Environmental Assessment
East Canada CSEM Survey, 2014–2018
Amendment

Prepared by

LGL LIMITED
environmental research associates

Prepared for

emgs

10 May 2017
LGL Report No. FA0110

Environmental Assessment
East Canada CSEM Survey, 2014–2018
Amendment

Prepared by

LGL Limited
environmental research associates
388 Kenmount Road, Box 13248, Stn. A.
St. John's, NL A1B 4A5
Tel: 709-754-1992
pabgrall@lgl.com

Prepared for

Electromagnetic Geoservices Canada Inc.
Suite 1700, Park Place
666 Burrard Street
Vancouver, BC V6C 2X8

10 May 2017
LGL Report No. FA0110

Suggested format for citation:

LGL Limited. 2017. Environmental Assessment EMGS East Canada CSEM Survey, 2014–2018 Amendment. LGL Rep. FA0110. Rep. by LGL Limited, St. John's, NL, for Electromagnetic Geoservices Canada Inc., Vancouver, BC. 6 p.

Table of Contents

List of Tables

Page

Introduction

This document is an Amendment of the Environmental Assessment (EA) of the Electromagnetic Geoservices Canada Inc. (EMGS) East Canada Controlled Source Electromagnetic (CSEM) Survey, 2014–2018 (LGL 2014a), and the associated Addendum (LGL 2014b), two Amendments (LGL 2014c, 2015a), and 2015 EA Update (LGL 2015b). The proposed changes to the Project activities assessed in this Amendment are as follow:

- a one-year extension to the Project's temporal scope to include 2019;
- the inclusion of solid streamer use; and
- an increase in source output from 1,250 A to 10,000 A.

Extension of Temporal Scope

EMGS proposes to extend the temporal scope of the Project from 31 December 2018 to include the period 1 May–31 December 2019. EMGS has interest in a three-year exploration program in the Project Area (i.e., 2017–2019). The total duration of exploration activities with an extension for 2019 would still be less than the five years initially permitted for in the original EA considering that CSEM activities took place in 2014, but not in 2015 and 2016.

Inclusion of Solid Steamer

EMGS proposes to use a new CSEM streamer that it has developed. It uses thermoplastic rubber (TPR) instead of Isopar M fluid for flotation, as previously indicated in Section 2.9 of LGL (2014a). The CSEM streamer consists of tow and conductor cables, as well as a flotation section. The 300–500 m long flotation section consists of 5 to 30 buoyancy tubes made of TPR that are braided together. The total length of the tow package will depend on the depth of the survey area, with a maximum length of several thousand metres. Compared to a typical 3D seismic survey, a CSEM towed system is very different in that it consists of only one streamer and it is much shorter. As such a CSEM survey occupies relatively little "sea-space" and other vessels can pass safely as close as one kilometre astern.

This change represents an improvement to the program by removing the potential risk for flotation fluid discharge.

Increase in Source Output

The new Deep Blue Source System proposed for use by EMGS is a more powerful source capable of transmitting 10,000 A and has a voltage of 135 V. The previously proposed conventional source transmitted 1,250 A with a voltage of 85 V (see Table 5.1 in Section 5.7.1 of LGL 2014a). The new Deep Blue Source System can transmit from 0 Hz (equal to DC) to 25 Hz. The new source has a maximum operating depth of 4,000 m, 500 m deeper than the conventional source described in the original EA. The technical specifications of the new Deep Blue Source System are provided in Appendix 1.

Electromagnetic (EM) fields are generated by anything that carries or produces electricity. EM fields consist of an electric field component and a magnetic field component that travel together in space at the speed of light. The geographic extent of effects (i.e., zone of influence or ZOI) of EM fields generated by the CSEM source was determined in the EA (LGL 2014a) through modeling conducted by the EM survey industry. Results of the modeling presented in Buchanan et al. (2011) are adapted for the more powerful source (an eightfold increase in the current results in an increase of the magnetic and electric fields by about the same factor; Johnsson and Oftedal 2011). Although modelling results are only available for a frequency range of 0.25–10 Hz, they indicate that the ZOI radii for both the magnetic and electric fields decrease with increasing frequency. Therefore, the ZOI radii for 25 Hz would be less than those associated with operations at lower frequencies. The adapted modeling results (see Tables 1 and 2) were then combined with a theoretical biological threshold based on the scientific literature across a wide range of organisms (see Buchanan et al. 2011). Based on available scientific information and the professional judgment of the authors, 200 nT and 386 nV/cm were selected as generic thresholds of effects for magnetic and electric fields, respectively, generated by EM surveys (see Buchanan et al. 2011 and LGL 2014a). Effects in this case simply mean an elicited response of some kind with no negative or positive implications. Many animals will have no reactions to these levels while others may be able to detect fields below these values.

For the worst-case scenario of operating the Deep Blue Source System at a frequency of 0.25 Hz, the model predicted maximum ZOI radii of 800 and 1,400 m for the magnetic and electric fields, respectively, at an operating depth of 4,000 m (Tables 1 and 2, respectively). These effects thresholds are based on reported abilities of some of the more sensitive groups of animals (e.g., elasmobranchs) to detect magnetic and electric fields. The ability to detect these fields does not imply negative effects on these animals.

Effects Assessment

Effects on the valued environmental components (VECs) have been reviewed based on the proposed Project amendments. EM emissions from the new Deep Blue Source System will potentially be detected by some animals, especially elasmobranchs. The geographic extent (area) used in the assessment is conservative and on the order of 2.0 km^2–6.2 km^2. Duration of

exposure of a fixed point along the axis of the tow (i.e., "worst case") would be short; on the order of 26–45 minutes with the vessel moving at 2 kts. This duration of exposure to EM emissions is too short to interfere with any known processes such as orientation, movements or prey detection (see LGL 2014a). Thus, any residual effects are considered *negligible* to *low* in magnitude and hence are predicted to be *not significant*. The only notable change from the previous CSEM source assessment (see LGL 2014a) is an increase in the geographic extent from a rating of 1 (*<1 km²*) to a rating of 1–2 (*<1 km²* to *1–10 km²*) for all VECs. The level of confidence associated with this prediction remains *high*.

Table 1 Distribution of magnetic fields exceeding 200 nT for deep towed source.

Source	Current	Frequency	Radial	Intensity (nT)											
Depth (m)	(A)	(Hz)	Distance (m)	*3000 m*	*3100 m*	*3200 m*	*3300 m*	*3400 m*	*3500 m*	*3600 m*	*3700 m*	*3800 m*	*3900 m*	*4000 m*
3970	10,000	0.25	0	202	275	382	544	800	1232	2030	3726	8247	27649	59061
			100	197	267	369	522	759	1154	1852	3246	6664	21672	51307
			200	185	249	339	469	662	958	1427	2191	3414	4363	6085
			300	167	221	294	394	531	719	965	1239	1349	583	1876
			400	146	188	243	313	401	503	603	648	509	38	935
			500	123	155	193	239	289	336	362	330	185	129	558
			600	101	124	149	177	202	218	212	165	60	138	368
			700	81	96	112	127	138	139	123	80	29	123	258
			800	64	74	83	90	93	87	70	38	37	105	188
3970	10,000	0.5	0	129	188	278	421	656	1067	1848	3536	8075	27546	59002
			100	125	182	268	402	622	995	1678	3066	6503	21578	51248
			200	117	168	243	357	533	814	1272	2037	3284	4299	6032
			300	104	146	206	293	418	596	838	1120	1257	549	1830
			400	89	121	166	227	306	403	504	561	450	60	893
			500	73	97	128	167	212	258	288	269	151	136	520
			600	58	75	95	118	141	159	159	125	48	136	333
			700	44	56	68	81	92	95	86	56	36	116	226
			800	34	41	48	54	58	56	45	27	41	94	160
3970	10,000	1	0	63	100	163	272	464	824	1548	3185	7711	27290	58867
			100	61	97	156	259	437	762	1393	2738	6169	21349	51113
			200	56	88	139	225	367	609	1030	1770	3033	4158	5920
			300	48	74	115	179	278	429	650	927	1097	487	1738
			400	40	60	89	133	194	275	368	433	359	81	816
			500	31	46	65	92	127	165	195	190	106	137	454
			600	24	33	46	61	79	94	98	79	38	123	277
			700	17	23	31	39	47	51	47	32	37	97	178
			800	12	16	20	24	27	27	22	18	36	73	119
3970	10,000	10	0	0	0	1	4	15	54	204	830	3755	22159	55769
			100	0	0	1	4	13	47	171	662	2818	17225	48267
			200	0	0	1	3	9	31	103	338	1073	2562	4315
			300	0	0	1	2	5	16	46	119	237	132	832
			400	0	0	0	1	3	7	16	32	36	42	251
			500	0	0	0	0	1	3	5	7	4	30	89
			600	0	0	0	0	0	1	1	1	4	14	34
			700	0	0	0	0	0	0	0	1	2	6	14
			800	0	0	0	0	0	0	0	0	1	3	6
Notes: numbers in italics are water depths														
Shaded areas are those depths >200 nT														

Table 2 Distribution of electric fields exceeding 386 nV/cm for deep towed source.

Source	Current	Frequency	Radial	Intensity (nV/cm)										
Depth (m)	(A)	(Hz)	Distance (m)	*3000 m*	*3100 m*	*3200 m*	*3300 m*	*3400 m*	*3500 m*	*3600 m*	*3700 m*	*3800 m*	*3900 m*	*4000 m*
3970	10,000	0.25	0	1351	1867	2643	3865	5908	9631	17262	35659	89649	254636	401142
			100	1321	1822	2578	3777	5763	9391	16912	35704	98935	498016	1498982
			200	1264	1734	2433	3522	5329	8600	15284	31452	81588	311496	652706
			300	1165	1583	2196	3133	4651	7291	12293	22644	45217	87266	112306
			400	1043	1398	1908	2666	3844	5761	9007	14562	23384	33857	38419
			500	908	1198	1604	2185	3041	4331	6278	9103	12712	16112	17426
			600	773	1002	1312	1738	2334	3165	4300	5750	7358	8695	9193
			700	644	820	1050	1355	1757	2283	2946	3717	4497	5102	5330
			800	529	661	828	1042	1311	1643	2036	2465	2873	3178	3298
			900	428	526	647	795	974	1186	1425	1674	1903	2071	2140
			1000	344	415	501	604	725	862	1012	1163	1298	1397	1441
			1100	274	326	387	459	541	632	728	823	908	970	1000
			1200	217	255	299	349	406	467	531	594	649	690	711
			1300	171	199	231	267	306	349	393	435	472	501	517
			1400	135	156	179	205	233	263	294	323	350	371	383
3970	10,000	0.5	0	1180	1727	2576	3944	6260	10463	18914	38666	94838	264298	417065
			100	1149	1678	2495	3819	6032	10037	18132	37679	101685	502075	1507152
			200	1082	1566	2304	3469	5398	8828	15636	31680	80977	308471	648061
			300	974	1390	2011	2968	4502	7114	11948	21825	43452	84290	109068
			400	844	1183	1676	2409	3532	5325	8316	13425	21640	31601	36127
			500	707	971	1343	1873	2643	3786	5501	8005	11270	14445	15771
			600	575	773	1041	1408	1913	2613	3569	4810	6228	7461	7980
			700	456	600	788	1034	1357	1778	2313	2954	3628	4185	4433
			800	355	456	585	747	952	1206	1512	1860	2209	2492	2630
			900	271	342	429	535	665	821	1002	1201	1396	1555	1640
			1000	205	254	312	382	465	563	675	795	912	1008	1066
			1100	153	187	226	273	327	390	462	538	613	676	718
			1200	114	137	164	195	232	274	322	373	422	466	499
			1300	84	100	119	141	166	195	228	264	298	330	356
			1400	62	74	87	102	120	141	165	190	216	239	261
3970	10,000	1	0	797	1279	2088	3483	5983	10714	20417	42913	104877	289067	463897
			100	772	1236	2014	3338	5691	10100	19090	40317	106941	512360	1529547
			200	714	1129	1808	2946	4911	8477	15497	31527	79493	301704	637721
			300	624	969	1519	2409	3879	6398	10983	20127	40036	78435	102757
			400	520	789	1203	1843	2844	4436	7048	11452	18617	27651	32157
			500	414	613	906	1337	1969	2901	4281	6300	9013	11827	13202
			600	318	458	655	930	1310	1833	2545	3489	4627	5716	6289
			700	237	331	458	628	850	1139	1511	1978	2512	3012	3308
			800	171	233	313	415	544	705	908	1156	1434	1697	1876
			900	121	160	210	271	346	440	556	698	858	1012	1132
			1000	84	109	139	176	221	278	350	437	535	633	720
			1100	58	73	92	115	143	180	226	283	347	414	479
			1200	39	49	61	75	94	119	151	189	233	280	330
			1300	26	33	40	50	64	81	103	130	161	195	234
			1400	18	22	27	35	44	57	73	92	114	139	169
3970	10,000	10	0	4	14	47	163	579	2109	7967	31699	135502	649114	1544048
			100	4	13	43	148	517	1841	6757	26028	111384	685040	2168827
			200	3	10	34	112	370	1236	4149	14074	49542	209214	490793
			300	2	7	23	70	217	656	1914	5262	13099	29463	50111
			400	1	4	13	38	107	286	709	1560	3010	5920	10566
			500	1	2	7	18	46	107	225	414	764	1671	3269
			600	0	1	3	8	17	35	65	114	254	596	1231
			700	0	1	1	3	6	11	19	40	103	238	506
			800	0	0	1	1	2	3	7	18	45	100	217
			900	0	0	0	0	1	1	3	8	20	43	95
			1000	0	0	0	0	0	1	2	4	9	19	42
			1100	0	0	0	0	0	0	1	2	4	8	19
			1200	0	0	0	0	0	0	0	1	2	4	9
			1300	0	0	0	0	0	0	0	0	1	2	4
			1400	0	0	0	0	0	0	0	0	0	1	2
Notes: numbers in italics are water depths														
Shaded areas >386 nV/cm														

Otherwise, all predictions of significance of residual effects of the Project activities on the VECs (Fish and Fish Habitat, Commercial Fisheries, Seabirds, Marine Mammals, Sea Turtles, Species at Risk, and Sensitive Areas) remain the same. In fact, the proposed change in streamer type decreases the potential for accidental spills.

Proposed mitigation procedures intended to minimize the potential effects of the Project activities associated with CSEM surveys are discussed in detail in Sections 5.5 and 6.0 of the EMGS EA (LGL 2014a).

Conclusion

The proposed one-year extension to the Project's temporal scope to include 2019 does not change any of the EA conclusions. There will be *no significant* residual environmental effects caused by this extension.

The proposed inclusion of solid streamer use is an improvement to the program and does not change any of the EA conclusions. There will be *no significant* residual environmental effects caused by the use of a solid streamer.

The proposed increase in source output from 1,250 A to 10,000 A does not change any of the EA conclusions. There will be *no significant* residual environmental effects caused by the new source system.

Literature Cited

Buchanan, R.A., R. Fechhelm, P. Abgrall, and A.L. Lang. 2011. Environmental Impact Assessment of Electromagnetic Techniques Used for Oil & Gas Exploration & Production. LGL Rep. SA1084. Rep. by LGL Limited, St. John's, NL, for International Association of Geophysical Contractors, Houston, Texas. 132 p. + app.

Johnsson, A. and G. Oftedal. 2011. Seabed Electromagnetic Logging and Marine Life. Report by the Norwegian University of Science and Technology and HiST, Sør-Trøndelag University College for Electromagnetic Geoservices AS, Trondheim, Norway. 37 p.

LGL (LGL Limited). 2014a. Environmental Assessment East Canada CSEM Survey, 2014-2018. LGL Rep. SA1248. Rep. by LGL Limited, St. John's, NL for Electromagnetic Geoservices Canada (Operator) (EMGS), Vancouver, BC. 192 p. + appendices.

LGL. 2014b. Environmental Assessment EMGS East Canada CSEM Survey, 2014–2018 Addendum. LGL Rep. SA1248. Rep. by LGL Limited, St. John's, NL, for Electromagnetic Geoservices Americas Inc., Vancouver, BC. 26 p. + appendices.

LGL. 2014c. Environmental Assessment EMGS East Canada CSEM Survey, 2014–2018 Amendment. LGL Rep. SA1248. Rep. by LGL Limited, St. John's, NL, for Electromagnetic Geoservices Americas Inc., Vancouver, BC. 1 p.

LGL. 2015a. Environmental Assessment EMGS East Canada CSEM Survey, 2014–2018 Amendment. LGL Rep. SA1248. Rep. by LGL Limited, St. John's, NL, for Electromagnetic Geoservices Americas Inc., Vancouver, BC. 9 p.

LGL. 2015b. Environmental Assessment Update of the EMGS East Canada CSEM Survey, 2014-2018. LGL Rep. FA0047. Rep. by LGL Limited, St. John's, NL for Electromagnetic Geoservices Canada Inc., Vancouver, BC. 30 p.

Appendix 1

Deep Blue Source System

Technical Specifications

1 Source System Specification

1.1 Deep Towed Source System

1.1.1 Deep Blue Source System Overview

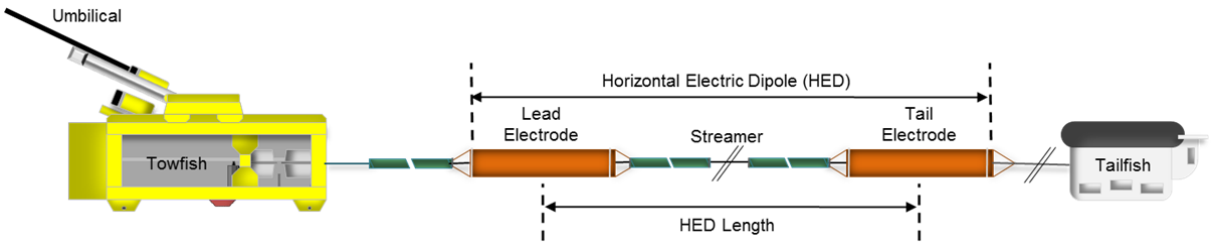
System Overview

The Deep Blue Source Systems' design is the latest EM equipment development with respect to performance, physical dimensions and safety when handling the equipment.

The EM source system is based on the same principals as the conventional system, but with improved timing control and output strength. The system consists of a:

- Top Side System consisting of a Power Supply and Operator Console
- Subsea System consisting of Tow fish, Antenna (Horizontal Electric Dipole) and Tail fish
- Communication System consisting of Umbilical, Multiplexer and a Slip Ring

The Top Side System is controlling the power to generate the predefined EM pulse at the electric dipole. The power is transformed to high voltage / low current and transferred via umbilical to the Subsea System. In the Tow fish, the power is transformed to low voltage / high current and rectified to DC. This antenna is fed from the Tow fish with a controllable periodic current. The waveform, amplitude and periodic time of this current are controlled at the Operator Console top side. A separate power supply feeds the auxiliary instrumentation on the Tow fish.



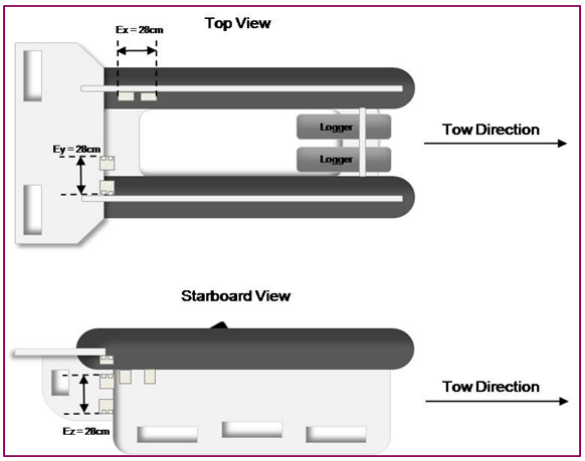
Schematic drawing of the source

The Figure shows the general schematic of the subsea configuration. The electric dipole (antenna) is neutrally balanced for in-line towing operation. The Tow fish and Tail fish are carrying attitude instrumentation.

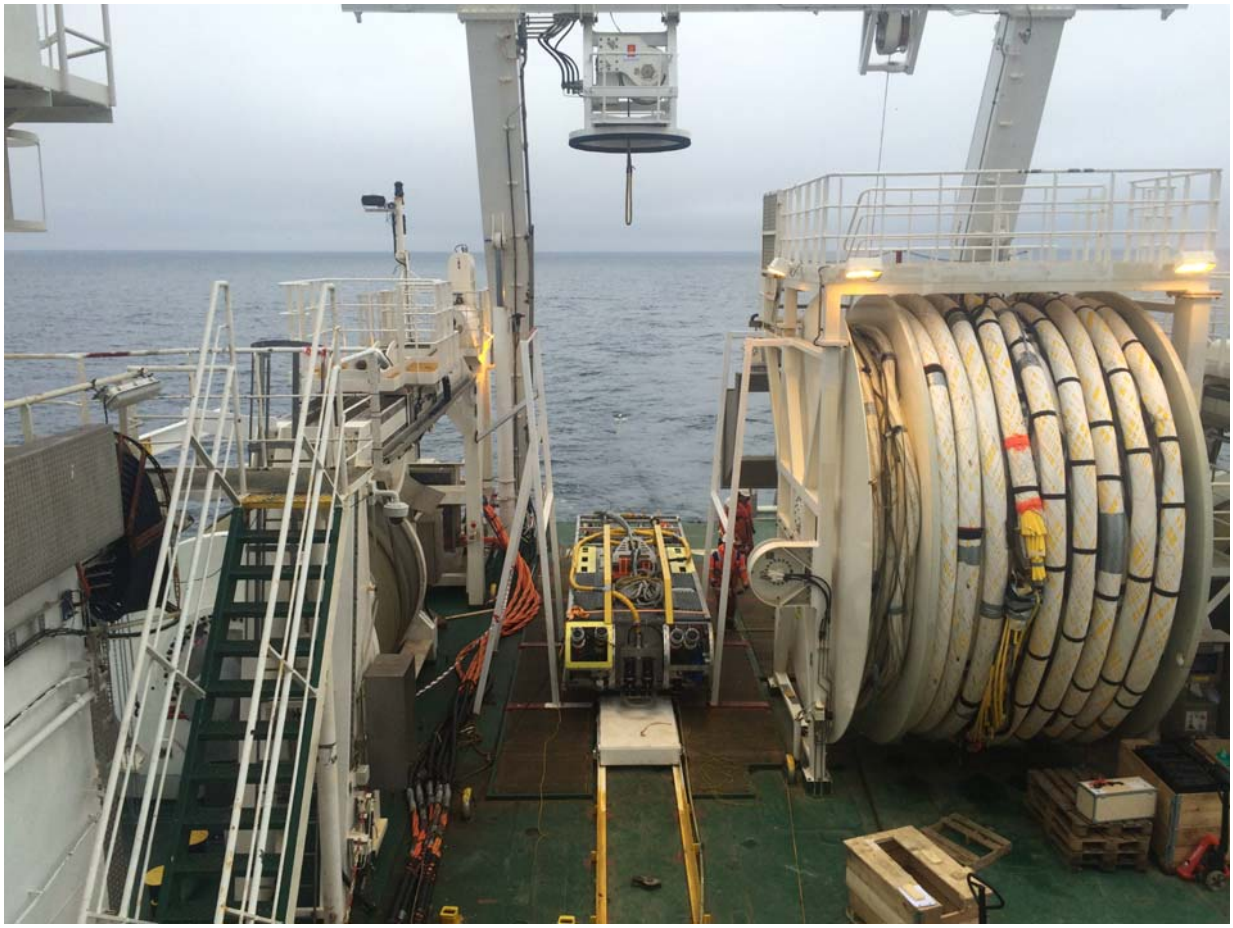
The Communication System includes an 5.500 meter long armoured Umbilical that encompasses high voltage power conductors for the signal source, low voltage conductors for supply of instrument supply and fibre optic leads for instrument communication. A fibre optical high voltage Slip Ring allows the Umbilical to be winded up on a Winch. All signals are fed through a fibre optical Multiplexer into the Umbilical.

A logger is mounted on the Tail fish and is able to provide a method for monitoring and verifying the source signal. Sensors are placed as described in the picture and sketch below.

Tail fish logger



E-Sensor offsets on Tail fish fins



System overview with the Towfish in the centre and streamer section on the winch to the left

1.1.2 Deep Blue Source Technical Specifications

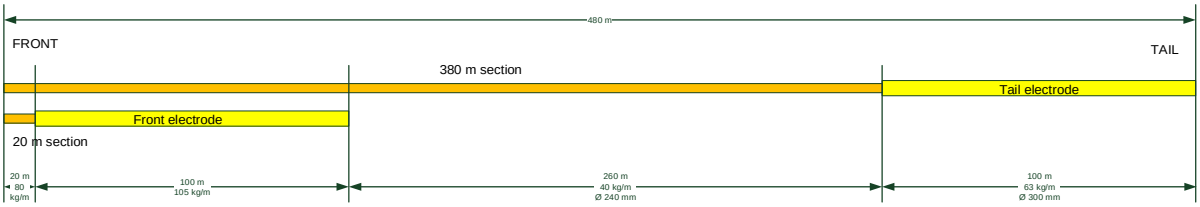
DEEP BLUE SOURCE SYSTEM	
Top Side System Technical Specification	
Manufacturer	Ultra Electronics PMES
Supply from vessels mains supply	690 V / 1500 A - Three phase 60 Hz
	440 V / (400 A Fuse) - Three phase 60 Hz
Output to transformer	0-590 V / 2500 A - Three phase 200 Hz
Output to umbilical	24 kV / 40 A - Three phase, 200 Hz (Power to EM-Source)
	3 kV / 1A - Single phase (Power to instrumentation)
Subsea System Technical Specification	
Manufacturer	Siemens Norway AS
Current, Subsea	10 000 A (peak)
Repeatability for current	Better than +/- 2%
Peak Power	1 500 kW (peak)
Voltage	135 V @ 10 000 ADC
Frequency	DC - 10Hz
Time accuracy	+/- 100 us (Synchronised to GPS Clock)
Maximum operational depth	4000 m
Tow fish weight in air (incl. instruments)	12 500 kg
Tow fish Instrument Interface	3/4 x PGT (one configured as responder), DLV, Gyro, CDT, Digiquarts, iUSBL

DEEP BLUE UMBILICAL TECHNICAL SPECIFICATION	
Manufacturer	Nexans Norway AS
Length	5.000 - 5.500 m
Outer Diameter [mm]	52.7 mm
Weight in air	8 kg/m
Weight in seawater	5.8 kg/m
Minimum bending diameter @ SWL	1.6 m
Armouring breaking strength	1220 kN
Safe working load (max repeated)	345 kN

Power Conductors	3x 16mm^2 / 24 kV
Fibre optic element	4 x Single mode 9/125µm
Power Conductors	3x 2mm^2 / 3.3 kV

DEEP BLUE SLIP RING TECHNICAL SPECIFICATION	
Manufacturer	Focal Technologies Corp.
Voltage / Current	3x 24 000 V/40 A, 2x 3500 V/20 A, 1x GND/40A , 2x SM Fibre 9/125µm/1300nm/1550nm
Rotation Speed	Maximum 28 rpm
Protection Class	IP 56
Operating Temperature	+10°C to +55°C

DEEP BLUE MULTIPLEXER TECHNICAL SPECIFICATION	
Manufacturer	MacArtney AS
Interface	PGT, Doppler, CTD, Gyro, Ethernet, Gyro iUSBL Digiquartz 1+2, Dual RS232 Spare, RS486/422 & RS232 Spare Power and Fibre Optical Link (2 pass)
Maximum operational depth	4000 meter



10000A SOLID ANTENNA, TECHNICAL SPECIFICATION	
Manufacturer	EMGS ASA
Cu Electrode Length	100 meters
Cu Electrode Diameter	1050 mm2 copper wire, 3x350mm2
Front-section length	120 meters

Front-section weight in air	40-60 kg/m
Mid-section length	1 x 480 meter
Mid-section weight in air	40 - 60kg/m
Type of Buoyancy	TPR, Thermo Plastic Rubber
Maximum operational depth	4500m

TAIL FISH TECHNICAL SPECIFICATION	
Manufacturer	Partnerplast AS
Weight in air	263 kg, with all components mounted. -2kg
Weight in water	
Instrument Interface	2 x PGT, 2 x SSM, Source Signal Monitoring System
Maximum operational depth	3.500 meters