00541	1.00535	1.00541
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.54364	0.5334	0.54382
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0039	0.01516	0.00391
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.02134	0.00488	0.02882
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00033	0.0	0.00001
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.02243	0.08878	0.02357
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.04506	0.10774	0.04186
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.36997	0.36997	0.36997
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	29.7	29.7	29.7
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04684	0.04684	0.04684
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.5	5.5	5.5
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	58.4	63.7	58.4
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.22792	0.22074	0.22802
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.7982	0.83638	0.79969
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.675	0.675	0.675
64	y	Longer Side of the Duct Bank/Backfill	[m]	1.7	1.7	1.7
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	0.47741	0.47741	0.47741
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		2.01505	2.01505	2.01505
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	0.85	0.85	0.85
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.7982	0.83638	0.79969
72	T_4	Total External Thermal Resistance	[K.m/W]	1.06058	1.09159	1.06218
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2119.1	2119.1	2119.1

Study Summary

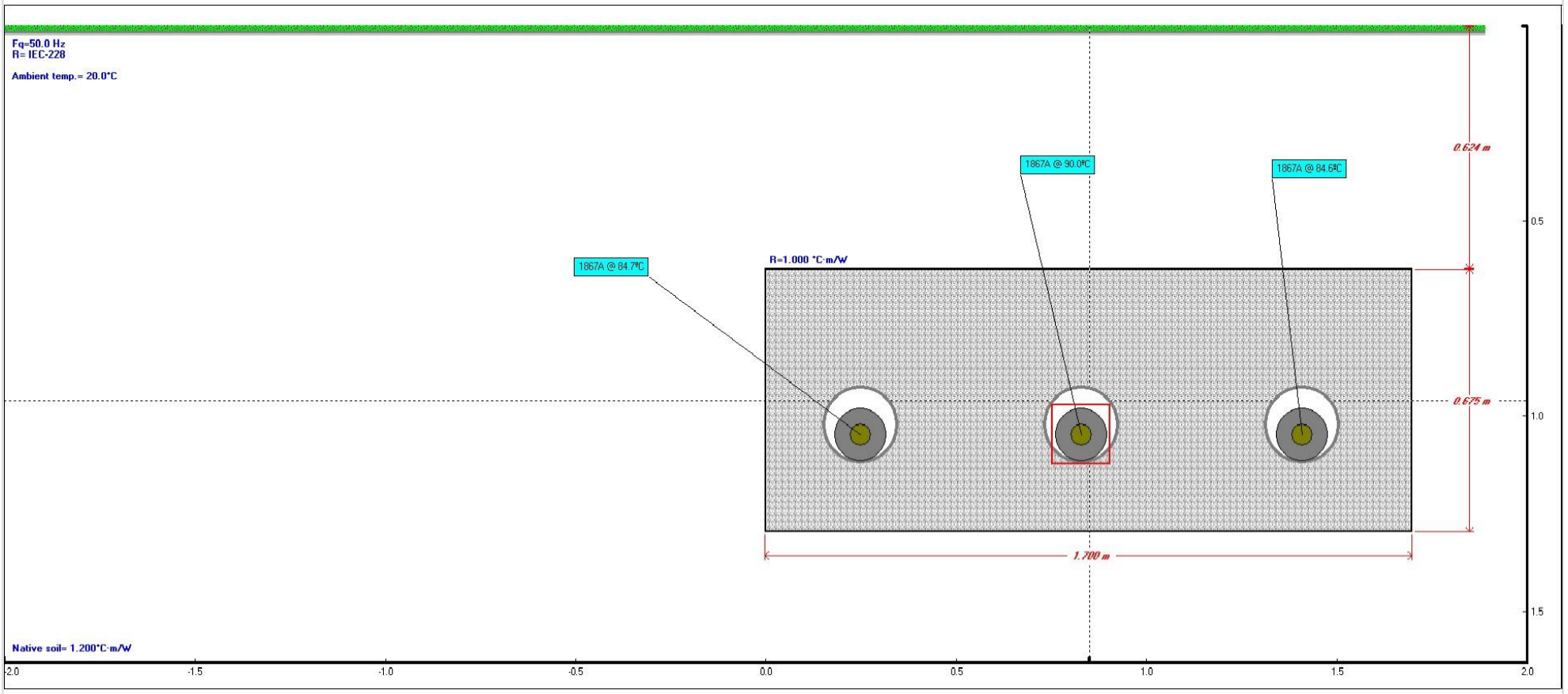
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:24:12

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	20.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	1.0
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	1.7
Duct Bank Height	[m]	0.68



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	400KV.011	1		A	50.0	1.0	0.25	1.05	84.7	1866.6
2	400KV.011	1		B	50.0	1.0	0.83	1.05	90.0	1866.6
3	400KV.011	1		C	50.0	1.0	1.41	1.05	84.6	1866.6

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:24:12

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	20
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		400KV.011	400KV.011	400KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	0.25	0.83	1.41
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	1866.6	1866.6	1866.6
Temperatures					
θc	Conductor temperature	[°C]	84.7	90.0	84.6
θs	Sheath/Shield temperature	[°C]	71.0	76.1	70.9
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	69.1	74.1	69.0
θduct	Duct surface temperature	[°C]	58.8	63.3	58.7
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01006	0.0102	0.01006
ys	Skin Effect Factor		0.11243	0.1091	0.11249
yp	Proximity Effect Factor		0.00176	0.00171	0.00176
Losses					
Wc	Conductor Losses	[W/m]	35.05604	35.53122	35.04811
Wd	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
Ws	Metallic Screen Losses	[W/m]	1.58059	3.81093	1.46462
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	40.64599	43.3515	40.52208
λ_1	Screen Loss Factor		0.04509	0.10726	0.04179
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.36997	0.36997	0.36997
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04684	0.04684	0.04684
T4	External thermal resistance	[K.m/W]	1.20743	1.24765	1.20931
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	116.9	106.7	105.0

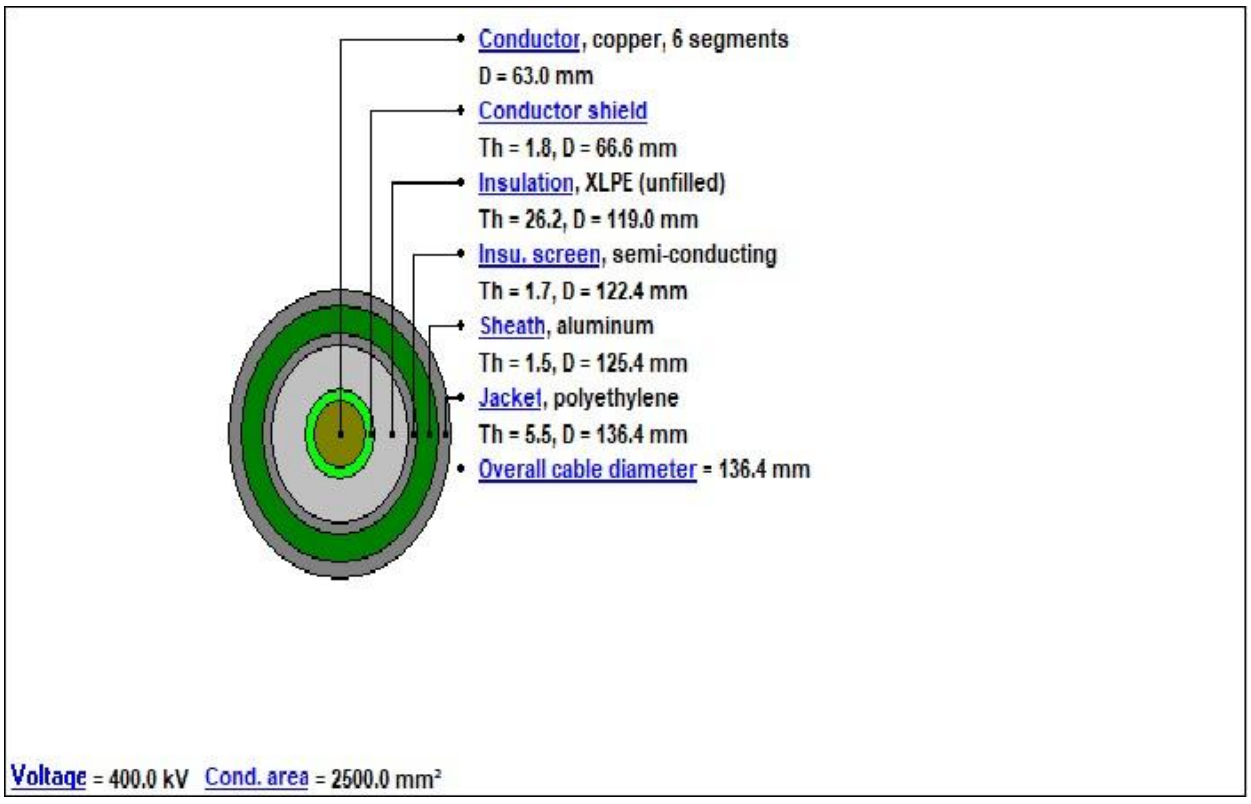
Cables Report

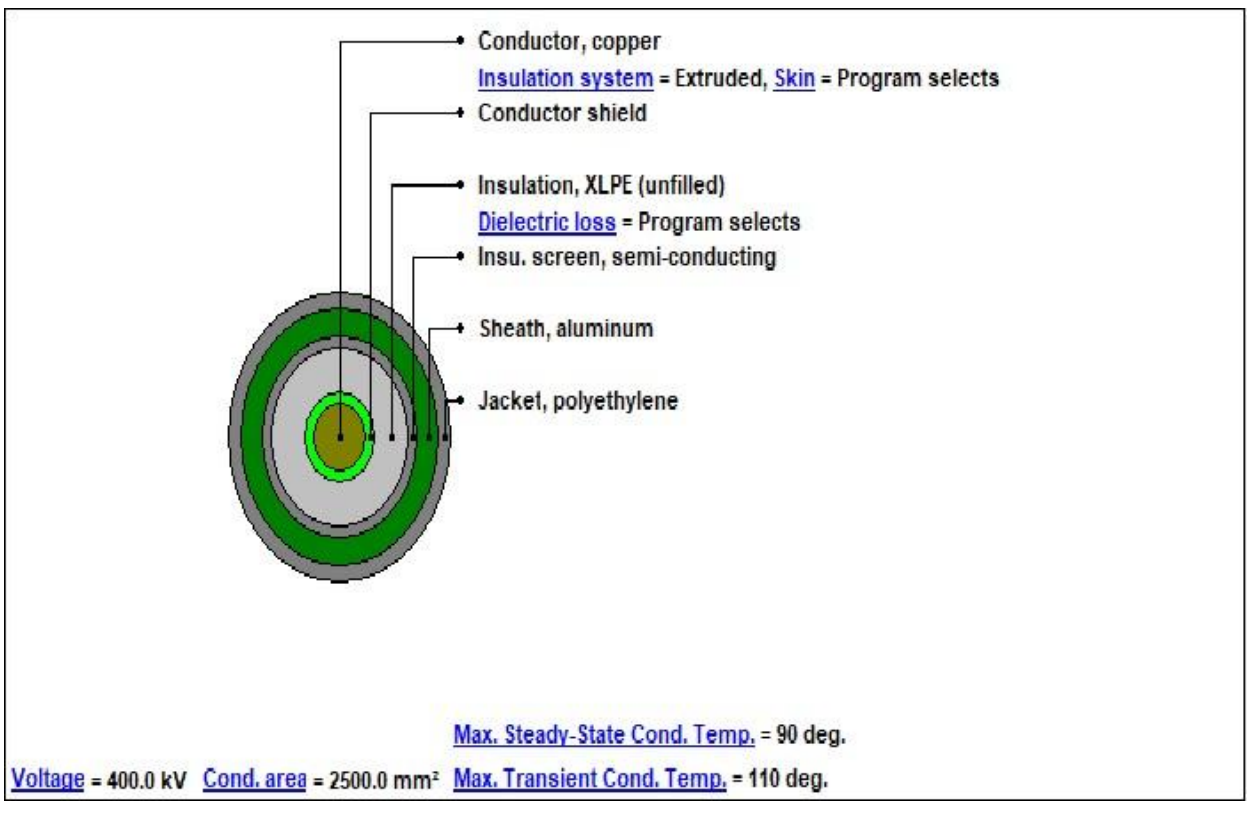
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:24:12

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		400KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	400
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	136.4
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	63.0
Conductor Shield			
19	Thickness	[mm]	1.8
20	Diameter	[mm]	66.6
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	26.2
27	Diameter	[mm]	119.0
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.7
30	Diameter	[mm]	122.4
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Aluminum
33	Electrical Resistivity at 20°C	[µΩ.cm]	2.84
34	Temperature Coefficient at 20°C	[1/K]	0.00403
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	228
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	2.5
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	1.5
39	Diameter	[mm]	125.4
Jacket			
40	Material		Polyethylene
41	Thermal Resistivity	[K.m/W]	3.5
42	Thickness	[mm]	5.5
43	Diameter	[mm]	136.4

No.	Description	Unit	1
Specific Installation Data			
44	Cable Equipment ID		400KV.011
45	Cable Frequency	[Hz]	50
46	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
47	Loss Factor Constant (ALOS)		0.3
48	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
49	Duct construction		Polyethylene in Concrete
50	Duct material thermal resistivity	[K.m/W]	3.5
51	Inside Diameter of the Duct/Pipe	[mm]	188.0
52	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 400KV.011	
Cable Title	2500sqmm Cu (insulated wires)_XLPE_CAS_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:24:12

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**400KV.011**	**400KV.011**	**400KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00903	0.00918	0.00903
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00843	0.00843	0.00843
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01006	0.0102	0.01006
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.04864	0.04864	0.04864
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.05864	0.05964	0.05862
Losses					
8	Conductor Losses	[W/m]	35.05604	35.53122	35.04811
9	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
10	Metallic Screen Losses	[W/m]	1.58059	3.81093	1.46462
11	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
12	Total Losses	[W/m]	40.64599	43.3515	40.52208
Capacitance, Inductance, Impedance					
13	Capacitance	[µF/km]	0.239	0.239	0.239
14	Inductance of Conductor	[mH/km]	0.63261	0.63261	0.63261
15	Reactance of Conductor	[Ω/km]	0.19874	0.19874	0.19874
16	Inductance of Metallic Sheath	[mH/km]	0.44734	0.44734	0.44734
17	Reactance of Metallic Sheath	[Ω/km]	0.14054	0.14054	0.14054
18	Positive Sequence Impedance	[Ω/km]	0.010060 + j0.198740	0.010200 + j0.198740	0.010060 + j0.198740
19	Negative Sequence Impedance	[Ω/km]	0.010060 + j0.198740	0.010200 + j0.198740	0.010060 + j0.198740
20	Zero Sequence Impedance	[Ω/km]	0.056650 + j0.140540	0.056630 + j0.140540	0.056650 + j0.140540
21	Surge Impedance	[Ω]	51.41672	51.41672	51.41672
Others					
22	Dielectric Stress at Conductor Surface	[kV/mm]	11.94851	11.94851	11.94851
23	Dielectric Stress at Insulation Surface	[kV/mm]	6.68715	6.68715	6.68715
24	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	16540.20553	16540.20553	16540.20553
25	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
26	Charging Current for One Phase	[A/km]	17.36102	17.36102	17.36102
27	Charging Capacity of three phase system at Uo	[kvar/km]	12028.06597	12028.06597	12028.06597
28	Voltage drop for Three Phase System	[V/A/km]	0.01743	0.01766	0.01742
29	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
30	Induced current on Metallic Screen	[A]	116.9	106.7	105.0

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:24:12

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		400KV.011	400KV.011	400KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00903	0.00918	0.00903
4	dc	Conductor Diameter	[mm]	63.0	63.0	63.0
5	s	Distance Between Conductor Axes	[mm]	580.0	580.0	580.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.20688	2.18874	2.20718
9	xp	Component of Yp Calculation (Proximity Effect)		1.66824	1.65453	1.66847
10	ys	Skin Effect Factor		0.11243	0.1091	0.11249
11	yp	Proximity Effect Factor		0.00176	0.00171	0.00176
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01006	0.0102	0.01006
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[µF/km]	0.239	0.239	0.239
16	U_0	Voltage	[kV]	230.94011	230.94011	230.94011
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	4.00936	4.00936	4.00936
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.05864	0.05964	0.05862
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	123.9	123.9	123.9
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.14054	0.14054	0.14054
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.18409	0.18409	0.18409
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.12602	0.12602	0.12602
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.02287	0.01911	0.01845
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.05864	0.05964	0.05862
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	123.9	123.9	123.9
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	125.4	125.4	125.4
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	1.5	1.5	1.5
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		107.3843	106.47436	107.3997
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00537	1.00531	1.00537
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.53578	0.52674	0.53593
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00382	0.01487	0.00382
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.02153	0.00479	0.0286
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00031	0.0	0.00001
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.02221	0.08814	0.02334
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.04509	0.10726	0.04179
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.36997	0.36997	0.36997
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	29.7	29.7	29.7
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04684	0.04684	0.04684
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.5	5.5	5.5
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	64.6	69.5	64.6
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.21956	0.21343	0.21965
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.9534	0.99975	0.95519
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.675	0.675	0.675
64	y	Longer Side of the Duct Bank/Backfill	[m]	1.7	1.7	1.7
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	0.47741	0.47741	0.47741
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		2.01505	2.01505	2.01505
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.9534	0.99975	0.95519
72	T_4	Total External Thermal Resistance	[K.m/W]	1.20743	1.24765	1.20931
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	1866.6	1866.6	1866.6

Study Summary

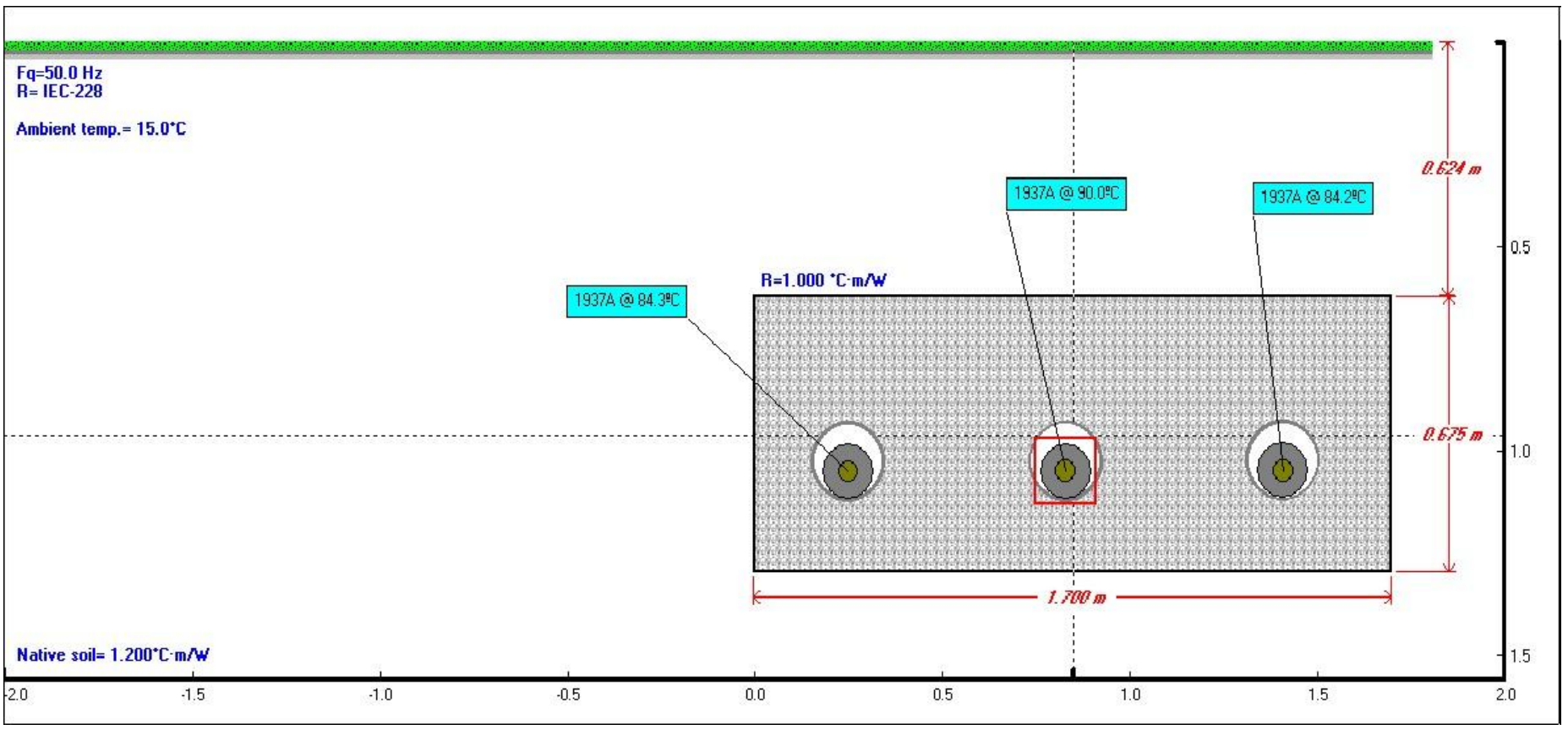
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2
Date:	16/01/2020 14:24:42

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	15.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	1.0
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	1.7
Duct Bank Height	[m]	0.68



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	400KV.011	1		A	50.0	1.0	0.25	1.05	84.3	1937.1
2	400KV.011	1		B	50.0	1.0	0.83	1.05	90.0	1937.1
3	400KV.011	1		C	50.0	1.0	1.41	1.05	84.2	1937.1

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2
Date:	16/01/2020 14:24:42

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	15
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		400KV.011	400KV.011	400KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	0.25	0.83	1.41
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	1937.1	1937.1	1937.1
Temperatures					
θc	Conductor temperature	[°C]	84.3	90.0	84.2
θs	Sheath/Shield temperature	[°C]	69.6	75.1	69.5
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	67.6	72.9	67.5
θduct	Duct surface temperature	[°C]	56.4	61.3	56.4
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01005	0.0102	0.01005
ys	Skin Effect Factor		0.11269	0.1091	0.11275
yp	Proximity Effect Factor		0.00177	0.00171	0.00177
Losses					
Wc	Conductor Losses	[W/m]	37.71928	38.26944	37.71014
Wd	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
Ws	Metallic Screen Losses	[W/m]	1.70128	4.10956	1.5776
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	43.42991	46.38836	43.2971
$ƛ_1$	Screen Loss Factor		0.0451	0.10738	0.04183
$ƛ_2$	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.36997	0.36997	0.36997
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04684	0.04684	0.04684
T4	External thermal resistance	[K.m/W]	1.21029	1.24885	1.21218
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	121.4	110.8	109.1

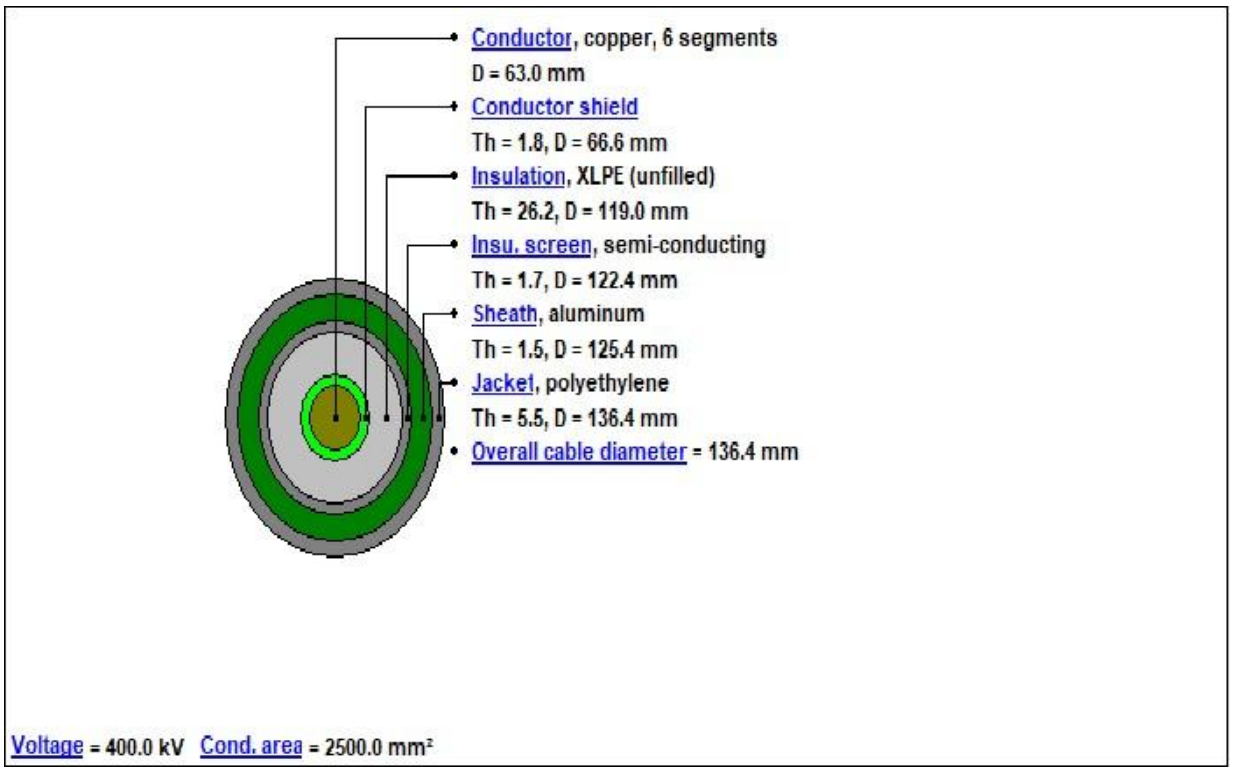
Cables Report

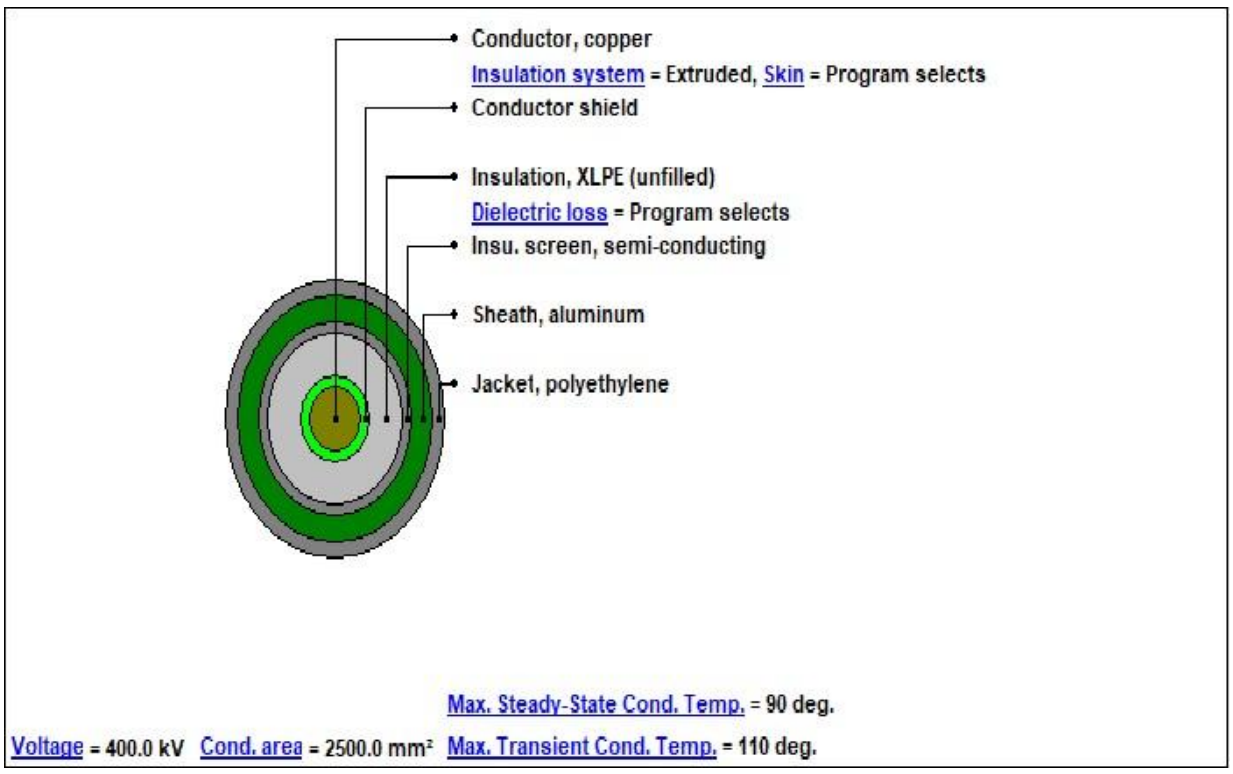
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2
Date:	16/01/2020 14:24:42

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		400KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	400
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	136.4
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	63.0
Conductor Shield			
19	Thickness	[mm]	1.8
20	Diameter	[mm]	66.6
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	26.2
27	Diameter	[mm]	119.0
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.7
30	Diameter	[mm]	122.4
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Aluminum
33	Electrical Resistivity at 20°C	[µΩ.cm]	2.84
34	Temperature Coefficient at 20°C	[1/K]	0.00403
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	228
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	2.5
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	1.5
39	Diameter	[mm]	125.4
Jacket			
40	Material		Polyethylene
41	Thermal Resistivity	[K.m/W]	3.5
42	Thickness	[mm]	5.5
43	Diameter	[mm]	136.4

No.	Description	Unit	1
Specific Installation Data			
44	Cable Equipment ID		400KV.011
45	Cable Frequency	[Hz]	50
46	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
47	Loss Factor Constant (ALOS)		0.3
48	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
49	Duct construction		Polyethylene in Concrete
50	Duct material thermal resistivity	[K.m/W]	3.5
51	Inside Diameter of the Duct/Pipe	[mm]	188.0
52	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 400KV.011	
Cable Title	2500sqmm Cu (insulated wires)_XLPE_CAS_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2
Date:	16/01/2020 14:24:42

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**400KV.011**	**400KV.011**	**400KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00902	0.00918	0.00902
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00843	0.00843	0.00843
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01005	0.0102	0.01005
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.04864	0.04864	0.04864
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.05836	0.05944	0.05835
Losses					
8	Conductor Losses	[W/m]	37.71928	38.26944	37.71014
9	Dielectric Losses	[W/m]	4.00936	4.00936	4.00936
10	Metallic Screen Losses	[W/m]	1.70128	4.10956	1.5776
11	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
12	Total Losses	[W/m]	43.42991	46.38836	43.2971
Capacitance, Inductance, Impedance					
13	Capacitance	[µF/km]	0.239	0.239	0.239
14	Inductance of Conductor	[mH/km]	0.63261	0.63261	0.63261
15	Reactance of Conductor	[Ω/km]	0.19874	0.19874	0.19874
16	Inductance of Metallic Sheath	[mH/km]	0.44734	0.44734	0.44734
17	Reactance of Metallic Sheath	[Ω/km]	0.14054	0.14054	0.14054
18	Positive Sequence Impedance	[Ω/km]	0.010050 + j0.198740	0.010200 + j0.198740	0.010050 + j0.198740
19	Negative Sequence Impedance	[Ω/km]	0.010050 + j0.198740	0.010200 + j0.198740	0.010050 + j0.198740
20	Zero Sequence Impedance	[Ω/km]	0.056650 + j0.140540	0.056630 + j0.140540	0.056650 + j0.140540
21	Surge Impedance	[Ω]	51.41672	51.41672	51.41672
Others					
22	Dielectric Stress at Conductor Surface	[kV/mm]	11.94851	11.94851	11.94851
23	Dielectric Stress at Insulation Surface	[kV/mm]	6.68715	6.68715	6.68715
24	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	16540.20553	16540.20553	16540.20553
25	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
26	Charging Current for One Phase	[A/km]	17.36102	17.36102	17.36102
27	Charging Capacity of three phase system at Uo	[kvar/km]	12028.06597	12028.06597	12028.06597
28	Voltage drop for Three Phase System	[V/A/km]	0.01741	0.01766	0.01741
29	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
30	Induced current on Metallic Screen	[A]	121.4	110.8	109.1

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 400kV CABLE) v2
Date:	16/01/2020 14:24:42

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		400KV.011	400KV.011	400KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00902	0.00918	0.00902
4	dc	Conductor Diameter	[mm]	63.0	63.0	63.0
5	s	Distance Between Conductor Axes	[mm]	580.0	580.0	580.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.20826	2.18874	2.20858
9	xp	Component of Yp Calculation (Proximity Effect)		1.66928	1.65453	1.66953
10	ys	Skin Effect Factor		0.11269	0.1091	0.11275
11	yp	Proximity Effect Factor		0.00177	0.00171	0.00177
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01005	0.0102	0.01005
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[µF/km]	0.239	0.239	0.239
16	U_0	Voltage	[kV]	230.94011	230.94011	230.94011
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	4.00936	4.00936	4.00936
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.05836	0.05944	0.05835
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	123.9	123.9	123.9
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.14054	0.14054	0.14054
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.18409	0.18409	0.18409
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.12602	0.12602	0.12602
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.02281	0.01907	0.01841
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.05836	0.05944	0.05835
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	123.9	123.9	123.9
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	125.4	125.4	125.4
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	1.5	1.5	1.5
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		107.6336	106.65209	107.65015
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00538	1.00532	1.00538
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.53827	0.5285	0.53843
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00384	0.01494	0.00385
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.02147	0.00482	0.02867
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00032	0.0	0.00001
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.0223	0.08831	0.02342
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.0451	0.10738	0.04183
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.36997	0.36997	0.36997
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	29.7	29.7	29.7
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04684	0.04684	0.04684
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.5	5.5	5.5
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	62.7	67.9	62.7
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.22203	0.21532	0.22212
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.9538	0.99906	0.95559
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.675	0.675	0.675
64	y	Longer Side of the Duct Bank/Backfill	[m]	1.7	1.7	1.7
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	0.47741	0.47741	0.47741
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		2.01505	2.01505	2.01505
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.9538	0.99906	0.95559
72	T_4	Total External Thermal Resistance	[K.m/W]	1.21029	1.24885	1.21218
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	1937.1	1937.1	1937.1

Study Summary

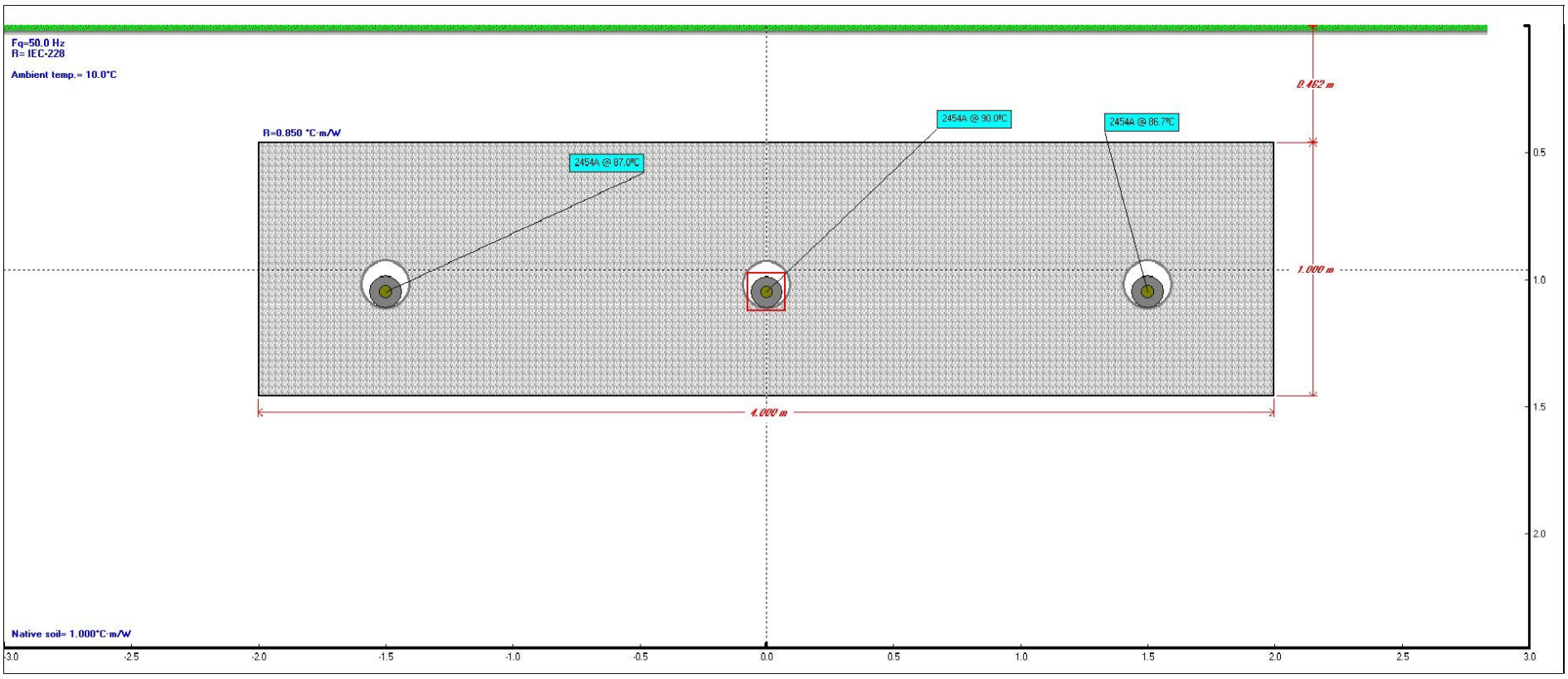
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE)
Date:	18/03/2020 11:21:16

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	10.0
Native Soil Thermal Resistivity	[K.m/W]	1.0
Thermal Resistivity of Duct Bank	[K.m/W]	0.9
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	4.0
Duct Bank Height	[m]	1.0



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	220KV.011	1		A	50.0	1.0	-1.5	1.05	87.0	2454.5
2	220KV.011	1		B	50.0	1.0	0.0	1.05	90.0	2454.5
3	220KV.011	1		C	50.0	1.0	1.5	1.05	86.7	2454.5

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE)
Date:	18/03/2020 11:21:16

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	10
Native Soil Thermal Resistivity [K.m/W]	1.0
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		220KV.011	220KV.011	220KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	-1.5	0.0	1.5
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2454.5	2454.5	2454.5
Temperatures					
θc	Conductor temperature	[°C]	87.0	90.0	86.7
θs	Sheath/Shield temperature	[°C]	66.0	68.9	65.8
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	63.0	65.9	62.8
θduct	Duct surface temperature	[°C]	45.2	48.3	45.1
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01011	0.01018	0.0101
ys	Skin Effect Factor		0.11099	0.1091	0.11116
yp	Proximity Effect Factor		0.00025	0.00024	0.00025
Losses					
Wc	Conductor Losses	[W/m]	60.88483	61.35644	60.84297
Wd	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
Ws	Metallic Screen Losses	[W/m]	2.23417	2.05405	1.8898
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	64.49216	64.78365	64.10592
λ_1	Screen Loss Factor		0.0367	0.03348	0.03106
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.3402	0.3402	0.3402
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04631	0.04631	0.04631
T4	External thermal resistance	[K.m/W]	0.82222	0.86282	0.8235
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	148.4	137.3	136.3

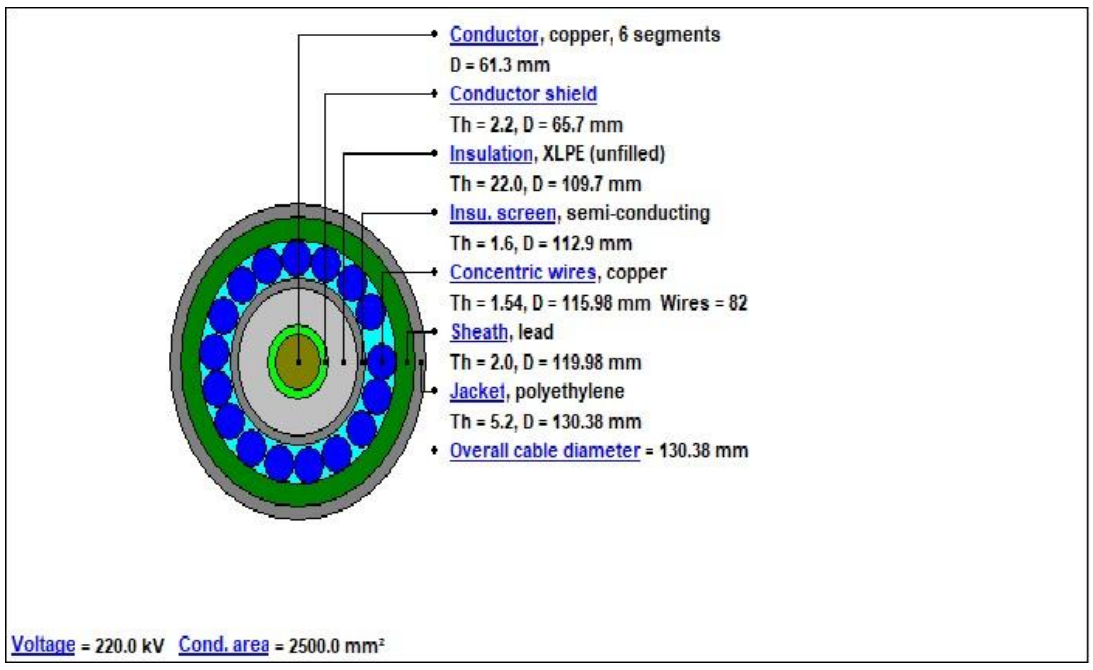
Cables Report

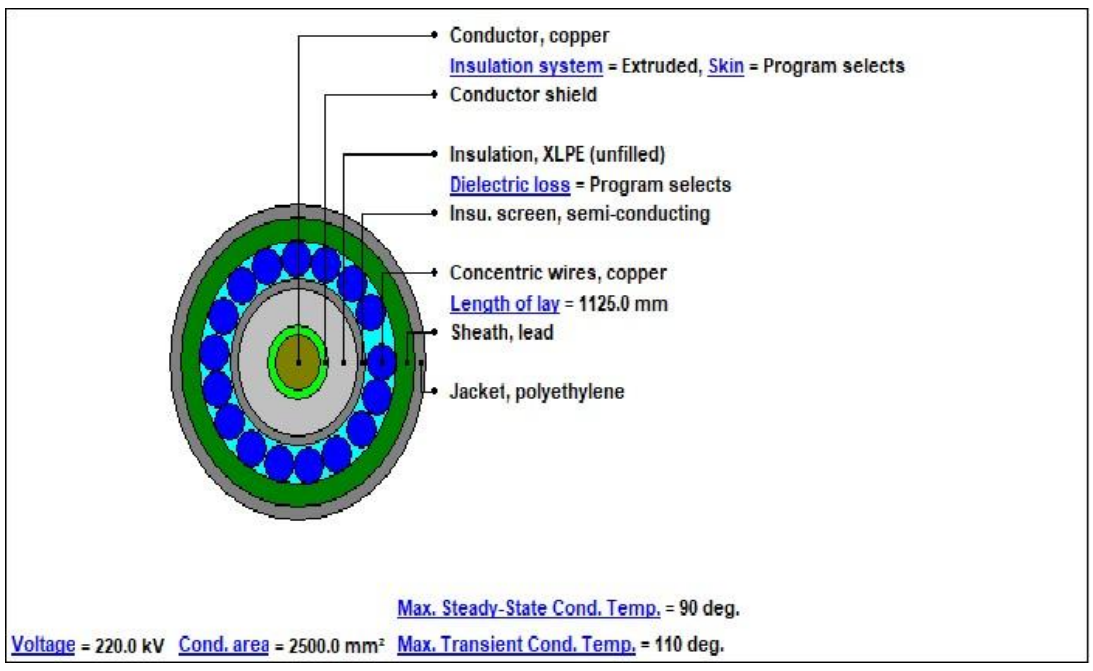
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE)
Date:	18/03/2020 11:21:16

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		220KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	220
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	130.38
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	61.3
Conductor Shield			
19	Thickness	[mm]	2.2
20	Diameter	[mm]	65.7
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	22.0
27	Diameter	[mm]	109.7
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.6
30	Diameter	[mm]	112.9
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Lead
33	Electrical Resistivity at 20°C	[µΩ.cm]	21.4
34	Temperature Coefficient at 20°C	[1/K]	0.004
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	230
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	1.45
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	2.0
39	Diameter	[mm]	119.98
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1125.0
47	Number of Wires		82
48	Wire Gauge		Undefined
49	Thickness	[mm]	1.54
50	Diameter	[mm]	115.98
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	130.38

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		220KV.011
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 220KV.011	
Cable Title	2500sqmm Cu (insulated Wires)_XLPE_CWS+Pb_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE)
Date:	18/03/2020 11:21:16

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**220KV.011**	**220KV.011**	**220KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00909	0.00918	0.00909
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00841	0.00841	0.00841
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01011	0.01018	0.0101
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.28869	0.28869	0.28869
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.34182	0.34515	0.34153
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.1185	0.1185	0.1185
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.13993	0.14128	0.13982
Losses					
10	Conductor Losses	[W/m]	60.88483	61.35644	60.84297
11	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
12	Metallic Screen Losses	[W/m]	2.23417	2.05405	1.8898
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	64.49216	64.78365	64.10592
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.271	0.271	0.271
16	Inductance of Conductor	[mH/km]	0.82812	0.82812	0.82812
17	Reactance of Conductor	[Ω/km]	0.26016	0.26016	0.26016
18	Inductance of Metallic Sheath	[mH/km]	0.65017	0.65017	0.65017
19	Reactance of Metallic Sheath	[Ω/km]	0.20426	0.20426	0.20426
20	Positive Sequence Impedance	[Ω/km]	0.010110 + j0.260160	0.010180 + j0.260160	0.010100 + j0.260160
21	Negative Sequence Impedance	[Ω/km]	0.010110 + j0.260160	0.010180 + j0.260160	0.010100 + j0.260160
22	Zero Sequence Impedance	[Ω/km]	0.092020 + j0.204260	0.092000 + j0.204260	0.092020 + j0.204260
23	Surge Impedance	[Ω]	55.28699	55.28699	55.28699
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	7.54233	7.54233	7.54233
25	Dielectric Stress at Insulation Surface	[kV/mm]	4.51715	4.51715	4.51715
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	14609.00643	14609.00643	14609.00643
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	10.81081	10.81081	10.81081
29	Charging Capacity of three phase system at Uo	[kvar/km]	4119.47055	4119.47055	4119.47055
30	Voltage drop for Three Phase System	[V/A/km]	0.0175	0.01764	0.01749
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	148.4	137.3	136.3

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE)
Date:	18/03/2020 11:21:16

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		220KV.011	220KV.011	220KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00909	0.00918	0.00909
4	dc	Conductor Diameter	[mm]	61.3	61.3	61.3
5	s	Distance Between Conductor Axes	[mm]	1500.0	1500.0	1500.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.19909	2.18875	2.20002
9	xp	Component of Yp Calculation (Proximity Effect)		1.66236	1.65454	1.66306
10	ys	Skin Effect Factor		0.11099	0.1091	0.11116
11	yp	Proximity Effect Factor		0.00025	0.00024	0.00025
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01011	0.01018	0.0101
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[μF/km]	0.271	0.271	0.271
16	U_0	Voltage	[kV]	127.01706	127.01706	127.01706
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	1.37316	1.37316	1.37316
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.09929	0.10024	0.0992
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	116.22348	116.22348	116.22348
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.20426	0.20426	0.20426
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.24781	0.24781	0.24781
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.18974	0.18974	0.18974
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.03593	0.03078	0.03029
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.34182	0.34515	0.34153
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	117.98	117.98	117.98
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	119.98	119.98	119.98
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	2.0	2.0	2.0
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		39.47168	39.28088	39.48876
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00253	1.00251	1.00253
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.09191	0.09102	0.09199
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00002	0.00008	0.00002
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00671	0.00004	0.0013
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00076	0.0027	0.00077
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.0367	0.03348	0.03106
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.3402	0.3402	0.3402
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	25.8	25.8	25.8
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04631	0.04631	0.04631
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	55.2	58.2	55.0
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.24185	0.23744	0.24215
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.54591	0.59092	0.54688
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	1.0	1.0	1.0
64	y	Longer Side of the Duct Bank/Backfill	[m]	4.0	4.0	4.0
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	1.19983	1.19983	1.19983
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		0.80178	0.80178	0.80178
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	0.85	0.85	0.85
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.54591	0.59092	0.54688
72	T_4	Total External Thermal Resistance	[K.m/W]	0.82222	0.86282	0.8235
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2454.5	2454.5	2454.5

Study Summary

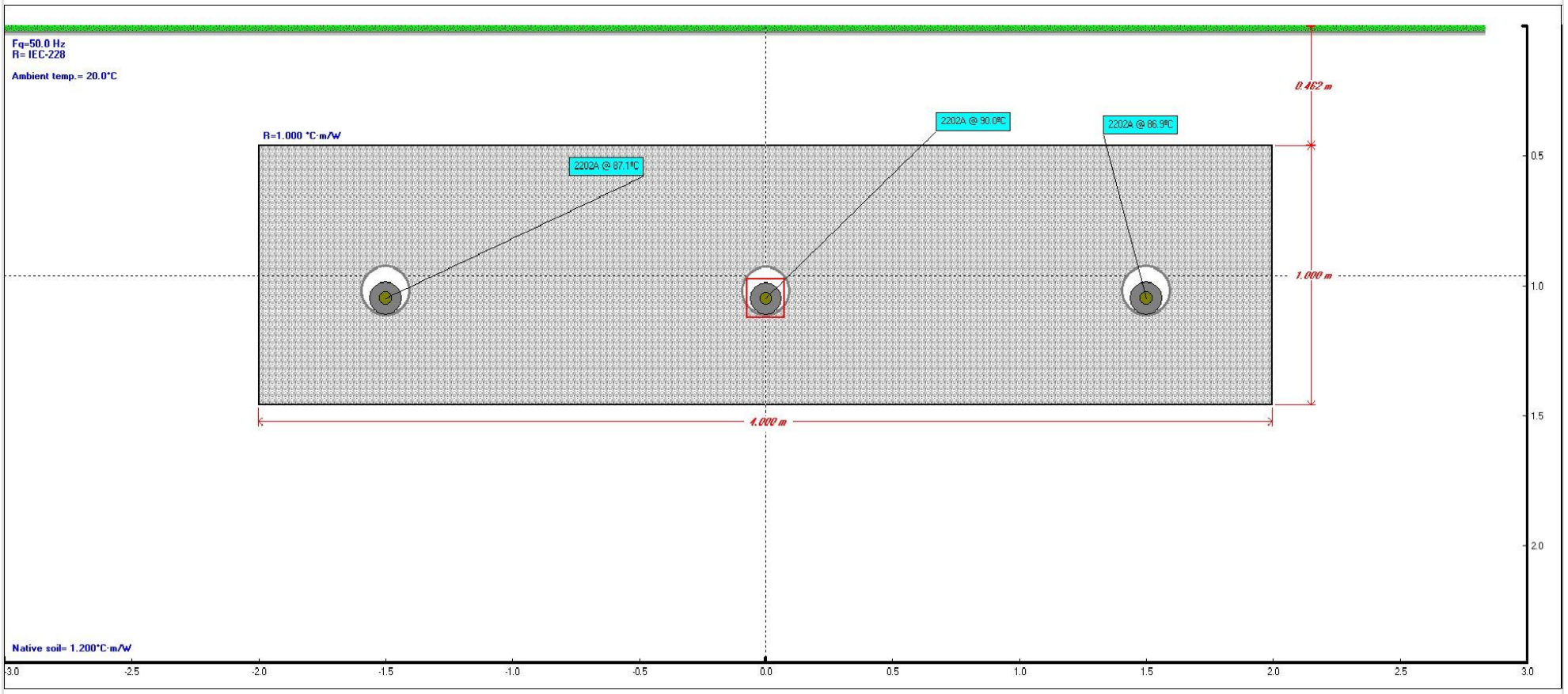
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE) - Summer (20C)
Date:	02/03/2020 16:05:16

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	20.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	1.0
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	4.0
Duct Bank Height	[m]	1.0



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	220KV.011	1		A	50.0	1.0	-1.5	1.05	87.1	2202.5
2	220KV.011	1		B	50.0	1.0	0.0	1.05	90.0	2202.5
3	220KV.011	1		C	50.0	1.0	1.5	1.05	86.9	2202.5

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE) - Summer (20C)
Date:	02/03/2020 16:05:16

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	20
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		220KV.011	220KV.011	220KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	-1.5	0.0	1.5
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2202.5	2202.5	2202.5
Temperatures					
θc	Conductor temperature	[°C]	87.1	90.0	86.9
θs	Sheath/Shield temperature	[°C]	70.2	73.0	70.0
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	67.8	70.5	67.6
θduct	Duct surface temperature	[°C]	53.8	56.7	53.7
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01011	0.01018	0.0101
ys	Skin Effect Factor		0.1109	0.1091	0.11105
yp	Proximity Effect Factor		0.00025	0.00024	0.00025
Losses					
Wc	Conductor Losses	[W/m]	49.04357	49.40582	49.01384
Wd	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
Ws	Metallic Screen Losses	[W/m]	1.81642	1.66362	1.53425
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	52.23315	52.44259	51.92124
λ_1	Screen Loss Factor		0.03704	0.03367	0.0313
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.3402	0.3402	0.3402
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04631	0.04631	0.04631
T4	External thermal resistance	[K.m/W]	0.91444	0.96362	0.91587
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	133.0	122.8	122.0

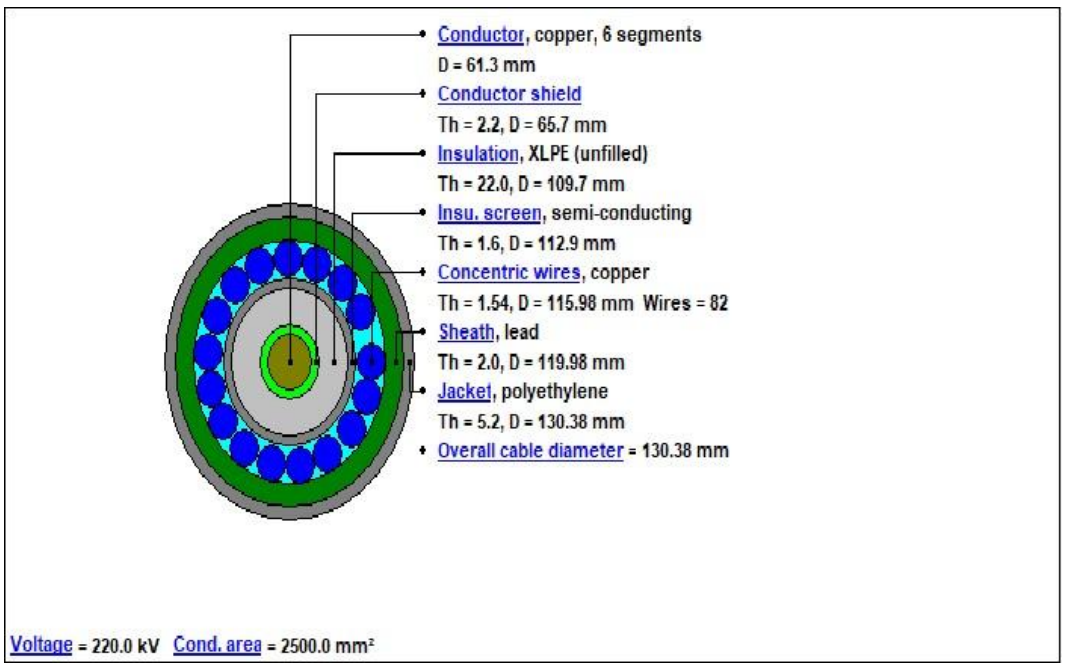
Cables Report

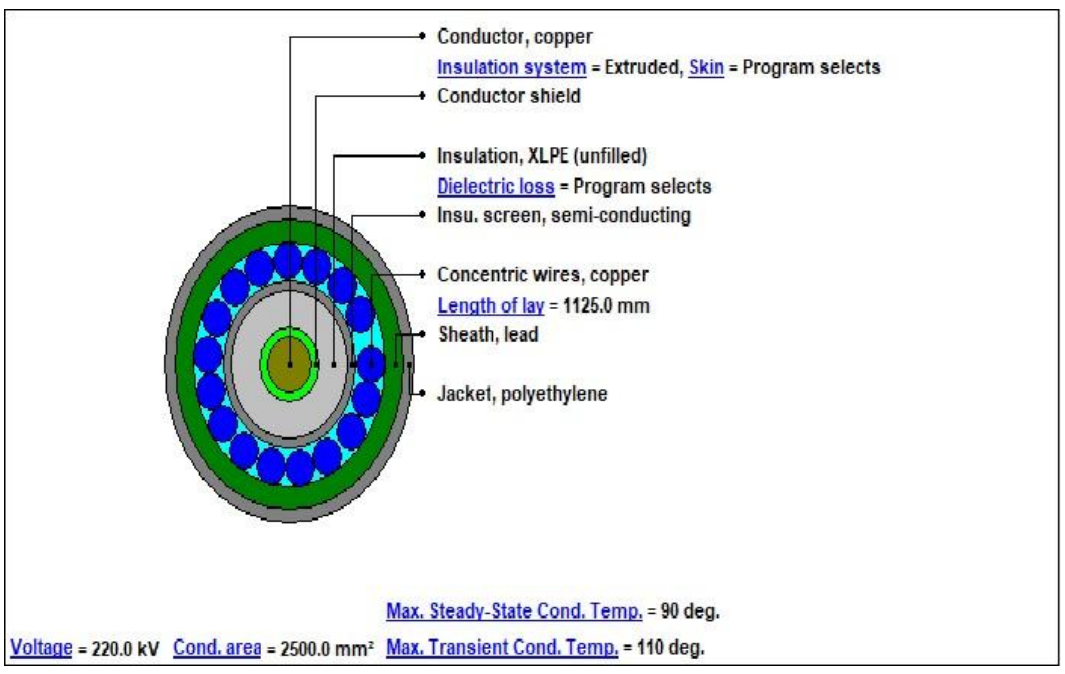
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE) - Summer (20C)
Date:	02/03/2020 16:05:16

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		220KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	220
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	130.38
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	61.3
Conductor Shield			
19	Thickness	[mm]	2.2
20	Diameter	[mm]	65.7
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	22.0
27	Diameter	[mm]	109.7
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.6
30	Diameter	[mm]	112.9
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Lead
33	Electrical Resistivity at 20°C	[µΩ.cm]	21.4
34	Temperature Coefficient at 20°C	[1/K]	0.004
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	230
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	1.45
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	2.0
39	Diameter	[mm]	119.98
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1125.0
47	Number of Wires		82
48	Wire Gauge		Undefined
49	Thickness	[mm]	1.54
50	Diameter	[mm]	115.98
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	130.38

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		220KV.011
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 220KV.011	
Cable Title	2500sqmm Cu (insulated Wires)_XLPE_CWS+Pb_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE) - Summer (20C)
Date:	02/03/2020 16:05:16

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**220KV.011**	**220KV.011**	**220KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.0091	0.00918	0.00909
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00841	0.00841	0.00841
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01011	0.01018	0.0101
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.28869	0.28869	0.28869
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.34664	0.34985	0.34637
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.1185	0.1185	0.1185
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.14188	0.14317	0.14177
Losses					
10	Conductor Losses	[W/m]	49.04357	49.40582	49.01384
11	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
12	Metallic Screen Losses	[W/m]	1.81642	1.66362	1.53425
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	52.23315	52.44259	51.92124
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.271	0.271	0.271
16	Inductance of Conductor	[mH/km]	0.82812	0.82812	0.82812
17	Reactance of Conductor	[Ω/km]	0.26016	0.26016	0.26016
18	Inductance of Metallic Sheath	[mH/km]	0.65017	0.65017	0.65017
19	Reactance of Metallic Sheath	[Ω/km]	0.20426	0.20426	0.20426
20	Positive Sequence Impedance	[Ω/km]	0.010110 + j0.260160	0.010180 + j0.260160	0.010100 + j0.260160
21	Negative Sequence Impedance	[Ω/km]	0.010110 + j0.260160	0.010180 + j0.260160	0.010100 + j0.260160
22	Zero Sequence Impedance	[Ω/km]	0.092010 + j0.204260	0.092000 + j0.204260	0.092020 + j0.204260
23	Surge Impedance	[Ω]	55.28699	55.28699	55.28699
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	7.54233	7.54233	7.54233
25	Dielectric Stress at Insulation Surface	[kV/mm]	4.51715	4.51715	4.51715
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	14609.00643	14609.00643	14609.00643
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	10.81081	10.81081	10.81081
29	Charging Capacity of three phase system at Uo	[kvar/km]	4119.47055	4119.47055	4119.47055
30	Voltage drop for Three Phase System	[V/A/km]	0.01751	0.01764	0.0175
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	133.0	122.8	122.0

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE) - Summer (20C)
Date:	02/03/2020 16:05:16

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		220KV.011	220KV.011	220KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.0091	0.00918	0.00909
4	dc	Conductor Diameter	[mm]	61.3	61.3	61.3
5	s	Distance Between Conductor Axes	[mm]	1500.0	1500.0	1500.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.19861	2.18875	2.19942
9	xp	Component of Yp Calculation (Proximity Effect)		1.66199	1.65454	1.66261
10	ys	Skin Effect Factor		0.1109	0.1091	0.11105
11	yp	Proximity Effect Factor		0.00025	0.00024	0.00025
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01011	0.01018	0.0101
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[µF/km]	0.271	0.271	0.271
16	U_0	Voltage	[kV]	127.01706	127.01706	127.01706
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	1.37316	1.37316	1.37316
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.10067	0.10159	0.1006
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	116.22348	116.22348	116.22348
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.20426	0.20426	0.20426
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.24781	0.24781	0.24781
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.18974	0.18974	0.18974
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.03628	0.03101	0.03054
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.34664	0.34985	0.34637
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	117.98	117.98	117.98
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	119.98	119.98	119.98
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	2.0	2.0	2.0
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		39.19658	39.01637	39.21149
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.0025	1.00248	1.0025
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.09063	0.0898	0.0907
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00002	0.00007	0.00002
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00668	0.00004	0.00129
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00075	0.00266	0.00076
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.03704	0.03367	0.0313
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.3402	0.3402	0.3402
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	25.8	25.8	25.8
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04631	0.04631	0.04631
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	61.7	64.5	61.5
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.23247	0.22857	0.23273
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.6475	0.70058	0.64867
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	1.0	1.0	1.0
64	y	Longer Side of the Duct Bank/Backfill	[m]	4.0	4.0	4.0
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	1.19983	1.19983	1.19983
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		0.80178	0.80178	0.80178
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.6475	0.70058	0.64867
72	T_4	Total External Thermal Resistance	[K.m/W]	0.91444	0.96362	0.91587
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2202.5	2202.5	2202.5

Study Summary

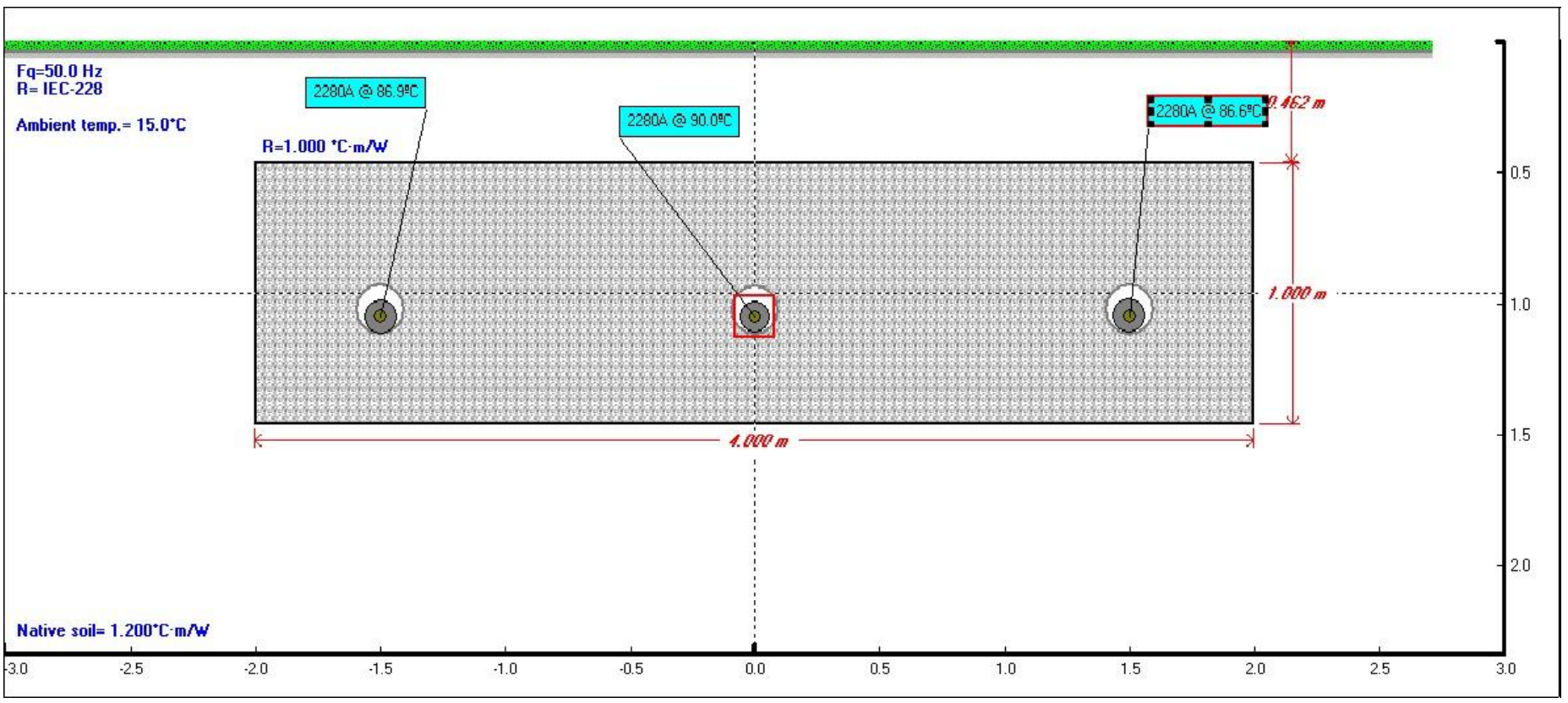
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE)
Date:	16/01/2020 13:53:26

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	15.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	1.0
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	4.0
Duct Bank Height	[m]	1.0



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	220KV.011	1		A	50.0	1.0	-1.5	1.05	86.9	2279.5
2	220KV.011	1		B	50.0	1.0	0.0	1.05	90.0	2279.5
3	220KV.011	1		C	50.0	1.0	1.5	1.05	86.6	2279.5

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE)
Date:	16/01/2020 13:53:26

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	15
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		220KV.011	220KV.011	220KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	-1.5	0.0	1.5
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2279.5	2279.5	2279.5
Temperatures					
θc	Conductor temperature	[°C]	86.9	90.0	86.6
θs	Sheath/Shield temperature	[°C]	68.8	71.8	68.6
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	66.2	69.2	66.0
θduct	Duct surface temperature	[°C]	51.1	54.3	51.0
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.0101	0.01018	0.0101
ys	Skin Effect Factor		0.11104	0.1091	0.1112
yp	Proximity Effect Factor		0.00025	0.00024	0.00025
Losses					
Wc	Conductor Losses	[W/m]	52.50642	52.9227	52.47224
Wd	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
Ws	Metallic Screen Losses	[W/m]	1.93954	1.77902	1.63899
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	55.81911	56.07488	55.48438
λ_1	Screen Loss Factor		0.03694	0.03362	0.03124
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.3402	0.3402	0.3402
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04631	0.04631	0.04631
T4	External thermal resistance	[K.m/W]	0.91739	0.96602	0.91885
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	137.7	127.2	126.4

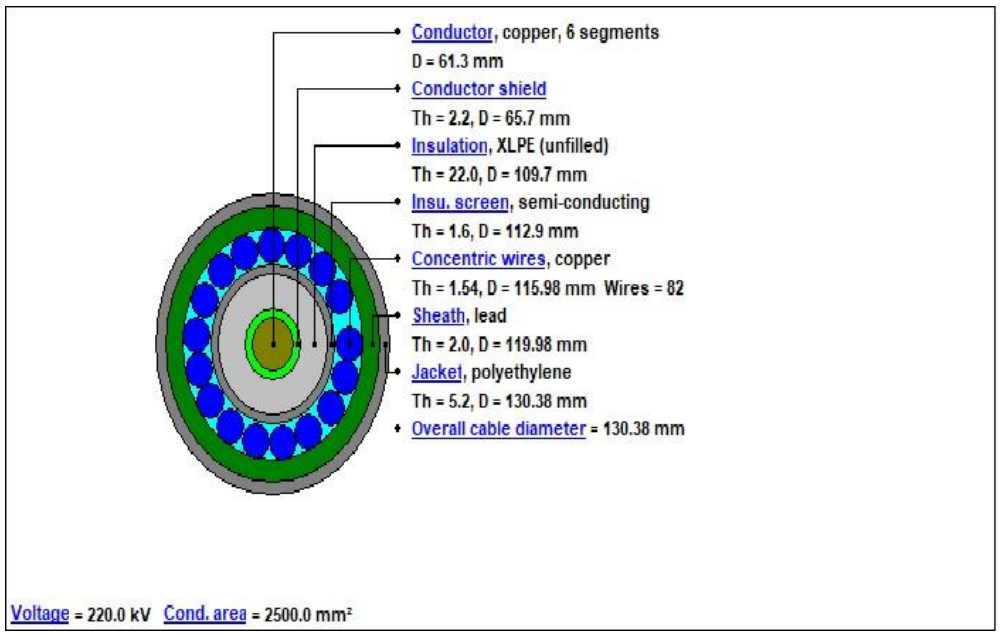
Cables Report

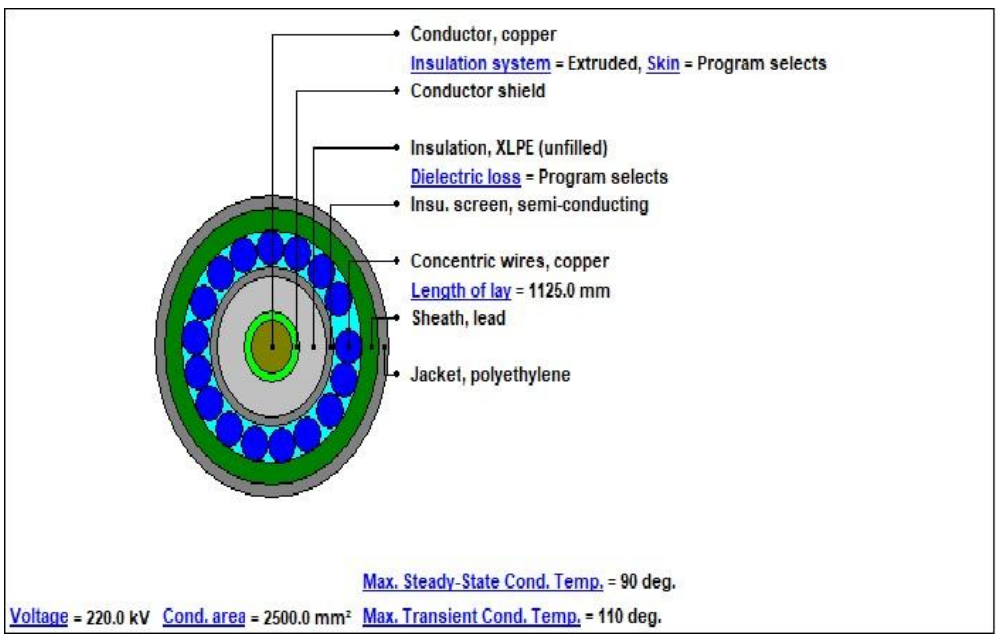
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE)
Date:	16/01/2020 13:53:26

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		220KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	220
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	130.38
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	61.3
Conductor Shield			
19	Thickness	[mm]	2.2
20	Diameter	[mm]	65.7
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	22.0
27	Diameter	[mm]	109.7
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.6
30	Diameter	[mm]	112.9
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Lead
33	Electrical Resistivity at 20°C	[µΩ.cm]	21.4
34	Temperature Coefficient at 20°C	[1/K]	0.004
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	230
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	1.45
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	2.0
39	Diameter	[mm]	119.98
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1125.0
47	Number of Wires		82
48	Wire Gauge		Undefined
49	Thickness	[mm]	1.54
50	Diameter	[mm]	115.98
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	130.38

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		220KV.011
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 220KV.011	
Cable Title	2500sqmm Cu (insulated Wires)_XLPE_CWS+Pb_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE)
Date:	16/01/2020 13:53:26

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**220KV.011**	**220KV.011**	**220KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00909	0.00918	0.00909
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00841	0.00841	0.00841
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.0101	0.01018	0.0101
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.28869	0.28869	0.28869
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.34503	0.34846	0.34475
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.1185	0.1185	0.1185
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.14123	0.14261	0.14112
Losses					
10	Conductor Losses	[W/m]	52.50642	52.9227	52.47224
11	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
12	Metallic Screen Losses	[W/m]	1.93954	1.77902	1.63899
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	55.81911	56.07488	55.48438
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.271	0.271	0.271
16	Inductance of Conductor	[mH/km]	0.82812	0.82812	0.82812
17	Reactance of Conductor	[Ω/km]	0.26016	0.26016	0.26016
18	Inductance of Metallic Sheath	[mH/km]	0.65017	0.65017	0.65017
19	Reactance of Metallic Sheath	[Ω/km]	0.20426	0.20426	0.20426
20	Positive Sequence Impedance	[Ω/km]	0.010100 + j0.260160	0.010180 + j0.260160	0.010100 + j0.260160
21	Negative Sequence Impedance	[Ω/km]	0.010100 + j0.260160	0.010180 + j0.260160	0.010100 + j0.260160
22	Zero Sequence Impedance	[Ω/km]	0.092020 + j0.204260	0.092000 + j0.204260	0.092020 + j0.204260
23	Surge Impedance	[Ω]	55.28699	55.28699	55.28699
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	7.54233	7.54233	7.54233
25	Dielectric Stress at Insulation Surface	[kV/mm]	4.51715	4.51715	4.51715
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	14609.00643	14609.00643	14609.00643
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	10.81081	10.81081	10.81081
29	Charging Capacity of three phase system at Uo	[kvar/km]	4119.47055	4119.47055	4119.47055
30	Voltage drop for Three Phase System	[V/A/km]	0.0175	0.01764	0.01749
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	137.7	127.2	126.4

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Road Width Trench (1ct 220kV CABLE)
Date:	16/01/2020 13:53:26

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		220KV.011	220KV.011	220KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00909	0.00918	0.00909
4	dc	Conductor Diameter	[mm]	61.3	61.3	61.3
5	s	Distance Between Conductor Axes	[mm]	1500.0	1500.0	1500.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.19933	2.18875	2.20021
9	xp	Component of Yp Calculation (Proximity Effect)		1.66254	1.65454	1.6632
10	ys	Skin Effect Factor		0.11104	0.1091	0.1112
11	yp	Proximity Effect Factor		0.00025	0.00024	0.00025
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.0101	0.01018	0.0101
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[µF/km]	0.271	0.271	0.271
16	U_0	Voltage	[kV]	127.01706	127.01706	127.01706
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	1.37316	1.37316	1.37316
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.10021	0.1012	0.10013
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	116.22348	116.22348	116.22348
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.20426	0.20426	0.20426
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.24781	0.24781	0.24781
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.18974	0.18974	0.18974
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.03618	0.03094	0.03047
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.34503	0.34846	0.34475
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	117.98	117.98	117.98
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	119.98	119.98	119.98
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	2.0	2.0	2.0
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		39.28764	39.09367	39.30371
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00251	1.00249	1.00251
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.09105	0.09016	0.09113
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00002	0.00007	0.00002
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00669	0.00004	0.0013
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00076	0.00267	0.00076
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.03694	0.03362	0.03124
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.3402	0.3402	0.3402
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	25.8	25.8	25.8
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04631	0.04631	0.04631
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	59.6	62.7	59.4
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.23537	0.23109	0.23565
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.64756	0.70047	0.64873
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	1.0	1.0	1.0
64	y	Longer Side of the Duct Bank/Backfill	[m]	4.0	4.0	4.0
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	1.19983	1.19983	1.19983
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		0.80178	0.80178	0.80178
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.64756	0.70047	0.64873
72	T_4	Total External Thermal Resistance	[K.m/W]	0.91739	0.96602	0.91885
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2279.5	2279.5	2279.5

Study Summary

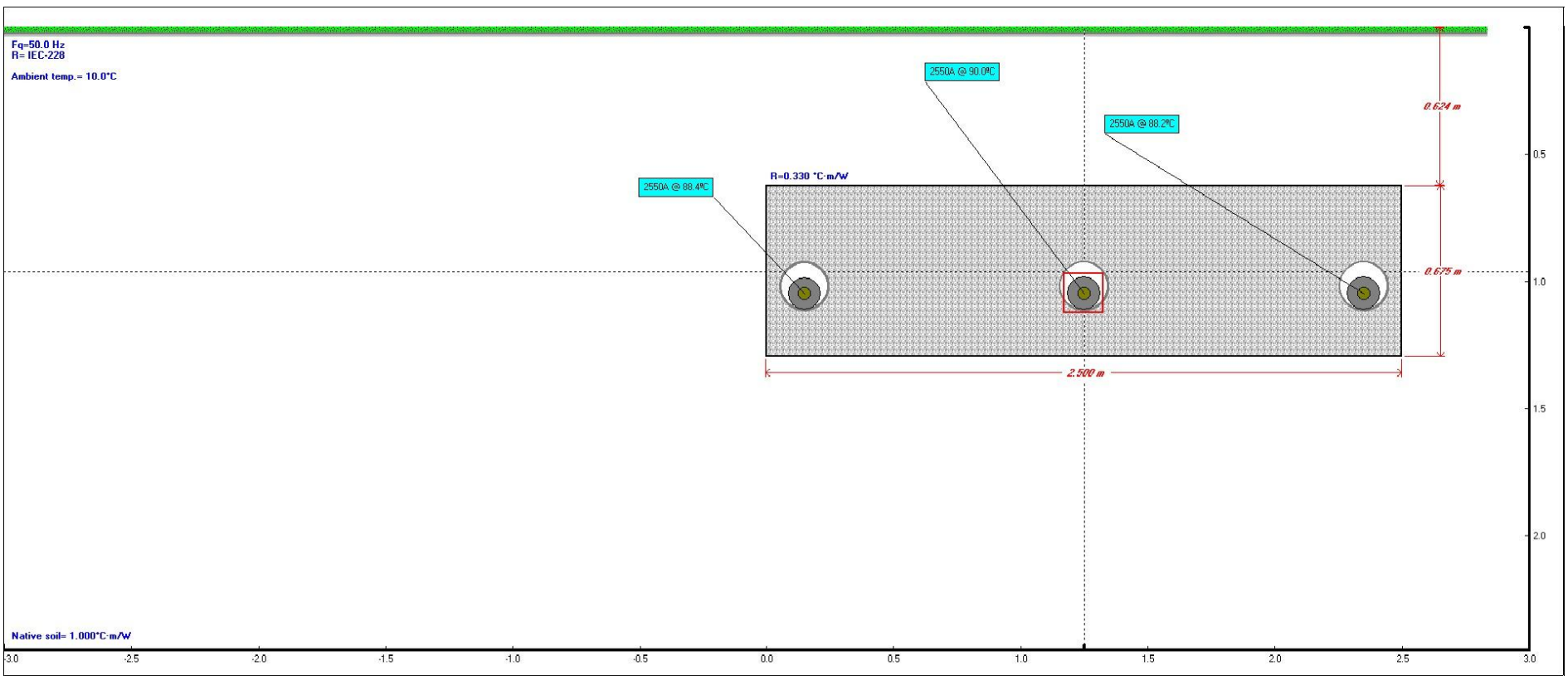
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2
Date:	18/03/2020 11:17:31

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	10.0
Native Soil Thermal Resistivity	[K.m/W]	1.0
Thermal Resistivity of Duct Bank	[K.m/W]	0.3
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	2.5
Duct Bank Height	[m]	0.68



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	220KV.011	1		A	50.0	1.0	0.15	1.05	88.4	2550.2
2	220KV.011	1		B	50.0	1.0	1.25	1.05	90.0	2550.2
3	220KV.011	1		C	50.0	1.0	2.35	1.05	88.2	2550.2

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2
Date:	18/03/2020 11:17:31

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	10
Native Soil Thermal Resistivity [K.m/W]	1.0
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		220KV.011	220KV.011	220KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	0.15	1.25	2.35
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2550.2	2550.2	2550.2
Temperatures					
θc	Conductor temperature	[°C]	88.4	90.0	88.2
θs	Sheath/Shield temperature	[°C]	65.7	67.2	65.5
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	62.5	64.0	62.3
θduct	Duct surface temperature	[°C]	43.1	44.7	43.0
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01015	0.01019	0.01014
ys	Skin Effect Factor		0.11008	0.1091	0.11022
yp	Proximity Effect Factor		0.00045	0.00045	0.00045
Losses					
Wc	Conductor Losses	[W/m]	65.98356	66.25004	65.94775
Wd	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
Ws	Metallic Screen Losses	[W/m]	2.40472	2.25926	1.98904
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	69.76143	69.88246	69.30994
λ_1	Screen Loss Factor		0.03644	0.0341	0.03016
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.3402	0.3402	0.3402
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04631	0.04631	0.04631
T4	External thermal resistance	[K.m/W]	0.75253	0.77267	0.7549
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	152.9	139.2	138.5

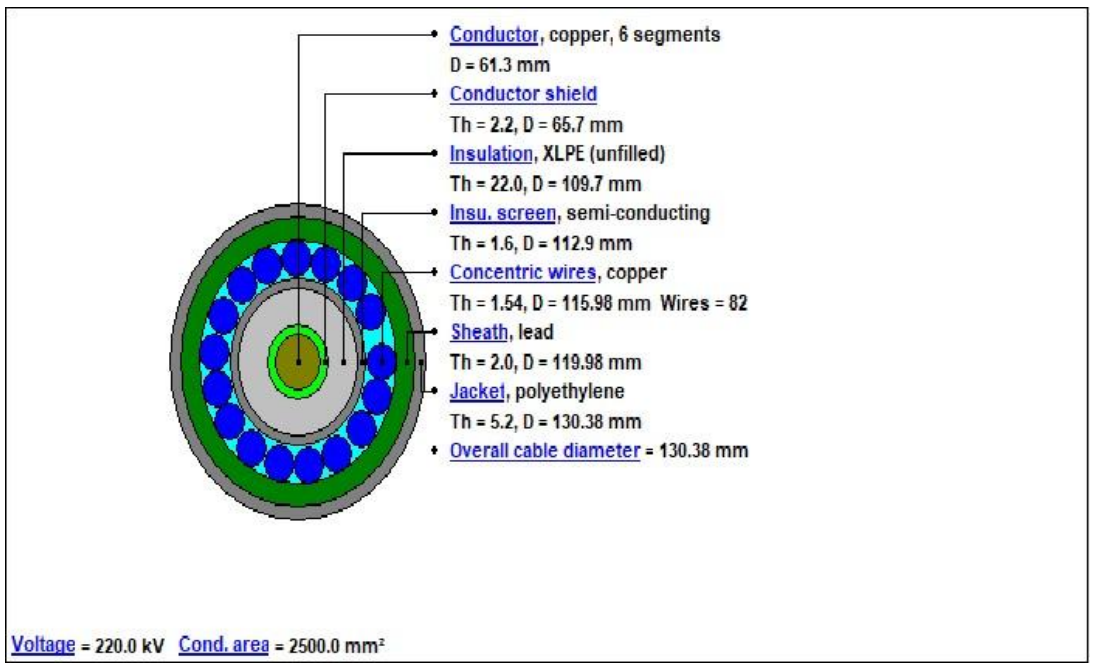
Cables Report

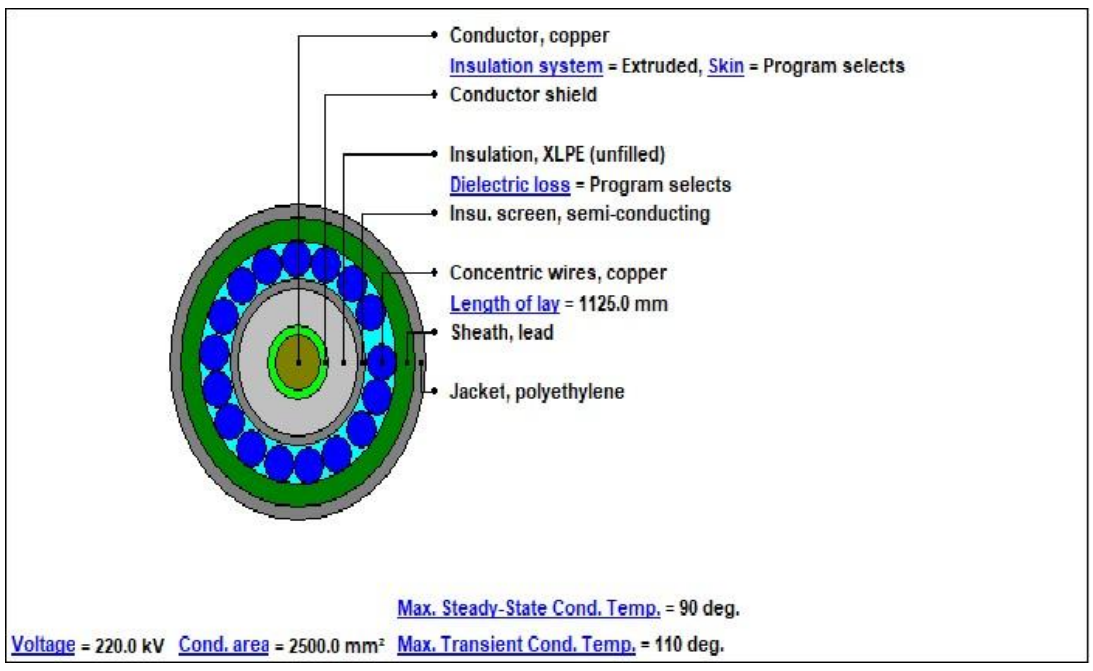
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2
Date:	18/03/2020 11:17:31

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		220KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	220
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	130.38
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	61.3
Conductor Shield			
19	Thickness	[mm]	2.2
20	Diameter	[mm]	65.7
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	22.0
27	Diameter	[mm]	109.7
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.6
30	Diameter	[mm]	112.9
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Lead
33	Electrical Resistivity at 20°C	[µΩ.cm]	21.4
34	Temperature Coefficient at 20°C	[1/K]	0.004
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	230
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	1.45
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	2.0
39	Diameter	[mm]	119.98
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1125.0
47	Number of Wires		82
48	Wire Gauge		Undefined
49	Thickness	[mm]	1.54
50	Diameter	[mm]	115.98
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	130.38

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		220KV.011
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 220KV.011	
Cable Title	2500sqmm Cu (insulated Wires)_XLPE_CWS+Pb_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2
Date:	18/03/2020 11:17:31

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**220KV.011**	**220KV.011**	**220KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00914	0.00918	0.00913
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00842	0.00842	0.00842
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01015	0.01019	0.01014
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.28869	0.28869	0.28869
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.3415	0.34323	0.34126
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.1185	0.1185	0.1185
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.1398	0.1405	0.13971
Losses					
10	Conductor Losses	[W/m]	65.98356	66.25004	65.94775
11	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
12	Metallic Screen Losses	[W/m]	2.40472	2.25926	1.98904
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	69.76143	69.88246	69.30994
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.271	0.271	0.271
16	Inductance of Conductor	[mH/km]	0.76609	0.76609	0.76609
17	Reactance of Conductor	[Ω/km]	0.24067	0.24067	0.24067
18	Inductance of Metallic Sheath	[mH/km]	0.58814	0.58814	0.58814
19	Reactance of Metallic Sheath	[Ω/km]	0.18477	0.18477	0.18477
20	Positive Sequence Impedance	[Ω/km]	0.010150 + j0.240670	0.010190 + j0.240670	0.010140 + j0.240670
21	Negative Sequence Impedance	[Ω/km]	0.010150 + j0.240670	0.010190 + j0.240670	0.010140 + j0.240670
22	Zero Sequence Impedance	[Ω/km]	0.092010 + j0.184770	0.092000 + j0.184770	0.092010 + j0.184770
23	Surge Impedance	[Ω]	53.17602	53.17602	53.17602
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	7.54233	7.54233	7.54233
25	Dielectric Stress at Insulation Surface	[kV/mm]	4.51715	4.51715	4.51715
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	14609.00643	14609.00643	14609.00643
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	10.81081	10.81081	10.81081
29	Charging Capacity of three phase system at Uo	[kvar/km]	4119.47055	4119.47055	4119.47055
30	Voltage drop for Three Phase System	[V/A/km]	0.01757	0.01764	0.01756
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	152.9	139.2	138.5

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2
Date:	18/03/2020 11:17:31

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		220KV.011	220KV.011	220KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00914	0.00918	0.00913
4	dc	Conductor Diameter	[mm]	61.3	61.3	61.3
5	s	Distance Between Conductor Axes	[mm]	1099.99995	1099.99995	1099.99995
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.19414	2.18875	2.19487
9	xp	Component of Yp Calculation (Proximity Effect)		1.65861	1.65454	1.65916
10	ys	Skin Effect Factor		0.11008	0.1091	0.11022
11	yp	Proximity Effect Factor		0.00045	0.00045	0.00045
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01015	0.01019	0.01014
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[μF/km]	0.271	0.271	0.271
16	U_0	Voltage	[kV]	127.01706	127.01706	127.01706
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	1.37316	1.37316	1.37316
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.09919	0.09969	0.09913
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	116.22348	116.22348	116.22348
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.18477	0.18477	0.18477
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.22832	0.22832	0.22832
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.17025	0.17025	0.17025
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.03512	0.02915	0.02883
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.3415	0.34323	0.34126
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	117.98	117.98	117.98
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	119.98	119.98	119.98
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	2.0	2.0	2.0
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		39.49052	39.39063	39.50401
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00253	1.00252	1.00253
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.09199	0.09153	0.09206
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00004	0.00014	0.00004
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00942	0.00005	0.00244
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00132	0.00495	0.00134
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.03644	0.0341	0.03016
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.3402	0.3402	0.3402
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	25.8	25.8	25.8
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04631	0.04631	0.04631
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	54.0	55.6	53.9
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.24371	0.24134	0.24392
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.47435	0.49687	0.47651
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.675	0.675	0.675
64	y	Longer Side of the Duct Bank/Backfill	[m]	2.5	2.5	2.5
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	0.85977	0.85977	0.85977
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		1.1189	1.1189	1.1189
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	0.33	0.33	0.33
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.47435	0.49687	0.47651
72	T_4	Total External Thermal Resistance	[K.m/W]	0.75253	0.77267	0.7549
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2550.2	2550.2	2550.2

Study Summary

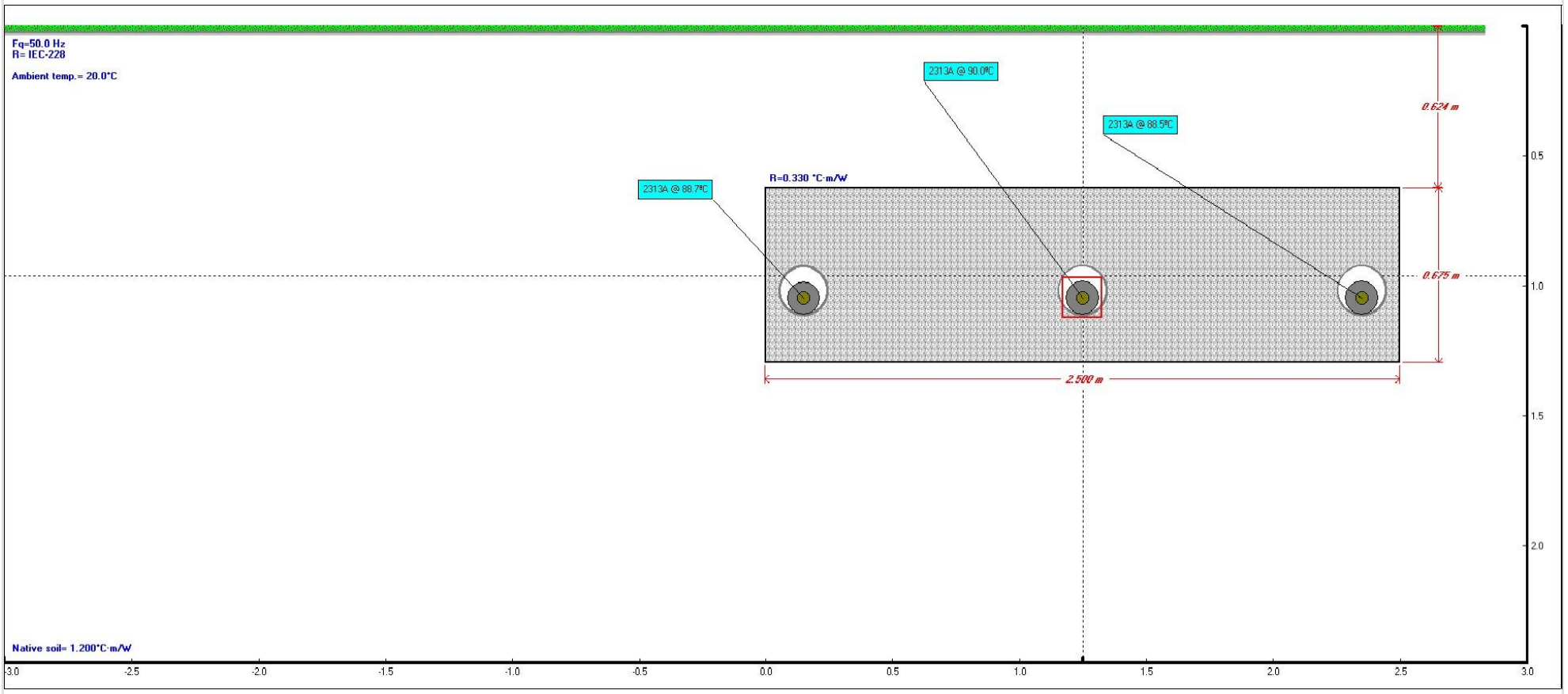
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 16:00:47

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	20.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	0.3
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	2.5
Duct Bank Height	[m]	0.68



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	220KV.011	1		A	50.0	1.0	0.15	1.05	88.7	2313.4
2	220KV.011	1		B	50.0	1.0	1.25	1.05	90.0	2313.4
3	220KV.011	1		C	50.0	1.0	2.35	1.05	88.5	2313.4

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 16:00:47

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	20
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		220KV.011	220KV.011	220KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	0.15	1.25	2.35
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2313.4	2313.4	2313.4
Temperatures					
θc	Conductor temperature	[°C]	88.7	90.0	88.5
θs	Sheath/Shield temperature	[°C]	70.0	71.2	69.8
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	67.3	68.5	67.2
θduct	Duct surface temperature	[°C]	51.8	53.1	51.7
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01015	0.01019	0.01015
ys	Skin Effect Factor		0.10991	0.1091	0.11002
yp	Proximity Effect Factor		0.00045	0.00045	0.00045
Losses					
Wc	Conductor Losses	[W/m]	54.33612	54.51722	54.31271
Wd	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
Ws	Metallic Screen Losses	[W/m]	1.99629	1.86583	1.64867
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	57.70557	57.75621	57.33453
λ_1	Screen Loss Factor		0.03674	0.03422	0.03036
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.3402	0.3402	0.3402
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04631	0.04631	0.04631
T4	External thermal resistance	[K.m/W]	0.81958	0.84053	0.82237
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	138.4	125.8	125.2

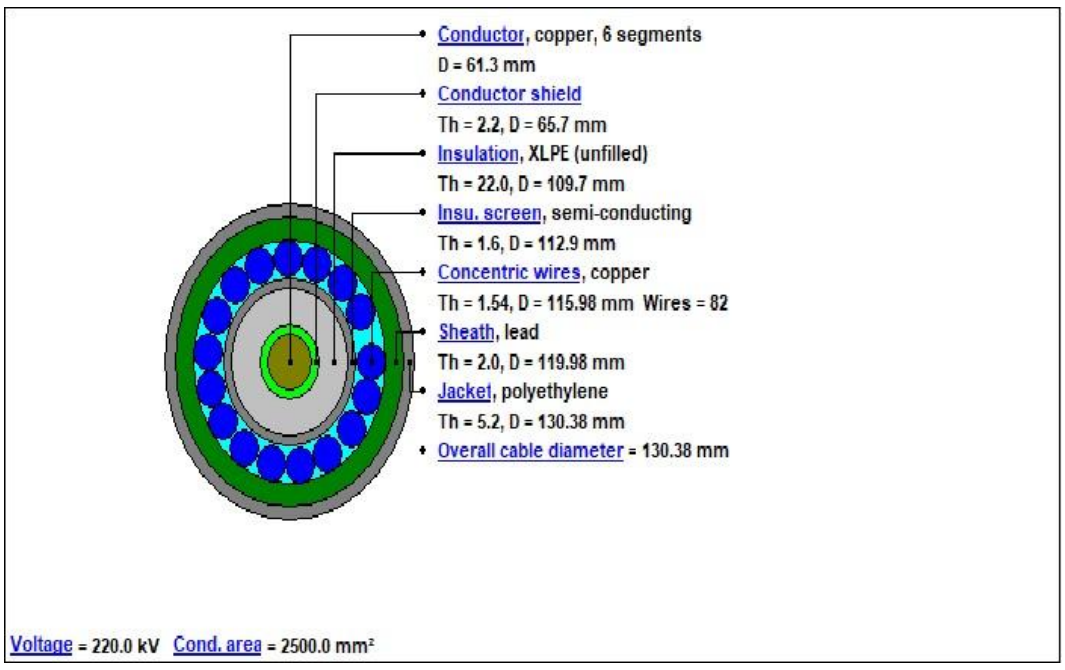
Cables Report

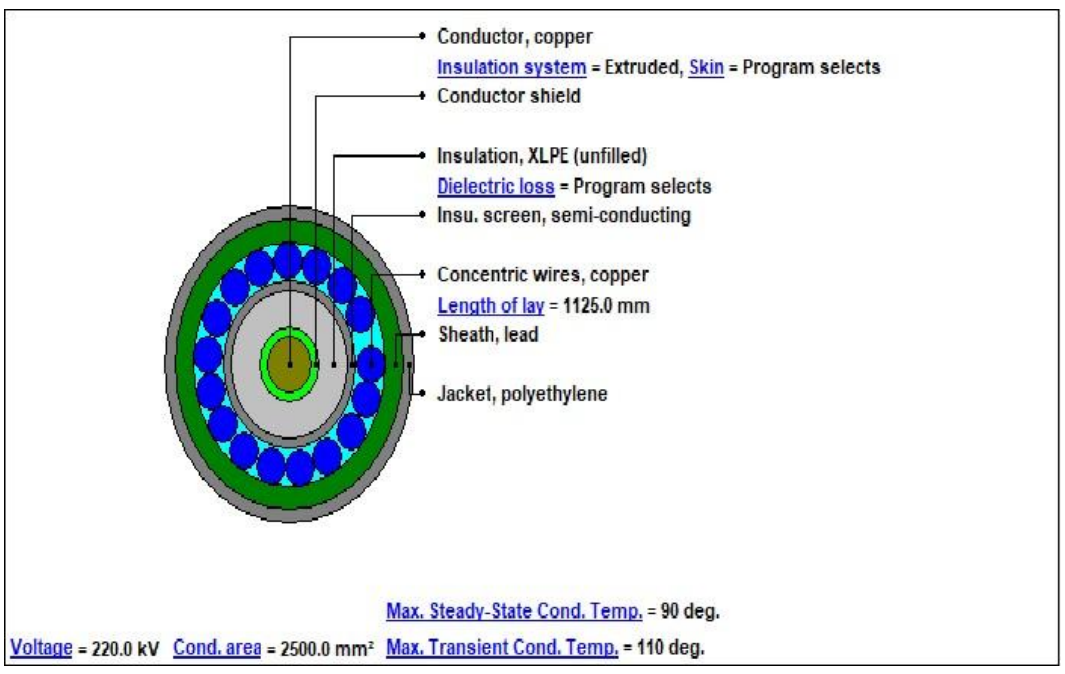
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 16:00:47

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		220KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	220
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	130.38
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	61.3
Conductor Shield			
19	Thickness	[mm]	2.2
20	Diameter	[mm]	65.7
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	22.0
27	Diameter	[mm]	109.7
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.6
30	Diameter	[mm]	112.9
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Lead
33	Electrical Resistivity at 20°C	[µΩ.cm]	21.4
34	Temperature Coefficient at 20°C	[1/K]	0.004
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	230
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	1.45
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	2.0
39	Diameter	[mm]	119.98
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1125.0
47	Number of Wires		82
48	Wire Gauge		Undefined
49	Thickness	[mm]	1.54
50	Diameter	[mm]	115.98
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	130.38

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		220KV.011
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 220KV.011	
Cable Title	2500sqmm Cu (insulated Wires)_XLPE_CWS+Pb_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 16:00:47

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**220KV.011**	**220KV.011**	**220KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00914	0.00918	0.00914
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00842	0.00842	0.00842
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01015	0.01019	0.01015
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.28869	0.28869	0.28869
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.34639	0.34783	0.3462
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.1185	0.1185	0.1185
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.14178	0.14236	0.1417
Losses					
10	Conductor Losses	[W/m]	54.33612	54.51722	54.31271
11	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
12	Metallic Screen Losses	[W/m]	1.99629	1.86583	1.64867
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	57.70557	57.75621	57.33453
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.271	0.271	0.271
16	Inductance of Conductor	[mH/km]	0.76609	0.76609	0.76609
17	Reactance of Conductor	[Ω/km]	0.24067	0.24067	0.24067
18	Inductance of Metallic Sheath	[mH/km]	0.58814	0.58814	0.58814
19	Reactance of Metallic Sheath	[Ω/km]	0.18477	0.18477	0.18477
20	Positive Sequence Impedance	[Ω/km]	0.010150 + j0.240670	0.010190 + j0.240670	0.010150 + j0.240670
21	Negative Sequence Impedance	[Ω/km]	0.010150 + j0.240670	0.010190 + j0.240670	0.010150 + j0.240670
22	Zero Sequence Impedance	[Ω/km]	0.092010 + j0.184770	0.092000 + j0.184770	0.092010 + j0.184770
23	Surge Impedance	[Ω]	53.17602	53.17602	53.17602
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	7.54233	7.54233	7.54233
25	Dielectric Stress at Insulation Surface	[kV/mm]	4.51715	4.51715	4.51715
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	14609.00643	14609.00643	14609.00643
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	10.81081	10.81081	10.81081
29	Charging Capacity of three phase system at Uo	[kvar/km]	4119.47055	4119.47055	4119.47055
30	Voltage drop for Three Phase System	[V/A/km]	0.01758	0.01764	0.01758
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	138.4	125.8	125.2

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 16:00:47

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		220KV.011	220KV.011	220KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00914	0.00918	0.00914
4	dc	Conductor Diameter	[mm]	61.3	61.3	61.3
5	s	Distance Between Conductor Axes	[mm]	1099.99995	1099.99995	1099.99995
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.19322	2.18877	2.1938
9	xp	Component of Yp Calculation (Proximity Effect)		1.65792	1.65455	1.65835
10	ys	Skin Effect Factor		0.10991	0.1091	0.11002
11	yp	Proximity Effect Factor		0.00045	0.00045	0.00045
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01015	0.01019	0.01015
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[µF/km]	0.271	0.271	0.271
16	U_0	Voltage	[kV]	127.01706	127.01706	127.01706
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	1.37316	1.37316	1.37316
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.1006	0.10102	0.10055
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	116.22348	116.22348	116.22348
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.18477	0.18477	0.18477
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.22832	0.22832	0.22832
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.17025	0.17025	0.17025
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.03544	0.02934	0.02904
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.34639	0.34783	0.3462
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	117.98	117.98	117.98
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	119.98	119.98	119.98
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	2.0	2.0	2.0
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		39.21082	39.12915	39.22142
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.0025	1.00249	1.0025
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0907	0.09032	0.09075
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00004	0.00014	0.00004
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00938	0.00005	0.00241
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.0013	0.00489	0.00132
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.03674	0.03422	0.03036
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.3402	0.3402	0.3402
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	25.8	25.8	25.8
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04631	0.04631	0.04631
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	60.5	61.8	60.4
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.23409	0.23227	0.23424
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.55103	0.5738	0.55367
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.675	0.675	0.675
64	y	Longer Side of the Duct Bank/Backfill	[m]	2.5	2.5	2.5
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	0.85977	0.85977	0.85977
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		1.1189	1.1189	1.1189
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	0.33	0.33	0.33
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.55103	0.5738	0.55367
72	T_4	Total External Thermal Resistance	[K.m/W]	0.81958	0.84053	0.82237
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2313.4	2313.4	2313.4

Study Summary

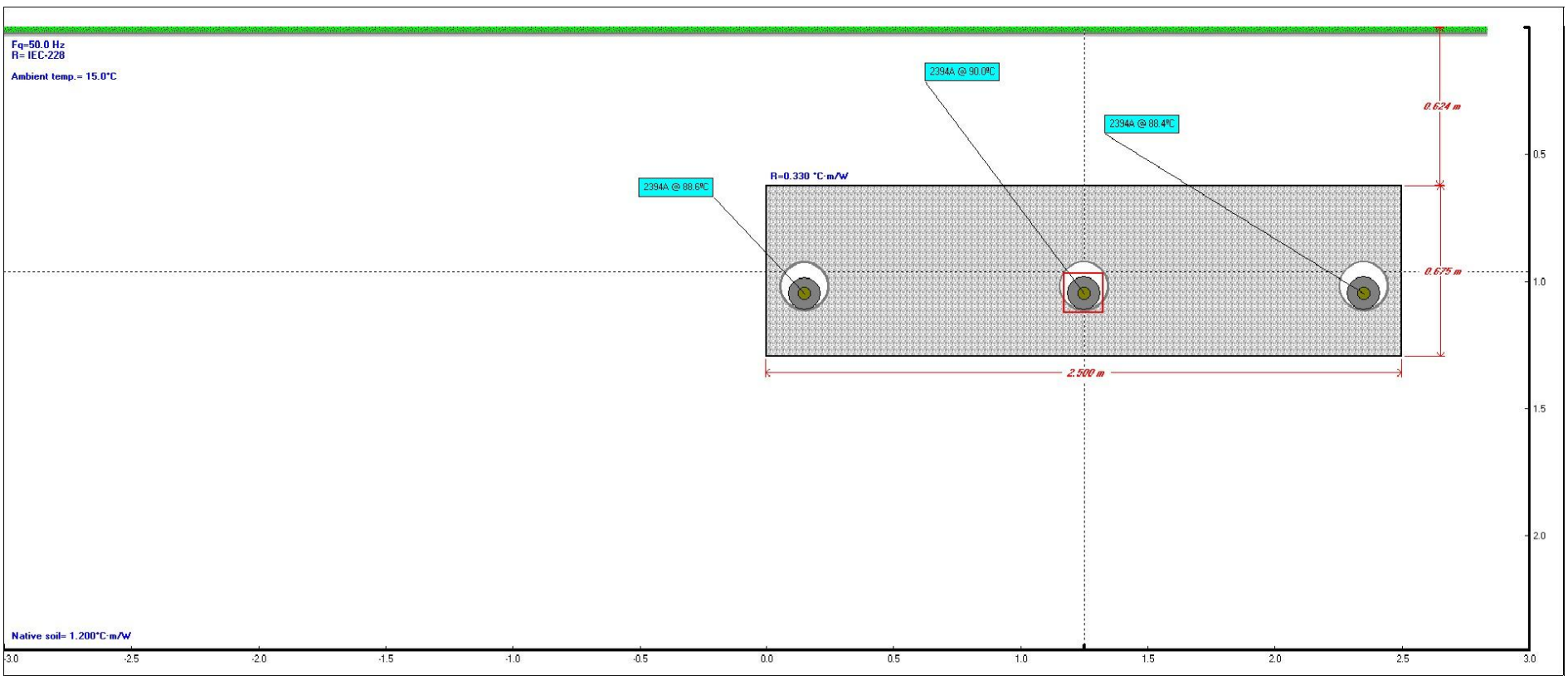
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2
Date:	17/01/2020 16:09:59

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	15.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	0.3
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	2.5
Duct Bank Height	[m]	0.68



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	220KV.011	1		A	50.0	1.0	0.15	1.05	88.6	2393.6
2	220KV.011	1		B	50.0	1.0	1.25	1.05	90.0	2393.6
3	220KV.011	1		C	50.0	1.0	2.35	1.05	88.4	2393.6

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2
Date:	17/01/2020 16:09:59

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	15
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		220KV.011	220KV.011	220KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	0.15	1.25	2.35
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2393.6	2393.6	2393.6
Temperatures					
θc	Conductor temperature	[°C]	88.6	90.0	88.4
θs	Sheath/Shield temperature	[°C]	68.6	69.9	68.4
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	65.7	67.1	65.6
θduct	Duct surface temperature	[°C]	49.0	50.4	48.9
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01015	0.01019	0.01015
ys	Skin Effect Factor		0.10997	0.1091	0.11008
yp	Proximity Effect Factor		0.00045	0.00045	0.00045
Losses					
Wc	Conductor Losses	[W/m]	58.1547	58.36176	58.12696
Wd	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
Ws	Metallic Screen Losses	[W/m]	2.13098	1.99507	1.76077
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	61.65884	61.72998	61.26089
λ_1	Screen Loss Factor		0.03664	0.03418	0.03029
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.3402	0.3402	0.3402
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04631	0.04631	0.04631
T4	External thermal resistance	[K.m/W]	0.82266	0.84331	0.82548
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	143.3	130.3	129.7

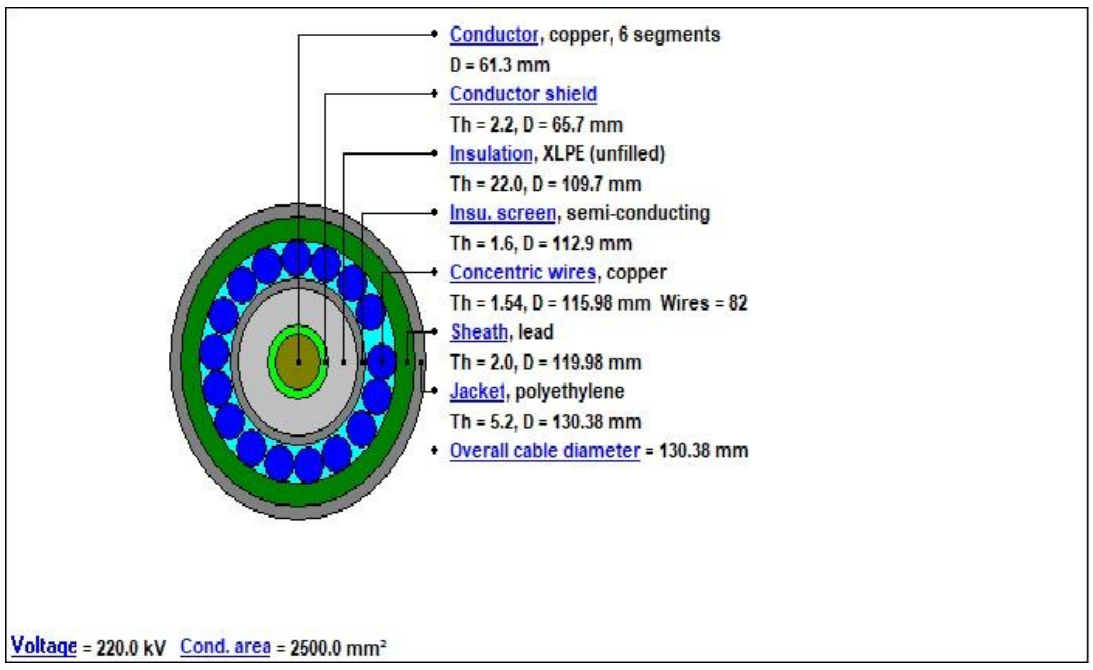
Cables Report

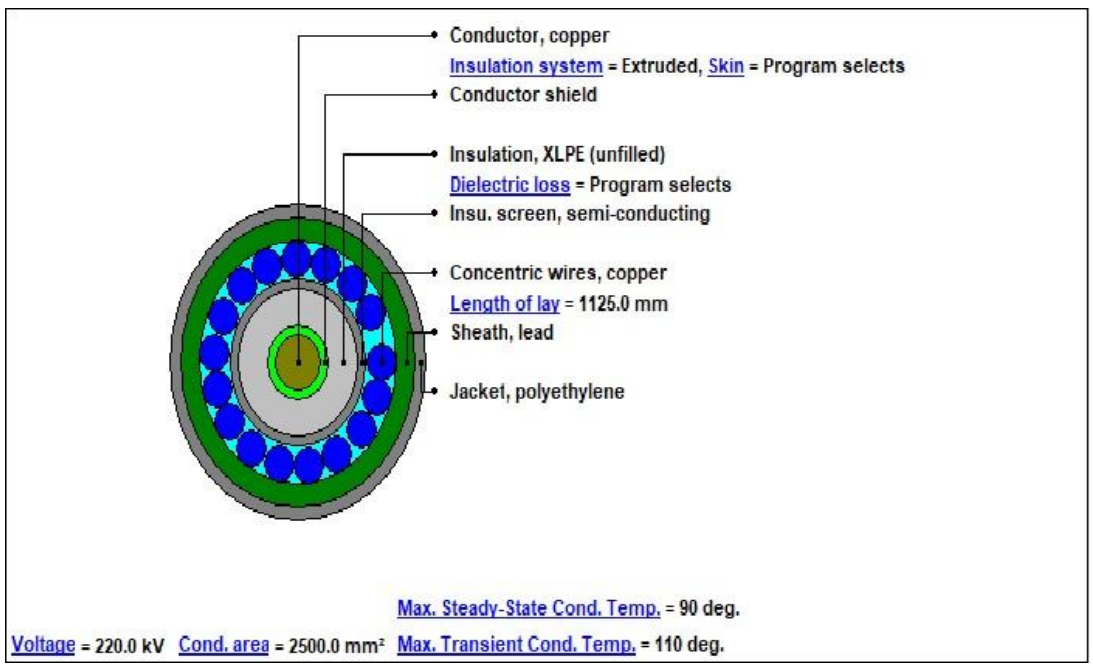
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2
Date:	17/01/2020 16:09:59

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		220KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	220
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	130.38
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	61.3
Conductor Shield			
19	Thickness	[mm]	2.2
20	Diameter	[mm]	65.7
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	22.0
27	Diameter	[mm]	109.7
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.6
30	Diameter	[mm]	112.9
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Lead
33	Electrical Resistivity at 20°C	[µΩ.cm]	21.4
34	Temperature Coefficient at 20°C	[1/K]	0.004
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	230
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	1.45
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	2.0
39	Diameter	[mm]	119.98
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1125.0
47	Number of Wires		82
48	Wire Gauge		Undefined
49	Thickness	[mm]	1.54
50	Diameter	[mm]	115.98
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	130.38

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		220KV.011
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 220KV.011	
Cable Title	2500sqmm Cu (insulated Wires)_XLPE_CWS+Pb_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2
Date:	17/01/2020 16:09:59

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**220KV.011**	**220KV.011**	**220KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00914	0.00918	0.00914
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00842	0.00842	0.00842
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01015	0.01019	0.01015
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.28869	0.28869	0.28869
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.34479	0.34633	0.34458
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.1185	0.1185	0.1185
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.14113	0.14175	0.14105
Losses					
10	Conductor Losses	[W/m]	58.1547	58.36176	58.12696
11	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
12	Metallic Screen Losses	[W/m]	2.13098	1.99507	1.76077
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	61.65884	61.72998	61.26089
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.271	0.271	0.271
16	Inductance of Conductor	[mH/km]	0.76609	0.76609	0.76609
17	Reactance of Conductor	[Ω/km]	0.24067	0.24067	0.24067
18	Inductance of Metallic Sheath	[mH/km]	0.58814	0.58814	0.58814
19	Reactance of Metallic Sheath	[Ω/km]	0.18477	0.18477	0.18477
20	Positive Sequence Impedance	[Ω/km]	0.010150 + j0.240670	0.010190 + j0.240670	0.010150 + j0.240670
21	Negative Sequence Impedance	[Ω/km]	0.010150 + j0.240670	0.010190 + j0.240670	0.010150 + j0.240670
22	Zero Sequence Impedance	[Ω/km]	0.092010 + j0.184770	0.092000 + j0.184770	0.092010 + j0.184770
23	Surge Impedance	[Ω]	53.17602	53.17602	53.17602
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	7.54233	7.54233	7.54233
25	Dielectric Stress at Insulation Surface	[kV/mm]	4.51715	4.51715	4.51715
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	14609.00643	14609.00643	14609.00643
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	10.81081	10.81081	10.81081
29	Charging Capacity of three phase system at Uo	[kvar/km]	4119.47055	4119.47055	4119.47055
30	Voltage drop for Three Phase System	[V/A/km]	0.01758	0.01764	0.01757
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	143.3	130.3	129.7

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - WIDE trench (1ct 220kV CABLE) v2
Date:	17/01/2020 16:09:59

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		220KV.011	220KV.011	220KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00914	0.00918	0.00914
4	dc	Conductor Diameter	[mm]	61.3	61.3	61.3
5	s	Distance Between Conductor Axes	[mm]	1099.99995	1099.99995	1099.99995
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.1935	2.18875	2.19414
9	xp	Component of Yp Calculation (Proximity Effect)		1.65813	1.65454	1.65861
10	ys	Skin Effect Factor		0.10997	0.1091	0.11008
11	yp	Proximity Effect Factor		0.00045	0.00045	0.00045
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01015	0.01019	0.01015
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[µF/km]	0.271	0.271	0.271
16	U_0	Voltage	[kV]	127.01706	127.01706	127.01706
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	1.37316	1.37316	1.37316
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.10014	0.10058	0.10008
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	116.22348	116.22348	116.22348
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.18477	0.18477	0.18477
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.22832	0.22832	0.22832
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.17025	0.17025	0.17025
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.03534	0.02928	0.02897
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.34479	0.34633	0.34458
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	117.98	117.98	117.98
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	119.98	119.98	119.98
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	2.0	2.0	2.0
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		39.30146	39.21396	39.31324
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00251	1.0025	1.00251
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.09112	0.09071	0.09117
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00004	0.00014	0.00004
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00939	0.00005	0.00242
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00131	0.00491	0.00132
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.03664	0.03418	0.03029
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.3402	0.3402	0.3402
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	25.8	25.8	25.8
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04631	0.04631	0.04631
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	58.4	59.8	58.3
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.23713	0.23514	0.2373
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.55106	0.57371	0.55372
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.675	0.675	0.675
64	y	Longer Side of the Duct Bank/Backfill	[m]	2.5	2.5	2.5
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	0.85977	0.85977	0.85977
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		1.1189	1.1189	1.1189
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	0.33	0.33	0.33
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.55106	0.57371	0.55372
72	T_4	Total External Thermal Resistance	[K.m/W]	0.82266	0.84331	0.82548
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2393.6	2393.6	2393.6

Study Summary

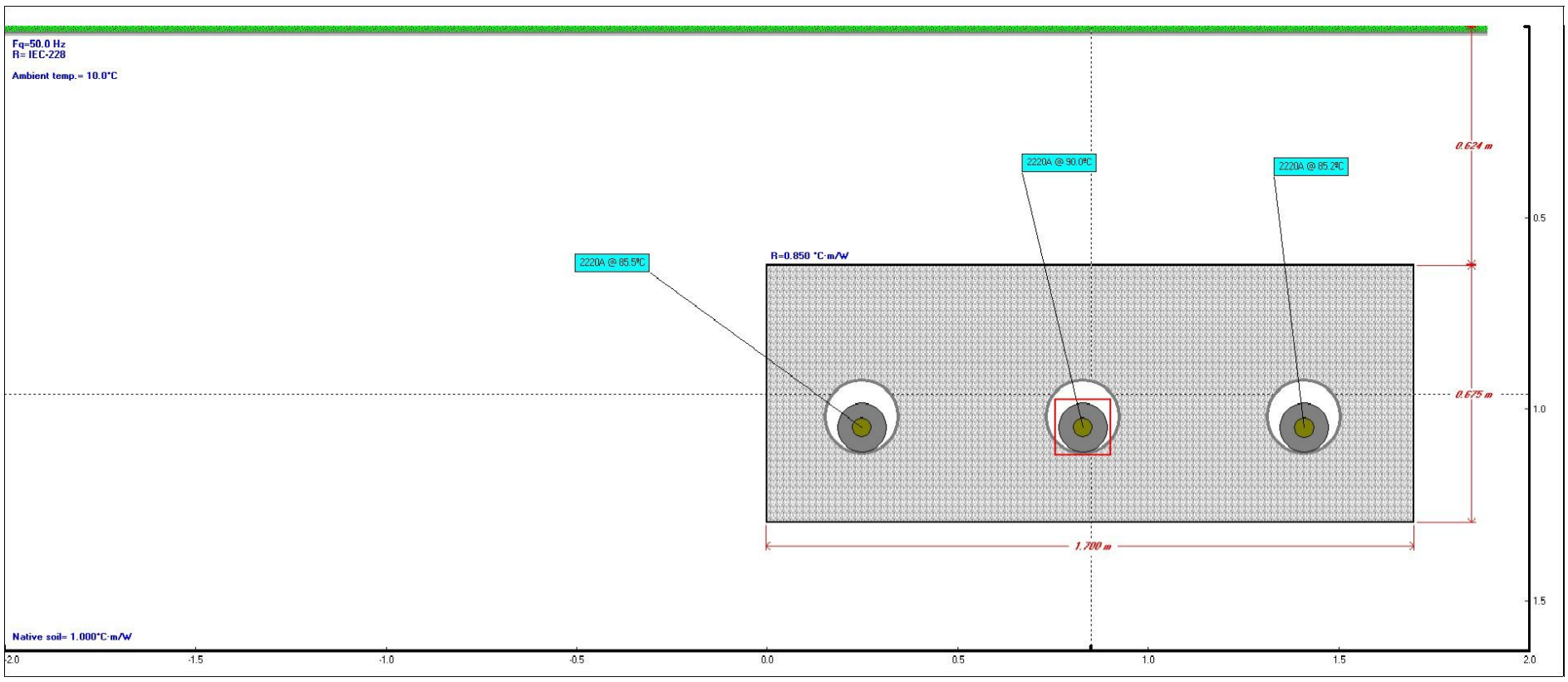
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2
Date:	18/03/2020 10:45:00

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	10.0
Native Soil Thermal Resistivity	[K.m/W]	1.0
Thermal Resistivity of Duct Bank	[K.m/W]	0.9
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	1.7
Duct Bank Height	[m]	0.68



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	220KV.011	1		A	50.0	1.0	0.25	1.05	85.5	2219.7
2	220KV.011	1		B	50.0	1.0	0.83	1.05	90.0	2219.7
3	220KV.011	1		C	50.0	1.0	1.41	1.05	85.2	2219.7

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2
Date:	18/03/2020 10:45:00

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	10
Native Soil Thermal Resistivity [K.m/W]	1.0
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		220KV.011	220KV.011	220KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	0.25	0.83	1.41
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2219.7	2219.7	2219.7
Temperatures					
θc	Conductor temperature	[°C]	85.5	90.0	85.2
θs	Sheath/Shield temperature	[°C]	68.3	72.7	68.1
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	65.9	70.2	65.6
θduct	Duct surface temperature	[°C]	51.6	56.0	51.5
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01008	0.0102	0.01007
ys	Skin Effect Factor		0.11194	0.1091	0.11211
yp	Proximity Effect Factor		0.00166	0.00162	0.00166
Losses					
Wc	Conductor Losses	[W/m]	49.66919	50.24438	49.63503
Wd	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
Ws	Metallic Screen Losses	[W/m]	1.88015	2.10722	1.48868
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	52.9225	53.72476	52.49686
λ_1	Screen Loss Factor		0.03785	0.04194	0.02999
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.3402	0.3402	0.3402
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04631	0.04631	0.04631
T4	External thermal resistance	[K.m/W]	1.05581	1.12033	1.05992
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	128.8	110.7	112.4

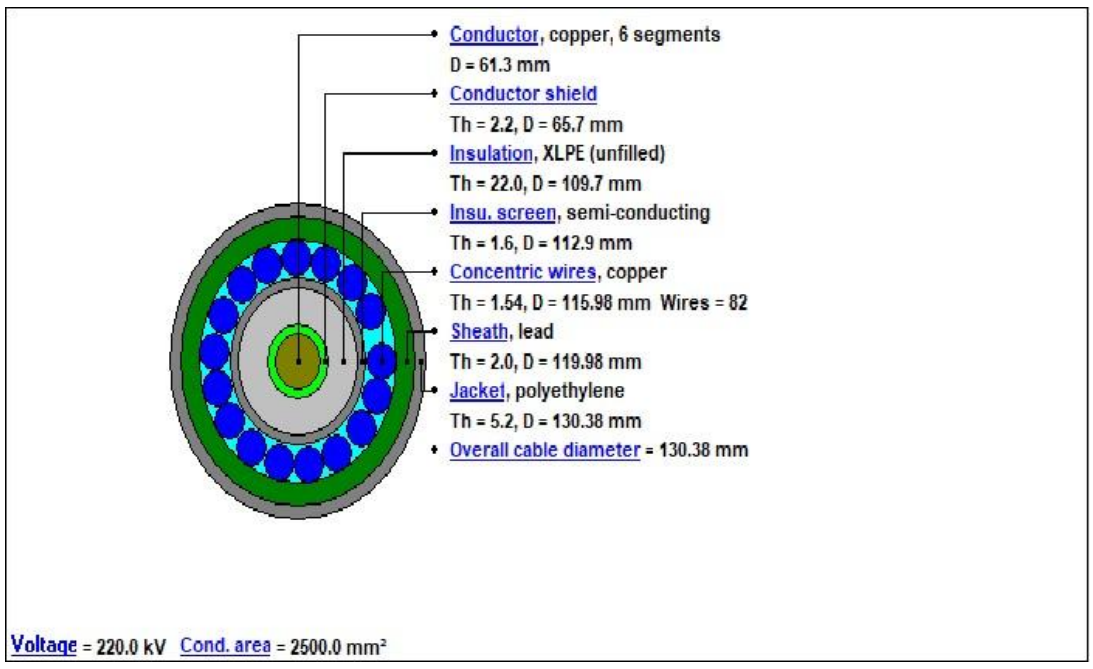
Cables Report

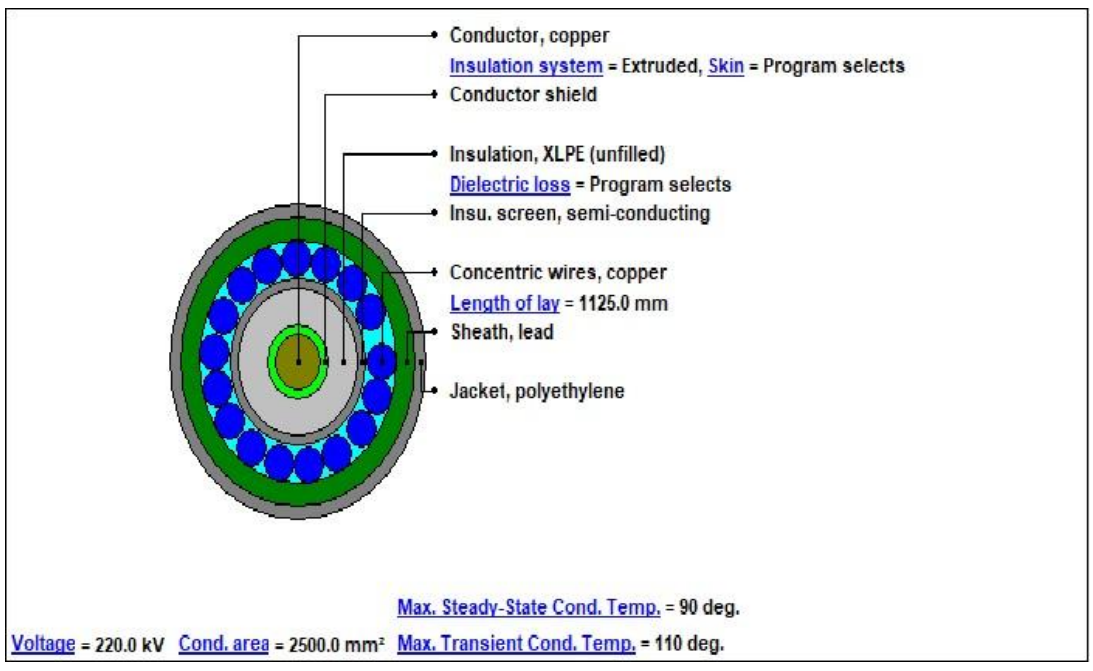
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2
Date:	18/03/2020 10:45:00

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		220KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	220
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	130.38
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	61.3
Conductor Shield			
19	Thickness	[mm]	2.2
20	Diameter	[mm]	65.7
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	22.0
27	Diameter	[mm]	109.7
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.6
30	Diameter	[mm]	112.9
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Lead
33	Electrical Resistivity at 20°C	[µΩ.cm]	21.4
34	Temperature Coefficient at 20°C	[1/K]	0.004
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	230
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	1.45
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	2.0
39	Diameter	[mm]	119.98
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1125.0
47	Number of Wires		82
48	Wire Gauge		Undefined
49	Thickness	[mm]	1.54
50	Diameter	[mm]	115.98
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	130.38

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		220KV.011
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 220KV.011	
Cable Title	2500sqmm Cu (insulated Wires)_XLPE_CWS+Pb_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2
Date:	18/03/2020 10:45:00

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**220KV.011**	**220KV.011**	**220KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00905	0.00918	0.00904
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00843	0.00843	0.00843
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01008	0.0102	0.01007
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.28869	0.28869	0.28869
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.3445	0.34952	0.3442
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.1185	0.1185	0.1185
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.14101	0.14304	0.14089
Losses					
10	Conductor Losses	[W/m]	49.66919	50.24438	49.63503
11	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
12	Metallic Screen Losses	[W/m]	1.88015	2.10722	1.48868
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	52.9225	53.72476	52.49686
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.271	0.271	0.271
16	Inductance of Conductor	[mH/km]	0.63808	0.63808	0.63808
17	Reactance of Conductor	[Ω/km]	0.20046	0.20046	0.20046
18	Inductance of Metallic Sheath	[mH/km]	0.46013	0.46013	0.46013
19	Reactance of Metallic Sheath	[Ω/km]	0.14455	0.14455	0.14455
20	Positive Sequence Impedance	[Ω/km]	0.010080 + j0.200460	0.010200 + j0.200460	0.010070 + j0.200460
21	Negative Sequence Impedance	[Ω/km]	0.010080 + j0.200460	0.010200 + j0.200460	0.010070 + j0.200460
22	Zero Sequence Impedance	[Ω/km]	0.092020 + j0.144550	0.092000 + j0.144550	0.092020 + j0.144550
23	Surge Impedance	[Ω]	48.53043	48.53043	48.53043
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	7.54233	7.54233	7.54233
25	Dielectric Stress at Insulation Surface	[kV/mm]	4.51715	4.51715	4.51715
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	14609.00643	14609.00643	14609.00643
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	10.81081	10.81081	10.81081
29	Charging Capacity of three phase system at Uo	[kvar/km]	4119.47055	4119.47055	4119.47055
30	Voltage drop for Three Phase System	[V/A/km]	0.01746	0.01766	0.01745
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	128.8	110.7	112.4

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2
Date:	18/03/2020 10:45:00

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		220KV.011	220KV.011	220KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00905	0.00918	0.00904
4	dc	Conductor Diameter	[mm]	61.3	61.3	61.3
5	s	Distance Between Conductor Axes	[mm]	580.0	580.0	580.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.20424	2.18875	2.20517
9	xp	Component of Yp Calculation (Proximity Effect)		1.66625	1.65454	1.66695
10	ys	Skin Effect Factor		0.11194	0.1091	0.11211
11	yp	Proximity Effect Factor		0.00166	0.00162	0.00166
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01008	0.0102	0.01007
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[μF/km]	0.271	0.271	0.271
16	U_0	Voltage	[kV]	127.01706	127.01706	127.01706
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	1.37316	1.37316	1.37316
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.10006	0.1015	0.09997
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	116.22348	116.22348	116.22348
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.14455	0.14455	0.14455
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.18811	0.18811	0.18811
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.13004	0.13004	0.13004
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.03344	0.02474	0.02545
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.3445	0.34952	0.3442
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	117.98	117.98	117.98
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	119.98	119.98	119.98
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	2.0	2.0	2.0
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		39.31816	39.03469	39.3352
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00251	1.00248	1.00251
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.09119	0.08988	0.09127
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00013	0.0005	0.00013
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.01888	0.00008	0.0088
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00441	0.0172	0.00454
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.03785	0.04194	0.02999
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.3402	0.3402	0.3402
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	25.8	25.8	25.8
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04631	0.04631	0.04631
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	59.7	64.0	59.5
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.23535	0.22925	0.23563
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.78599	0.85661	0.78982
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.675	0.675	0.675
64	y	Longer Side of the Duct Bank/Backfill	[m]	1.7	1.7	1.7
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	0.47741	0.47741	0.47741
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		2.01505	2.01505	2.01505
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	0.85	0.85	0.85
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.78599	0.85661	0.78982
72	T_4	Total External Thermal Resistance	[K.m/W]	1.05581	1.12033	1.05992
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2219.7	2219.7	2219.7

Study Summary

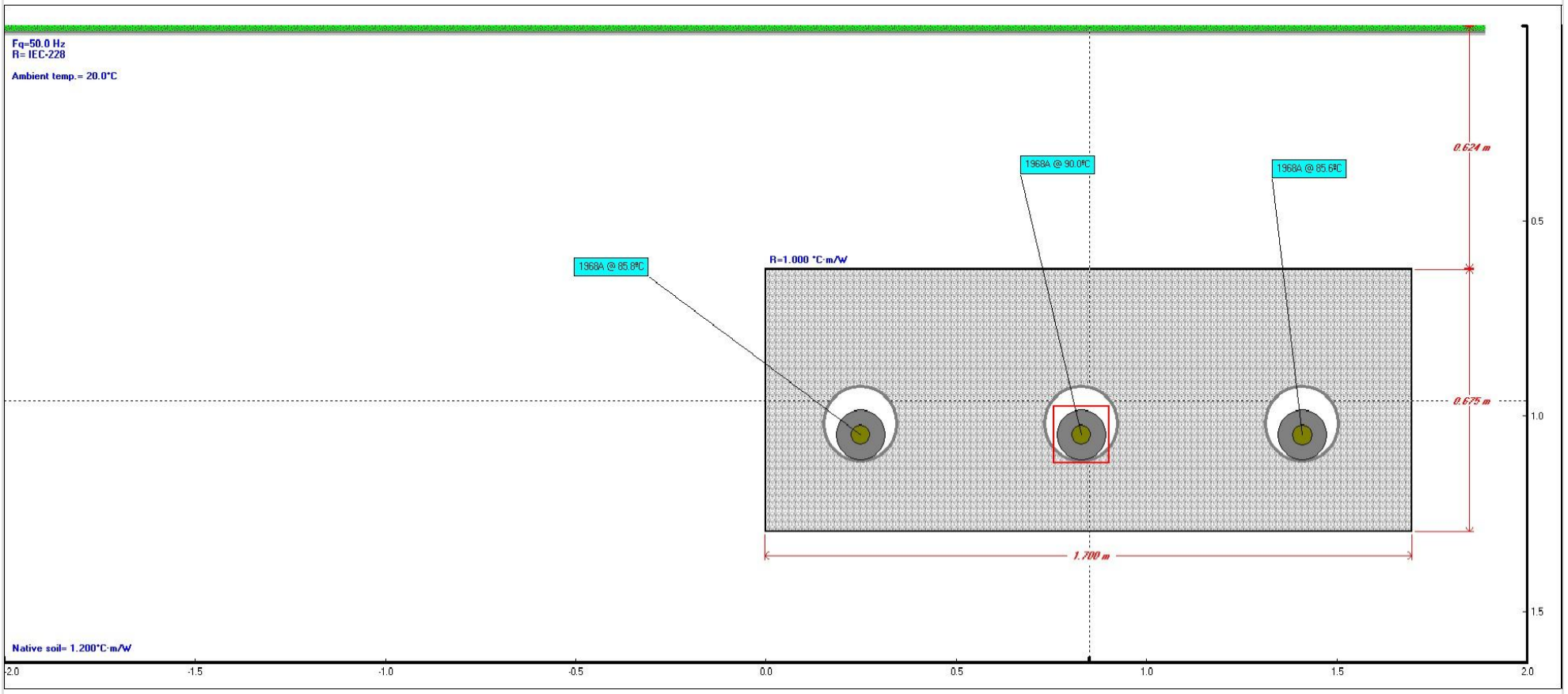
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:28:13

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	20.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	1.0
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	1.7
Duct Bank Height	[m]	0.68



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	220KV.011	1		A	50.0	1.0	0.25	1.05	85.8	1967.5
2	220KV.011	1		B	50.0	1.0	0.83	1.05	90.0	1967.5
3	220KV.011	1		C	50.0	1.0	1.41	1.05	85.6	1967.5

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:28:13

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	20
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		220KV.011	220KV.011	220KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	0.25	0.83	1.41
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	1967.5	1967.5	1967.5
Temperatures					
θc	Conductor temperature	[°C]	85.8	90.0	85.6
θs	Sheath/Shield temperature	[°C]	72.3	76.3	72.1
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	70.3	74.4	70.1
θduct	Duct surface temperature	[°C]	59.4	63.5	59.2
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01009	0.0102	0.01008
ys	Skin Effect Factor		0.11172	0.1091	0.11187
yp	Proximity Effect Factor		0.00166	0.00162	0.00166
Losses					
Wc	Conductor Losses	[W/m]	39.05692	39.47495	39.03405
Wd	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
Ws	Metallic Screen Losses	[W/m]	1.48395	1.6503	1.17305
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	41.91402	42.49841	41.58025
λ_1	Screen Loss Factor		0.03799	0.04181	0.03005
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.3402	0.3402	0.3402
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04631	0.04631	0.04631
T4	External thermal resistance	[K.m/W]	1.20096	1.27943	1.20578
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	113.9	97.6	99.3

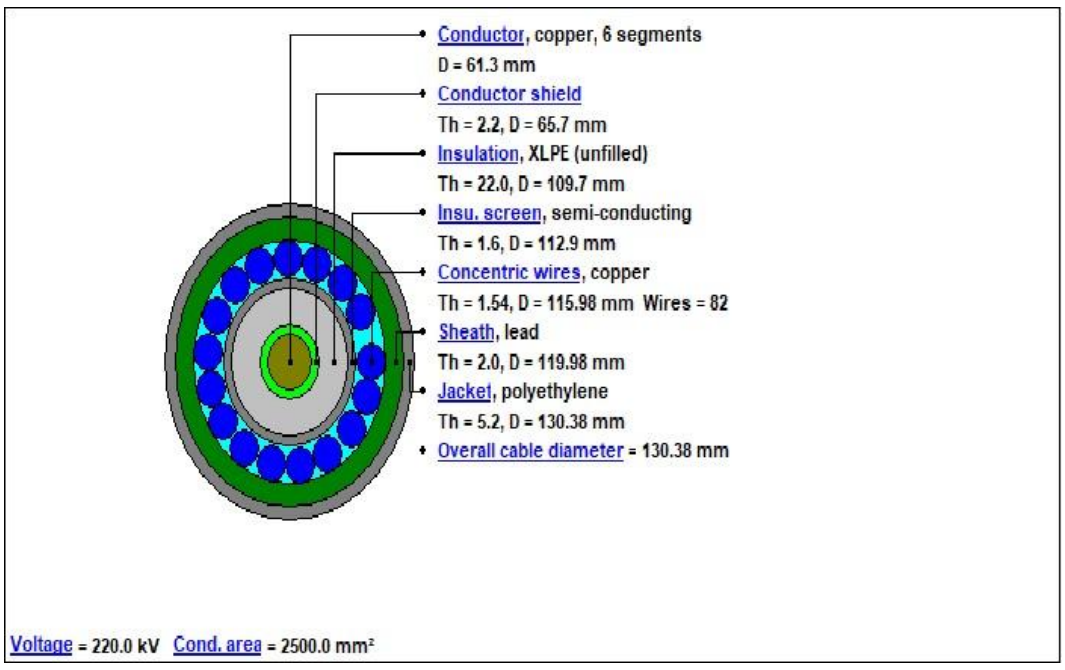
Cables Report

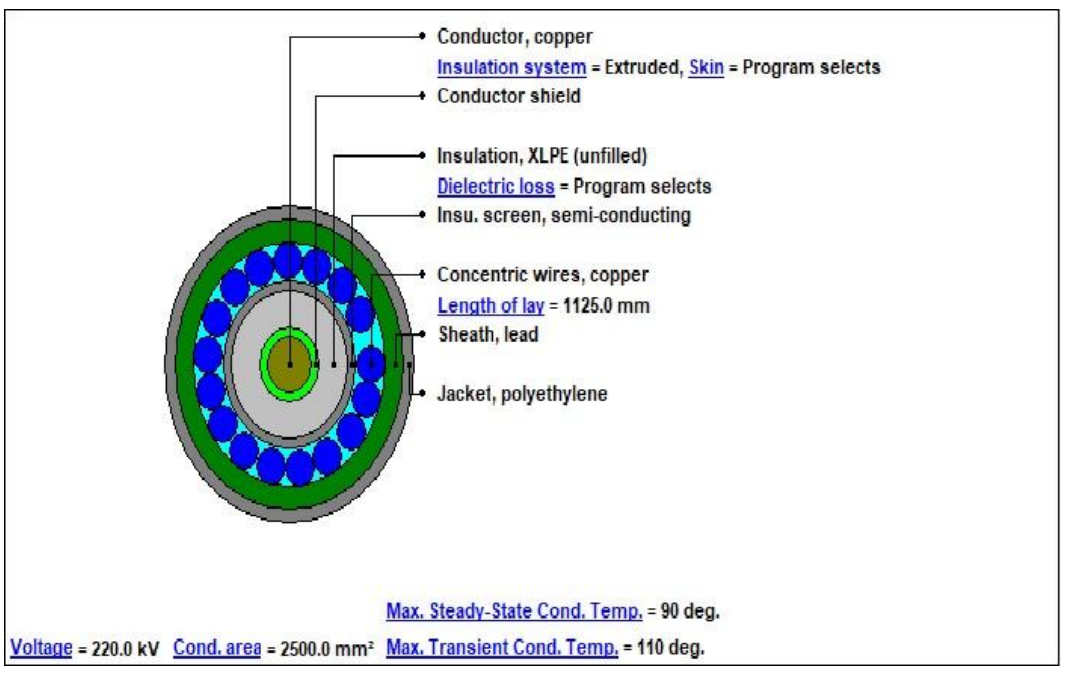
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:28:13

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		220KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	220
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	130.38
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	61.3
Conductor Shield			
19	Thickness	[mm]	2.2
20	Diameter	[mm]	65.7
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	22.0
27	Diameter	[mm]	109.7
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.6
30	Diameter	[mm]	112.9
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Lead
33	Electrical Resistivity at 20°C	[µΩ.cm]	21.4
34	Temperature Coefficient at 20°C	[1/K]	0.004
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	230
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	1.45
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	2.0
39	Diameter	[mm]	119.98
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1125.0
47	Number of Wires		82
48	Wire Gauge		Undefined
49	Thickness	[mm]	1.54
50	Diameter	[mm]	115.98
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	130.38

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		220KV.011
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 220KV.011	
Cable Title	2500sqmm Cu (insulated Wires)_XLPE_CWS+Pb_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:28:13

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**220KV.011**	**220KV.011**	**220KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00906	0.00918	0.00906
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00843	0.00843	0.00843
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01009	0.0102	0.01008
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.28869	0.28869	0.28869
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.34906	0.35375	0.3488
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.1185	0.1185	0.1185
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.14285	0.14475	0.14275
Losses					
10	Conductor Losses	[W/m]	39.05692	39.47495	39.03405
11	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
12	Metallic Screen Losses	[W/m]	1.48395	1.6503	1.17305
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	41.91402	42.49841	41.58025
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.271	0.271	0.271
16	Inductance of Conductor	[mH/km]	0.63808	0.63808	0.63808
17	Reactance of Conductor	[Ω/km]	0.20046	0.20046	0.20046
18	Inductance of Metallic Sheath	[mH/km]	0.46013	0.46013	0.46013
19	Reactance of Metallic Sheath	[Ω/km]	0.14455	0.14455	0.14455
20	Positive Sequence Impedance	[Ω/km]	0.010090 + j0.200460	0.010200 + j0.200460	0.010080 + j0.200460
21	Negative Sequence Impedance	[Ω/km]	0.010090 + j0.200460	0.010200 + j0.200460	0.010080 + j0.200460
22	Zero Sequence Impedance	[Ω/km]	0.092020 + j0.144550	0.092000 + j0.144550	0.092020 + j0.144550
23	Surge Impedance	[Ω]	48.53043	48.53043	48.53043
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	7.54233	7.54233	7.54233
25	Dielectric Stress at Insulation Surface	[kV/mm]	4.51715	4.51715	4.51715
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	14609.00643	14609.00643	14609.00643
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	10.81081	10.81081	10.81081
29	Charging Capacity of three phase system at Uo	[kvar/km]	4119.47055	4119.47055	4119.47055
30	Voltage drop for Three Phase System	[V/A/km]	0.01748	0.01766	0.01747
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	113.9	97.6	99.3

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2 - Summer (20C)
Date:	02/03/2020 15:28:13

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		220KV.011	220KV.011	220KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00906	0.00918	0.00906
4	dc	Conductor Diameter	[mm]	61.3	61.3	61.3
5	s	Distance Between Conductor Axes	[mm]	580.0	580.0	580.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.20306	2.18874	2.20385
9	xp	Component of Yp Calculation (Proximity Effect)		1.66536	1.65454	1.66596
10	ys	Skin Effect Factor		0.11172	0.1091	0.11187
11	yp	Proximity Effect Factor		0.00166	0.00162	0.00166
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01009	0.0102	0.01008
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[µF/km]	0.271	0.271	0.271
16	U_0	Voltage	[kV]	127.01706	127.01706	127.01706
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	1.37316	1.37316	1.37316
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.10137	0.10272	0.10129
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	116.22348	116.22348	116.22348
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.14455	0.14455	0.14455
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.18811	0.18811	0.18811
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.13004	0.13004	0.13004
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.03364	0.02481	0.02558
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.34906	0.35375	0.3488
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	117.98	117.98	117.98
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	119.98	119.98	119.98
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	2.0	2.0	2.0
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		39.06026	38.8005	39.07464
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00249	1.00246	1.00249
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.09	0.08881	0.09007
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00012	0.00049	0.00012
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.01879	0.00008	0.00872
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00435	0.017	0.00448
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.03799	0.04181	0.03005
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.3402	0.3402	0.3402
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	25.8	25.8	25.8
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04631	0.04631	0.04631
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	65.6	69.7	65.4
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.22717	0.22187	0.2274
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.93932	1.02309	0.94391
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.675	0.675	0.675
64	y	Longer Side of the Duct Bank/Backfill	[m]	1.7	1.7	1.7
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	0.47741	0.47741	0.47741
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		2.01505	2.01505	2.01505
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.93932	1.02309	0.94391
72	T_4	Total External Thermal Resistance	[K.m/W]	1.20096	1.27943	1.20578
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	1967.5	1967.5	1967.5

Study Summary

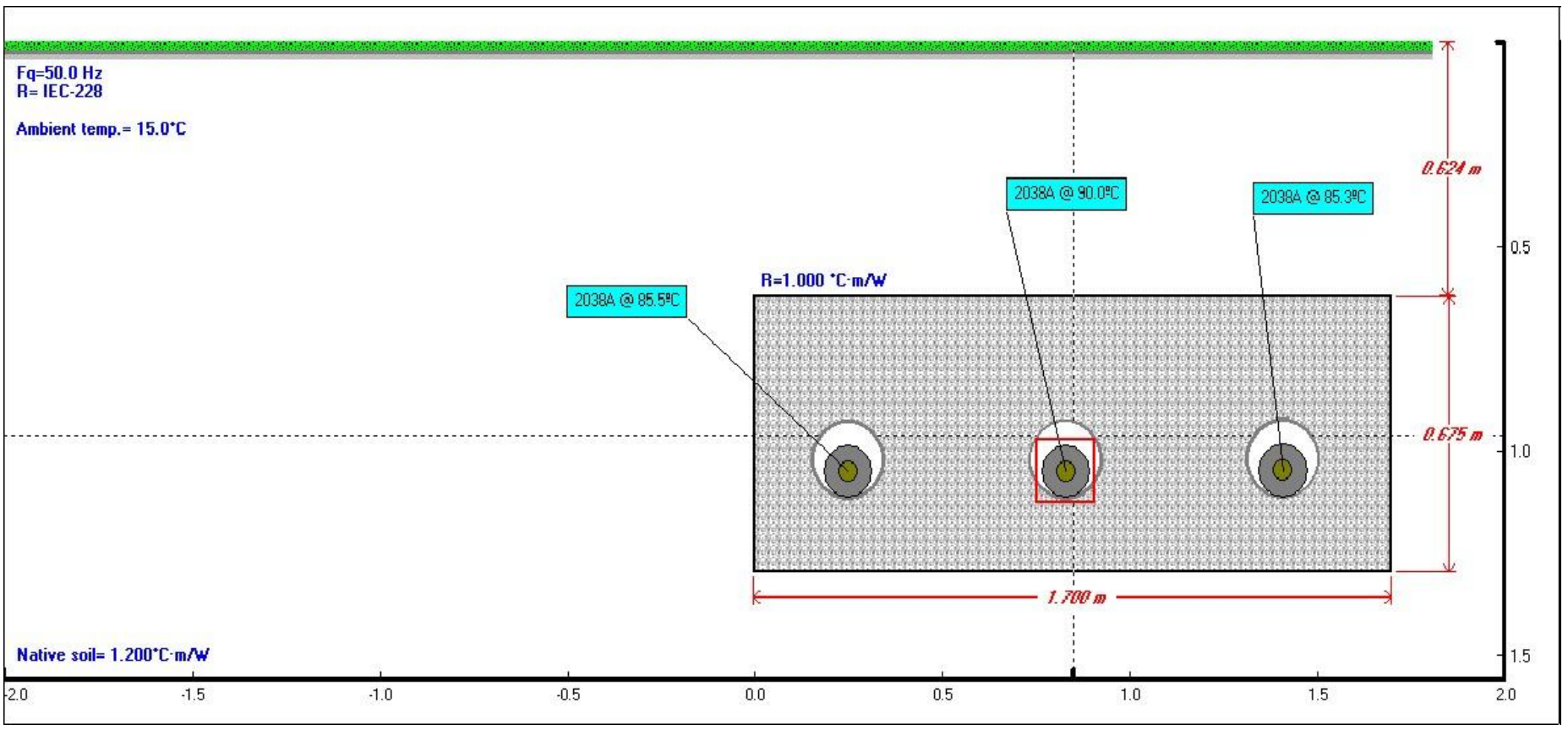
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2
Date:	16/01/2020 14:02:08

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	15.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	1.0
Depth of Center of Duct Bank	[m]	0.96
Duct Bank Width	[m]	1.7
Duct Bank Height	[m]	0.68



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	220KV.011	1		A	50.0	1.0	0.25	1.05	85.5	2037.6
2	220KV.011	1		B	50.0	1.0	0.83	1.05	90.0	2037.6
3	220KV.011	1		C	50.0	1.0	1.41	1.05	85.3	2037.6

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2
Date:	16/01/2020 14:02:08

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	15
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		220KV.011	220KV.011	220KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	0.25	0.83	1.41
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2037.6	2037.6	2037.6
Temperatures					
θc	Conductor temperature	[°C]	85.5	90.0	85.3
θs	Sheath/Shield temperature	[°C]	71.0	75.4	70.8
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	69.0	73.3	68.7
θduct	Duct surface temperature	[°C]	57.1	61.5	57.0
Resistances					
R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01008	0.0102	0.01008
ys	Skin Effect Factor		0.11192	0.1091	0.11207
yp	Proximity Effect Factor		0.00166	0.00162	0.00166
Losses					
Wc	Conductor Losses	[W/m]	41.85832	42.33914	41.83198
Wd	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
Ws	Metallic Screen Losses	[W/m]	1.58932	1.77154	1.25699
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	44.8208	45.48384	44.46212
λ_1	Screen Loss Factor		0.03797	0.04184	0.03005
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.3402	0.3402	0.3402
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04631	0.04631	0.04631
T4	External thermal resistance	[K.m/W]	1.20356	1.28091	1.20842
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	118.0	101.3	102.9

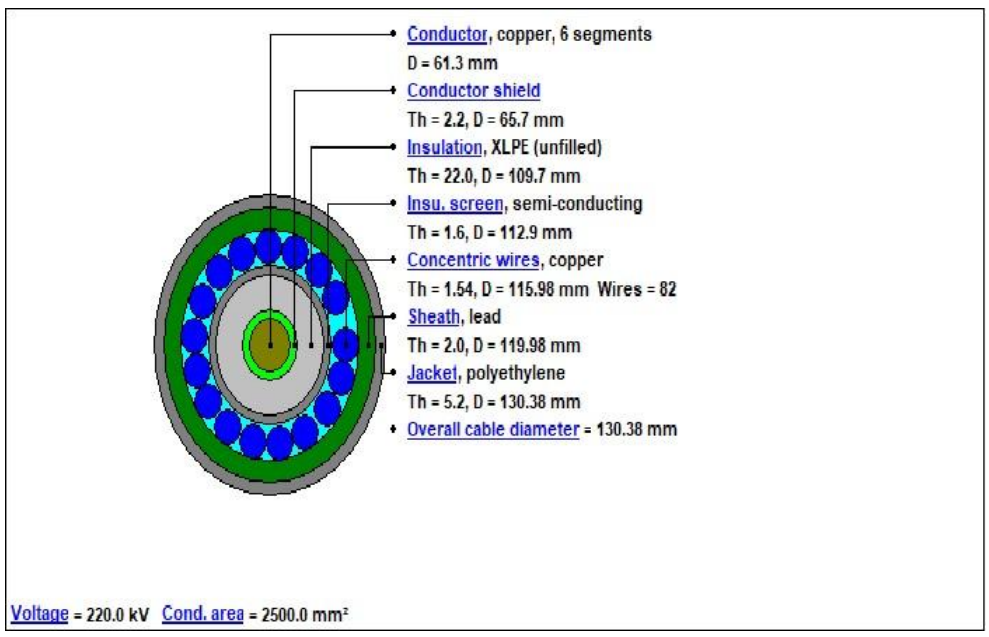
Cables Report

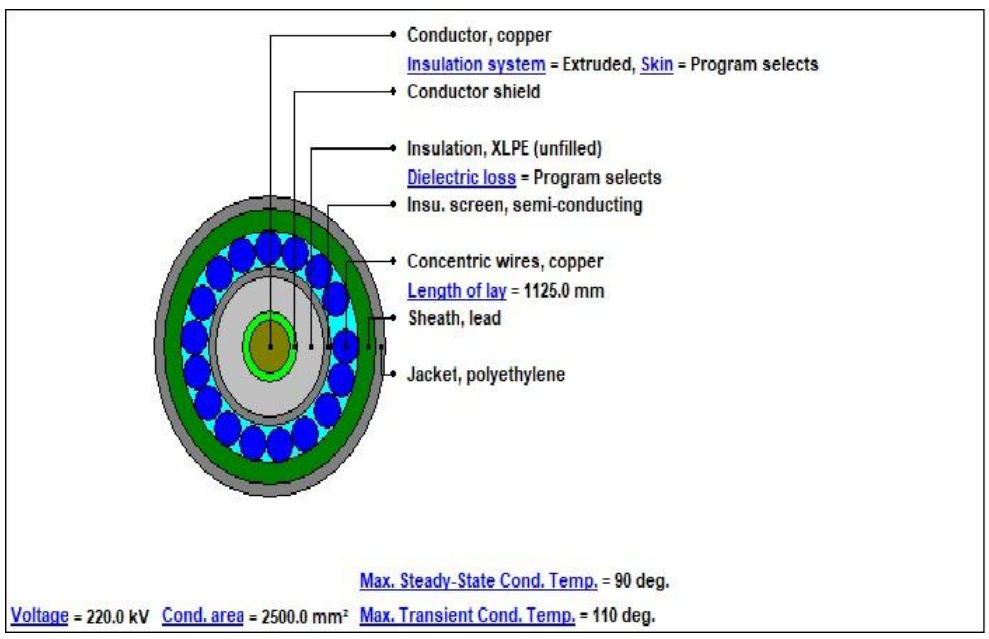
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2
Date:	16/01/2020 14:02:08

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		220KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	220
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	130.38
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	61.3
Conductor Shield			
19	Thickness	[mm]	2.2
20	Diameter	[mm]	65.7
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	22.0
27	Diameter	[mm]	109.7
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.6
30	Diameter	[mm]	112.9
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Lead
33	Electrical Resistivity at 20°C	[µΩ.cm]	21.4
34	Temperature Coefficient at 20°C	[1/K]	0.004
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	230
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	1.45
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	2.0
39	Diameter	[mm]	119.98
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1125.0
47	Number of Wires		82
48	Wire Gauge		Undefined
49	Thickness	[mm]	1.54
50	Diameter	[mm]	115.98
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	130.38

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		220KV.011
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 220KV.011	
Cable Title	2500sqmm Cu (insulated Wires)_XLPE_CWS+Pb_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2
Date:	16/01/2020 14:02:08

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**220KV.011**	**220KV.011**	**220KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00905	0.00918	0.00905
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00843	0.00843	0.00843
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01008	0.0102	0.01008
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.28869	0.28869	0.28869
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.34761	0.35262	0.34733
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.1185	0.1185	0.1185
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.14227	0.14429	0.14216
Losses					
10	Conductor Losses	[W/m]	41.85832	42.33914	41.83198
11	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
12	Metallic Screen Losses	[W/m]	1.58932	1.77154	1.25699
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	44.8208	45.48384	44.46212
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.271	0.271	0.271
16	Inductance of Conductor	[mH/km]	0.63808	0.63808	0.63808
17	Reactance of Conductor	[Ω/km]	0.20046	0.20046	0.20046
18	Inductance of Metallic Sheath	[mH/km]	0.46013	0.46013	0.46013
19	Reactance of Metallic Sheath	[Ω/km]	0.14455	0.14455	0.14455
20	Positive Sequence Impedance	[Ω/km]	0.010080 + j0.200460	0.010200 + j0.200460	0.010080 + j0.200460
21	Negative Sequence Impedance	[Ω/km]	0.010080 + j0.200460	0.010200 + j0.200460	0.010080 + j0.200460
22	Zero Sequence Impedance	[Ω/km]	0.092020 + j0.144550	0.092000 + j0.144550	0.092020 + j0.144550
23	Surge Impedance	[Ω]	48.53043	48.53043	48.53043
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	7.54233	7.54233	7.54233
25	Dielectric Stress at Insulation Surface	[kV/mm]	4.51715	4.51715	4.51715
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	14609.00643	14609.00643	14609.00643
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	10.81081	10.81081	10.81081
29	Charging Capacity of three phase system at Uo	[kvar/km]	4119.47055	4119.47055	4119.47055
30	Voltage drop for Three Phase System	[V/A/km]	0.01746	0.01766	0.01745
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	118.0	101.3	102.9

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - std trench (1ct 220kV CABLE) v2
Date:	16/01/2020 14:02:08

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		220KV.011	220KV.011	220KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_0	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00905	0.00918	0.00905
4	dc	Conductor Diameter	[mm]	61.3	61.3	61.3
5	s	Distance Between Conductor Axes	[mm]	580.0	580.0	580.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.20411	2.18875	2.20496
9	xp	Component of Yp Calculation (Proximity Effect)		1.66615	1.65454	1.6668
10	ys	Skin Effect Factor		0.11192	0.1091	0.11207
11	yp	Proximity Effect Factor		0.00166	0.00162	0.00166
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01008	0.0102	0.01008
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[µF/km]	0.271	0.271	0.271
16	U_0	Voltage	[kV]	127.01706	127.01706	127.01706
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	1.37316	1.37316	1.37316
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.10095	0.10239	0.10087
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	116.22348	116.22348	116.22348
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.14455	0.14455	0.14455
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.18811	0.18811	0.18811
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.13004	0.13004	0.13004
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.0336	0.02479	0.02555
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.34761	0.35262	0.34733
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	117.98	117.98	117.98
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	119.98	119.98	119.98
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	2.0	2.0	2.0
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		39.14181	38.86239	39.15731
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00249	1.00247	1.0025
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.09038	0.08909	0.09045
35	λ_0	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00013	0.00049	0.00013
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.01882	0.00008	0.00875
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00437	0.01705	0.0045
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.03797	0.04184	0.03005
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.3402	0.3402	0.3402
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	25.8	25.8	25.8
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04631	0.04631	0.04631
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	63.8	68.2	63.6
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.22956	0.22377	0.22982
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.93953	1.02267	0.94414
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.675	0.675	0.675
64	y	Longer Side of the Duct Bank/Backfill	[m]	1.7	1.7	1.7
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	0.47741	0.47741	0.47741
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	0.962	0.962	0.962
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		2.01505	2.01505	2.01505
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.93953	1.02267	0.94414
72	T_4	Total External Thermal Resistance	[K.m/W]	1.20356	1.28091	1.20842
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2037.6	2037.6	2037.6

Study Summary

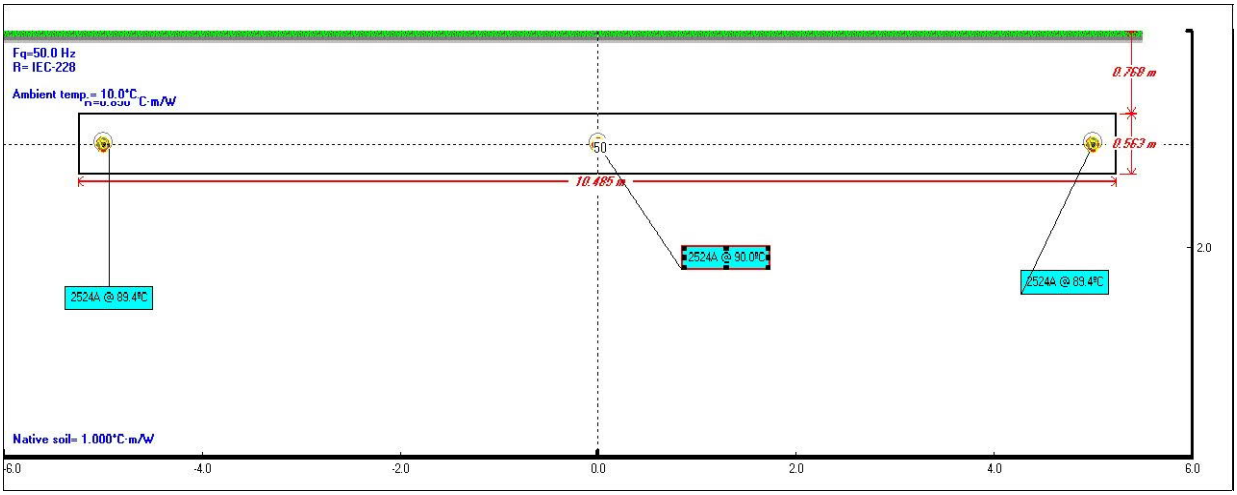
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:55:53

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	10.0
Native Soil Thermal Resistivity	[K.m/W]	1.0
Thermal Resistivity of Duct Bank	[K.m/W]	0.9
Depth of Center of Duct Bank	[m]	1.05
Duct Bank Width	[m]	10.49
Duct Bank Height	[m]	0.56



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	400KV.032	1		A	50.0	1.0	-5.0	1.05	89.4	2523.7
2	400KV.032	1		B	50.0	1.0	0.0	1.05	90.0	2523.7
3	400KV.032	1		C	50.0	1.0	5.0	1.05	89.4	2523.7

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:55:53

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	10
Native Soil Thermal Resistivity [K.m/W]	1.0
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		400KV.032	400KV.032	400KV.032
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	-5.0	0.0	5.0
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2523.7	2523.7	2523.7
Temperatures					
θc	Conductor temperature	[°C]	89.4	90.0	89.4
θs	Sheath/Shield temperature	[°C]	64.4	64.9	64.3
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	61.3	61.9	61.3
θduct	Duct surface temperature	[°C]	42.4	43.0	42.4
Resistances					
R_o	DC Resistance of the conductor at 20°C	[Ω/km]	0.00586	0.00586	0.00586
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01041	0.01042	0.01041
ys	Skin Effect Factor		0.39468	0.3937	0.39476
yp	Proximity Effect Factor		0.00008	0.00008	0.00008
Losses					
Wc	Conductor Losses	[W/m]	66.28068	66.3506	66.27516
Wd	Dielectric Losses	[W/m]	4.00787	4.00787	4.00787
Ws	Metallic Screen Losses	[W/m]	1.14406	1.1141	1.08469
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	71.4326	71.47256	71.36771
λ_1	Screen Loss Factor		0.01726	0.01679	0.01637
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.36693	0.36693	0.36693
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.0429	0.0429	0.0429
T4	External thermal resistance	[K.m/W]	0.7183	0.7255	0.7184
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	159.9	157.3	155.7

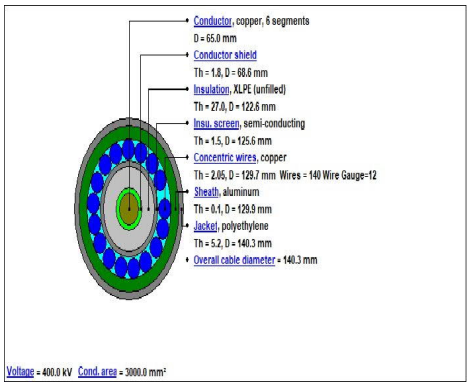
Cables Report

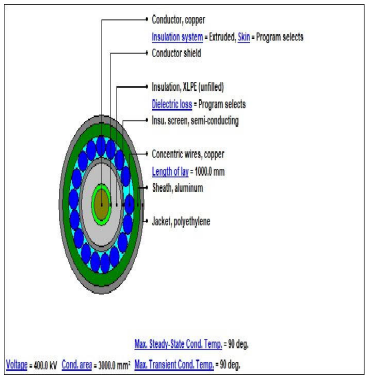
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:55:53

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		400KV.032
2	Number of Cores		Single Core
3	Voltage	[kV]	400
4	Conductor Area	[mm²]	3000.0
5	Cable Overall Diameter	[mm]	140.3
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	90
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Bare Unidirectional Wires
16	Ks (Skin Effect Coefficient)		0.62
17	Kp (Proximity Effect Coefficient)		0.37
18	Diameter	[mm]	65.0
Conductor Shield			
19	Thickness	[mm]	1.8
20	Diameter	[mm]	68.6
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	27.0
27	Diameter	[mm]	122.6
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.5
30	Diameter	[mm]	125.6
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Aluminum
33	Electrical Resistivity at 20°C	[µΩ.cm]	2.84
34	Temperature Coefficient at 20°C	[1/K]	0.00403
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	228
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	2.5
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	0.1
39	Diameter	[mm]	129.9
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1000.0
47	Number of Wires		140
48	Wire Gauge		12
49	Thickness	[mm]	2.05
50	Diameter	[mm]	129.7
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	140.3

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		400KV.032
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 400KV.032	
Cable Title	3000sqmm milliken Cu_xlpe_cws_pe (Generic design)





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:55:53

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**400KV.032**	**400KV.032**	**400KV.032**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.00586	0.00586	0.00586
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00746	0.00747	0.00746
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00907	0.00907	0.00907
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01041	0.01042	0.01041
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.69646	0.69646	0.69646
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.821	0.82253	0.82088
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.0402	0.0402	0.0402
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.04721	0.0473	0.0472
Losses					
10	Conductor Losses	[W/m]	66.28068	66.3506	66.27516
11	Dielectric Losses	[W/m]	4.00787	4.00787	4.00787
12	Metallic Screen Losses	[W/m]	1.14406	1.1141	1.08469
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	71.4326	71.47256	71.36771
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.239	0.239	0.239
16	Inductance of Conductor	[mH/km]	1.05719	1.05719	1.05719
17	Reactance of Conductor	[Ω/km]	0.33213	0.33213	0.33213
18	Inductance of Metallic Sheath	[mH/km]	0.87053	0.87053	0.87053
19	Reactance of Metallic Sheath	[Ω/km]	0.27348	0.27348	0.27348
20	Positive Sequence Impedance	[Ω/km]	0.010410 + j0.332130	0.010420 + j0.332130	0.010410 + j0.332130
21	Negative Sequence Impedance	[Ω/km]	0.010410 + j0.332130	0.010420 + j0.332130	0.010410 + j0.332130
22	Zero Sequence Impedance	[Ω/km]	0.046180 + j0.273480	0.046180 + j0.273480	0.046180 + j0.273480
23	Surge Impedance	[Ω]	66.48051	66.48051	66.48051
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	11.59585	11.59585	11.59585
25	Dielectric Stress at Insulation Surface	[kV/mm]	6.48838	6.48838	6.48838
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	16546.34872	16546.34872	16546.34872
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	17.35457	17.35457	17.35457
29	Charging Capacity of three phase system at Uo	[kvar/km]	12023.60029	12023.60029	12023.60029
30	Voltage drop for Three Phase System	[V/A/km]	0.01803	0.01804	0.01802
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	159.9	157.3	155.7

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:55:53

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		400KV.032	400KV.032	400KV.032
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_θ	DC Resistance of the conductor at 20°C	[Ω/km]	0.00586	0.00586	0.00586
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00746	0.00747	0.00746
4	dc	Conductor Diameter	[mm]	65.0	65.0	65.0
5	s	Distance Between Conductor Axes	[mm]	5000.0	5000.0	5000.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.62	0.62	0.62
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.37	0.37	0.37
8	xs	Component of Ys Calculation (Skin Effect)		3.23139	3.22855	3.23161
9	xp	Component of Yp Calculation (Proximity Effect)		2.49629	2.49409	2.49646
10	ys	Skin Effect Factor		0.39468	0.3937	0.39476
11	yp	Proximity Effect Factor		0.00008	0.00008	0.00008
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01041	0.01042	0.01041
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[μF/km]	0.239	0.239	0.239
16	U_o	Voltage	[kV]	230.94011	230.94011	230.94011
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	4.00787	4.00787	4.00787
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.04464	0.04472	0.04464
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	128.72949	128.72949	128.72949
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.27348	0.27348	0.27348
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.31704	0.31704	0.31704
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.25897	0.25897	0.25897
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.01723	0.01667	0.01634
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.821	0.82253	0.82088
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	129.8	129.8	129.8
28	ps	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	129.9	129.9	129.9
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	0.1	0.1	0.1
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		108.59124	108.49026	108.59922
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00005	1.00005	1.00005
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.03827	0.03819	0.03827
35	λ_θ	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
36	Δ_t	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00157	0.0	0.00008
37	Δ_θ	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00003	0.00012	0.00003
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.01726	0.01679	0.01637
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.36693	0.36693	0.36693
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	30.3	30.3	30.3
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.0429	0.0429	0.0429
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	53.1	53.7	53.1
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.22991	0.22907	0.22996
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.45393	0.46196	0.45397
Cable in a Duct Bank/Backfill Installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.563	0.563	0.563
64	y	Longer Side of the Duct Bank/Backfill	[m]	10.485	10.485	10.485
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	1.40996	1.40996	1.40996
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	1.049	1.049	1.049
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		0.74399	0.74399	0.74399
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	0.85	0.85	0.85
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.45393	0.46196	0.45397
72	T_4	Total External Thermal Resistance	[K.m/W]	0.7183	0.7255	0.7184
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2523.7	2523.7	2523.7

Study Summary

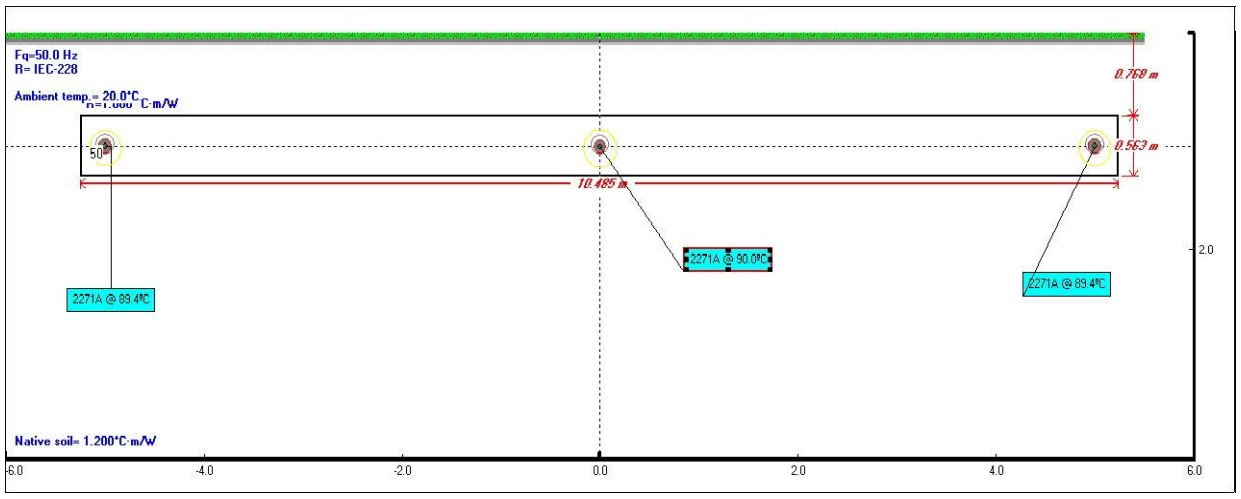
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:50:42

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	20.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	1.0
Depth of Center of Duct Bank	[m]	1.05
Duct Bank Width	[m]	10.49
Duct Bank Height	[m]	0.56



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	400KV.032	1		A	50.0	1.0	-5.0	1.05	89.4	2271.1
2	400KV.032	1		B	50.0	1.0	0.0	1.05	90.0	2271.1
3	400KV.032	1		C	50.0	1.0	5.0	1.05	89.4	2271.1

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:50:42

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	20
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		400KV.032	400KV.032	400KV.032
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	-5.0	0.0	5.0
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2271.1	2271.1	2271.1
Temperatures					
θc	Conductor temperature	[°C]	89.4	90.0	89.4
θs	Sheath/Shield temperature	[°C]	69.0	69.5	69.0
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	66.5	67.0	66.5
θduct	Duct surface temperature	[°C]	51.6	52.1	51.5
Resistances					
R_o	DC Resistance of the conductor at 20°C	[Ω/km]	0.00586	0.00586	0.00586
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01041	0.01042	0.01041
ys	Skin Effect Factor		0.39466	0.3937	0.39473
yp	Proximity Effect Factor		0.00008	0.00008	0.00008
Losses					
Wc	Conductor Losses	[W/m]	53.67911	53.73427	53.67506
Wd	Dielectric Losses	[W/m]	4.00787	4.00787	4.00787
Ws	Metallic Screen Losses	[W/m]	0.94059	0.91521	0.89109
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	58.62757	58.65735	58.57402
λ_1	Screen Loss Factor		0.01752	0.01703	0.0166
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.36693	0.36693	0.36693
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.0429	0.0429	0.0429
T4	External thermal resistance	[K.m/W]	0.79311	0.80182	0.79321
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	143.9	141.5	140.1

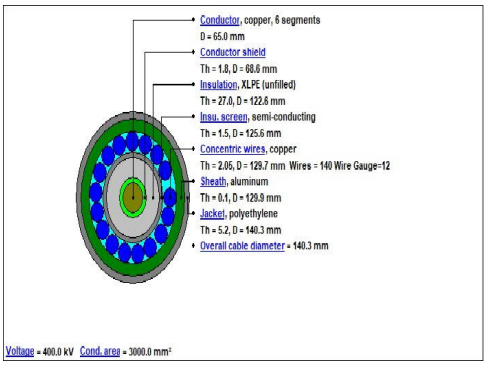
Cables Report

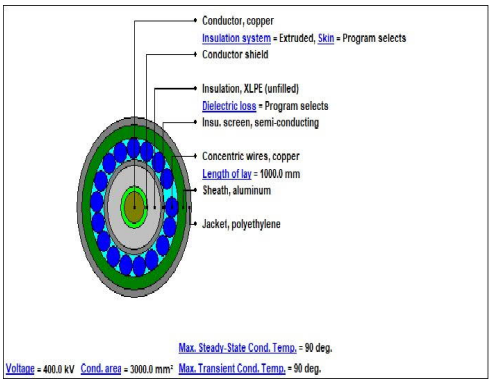
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:50:42

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		400KV.032
2	Number of Cores		Single Core
3	Voltage	[kV]	400
4	Conductor Area	[mm²]	3000.0
5	Cable Overall Diameter	[mm]	140.3
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	90
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[μΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Bare Unidirectional Wires
16	Ks (Skin Effect Coefficient)		0.62
17	Kp (Proximity Effect Coefficient)		0.37
18	Diameter	[mm]	65.0
Conductor Shield			
19	Thickness	[mm]	1.8
20	Diameter	[mm]	68.6
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	27.0
27	Diameter	[mm]	122.6
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.5
30	Diameter	[mm]	125.6
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Aluminum
33	Electrical Resistivity at 20°C	[μΩ.cm]	2.84
34	Temperature Coefficient at 20°C	[1/K]	0.00403
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	228
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	2.5
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	0.1
39	Diameter	[mm]	129.9
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[μΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1000.0
47	Number of Wires		140
48	Wire Gauge		12
49	Thickness	[mm]	2.05
50	Diameter	[mm]	129.7
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	140.3

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		400KV.032
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 400KV.032	
Cable Title	3000sqmm milliken Cu_xlpe_cws_pe (Generic design)





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:50:42

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**400KV.032**	**400KV.032**	**400KV.032**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.00586	0.00586	0.00586
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00746	0.00747	0.00746
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00907	0.00907	0.00907
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01041	0.01042	0.01041
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.69646	0.69646	0.69646
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.83402	0.83553	0.83391
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.0402	0.0402	0.0402
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.04794	0.04803	0.04794
Losses					
10	Conductor Losses	[W/m]	53.67911	53.73427	53.67506
11	Dielectric Losses	[W/m]	4.00787	4.00787	4.00787
12	Metallic Screen Losses	[W/m]	0.94059	0.91521	0.89109
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	58.62757	58.65735	58.57402
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.239	0.239	0.239
16	Inductance of Conductor	[mH/km]	1.05719	1.05719	1.05719
17	Reactance of Conductor	[Ω/km]	0.33213	0.33213	0.33213
18	Inductance of Metallic Sheath	[mH/km]	0.87053	0.87053	0.87053
19	Reactance of Metallic Sheath	[Ω/km]	0.27348	0.27348	0.27348
20	Positive Sequence Impedance	[Ω/km]	0.010410 + j0.332130	0.010420 + j0.332130	0.010410 + j0.332130
21	Negative Sequence Impedance	[Ω/km]	0.010410 + j0.332130	0.010420 + j0.332130	0.010410 + j0.332130
22	Zero Sequence Impedance	[Ω/km]	0.046180 + j0.273480	0.046180 + j0.273480	0.046180 + j0.273480
23	Surge Impedance	[Ω]	66.48051	66.48051	66.48051
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	11.59585	11.59585	11.59585
25	Dielectric Stress at Insulation Surface	[kV/mm]	6.48838	6.48838	6.48838
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	16546.34872	16546.34872	16546.34872
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	17.35457	17.35457	17.35457
29	Charging Capacity of three phase system at Uo	[kvar/km]	12023.60029	12023.60029	12023.60029
30	Voltage drop for Three Phase System	[V/A/km]	0.01803	0.01804	0.01802
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	143.9	141.5	140.1

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:50:42

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		400KV.032	400KV.032	400KV.032
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_θ	DC Resistance of the conductor at 20°C	[Ω/km]	0.00586	0.00586	0.00586
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00746	0.00747	0.00746
4	dc	Conductor Diameter	[mm]	65.0	65.0	65.0
5	s	Distance Between Conductor Axes	[mm]	5000.0	5000.0	5000.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.62	0.62	0.62
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.37	0.37	0.37
8	xs	Component of Ys Calculation (Skin Effect)		3.23132	3.22855	3.23152
9	xp	Component of Yp Calculation (Proximity Effect)		2.49623	2.49409	2.49639
10	ys	Skin Effect Factor		0.39466	0.3937	0.39473
11	yp	Proximity Effect Factor		0.00008	0.00008	0.00008
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01041	0.01042	0.01041
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[μF/km]	0.239	0.239	0.239
16	U_0	Voltage	[kV]	230.94011	230.94011	230.94011
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	4.00787	4.00787	4.00787
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.04534	0.04542	0.04533
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	128.72949	128.72949	128.72949
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.27348	0.27348	0.27348
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.31704	0.31704	0.31704
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.25897	0.25897	0.25897
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.01749	0.01692	0.01657
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.83402	0.83553	0.83391
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	129.8	129.8	129.8
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	129.9	129.9	129.9
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	0.1	0.1	0.1
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		107.74034	107.6434	107.74747
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00005	1.00005	1.00005
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.03767	0.0376	0.03767
35	λ_n	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00156	0.0	0.00008
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00003	0.00011	0.00003
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.01752	0.01703	0.0166
Armour and Pipe Loss Factor						
43	λ_1a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_1$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.36693	0.36693	0.36693
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	30.3	30.3	30.3
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.0429	0.0429	0.0429
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	60.0	60.6	60.0
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.22015	0.2194	0.22019
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.5385	0.54795	0.53855
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.563	0.563	0.563
64	y	Longer Side of the Duct Bank/Backfill	[m]	10.485	10.485	10.485
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	1.40996	1.40996	1.40996
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	1.049	1.049	1.049
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		0.74399	0.74399	0.74399
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.5385	0.54795	0.53855
72	T_4	Total External Thermal Resistance	[K.m/W]	0.79311	0.80182	0.79321
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2271.1	2271.1	2271.1

Study Summary

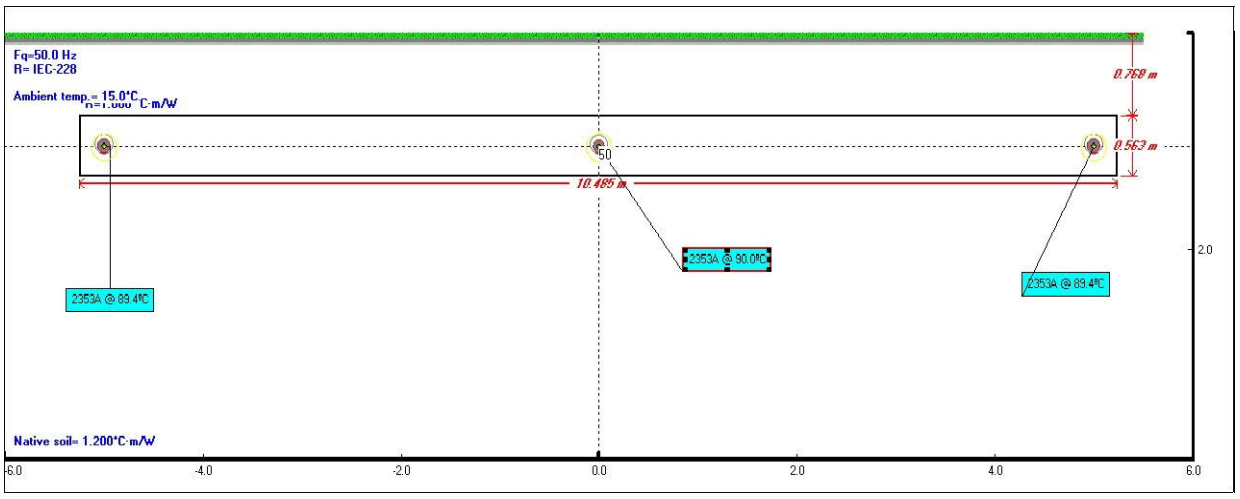
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:53:32

General Simulation Data

Steady State Option	Equally Loaded
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	15.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	1.0
Depth of Center of Duct Bank	[m]	1.05
Duct Bank Width	[m]	10.49
Duct Bank Height	[m]	0.56



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	400KV.032	1		A	50.0	1.0	-5.0	1.05	89.4	2352.7
2	400KV.032	1		B	50.0	1.0	0.0	1.05	90.0	2352.7
3	400KV.032	1		C	50.0	1.0	5.0	1.05	89.4	2352.7

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:53:32

Simulation Data

Installation type:	Ductbank
Steady State Option	Equally Loaded
Ambient temperature [°C]	15
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		400KV.032	400KV.032	400KV.032
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	-5.0	0.0	5.0
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2352.7	2352.7	2352.7
Temperatures					
θc	Conductor temperature	[°C]	89.4	90.0	89.4
θs	Sheath/Shield temperature	[°C]	67.5	68.1	67.5
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	64.8	65.4	64.8
θduct	Duct surface temperature	[°C]	48.7	49.3	48.7
Resistances					
R_o	DC Resistance of the conductor at 20°C	[Ω/km]	0.00586	0.00586	0.00586
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01041	0.01042	0.01041
ys	Skin Effect Factor		0.39472	0.3937	0.3948
yp	Proximity Effect Factor		0.00008	0.00008	0.00008
Losses					
Wc	Conductor Losses	[W/m]	57.60398	57.6673	57.59933
Wd	Dielectric Losses	[W/m]	4.00787	4.00787	4.00787
Ws	Metallic Screen Losses	[W/m]	1.00463	0.97787	0.95199
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	62.61647	62.65303	62.55918
λ_1	Screen Loss Factor		0.01744	0.01696	0.01653
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.36693	0.36693	0.36693
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.0429	0.0429	0.0429
T4	External thermal resistance	[K.m/W]	0.79609	0.80472	0.79619
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	149.1	146.6	145.1

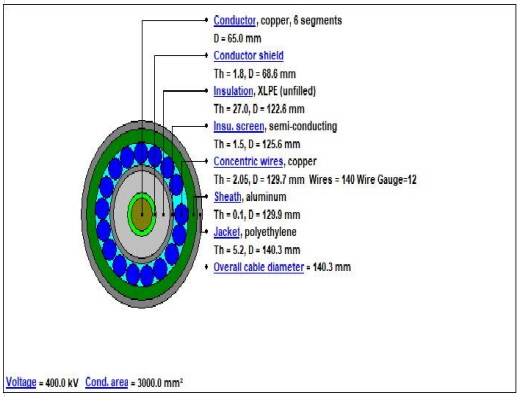
Cables Report

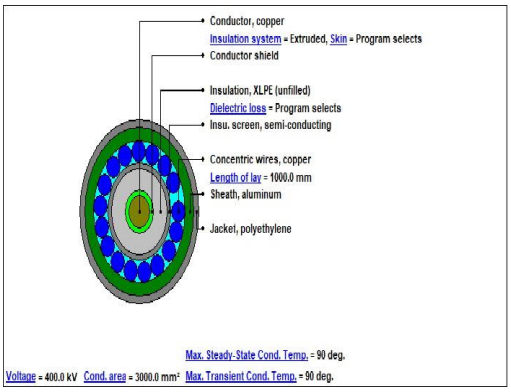
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:53:32

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		400KV.032
2	Number of Cores		Single Core
3	Voltage	[kV]	400
4	Conductor Area	[mm²]	3000.0
5	Cable Overall Diameter	[mm]	140.3
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	90
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Bare Unidirectional Wires
16	Ks (Skin Effect Coefficient)		0.62
17	Kp (Proximity Effect Coefficient)		0.37
18	Diameter	[mm]	65.0
Conductor Shield			
19	Thickness	[mm]	1.8
20	Diameter	[mm]	68.6
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	27.0
27	Diameter	[mm]	122.6
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.5
30	Diameter	[mm]	125.6
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Aluminum
33	Electrical Resistivity at 20°C	[µΩ.cm]	2.84
34	Temperature Coefficient at 20°C	[1/K]	0.00403
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	228
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	2.5
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	0.1
39	Diameter	[mm]	129.9
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1000.0
47	Number of Wires		140
48	Wire Gauge		12
49	Thickness	[mm]	2.05
50	Diameter	[mm]	129.7
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	140.3

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		400KV.032
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 400KV.032	
Cable Title	3000sqmm milliken Cu_xlpe_cws_pe (Generic design)





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:53:32

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**400KV.032**	**400KV.032**	**400KV.032**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.00586	0.00586	0.00586
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00746	0.00747	0.00746
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00907	0.00907	0.00907
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01041	0.01042	0.01041
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.69646	0.69646	0.69646
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.82987	0.83148	0.82976
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.0402	0.0402	0.0402
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.04771	0.0478	0.0477
Losses					
10	Conductor Losses	[W/m]	57.60398	57.6673	57.59933
11	Dielectric Losses	[W/m]	4.00787	4.00787	4.00787
12	Metallic Screen Losses	[W/m]	1.00463	0.97787	0.95199
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	62.61647	62.65303	62.55918
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.239	0.239	0.239
16	Inductance of Conductor	[mH/km]	1.05719	1.05719	1.05719
17	Reactance of Conductor	[Ω/km]	0.33213	0.33213	0.33213
18	Inductance of Metallic Sheath	[mH/km]	0.87053	0.87053	0.87053
19	Reactance of Metallic Sheath	[Ω/km]	0.27348	0.27348	0.27348
20	Positive Sequence Impedance	[Ω/km]	0.010410 + j0.332130	0.010420 + j0.332130	0.010410 + j0.332130
21	Negative Sequence Impedance	[Ω/km]	0.010410 + j0.332130	0.010420 + j0.332130	0.010410 + j0.332130
22	Zero Sequence Impedance	[Ω/km]	0.046180 + j0.273480	0.046180 + j0.273480	0.046180 + j0.273480
23	Surge Impedance	[Ω]	66.48051	66.48051	66.48051
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	11.59585	11.59585	11.59585
25	Dielectric Stress at Insulation Surface	[kV/mm]	6.48838	6.48838	6.48838
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	16546.34872	16546.34872	16546.34872
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	17.35457	17.35457	17.35457
29	Charging Capacity of three phase system at Uo	[kvar/km]	12023.60029	12023.60029	12023.60029
30	Voltage drop for Three Phase System	[V/A/km]	0.01802	0.01804	0.01802
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	149.1	146.6	145.1

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide (1ct 400kV CABLE) 3000sqmm Cond
Date:	20/03/2020 15:53:32

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		400KV.032	400KV.032	400KV.032
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_θ	DC Resistance of the conductor at 20°C	[Ω/km]	0.00586	0.00586	0.00586
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00746	0.00747	0.00746
4	dc	Conductor Diameter	[mm]	65.0	65.0	65.0
5	s	Distance Between Conductor Axes	[mm]	5000.0	5000.0	5000.0
6	ks	Factor Used for xs Calculation (Skin Effect)		0.62	0.62	0.62
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.37	0.37	0.37
8	xs	Component of Ys Calculation (Skin Effect)		3.23151	3.22855	3.23173
9	xp	Component of Yp Calculation (Proximity Effect)		2.49638	2.49409	2.49655
10	ys	Skin Effect Factor		0.39472	0.3937	0.3948
11	yp	Proximity Effect Factor		0.00008	0.00008	0.00008
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01041	0.01042	0.01041
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[μF/km]	0.239	0.239	0.239
16	U_o	Voltage	[kV]	230.94011	230.94011	230.94011
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	4.00787	4.00787	4.00787
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.04512	0.0452	0.04511
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	128.72949	128.72949	128.72949
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.27348	0.27348	0.27348
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.31704	0.31704	0.31704
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.25897	0.25897	0.25897
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.01741	0.01684	0.0165
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.82987	0.83148	0.82976
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	129.8	129.8	129.8
28	ps	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	129.9	129.9	129.9
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	0.1	0.1	0.1
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		108.00943	107.90527	108.01709
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00005	1.00005	1.00005
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.03786	0.03778	0.03786
35	λ_θ	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
36	Δ_t	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00156	0.0	0.00008
37	Δ_θ	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00003	0.00012	0.00003
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.01744	0.01696	0.01653
Armour and Pipe Loss Factor						
43	λ_2a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_2$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.36693	0.36693	0.36693
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	30.3	30.3	30.3
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.0429	0.0429	0.0429
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	57.9	58.5	57.8
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.22312	0.22231	0.22317
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.5385	0.54794	0.53855
Cable in a Duct Bank/Backfill installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.563	0.563	0.563
64	y	Longer Side of the Duct Bank/Backfill	[m]	10.485	10.485	10.485
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	1.40996	1.40996	1.40996
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	1.049	1.049	1.049
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		0.74399	0.74399	0.74399
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.5385	0.54794	0.53855
72	T_4	Total External Thermal Resistance	[K.m/W]	0.79609	0.80472	0.79619
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2352.7	2352.7	2352.7

Study Summary

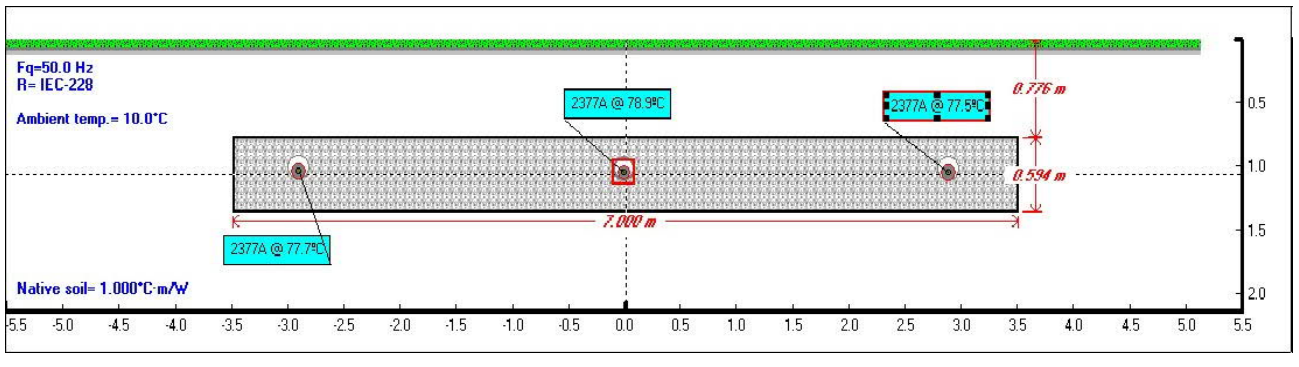
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:21:09

General Simulation Data

Steady State Option	Temperature
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	10.0
Native Soil Thermal Resistivity	[K.m/W]	1.0
Thermal Resistivity of Duct Bank	[K.m/W]	0.9
Depth of Center of Duct Bank	[m]	1.07
Duct Bank Width	[m]	7.0
Duct Bank Height	[m]	0.59



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	220KV.011	1		A	50.0	1.0	-2.9	1.05	77.7	2377.0
2	220KV.011	1		B	50.0	1.0	0.0	1.05	78.9	2377.0
3	220KV.011	1		C	50.0	1.0	2.89	1.05	77.5	2377.0

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:21:09

Simulation Data

Installation type:	Ductbank
Steady State Option	Temperature
Ambient temperature [°C]	10
Native Soil Thermal Resistivity [K.m/W]	1.0
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		220KV.011	220KV.011	220KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	-2.9	0.0	2.89
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2377.0	2377.0	2377.0
Temperatures					
θc	Conductor temperature	[°C]	77.7	78.9	77.5
θs	Sheath/Shield temperature	[°C]	58.5	59.6	58.4
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	55.8	56.9	55.6
θduct	Duct surface temperature	[°C]	38.8	40.0	38.7
Resistances					
R_o	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.00987	0.0099	0.00986
ys	Skin Effect Factor		0.11703	0.11625	0.11715
yp	Proximity Effect Factor		0.00007	0.00007	0.00007
Losses					
Wc	Conductor Losses	[W/m]	55.75545	55.92081	55.72848
Wd	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
Ws	Metallic Screen Losses	[W/m]	2.07944	1.91366	1.83477
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	59.20805	59.20763	58.93641
λ_1	Screen Loss Factor		0.0373	0.03422	0.03292
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.3402	0.3402	0.3402
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04631	0.04631	0.04631
T4	External thermal resistance	[K.m/W]	0.7114	0.70953	0.71162
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	146.0	138.6	137.1

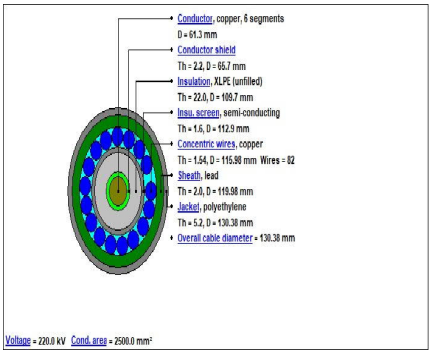
Cables Report

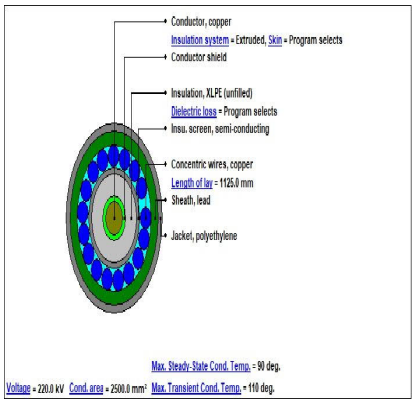
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:21:09

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		220KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	220
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	130.38
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	61.3
Conductor Shield			
19	Thickness	[mm]	2.2
20	Diameter	[mm]	65.7
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	22.0
27	Diameter	[mm]	109.7
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.6
30	Diameter	[mm]	112.9
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Lead
33	Electrical Resistivity at 20°C	[µΩ.cm]	21.4
34	Temperature Coefficient at 20°C	[1/K]	0.004
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	230
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	1.45
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	2.0
39	Diameter	[mm]	119.98
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1125.0
47	Number of Wires		82
48	Wire Gauge		Undefined
49	Thickness	[mm]	1.54
50	Diameter	[mm]	115.98
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	130.38

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		220KV.011
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 220KV.011	
Cable Title	2500sqmm Cu (insulated Wires)_XLPE_CWS+Pb_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:21:09

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**220KV.011**	**220KV.011**	**220KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00883	0.00887	0.00883
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00841	0.00841	0.00841
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00987	0.0099	0.00986
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.28869	0.28869	0.28869
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.33318	0.33443	0.33298
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.1185	0.1185	0.1185
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.13645	0.13696	0.13637
Losses					
10	Conductor Losses	[W/m]	55.75545	55.92081	55.72848
11	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
12	Metallic Screen Losses	[W/m]	2.07944	1.91366	1.83477
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	59.20805	59.20763	58.93641
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.271	0.271	0.271
16	Inductance of Conductor	[mH/km]	0.95962	0.95962	0.95962
17	Reactance of Conductor	[Ω/km]	0.30147	0.30147	0.30147
18	Inductance of Metallic Sheath	[mH/km]	0.78167	0.78167	0.78167
19	Reactance of Metallic Sheath	[Ω/km]	0.24557	0.24557	0.24557
20	Positive Sequence Impedance	[Ω/km]	0.009870 + j0.301470	0.009900 + j0.301470	0.009860 + j0.301470
21	Negative Sequence Impedance	[Ω/km]	0.009870 + j0.301470	0.009900 + j0.301470	0.009860 + j0.301470
22	Zero Sequence Impedance	[Ω/km]	0.092060 + j0.245570	0.092050 + j0.245570	0.092060 + j0.245570
23	Surge Impedance	[Ω]	59.51506	59.51506	59.51506
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	7.54233	7.54233	7.54233
25	Dielectric Stress at Insulation Surface	[kV/mm]	4.51715	4.51715	4.51715
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	14609.00643	14609.00643	14609.00643
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	10.81081	10.81081	10.81081
29	Charging Capacity of three phase system at Uo	[kvar/km]	4119.47055	4119.47055	4119.47055
30	Voltage drop for Three Phase System	[V/A/km]	0.01709	0.01714	0.01708
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	146.0	138.6	137.1

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:21:09

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		220KV.011	220KV.011	220KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_o	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00883	0.00887	0.00883
4	dc	Conductor Diameter	[mm]	61.3	61.3	61.3
5	s	Distance Between Conductor Axes	[mm]	2894.99578	2894.99578	2894.99578
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.23136	2.22729	2.23203
9	xp	Component of Yp Calculation (Proximity Effect)		1.68675	1.68367	1.68725
10	ys	Skin Effect Factor		0.11703	0.11625	0.11715
11	yp	Proximity Effect Factor		0.00007	0.00007	0.00007
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00987	0.0099	0.00986
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[μF/km]	0.271	0.271	0.271
16	U_o	Voltage	[kV]	127.01706	127.01706	127.01706
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	1.37316	1.37316	1.37316
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.0968	0.09716	0.09675
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	116.22348	116.22348	116.22348
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.24557	0.24557	0.24557
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.28912	0.28912	0.28912
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.23105	0.23105	0.23105
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.037	0.03337	0.03262
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.33318	0.33443	0.33298
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	117.98	117.98	117.98
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	119.98	119.98	119.98
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	2.0	2.0	2.0
31	β_s	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		39.98031	39.90524	39.9926
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00258	1.00257	1.00258
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.09429	0.09394	0.09435
35	λ_∞	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00001	0.00002	0.00001
36	Δ_s	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00329	0.00002	0.00035
37	Δ_∞	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.0003	0.00085	0.0003
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.0373	0.03422	0.03292
Armour and Pipe Loss Factor						
43	λ_aa	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_p$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_a	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.3402	0.3402	0.3402
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	25.8	25.8	25.8
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04631	0.04631	0.04631
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	48.3	49.4	48.2
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.25276	0.2509	0.25299
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.42417	0.42417	0.42417
Cable in a Duct Bank/Backfill Installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.594	0.594	0.594
64	y	Longer Side of the Duct Bank/Backfill	[m]	7.0	7.0	7.0
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	1.26566	1.26566	1.26566
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	1.073	1.073	1.073
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		0.84778	0.84778	0.84778
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	0.85	0.85	0.85
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.42417	0.42417	0.42417
72	T_4	Total External Thermal Resistance	[K.m/W]	0.7114	0.70953	0.71162
73	ΔΘint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2377.0	2377.0	2377.0

Study Summary

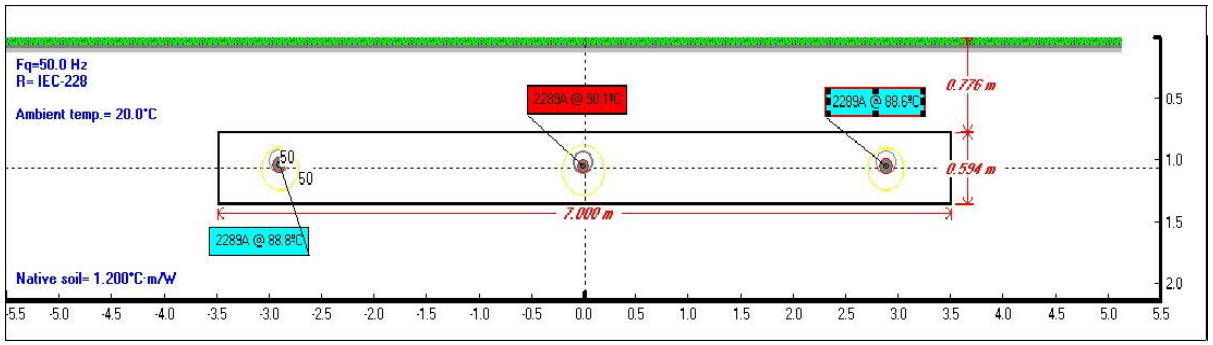
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:04:56

General Simulation Data

Steady State Option	Temperature
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	20.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	1.0
Depth of Center of Duct Bank	[m]	1.07
Duct Bank Width	[m]	7.0
Duct Bank Height	[m]	0.59



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	220KV.011	1		A	50.0	1.0	-2.9	1.05	88.8	2289.0
2	220KV.011	1		B	50.0	1.0	0.0	1.05	90.1	2289.0
3	220KV.011	1		C	50.0	1.0	2.89	1.05	88.6	2289.0

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:04:56

Simulation Data

Installation type:	Ductbank
Steady State Option	Temperature
Ambient temperature [°C]	20
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		220KV.011	220KV.011	220KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	-2.9	0.0	2.89
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2289.0	2289.0	2289.0
Temperatures					
θc	Conductor temperature	[°C]	88.8	90.1	88.6
θs	Sheath/Shield temperature	[°C]	70.4	71.7	70.2
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	67.8	69.1	67.6
θduct	Duct surface temperature	[°C]	52.7	54.0	52.6
Resistances					
R_o	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01015	0.01018	0.01015
ys	Skin Effect Factor		0.10987	0.10906	0.10999
yp	Proximity Effect Factor		0.00007	0.00007	0.00007
Losses					
Wc	Conductor Losses	[W/m]	53.18612	53.36265	53.15954
Wd	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
Ws	Metallic Screen Losses	[W/m]	1.99067	1.82164	1.74995
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	56.54994	56.55745	56.28265
λ_1	Screen Loss Factor		0.03743	0.03414	0.03292
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.3402	0.3402	0.3402
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04631	0.04631	0.04631
T4	External thermal resistance	[K.m/W]	0.7686	0.76679	0.76881
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	140.0	132.6	131.3

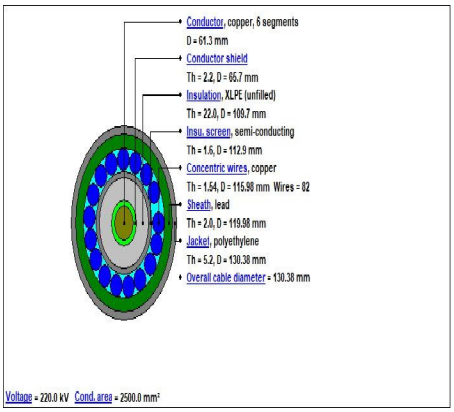
Cables Report

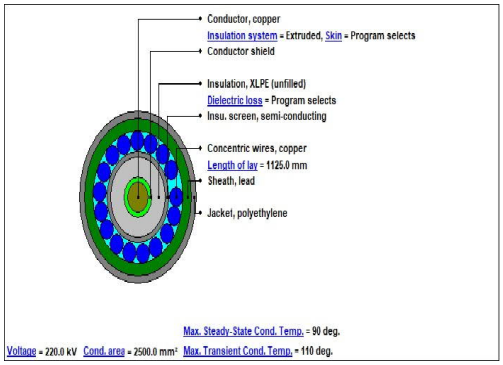
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:04:56

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		220KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	220
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	130.38
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	61.3
Conductor Shield			
19	Thickness	[mm]	2.2
20	Diameter	[mm]	65.7
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	22.0
27	Diameter	[mm]	109.7
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.6
30	Diameter	[mm]	112.9
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Lead
33	Electrical Resistivity at 20°C	[µΩ.cm]	21.4
34	Temperature Coefficient at 20°C	[1/K]	0.004
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	230
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	1.45
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	2.0
39	Diameter	[mm]	119.98
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1125.0
47	Number of Wires		82
48	Wire Gauge		Undefined
49	Thickness	[mm]	1.54
50	Diameter	[mm]	115.98
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	130.38

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		220KV.011
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 220KV.011	
Cable Title	2500sqmm Cu (insulated Wires)_XLPE_CWS+Pb_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:04:56

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**220KV.011**	**220KV.011**	**220KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00915	0.00918	0.00914
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00841	0.00841	0.00841
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01015	0.01018	0.01015
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.28869	0.28869	0.28869
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.34692	0.34836	0.3467
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.1185	0.1185	0.1185
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.14199	0.14257	0.1419
Losses					
10	Conductor Losses	[W/m]	53.18612	53.36265	53.15954
11	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
12	Metallic Screen Losses	[W/m]	1.99067	1.82164	1.74995
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	56.54994	56.55745	56.28265
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.271	0.271	0.271
16	Inductance of Conductor	[mH/km]	0.95962	0.95962	0.95962
17	Reactance of Conductor	[Ω/km]	0.30147	0.30147	0.30147
18	Inductance of Metallic Sheath	[mH/km]	0.78167	0.78167	0.78167
19	Reactance of Metallic Sheath	[Ω/km]	0.24557	0.24557	0.24557
20	Positive Sequence Impedance	[Ω/km]	0.010150 + j0.301470	0.010180 + j0.301470	0.010150 + j0.301470
21	Negative Sequence Impedance	[Ω/km]	0.010150 + j0.301470	0.010180 + j0.301470	0.010150 + j0.301470
22	Zero Sequence Impedance	[Ω/km]	0.092010 + j0.245570	0.092000 + j0.245570	0.092010 + j0.245570
23	Surge Impedance	[Ω]	59.51506	59.51506	59.51506
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	7.54233	7.54233	7.54233
25	Dielectric Stress at Insulation Surface	[kV/mm]	4.51715	4.51715	4.51715
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	14609.00643	14609.00643	14609.00643
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	10.81081	10.81081	10.81081
29	Charging Capacity of three phase system at Uo	[kvar/km]	4119.47055	4119.47055	4119.47055
30	Voltage drop for Three Phase System	[V/A/km]	0.01758	0.01764	0.01757
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	140.0	132.6	131.3

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:04:56

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		220KV.011	220KV.011	220KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_o	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00915	0.00918	0.00914
4	dc	Conductor Diameter	[mm]	61.3	61.3	61.3
5	s	Distance Between Conductor Axes	[mm]	2894.99578	2894.99578	2894.99578
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.19298	2.18855	2.19365
9	xp	Component of Yp Calculation (Proximity Effect)		1.65774	1.65439	1.65824
10	ys	Skin Effect Factor		0.10987	0.10906	0.10999
11	yp	Proximity Effect Factor		0.00007	0.00007	0.00007
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01015	0.01018	0.01015
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[μF/km]	0.271	0.271	0.271
16	U_o	Voltage	[kV]	127.01706	127.01706	127.01706
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	1.37316	1.37316	1.37316
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.10075	0.10117	0.10069
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	116.22348	116.22348	116.22348
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.24557	0.24557	0.24557
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.28912	0.28912	0.28912
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.23105	0.23105	0.23105
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.03715	0.03334	0.03264
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.34692	0.34836	0.3467
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	117.98	117.98	117.98
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	119.98	119.98	119.98
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	2.0	2.0	2.0
31	β_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		39.18066	39.09948	39.19293
32	αs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.0025	1.00249	1.0025
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.09056	0.09018	0.09061
35	λ_o	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00001	0.00002	0.00001
36	Δ_1	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00326	0.00002	0.00034
37	Δ_2	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00028	0.0008	0.00028
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.03743	0.03414	0.03292
Armour and Pipe Loss Factor						
43	λ_1a	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_1$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_1	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.3402	0.3402	0.3402
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	25.8	25.8	25.8
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04631	0.04631	0.04631
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	61.2	62.5	61.1
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.23314	0.23133	0.23335
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.501	0.501	0.501
Cable in a Duct Bank/Backfill Installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.594	0.594	0.594
64	y	Longer Side of the Duct Bank/Backfill	[m]	7.0	7.0	7.0
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	1.26566	1.26566	1.26566
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	1.073	1.073	1.073
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		0.84778	0.84778	0.84778
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.501	0.501	0.501
72	T_4	Total External Thermal Resistance	[K.m/W]	0.7686	0.76679	0.76881
73	Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2289.0	2289.0	2289.0

Study Summary

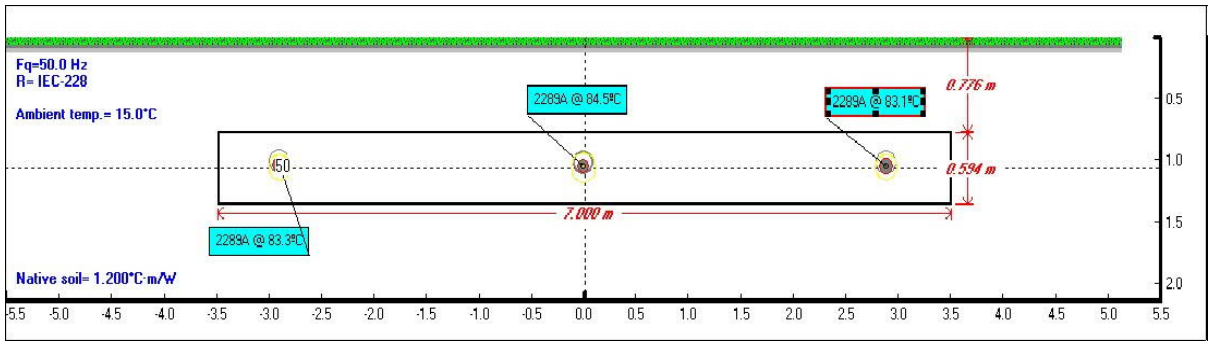
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:17:41

General Simulation Data

Steady State Option	Temperature
Consider Electrical interaction between circuits	No
Induced currents in metallic layers as a fraction of conductor current (applied to all single phase circuits) :	0.0
Conductor Resistances Computation Option:	IEC-228

Installation Type:Ductbank

Ambient Soil Temperature at Installation Depth	[°C]	15.0
Native Soil Thermal Resistivity	[K.m/W]	1.2
Thermal Resistivity of Duct Bank	[K.m/W]	1.0
Depth of Center of Duct Bank	[m]	1.07
Duct Bank Width	[m]	7.0
Duct Bank Height	[m]	0.59



Results Summary

Cable No.	Cable ID	Circuit No.	Feeder ID	Cable Phase	Cable Frequency	Daily Load Factor	X coordinate [m]	Y coordinate [m]	Conductor temperature [°C]	Ampacity [A]
1	220KV.011	1		A	50.0	1.0	-2.9	1.05	83.3	2289.0
2	220KV.011	1		B	50.0	1.0	0.0	1.05	84.5	2289.0
3	220KV.011	1		C	50.0	1.0	2.89	1.05	83.1	2289.0

Steady State Summary

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:17:41

Simulation Data

Installation type:	Ductbank
Steady State Option	Temperature
Ambient temperature [°C]	15
Native Soil Thermal Resistivity [K.m/W]	1.2
Consider Non-Isothermal Earth Surface	No
Consider effect of soil dry out	No
Consider Electrical interaction between circuits	No
Induced current in metallic layers as a fraction of conductor current (applied to all single phase circuits)	0

Variable	Description	Unit	Cables		
Cable No.	Cable Index Number		1	2	3
General Input Data					
Cable ID	Cable Equipment ID		220KV.011	220KV.011	220KV.011
Circuit No.	Circuit No.		1	1	1
Phase	Cable Phase		A	B	C
Fq	Operating Frequency	[Hz]	50.0	50.0	50.0
x	X coordinate	[m]	-2.9	0.0	2.89
y	Y coordinate	[m]	1.05	1.05	1.05
DLF	Daily Load Factor	[p.u.]	1.0	1.0	1.0
	Bonding Type		1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat	1 Conductor Crossbonded Flat
Ampacity					
I	Steady State Ampacity	[A]	2289.0	2289.0	2289.0
Temperatures					
θc	Conductor temperature	[°C]	83.3	84.5	83.1
θs	Sheath/Shield temperature	[°C]	65.2	66.4	65.0
θa	Armour temperature	[°C]	n/a	n/a	n/a
θsurf	Cable surface temperature	[°C]	62.6	63.8	62.4
θduct	Duct surface temperature	[°C]	47.2	48.6	47.1
Resistances					
R_o	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
R	AC Resistance of the Conductor at Operating Temperature	[Ω/km]	0.01001	0.01004	0.01
ys	Skin Effect Factor		0.11336	0.11253	0.11349
yp	Proximity Effect Factor		0.00007	0.00007	0.00007
Losses					
Wc	Conductor Losses	[W/m]	52.44476	52.61814	52.41874
Wd	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
Ws	Metallic Screen Losses	[W/m]	1.96335	1.80131	1.72872
Wa	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
Wt	Total Losses	[W/m]	55.78127	55.79261	55.52062
λ_1	Screen Loss Factor		0.03744	0.03423	0.03298
λ_2	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Thermal resistances					
T1	Thermal resistance of insulation	[K.m/W]	0.3402	0.3402	0.3402
T2	Thermal resistance of bedding/medium inside pipe-type	[K.m/W]	n/a	n/a	n/a
T3	Thermal resistance of outer covering	[K.m/W]	0.04631	0.04631	0.04631
T4	External thermal resistance	[K.m/W]	0.77634	0.77444	0.77656
Others					
Δθint	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
	Induced current on Metallic Screen	[A]	140.3	133.0	131.6

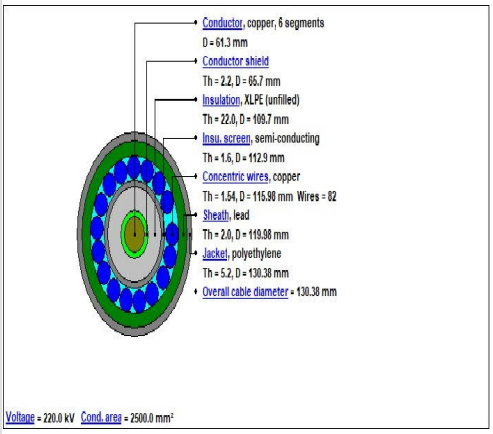
Cables Report

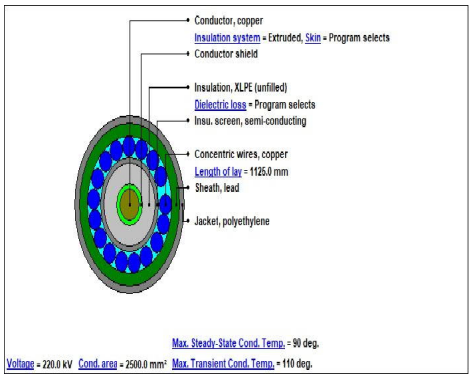
CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:17:41

No.	Description	Unit	1
General Cable Information			
1	Cable Equipment ID		220KV.011
2	Number of Cores		Single Core
3	Voltage	[kV]	220
4	Conductor Area	[mm²]	2500.0
5	Cable Overall Diameter	[mm]	130.38
6	Maximum Steady-State Conductor Temperature	[°C]	90
7	Maximum Emergency Conductor Temperature	[°C]	110
Conductor			
8	Material		Copper
9	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
10	Temperature Coefficient at 20°C	[1/K]	0.00393
11	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
12	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
13	Construction		6 Segments
14	Conductor Insulation System		Extruded
15	Milliken Wires Construction		Insulated Wires
16	Ks (Skin Effect Coefficient)		0.35
17	Kp (Proximity Effect Coefficient)		0.2
18	Diameter	[mm]	61.3
Conductor Shield			
19	Thickness	[mm]	2.2
20	Diameter	[mm]	65.7
Insulation			
21	Material		XLPE Unfilled
22	Thermal Resistivity	[K.m/W]	3.5
23	Dielectric Loss Factor - (tan delta)		0.001
24	Relative Permittivity - (epsilon)		2.5
25	Specific Insulation Resistance Constant at 60°F - (K)	[MΩ.km]	65617.
26	Thickness	[mm]	22.0
27	Diameter	[mm]	109.7
Insulation Screen			
28	Material		Semi Conducting Screen
29	Thickness	[mm]	1.6
30	Diameter	[mm]	112.9
Sheath			
31	Is Sheath Around Each Core?		n/a
32	Material		Lead
33	Electrical Resistivity at 20°C	[µΩ.cm]	21.4
34	Temperature Coefficient at 20°C	[1/K]	0.004
35	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	230
36	Volumetric Specific Heat (SH)	[J/(K*cm³)]	1.45
37	Corrugation Type		Non Corrugated
38	Thickness	[mm]	2.0
39	Diameter	[mm]	119.98
Concentric neutral/Skid wires			
40	Are Concentric Neutral Wires Around Each Core?		n/a
41	Material		Copper
42	Electrical Resistivity at 20°C	[µΩ.cm]	1.7241
43	Temperature Coefficient at 20°C	[1/K]	0.00393
44	Reciprocal of Temperature Coefficient of Resistance (BETA)	[K]	234.5
45	Volumetric Specific Heat (SH)	[J/(K*cm³)]	3.45
46	Length of Lay	[mm]	1125.0
47	Number of Wires		82
48	Wire Gauge		Undefined
49	Thickness	[mm]	1.54
50	Diameter	[mm]	115.98
Jacket			
51	Material		Polyethylene
52	Thermal Resistivity	[K.m/W]	3.5
53	Thickness	[mm]	5.2
54	Diameter	[mm]	130.38

No.	Description	Unit	1
Specific Installation Data			
55	Cable Equipment ID		220KV.011
56	Cable Frequency	[Hz]	50
57	Sheath / Shield Bonding		1 Conductor Crossbonded Flat
58	Loss Factor Constant (ALOS)		0.3
59	Minor section length		Crossbonded Unknown Section Lengths UNKNOWN
60	Duct construction		Polyethylene in Concrete
61	Duct material thermal resistivity	[K.m/W]	3.5
62	Inside Diameter of the Duct/Pipe	[mm]	188.0
63	Outside Diameter of the Duct/Pipe	[mm]	200.0

Cable ID : 220KV.011	
Cable Title	2500sqmm Cu (insulated Wires)_XLPE_CWS+Pb_PE NKT for Eirgrid





Electrical Parameters

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:17:41

No.	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1	**Cable Equipment ID**		**220KV.011**	**220KV.011**	**220KV.011**
Resistances					
2	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00899	0.00903	0.00898
4	AC Resistance of Conductor at 20°C	[Ω/km]	0.00841	0.00841	0.00841
5	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01001	0.01004	0.01
6	DC Resistance of Sheath at 20°C	[Ω/km]	0.28869	0.28869	0.28869
7	DC Resistance of Sheath at Operating Temperature	[Ω/km]	0.34085	0.34227	0.34064
8	DC Resistance of Concentric Wires at 20°C	[Ω/km]	0.1185	0.1185	0.1185
9	DC Resistance of Concentric Wires at Operating Temperature	[Ω/km]	0.13954	0.14012	0.13946
Losses					
10	Conductor Losses	[W/m]	52.44476	52.61814	52.41874
11	Dielectric Losses	[W/m]	1.37316	1.37316	1.37316
12	Metallic Screen Losses	[W/m]	1.96335	1.80131	1.72872
13	Armor/Pipe Losses	[W/m]	0.0	0.0	0.0
14	Total Losses	[W/m]	55.78127	55.79261	55.52062
Capacitance, Inductance, Impedance					
15	Capacitance	[µF/km]	0.271	0.271	0.271
16	Inductance of Conductor	[mH/km]	0.95962	0.95962	0.95962
17	Reactance of Conductor	[Ω/km]	0.30147	0.30147	0.30147
18	Inductance of Metallic Sheath	[mH/km]	0.78167	0.78167	0.78167
19	Reactance of Metallic Sheath	[Ω/km]	0.24557	0.24557	0.24557
20	Positive Sequence Impedance	[Ω/km]	0.010010 + j0.301470	0.010040 + j0.301470	0.010000 + j0.301470
21	Negative Sequence Impedance	[Ω/km]	0.010010 + j0.301470	0.010040 + j0.301470	0.010000 + j0.301470
22	Zero Sequence Impedance	[Ω/km]	0.092030 + j0.245570	0.092030 + j0.245570	0.092030 + j0.245570
23	Surge Impedance	[Ω]	59.51506	59.51506	59.51506
Others					
24	Dielectric Stress at Conductor Surface	[kV/mm]	7.54233	7.54233	7.54233
25	Dielectric Stress at Insulation Surface	[kV/mm]	4.51715	4.51715	4.51715
26	Insulation Resistance at 60°F (15.8°C)	[MΩ.km]	14609.00643	14609.00643	14609.00643
27	Reduction Factor (2pt bonded & single metallic screen)		n/a	n/a	n/a
28	Charging Current for One Phase	[A/km]	10.81081	10.81081	10.81081
29	Charging Capacity of three phase system at Uo	[kvar/km]	4119.47055	4119.47055	4119.47055
30	Voltage drop for Three Phase System	[V/A/km]	0.01734	0.01739	0.01733
31	Induced Voltage (standing) on Sheath	[V/km]	0.0	0.0	0.0
32	Induced Voltage (standing) on Concentric Wires	[V/km]	0.0	0.0	0.0
33	Induced current on Metallic Screen	[A]	140.3	133.0	131.6

Cable Parameters under Normal Operation

CYMCAP Version	7.3 Revision 2
Study:	Eirgrid Cp966 Feasibility study
Execution:	Eirgrid - Extra wide Trench (1ct 220kV CABLE)
Date:	23/03/2020 15:17:41

No.	Symbol	Description	Unit	Cable No.1	Cable No.2	Cable No.3
1		Cable Equipment ID		220KV.011	220KV.011	220KV.011
Normal Operation IEC 60287-1-1						
Conductor AC Resistance						
2	R_o	DC Resistance of the conductor at 20°C	[Ω/km]	0.0072	0.0072	0.0072
3	R'	DC Resistance of Conductor at Operating Temperature	[Ω/km]	0.00899	0.00903	0.00898
4	dc	Conductor Diameter	[mm]	61.3	61.3	61.3
5	s	Distance Between Conductor Axes	[mm]	2894.99578	2894.99578	2894.99578
6	ks	Factor Used for xs Calculation (Skin Effect)		0.35	0.35	0.35
7	kp	Factor Used for xp Calculation (Proximity Effect)		0.2	0.2	0.2
8	xs	Component of Ys Calculation (Skin Effect)		2.2119	2.20743	2.21257
9	xp	Component of Yp Calculation (Proximity Effect)		1.67204	1.66866	1.67255
10	ys	Skin Effect Factor		0.11336	0.11253	0.11349
11	yp	Proximity Effect Factor		0.00007	0.00007	0.00007
12	R	AC Resistance of Conductor at Operating Temperature	[Ω/km]	0.01001	0.01004	0.01
Dielectric Losses						
13	tanδ	Dielectric Loss Factor		0.001	0.001	0.001
14	ε	Insulation Relative Permitivity		2.5	2.5	2.5
15	C	Cable Capacitance	[μF/km]	0.271	0.271	0.271
16	U_o	Voltage	[kV]	127.01706	127.01706	127.01706
17	Wd	Cable Dielectric Losses Per Phase	[W/m]	1.37316	1.37316	1.37316
Circulating Loss Factor						
18	Rs	AC Resistance used for Circulating Loss Factor computation	[Ω/km]	0.09901	0.09942	0.09895
19	d	Mean diameter used for Circulating Loss Factor computation	[mm]	116.22348	116.22348	116.22348
20	X	Reactance used for Circulating Loss Factor computation	[Ω/km]	0.24557	0.24557	0.24557
21	Xm	Mutual Reactance	[Ω/km]	0.04355	0.04355	0.04355
22	P	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.28912	0.28912	0.28912
23	Q	Component for Circulating Loss Factor Formula (Clause 2.3.3)	[Ω/km]	0.23105	0.23105	0.23105
24	Fspacing	Spacing Factor (applied when spacing between cable uneven or non-equal minor section length)		0.004	0.004	0.004
25	λ'_1	Screen Loss Factor Caused by Circulating Current		0.03715	0.03341	0.03269
Eddy Loss Factor						
26	Rs	AC Resistance used for Eddy Loss Factor computation	[Ω/km]	0.34085	0.34227	0.34064
27	d	Mean diameter used for Eddy Loss Factor computation	[mm]	117.98	117.98	117.98
28	ρs	Electrical Resistivity used for Eddy Loss Factor computation	[Ω.m]	0.0	0.0	0.0
29	Ds	External diameter used for Eddy Loss Factor computation	[mm]	119.98	119.98	119.98
30	ts	Thickness used for Eddy Loss Factor computation	[mm]	2.0	2.0	2.0
31	β_s	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		39.52777	39.44569	39.54014
32	gs	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		1.00253	1.00252	1.00253
34	m	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.09217	0.09179	0.09223
35	λ_∞	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.00001	0.00002	0.00001
36	Δ_s	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		-0.00327	0.00002	0.00035
37	Δ_p	Coefficient used in IEC 60287-1-1 Clause 2.3.6.1		0.0	0.0	0.0
38	F	Milliken conductor Effect		1.0	1.0	1.0
39	Fpipe	Magnetic effect factor due to pipe		1.0	1.0	1.0
40	Farmour	Magnetic effect factor due to armour		1.0	1.0	1.0
41	λ''_1	Screen Loss Factor Caused by Eddy Current		0.00029	0.00082	0.00029
Metallic Screen Loss factor						
42	λ_1	Screen Loss Factor		0.03744	0.03423	0.03298
Armour and Pipe Loss Factor						
43	λ_aa	Armour Loss Factor		0.0	0.0	0.0
44	$\lambda_p$pipe	Pipe Loss Factor		0.0	0.0	0.0
46	λ_a	Armour Loss Factor + Pipe Loss Factor		0.0	0.0	0.0
Normal Operation IEC 60287-2-1						
47	T_1	Thermal Resistance Between Conductor and Screen	[K.m/W]	0.3402	0.3402	0.3402
48	t_1	Insulation Thickness Between Conductor and Screen	[mm]	25.8	25.8	25.8
49	ρTi	Thermal Resistivity of Insulation	[K.m/W]	3.5	3.5	3.5
50	T_3	Thermal Resistance of Jacket/Pipe Coating	[K.m/W]	0.04631	0.04631	0.04631
51	t_3	Thickness of Jacket/Pipe Coating	[mm]	5.2	5.2	5.2
52	ρTJ	Thermal Resistivity of Jacket/Pipe Coating	[K.m/W]	3.5	3.5	3.5
Cable in Ducts						
53	U	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		1.87	1.87	1.87
54	V	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.312	0.312	0.312
55	Y	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.1		0.0037	0.0037	0.0037
56	θm	Mean Temperature of the Medium Filling the Space	[°C]	55.9	57.2	55.7
57	T_4'	Thermal Resistance of the Medium Inside the Duct/Pipe	[K.m/W]	0.24088	0.23897	0.2411
58	Do	Outside Diameter of the Duct/Pipe	[mm]	200.0	200.0	200.0
59	Di	Inside Diameter of the Duct/Pipe	[mm]	188.0	188.0	188.0
60	ρT	Thermal Resistivity of the Duct/Pipe Material	[K.m/W]	3.5	3.5	3.5
61	T_4''	Thermal Resistance of the Duct/Pipe	[K.m/W]	0.03447	0.03447	0.03447
62	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.501	0.501	0.501
Cable in a Duct Bank/Backfill Installation						
63	x	Shorter Side of the Duct Bank/Backfill	[m]	0.594	0.594	0.594
64	y	Longer Side of the Duct Bank/Backfill	[m]	7.0	7.0	7.0
65	rb	Equivalent Radius of Duct Bank/Backfill	[m]	1.26566	1.26566	1.26566
66	LG	Depth of Laying to the Centre of Duct Bank/Backfill	[m]	1.073	1.073	1.073
67	u	Coefficient Used in IEC 60287-2-1 Clause 2.2.7.3		0.84778	0.84778	0.84778
68	N	Number of Loaded Cables in the Duct Bank/Backfill		3.0	3.0	3.0
69	ρe	Thermal Resistivity of Earth Around the Duct Bank/Backfill	[K.m/W]	1.2	1.2	1.2
70	ρc	Thermal Resistivity of the Duct Bank/Backfill	[K.m/W]	1.0	1.0	1.0
71	T_4'''	Thermal Resistance of the Surrounding Medium	[K.m/W]	0.501	0.501	0.501
72	T_4	Total External Thermal Resistance	[K.m/W]	0.77634	0.77444	0.77656
73	ΔθInt	Temperature Rise at the Surface of the Cable Due to Other Surrounding Elements	[°C]	0.0	0.0	0.0
74	I	Cable Core Current Ampacity	[A]	2289.0	2289.0	2289.0