Boundless Energy

REQUEST FOR PROPOSAL (RFP) NO. LC-SB-003

Strait of Belle Isle Submarine Cable Design, Supply and Install

Date: 12-August-2011

nalcor energy
LOWER CHURCHILL PROJECT

RFP No. LC-SB-003

STRAIT OF BELLE ISLE – SUBMARINE CABLE DESIGN, SUPPLY AND INSTALL

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PART 1

INSTRUCTIONS TO PROPONENTS

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0.5.1 INTRODUCTION

The Technical Proposal Questionnaire must be completed and submitted as part of the Proposal. The questionnaire shall be referred to herein as the Technical Proposal. It will be evaluated by Company as part of Company's overall evaluation process.

Exhibit 1 of Part 2 – Scope of Work describes the Work. However, Exhibit 1 is not a stand-alone description of the Agreement requirements. The entire Agreement contains Proponent's obligations and must be considered by Proponent in completing the Technical Proposal Questionnaire.

Questionnaire responses shall be presented in the same order, numbering system and format as presented in this questionnaire.

Some of the information requested in this questionnaire might be repetitive to information requested in other sections of this RFP. It is important that Proponent's response to this questionnaire be complete. Accordingly, if necessary, Proponent should repeat any such information.

Where applicable, information provided in the Technical Proposal will form part of the Agreement.

0.5.2 EXECUTION PLAN AND METHOD STATEMENT

Proponent shall provide a preliminary execution plan to enable Company to fully assess Proponent's understanding of the Work and evaluate Proponent's approach, commitment and ability to carry out the Work.

The preliminary execution plan shall detail and explain:

(a) Each element of the Work to be performed and completed;

(b) How each element of the Work will be performed and completed;

(c) When each element of the Work will be started and completed;

(d) Where each element of the Work will be performed and completed; and

(e) Who among Proponent, and if applicable, consortium members and candidate Subcontractors will have responsibility for each element of the Work.

Proponent's preliminary execution plan shall be a clear narrative supported as necessary by schematics, organization charts, and diagrams in sufficient detail for Company to assess Proponent's overall intent, and shall clearly define responsibilities of consortium members and/ or candidate Subcontractors, as applicable.

The preliminary execution plan shall specifically include, without limitation:

(a) Project objectives (critical success factors);

(b) Key risks and risk management;

(c) Project organization;

(d) Roles and responsibilities (Proponent, consortium members, Subcontractors);

(e) Mobilization and staffing plan for all Project phases clearly identifying how personnel will be assigned to the various locations;

(f) Project management systems and procedures;

(g) Planning and scheduling;

(h) Document control/ document management;

(i) Interface management;

(j) Reporting;

(k) Information management;

(l) Procurement management;

(m) Subcontract management;

(n) Management of change;

(o) Accounting and invoicing;

(p) Quality control and assurance;

(q) Safety plan;

(r) Environmental management plan;

(s) Regulatory compliance;

(t) Interface with 3rd Party Surveyor;

(u) Procurement plan;

(v) Master Document Register (including, without limitation, document type, issue date and revision dates);

(w) Execution method statements;

(x) Engineering execution (resources and tools available);

(y) Procurement execution (resources and tools available);

(z) Onshore cable manufacturing execution;

(aa) Onshore manufacturing completion, Testing (methodology, resources and tools required);

(bb) Loadout and transportation Execution;

(cc) Offshore installation execution (vessel selection, spread make-up; installation sequence, methodology and weather limitations on operations);

(dd) Onshore installation execution (cable pull-in, Termination, and land cable installation);

(ee) Pre-commissioning and handover to operations and performance testing (methodology and resources and tools required); and

(ff) Agreement completion execution (as-built survey, as-built drawings, data books and other final contract documentation).

It is anticipated that Proponent's execution plan will be discussed, clarified, and possibly revised and amended during the evaluation and clarification process. The revised and amended preliminary execution plan, once agreed and Approved by Company, will become part of the Agreement.

0.5.3 CABLE SUPPLY

Proponent shall provide preliminary details to support proposed cable design for SOBI including mechanical and electrical tests, material validation and minimum requirements defined within the Exhibit 1 – Scope of Work, Exhibit 6 - Company Supplied Data and Exhibit 7 – Deliverables List.

The Proponent shall define all applicable codes, standards, guidelines and regulations applicable to the design, manufacture, supply and installation of the HVDC cables.

Proponent shall provide, without limitation, the HVDC cable structural makeup and associated equipment required including terminations, joints, pulling heads, installation aids, corrosion protection, and abrasion protection for the described operation, transportation and installation.

Detailed design documents shall state maximum environmental service and installation loads applicable to each HVDC cable design.

The proposal for all proposed cable designs shall include, without limitation, the following:

(a) Cable length - submarine;

(b) Cable length – land;

(c) Cable cross section drawings (submarine and land);

(d) Termination design, details and drawings;

(e) Joint design, details and drawings (submarine and land);

(f) Transition joint design, details and drawings;

(g) Fiber optic design, details and operating requirements, including distributed temperature sensing (DTS);

(h) All design calculations and justifications required with proposal as defined herein;

(i) Spares philosophy including quantities (spare submarine cable, spare land cable Spare terminations, spare joints;

(j) Details of all additional accessories and appurtenances required for design, supply and installation of the submarine cable system; and

(k) Final cable routing.

Proponent shall, without limitation, provide the proposed cable design parameters for all cable designs submitted as per the following table:

PARAMETER	UNITS
GENERAL	
Type	
Rated voltage	kV DC
Switching impulse withstand voltage	kV DC
Lightning impulse withstand voltage	kV DC
Rated capacity (continuous at rated voltage)	A
Rated overload capacity and time (transient)	____A, ____s
Inductance	mH/km
Capacitance	uF/km
Operating temperature (continuous) at rated capacity	deg C
Maximum allowable operating temperature	deg C
Maximum allowable pulling tension	kN
Maximum allowable laying tension	kN
Tensile load distribution: armour/conductor	____%/____%
Minimum bend radius (with and without tension)	m
Minimum handling temperature (installation)	deg C
Cable weight in air	kg/m
Cable weight in water	kg/m
Yield strength of conductor	N/mm^2
Yield strength of conductor factory joint	N/mm^2
Maximum allowable side wall pressure	N/m
Impact resistance	kJ
Vertical inclination limit at rated temperature	Deg

PARAMETER	UNITS
Metal content in cable:	
copper (Cu)	kg/m
aluminum (Al)	kg/m
lead (Pb)	kg/m
Steel	kg/m
DC resistance at 20 deg C	ohm/km
DC resistance at steady state conductor operating temperature at rated capacity (continuous)	ohm/km
CONDUCTOR	
Material composition	
Type	
Conductor nominal outside diameter	mm
Cross-sectional area	mm^2
CONDUCTOR SCREEN	
Material	
Minimum and nominal thickness	mm
Nominal outside diameter	mm
INSULATION	
Material	
Thermal resistivity	K.m/W
Impregnating fluid composition	
Minimum thickness	mm
Nominal thickness	mm
Maximum allowable temperature drop across insulation	Deg C
Nominal outside diameter	mm
Maximum electric stress at conductor screen (no load and at steady state conductor operating temperature at rated capacity)	kV/mm
Maximum electric stress at insulation screen (no load and at steady state conductor operating temperature at rated capacity)	kV/mm
Average electric stress in insulation at rated capacity	kV/mm
Temperature dependency coefficient, α	K^{-1}
Dielectric design coefficients	$\beta =$ $\gamma =$ $\delta =$
INSULATION SCREEN	
Material	
Minimum and nominal thickness	mm
Nominal outside diamater	mm

PARAMETER	UNITS
Maximum temperature	deg C
METALLIC SHEATH	
Material composition	
Minimum thickness	mm
Average thickness	mm
Nominal outside diameter	mm
JACKET	
Material	
Minimum thickness	mm
Average thickness	mm
Nominal outside diameter	mm
Thermal resistivity	K.m/W
METALLIC TAPE	
Material	
Nominal thickness	mm
Nominal outside diameter	mm
Thermal resistivity	K.m/W
ARMOR BEDDING	
Material	
Nominal thickness	mm
Nominal outside diameter	mm
Thermal resistivity	K.m/W
ARMOR	
Material composition	
Armour wire size	
Galvanizing type and thickness	mm
Number of layers	
Lay-up length	m
Number of wires in each layer	
Tensile strength	kN
Nominal outside diameter of each armour layer	mm
OUTER SERVING	
Material	
Layer thicknesses	mm
Thermal Resistivity	K.m/W
Nominal outside diameter	mm

Criteria, justification, calculations, reporting or testing requirements not defined within Exhibit 1 – Scope of Work, but relevant to the cable supply, shall be included with the submittal.

Proponent shall provide preliminary or typical justification for the following criteria with proposal to support proposed cable design:

(a) Corrosion design (cathodic protection);

(b) Insulation coordination;

(c) Ampacity calculation;

(d) Preliminary Installation methodology analysis including, without limitation. conduit pull-in, cable lay, jointing, handling temperature, joint limitations, fiber optics reliability, minimum temperature handling limits and Contractor's Spread weather limitations;

(e) Thermal design shall include, without limitation, submarine cable, air filled and water filled portions of the conduit, land cable, terminations and loading due to thermal expansion;

(f) Special test methods and acceptance criteria;

(g) Type Test Reports;

(h) Reliability/availability assessment and data for manufactured mass-impregnated cable designs of voltages 300 kV and above;

(i) Grounding of cable armor and sheaths; and

(j) Land trench design and backfill methodology analysis.

The following items shall be provided by Proponent, without limitation, with submittal to support proposed cable design, and shall be considered preliminary or typical:

(a) Project quality plan;

(b) Manufacturing quality plan;

(c) Cable cross sectional drawings;

(d) Cable, termination and accessories general arrangements;

(e) Cable routing drawings;

(f) Cathodic protection method;

(g) Jointing methods and general arrangements;

(h) Electrical clearance calculations for transition compound;

(i) Factory and site testing philosophy;

(j) Inspection test plans for manufacturing and installation;

(k) Fault location philosophy;

(l) Cable repair method;

(m) Emergency abandonment method;

(n) Procedures and reports for type and routine testing;

(o) Methodology for post-loadout testing and pre-commissioning;

(p) Spares philosophy all phases of the Work and design life;

(q) Installation program overview;

(r) Maintenance plan for design life;

(s) Dimensional control methods;

(t) Manufacturer's inspection and test plan with acceptance criteria;

(u) Cable armor anchor details;

(v) Quality verification methods of metallic sheath extrusion process;

(w) Fiber optic supplier information and system specifications, including DTS method;

(x) Turntable/carousel details for spare; and

(y) Methods and recommendation's for cable polarity reversals.

Proponent shall provide preliminary land trench design for proposed cables included in submittal. The trench design supplied shall include, without limitation, details of the trench depth, trench width, cable separation and backfill material.

Landfall conduit is to be designed and constructed by Company's Other Contractor with input from Contractor as part of an ongoing interface. Proponent shall provide cable design limits with proposal, as per landfall conduit details defined in Exhibit 5 – Company Supplied Items.

Limits shall include, without limitation, preliminary maximums and minimums for the following at the Shoal Cove landfall:

(a) Conduit entry angle on land;

(b) Conduit exit angle at seabed;

(c) Conduit separation from exit to entry;

(d) 45 m conduit cover depth; and

(e) 2200 m overall length of conduit.

Limits shall include, without limitation, preliminary maximums and minimums for the following for the Forteau Point landfall:

(a) Conduit entry angle on land;

(b) Conduit exit angle at seabed;

(c) Conduit separation from exit to entry;

(d) 45 m conduit cover depth; and

(e) 1900 m overall length of conduit.

0.5.4 SUBCONTRACTORS

Proponent shall provide a complete listing and details of all proposed Subcontractors.

Proponent shall identify the name of the proposed Subcontractor, the element of the Work proposed to be Subcontracted, and the principal location at which the proposed Subcontractor would perform that element of the Work.

The level of Subcontractor surveillance is pending magnitude and criticality of Subcontracted works to be defined by Company. The Company reserves the right to request replacement of any Subcontractor to the Proponent without limitation.

0.5.5 PROPONENT ORGANIZATION

Proponent shall provide sufficient detail with respect to Proponent's corporate structure and proposed project organization and key Personnel to demonstrate an adequate understanding of the requirements for the management of the performance of the Work and the satisfaction of all obligations of Contractor under the Agreement.

Proponent shall provide details of the project specific organization that Proponent proposes for the management and control of the performance of the Work. The organizational structure shall be presented as a series of organization charts that clearly identify the lines of authority for all Agreement management functions.

Typical organization charts shall be arranged to present the proposed organization for each phase or separate element of the Work and shall include, as a minimum:

(a) Overall project management, inclusive of all significant subcontract interfaces;

(b) Overall project quality management;

(c) Overall project HSE management;

(d) Engineering management and execution;

(e) Procurement management including Subcontractor and supplier management;

(f) Cable manufacturing plant management;

(g) Loadout and transportation execution;

(h) Offshore installation execution;

(i) Onshore installation execution; and

(j) Pre-commissioning and mechanical completion management and execution.

The respective organization charts shall clearly identify:

(a) Proponent's proposed Key Personnel (Where Proponent is a consortium, the relevant employing consortium member shall be named);

(b) Any Subcontractor Personnel that are proposed to be integrated into Proponent's project management organization; and

(c) The organization of any nominated significant Subcontractor, including any key Personnel of the Subcontractor.

0.5.6 PROPONENT'S FACILITIES

Proponent shall provide details of all facilities that are proposed for the performance of the Work. The information provided shall cover both Proponent's own facilities and the facilities of nominated Subcontractors. Details of Proponent's facilities as agreed with Company as part of the formal Proposal clarification process will be included in the Agreement.

The description of Proponent's facilities shall include the following:

i) Central Project Management / Engineering / Procurement Office

Proponent shall provide complete details describing the proposed central project management / engineering / procurement office, inclusive of:

(a) Location;

(b) Office facilities and amenities;

(c) Communication and IT equipment; and

(d) Office arrangement and facilities for Company personnel.

ii) Engineering Software

Proponent shall provide complete details of the computer equipment and software programs that Proponent proposes to use for the performance of the engineering for the Work, including, but not limited to:

(a) Structural design analysis;

(b) Electrical design analysis;

(c) Dynamic installation analysis;

(d) Pull-in analysis;

(e) Thermal design analysis;

(f) Ampacity analysis;

(g) On-bottom stability;

(h) Insulation coordination system study;

(i) Cathodic protection design;

(j) Safety engineering;

(k) Manufacturing monitoring and completion system;

(l) Pre-commissioning system;

(m) Document control system; and

(n) Interface system.

iii) Manufacturing Plant Facilities

Proponent shall provide complete details of its proposed cable manufacturing facilities for the principal elements of the Work. Where Proponent is proposing more than one manufacturing facility, a separate attachment shall be provided for each facility. The details for each onshore manufacturing plant and yard shall include:

(a) Location;

(b) Layout detailing the locations of office accommodations, material storage, pre-fabrication facilities, and cable manufacturing facilities.

(c) Loadout facilities and yard, including storage, transpooling, and marine access;

(d) Any special yard or plant upgrade work required, as identified in the execution plan;

(e) Any additional equipment required to be mobilized for the Work; and

(f) Office arrangement and facilities for Company personnel.

iv) Offshore Marine Facilities

Proponent shall provide complete details of the Contractor's Spread required for the satisfactory performance of the Works, as well as details of all previous assignments in Canada. Contractor's Spread make-up shall identify and list all marine craft, equipment,

construction personnel and below deck crew necessary for the marine spread in question to function as intended in the performance of a particular element of the offshore Work. Details shall be provided for Contraction's Spread required by Proponent's chosen offshore execution methodology, for the transportation, installation and pre-commissioning, of the following;

(a) Submarine cable;

(b) All permanent equipment including terminations, joints, etc.;

(c) Spares equipment;

(d) Installation equipment;

(e) Onshore equipment (i.e. pull in equipment, anchoring, termination); and

(f) All other equipment required to perform the Work.

Proponent shall provide complete details of the primary installation vessels of Contractor's Spread nominated by Proponent to suit Proponent's chosen offshore execution methodology defined in the Exhibit 1 – Scope of Work and.

Details of the last and future required dry dockings shall be supplied to Company.

Proponent shall provide the maximum weather and environmental conditions in which the Contractor's Spread can perform Work including, without limitation, wave height, wave period, current, visibility, wind and any other conditions there of.

Proponent shall provide an alternative or secondary installation vessel to be executed in the event that the principle vessel is unable to perform the Work.

Proponent shall supply a separate attachment for each installation vessel proposed. Brochures and specifications of the installation vessel(s) shall be included as part of the Proposal, as appropriate.

The Contractor shall also provide certificates, specifications and limiting sea state criteria for the operability of all cranes/davits/A-frames. Wind shall also be considered in limiting crane operations.

Details to be provided in accordance with Exhibit 1C – Vessel Specification.

The Contractor shall provide the Company with details of all past relevant vessel assurance audits, trials and systems pertaining to the Contractor's spread. This shall include, but not be limited to:

(a) DP vessel annual trials;

(b) ROV and equipment audits;

(c) Crane and lifting equipment audits;

(d) Navigation, communication and survey audits;

(e) Helideck audit, if applicable;

(f) HSE audit;

(g) Quality assurance audit;

(h) COSHH audit;

(i) Disposal of waste; and

(j) Planned maintenance systems.

v) Onshore Site Facilities

Proponent shall provide complete details of onshore site facilities including equipment, construction personnel and facilities necessary to execute the onshore site requirements for completion of the Work. Details shall be provided for each onshore site required by Proponent's chosen execution methodology, for the following activities.

(a) Cable conduit pull-in;

(b) Termination installation;

(c) Cable termination in transition compound;

(d) Fiber optic and distributed temperature sensing unit termination;

(e) Cable interim testing and pre-commissioning;

(f) Anchoring of submarine cable (if required);

(g) Land trench backfill;

(h) Land cable jointing (if required);

(i) Land cable lay;

(j) Pre commissioning equipment; and

(k) Commissioning support.

0.5.7 PLANNING AND SCHEDULING

Proponent shall provide sufficient detail with respect to the sequence, timing and duration of the principal activities and phases of the Work to clearly demonstrate that the Work can be satisfactorily performed and completed on schedule. The Control Schedule detail provided shall in all respects be compatible with Proponent's execution

plan and method statement.

Company has declared a target mobilization date of 15 June, 2015, with the possibility of mobilization as early as 01 June 2015. This relates to potential seasonal environmental issues such as seastate and ice. Successful Proponent shall propose commercial terms for a collapsing mobilization call-out window, in an attachment to 0.4.1.1 – Commercial Form of Proposal, which addresses this objective. The call-out window shall have an early date of 01 June 2015 and a minimum late date of 30 June 2015. The finally agreed terms will be incorporated into Part 2, Exhibit 2 of the Agreement.

Proponent shall provide a Milestone Schedule which identifies a number of Milestones that it perceives to be significant events during the performance of the Work. The Milestones proposed by Proponent shall be in the format and in addition to the key Milestones designated by Company in Exhibit 11 – Milestone Schedule.

However, the actual nomination of Milestones shall be determined by Proponent appropriate to its chosen execution methodology.

In addition, Proponent shall provide, for each Milestone, a statement of Proponent's proposed criteria for measuring and determining the completion of the Milestone. A Milestone Table with associated Milestone acceptance criteria, as agreed with Company, as part of the formal Proposal clarification process, will be included in Exhibit 11 – Milestone Schedule.

Proponent shall provide proposed Control Schedule for the Work, in both electronic format and hard copy. The Control Schedule shall be equivalent to the level of detail referenced in Exhibit 4 - Coordination Procedures and shall incorporate the Milestones designated by Proponent in 0.5.6 above.

Details of Proponent's Control Schedule as agreed with Company as part of the formal Proposal clarification process will be included in Exhibit 11 – Milestone Schedule.

The Proponent's proposed Control Schedule will be a logically linked network covering the entire scope of Work, provided in both electronic format and hard copy. The Control Schedule shall be in the form of a critical path network, shall include all Milestones, and shall be in a format equivalent to the details referenced in Exhibit 4 - Coordination Procedure.

The Control Schedule will be used by Company during the evaluation of the Proposal to assess the relative strengths and weaknesses of the planning logic employed by Proponent in its overall execution plan and method statement. Accordingly, Proponent shall provide an electronic source file which is compatible with Primavera Version 6.2 or

later.

Proponent shall provide the planned progress s-curves as derived from the Control Schedule. Planned progress s-curves shall be prepared for:

(a) Overall Agreement;

(b) Engineering;

(c) Procurement;

(d) Manufacturing / fabrication; and

(e) Cables system installation, testing and handover to the Company.

Proponent shall provide the following additional information used in the preparation of the Control Schedule:

(a) Details of the estimated marine operation durations and all standby allowances (including weather standby, maintenance etc.);

(b) Details of the standard working hours per week used to establish Proponent's Control Schedule, and the flexibility to implement overtime working;

(c) All other assumptions, including assumptions related to interfaces with other entities; and

(d) Details of schedule tool settings used such as calendar for lags, scheduling vs. leveling, scheduling method for progressed activities (Progress Override, Retained Logic, Actual Dates), definition of critical, Units per Time period settings, total float and calculation method.

Proponent shall provide a Schedule Development and Control Plan which shall cover all essential areas of schedule development and control, including schedule analysis, schedule forecasting, schedule reporting, and corrective action. In particular, the plan shall provide a detailed description of Proponent's progress measurement methodology. The progress measurement plan should describe how Proponent will measure, verify and report physical progress of each major activity of the Work (e.g., engineering, procurement, manufacturing, installation and pre-commissioning).

Company wishes to note that its preferred planning CPM software is Primavera Version 6.2 or later.

0.5.8 CURRENT, BOOKED AND PROJECTED WORK COMMITMENTS

Proponent shall provide sufficient detail with respect to current and projected work

commitments to clearly demonstrate the current available uncommitted capacity of Proponent's proposed facilities and resources to ensure that the Work can be satisfactorily performed and completed in accordance with the Contract Schedule. The information provided shall cover Proponent's own facilities and the facilities of nominated Significant Subcontractors. The current and projected work commitment information provided in response to Section 0.5 of the ITB shall, where applicable, be an update and expansion of the information previously submitted by Proponent in response to the Prequalification Documents.

Proponent shall provide the current, booked and five year projected work commitments for:

(a) Cable design engineering;

(b) Cable manufacturing facility/yard;

(c) Installation engineering;

(d) Principle installation and transportation vessel(s); and

(e) Secondary installation and transportation vessel(s).

The information provided by Proponent in response to this item shall include;

(a) Current work in progress;

(b) Work awarded (booked) but not commenced;

(c) Work currently Proposal or in the process of being Proposal; and

(d) Other work that Proponent expects to be released for Proposal and awarded in the next twelve months.

The information provided shall be in the form of resource charts in histogram form for engineering and construction facilities and shall include summary project description detail and scheduled commitment timing and duration for all work or potential work indicated herein.

0.5.9 TECHNICAL EXCEPTIONS

The Proponent shall accept all technical requirements presented in this Section 0.5 of the Request for Proposal and confirm that its Proposal is based on said requirements. The Proponent is to advise if the Proposal does not comply with all technical requirements and shall submit a list of all such exceptions to said requirements together with the reasons for such exceptions and qualifications for Company consideration

SECTION 0.6

QUALITY MANAGEMENT QUESTIONNARIE

Commercial Section Not Filed

SECTION 0.7

HEALTH, SAFETY AND ENVIRONMENT (HSE) MANAGEMENT QUESTIONNAIRE

Commercial Section Not Filed

PART 2

AGREEMENT

PART 2 – Agreement Articles

Part 2 is comprised of the following:

Agreement (including Exhibits 1-12)

Exhibit	Description
1	Scope of Work
2	Compensation
3	Subcontractors
4	Coordination Procedures
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SUBMARINE CABLE DESIGN, SUPPLY AND INSTALL
STRAIT OF BELLE ISLE

BETWEEN

NALCOR ENERGY

- AND -

[INSERT CONTRACTOR NAME]

Contract No. LC-SB-003

Commercial Section Not Filed

EXHIBIT 1

SCOPE OF WORK

The Scope of Work shall be composed of three (3) sections:

Exhibit 1A – Scope of Work
Exhibit 1B – Cable Performance Specification
Exhibit 1C – Vessel Performance Specification

EXHIBIT 1A

SCOPE OF WORK

Commercial Section Not Filed

EXHIBIT 1B

CABLE PERFORMANCE SPECIFICATION

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1.0 INTRODUCTION

1.1 Purpose

This specification defines the minimum requirements for the high voltage direct current (HVDC) cables and associated accessories for the execution of the Lower Churchill Projects' Island Link Project located on the East Coast of Canada.

Contractor shall be responsible for the design and engineering necessary for successful execution of the Work, including safety and risk assessments. All items not listed in Exhibit 5 – Company Supplied Items, which are required for the Work shall be provided by Contractor.

The Work shall be subject to third party Approval by a verification body as necessary.

2.0 ABBREVIATIONS

AEIC	Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CEC	Canadian Electric Code
CIGRE	Conseil International Grands Reseaux Electriques
CSA	Canadian Standard Association
DC	Direct Current
DTS	Distributed Temperature Sensing
HDD	Horizontal Directional Drilling
HDPE	High-Density Polyethylene
HVDC	High Voltage Direct Current
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ISTA	International Safe Transit Association
LCC	Line Commutated Conversion
NBC	National Building Code of Canada

NEMA	National Electrical Manufacturers' Association
NRCAN	Natural Resources Canada
OECD	Organization for Economic Cooperation and Development
OHL	Overhead Line
OPGW	Optical Power Ground Wire
OTDR	Optical Time Domain Reflectommetry
ROV	Remote Operated Vehicle
SCADA	Supervisory control and data acquisition
TDR	Time Domain Reflectommetry

3.0 CODES, STANDARDS, SPECIFICATIONS, RULES, REGULATIONS, GUIDELINES AND RECOMMENDED PRACTICES

3.1 General

Contractor shall conform to the relevant sections of all statutory requirements and regulations. In the event of conflict, inconsistency or ambiguity between the Agreement, Exhibit 1 – Scope of Work, statutory requirements, and Section 3.2 of this specification or any other Company documents, Contractor shall refer to Company, whose decision shall prevail and be binding.

Contractor shall be responsible for bringing to the attention of Company the impact of any subsequent revisions or published amendments to the items in Section 3.2, which have a bearing on the execution of the Work.

The items in Section 3.2 shall be used by Contractor and Subcontractors who perform the Work. It shall be the responsibility of Contractor to ensure that all Subcontractors adhere to these requirements.

Contractor shall equip themselves with the latest copies of all the codes, standards, specifications, rules, regulations, guidelines and recommended practices referred to in this document and shall be fully conversant with their requirements and applications.

The latest revisions effective upon commencement of the Agreement (including supplements) of the items in Section 3.2 shall be used unless otherwise indicated by Company.

3.2 Governing Documentation

The cable system shall comply with the following:

AEIC CS4	Specifications for Impregnated Paper Insulated Low and Medium Pressure Self-contained Liquid Filled Cable
ASME B31	Standards of Pressure Piping
ASTM B749	Standard Specifications for Lead and Lead Alloy
ASTM D202	Sampling and Testing Untreated Papers for Electrical Insulation
ASTM A53	Specification for Pipe, Steel, black and Hot-Dipped, Zinc Coated Welded and Seamless
ASTM A123	Zinc (Hot Dip Galvanized) Coating on Iron and Steel Product
ASTM A153	Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware
ASTM B3	Standard Specification for Soft or Annealed Copper Wire
ASTM B187	Standard for Copper Bus Bar, Rod and Shapes and General Purpose Rod, Bar and Shapes
ASTM B230	Standard Specification for Aluminum 1350 H19 Wire for Electrical Purposes
ASTM B233	Standard Specification for Aluminum 1350 Drawing Stock for Electrical Purposes
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D4059	Standard Test Method for Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatograph
BS EN 50307	Lead and Lead Alloys
CEC	Canadian Electric Code
CSA A-23.1	Standard for Concrete Materials and Methods of Concrete Construction
CSA A-23.2	Test Methods and Standard Procedures for Concrete
CSA G40.20	General Requirements for Rolled or Welded Structural Quality Steel
CSA G40.21	Structural Quality Steels
CSA G164	Hot Dip Galvanizing of Irregularly Shaped Articles
CSA W59	Welded Steel Construction (Metal Arc Welding)

Electra 28	The Design of Specially Bonded Cable Systems
Electra 128	Guide to the Protection of specially bonded Cable Systems against sheath Overvoltages
Electra 171	Recommendations for Mechanical Tests on Submarine Cables
Electra 189	Recommendations for tests of power transmission DC cables for a rated voltage up to 800 kV
Electra 218	Addendum to: Recommendations for tests of power transmission DC cables for a rated voltage up to 800 kV
Cigre TB 86	Overvoltages on HVDC Cables
Cigre TB 151	Guidelines for Insulation Coordination in Live Working
Cigre TB 189	Insulation Co-ordination for HV AC Underground Cable System
Cigre TB 194	Construction, Laying and Installation Techniques for Extruded and Self-contained Fluid Filled Cable Systems
Cigre TB 268	Transient Voltages Affecting Long Cables
DnV-RP-B401	Cathodic Protection Design
DnV-RP-E305	On-Bottom Stability Design of Submarine Pipelines
DnV	Rules for Planning and Execution of Marine Operations
DnV-OS-D201	Electrical Installations
CSA S471-04	General requirements, design criteria, the environment, and loads
BS EN 10204	Metallic Materials: Types of Inspection Documents
IEC 60071	Insulation Coordination
IEC 60050	International Electrotechnical Vocabulary
IEC 60060	High-Voltage Test Techniques
IEC 60141	Tests on oil-filled and gas pressure cables and their accessories
IEC 60183	Guide to the Selection of High Voltage Cables
IEC 60228	Conductors of Insulated Cables
IEC 60229	Electric Cable Tests on Extruded Oversheaths with a Special Protective Function
IEC 60230	Impulse tests on cables and their accessories
IEC 60287	Electric Cables – Calculation of the current rating
IEC 60332	Tests on electric and optical fiber cables under fire conditions
IEC 60529	Degree of Protection Provided by Enclosures

IEC 60793	Optical Fibers
IEC 60794	Optical Fiber Cables
IEC 60811	Common test methods for insulating and sheathing materials of electric cables
IEC 60815	Guide for the Selection of Insulators for Polluted Conditions
IEC 60825	Safety of Laser Products
IEC 60853	Calculation of the Cyclic and Emergency Current Rating of Cables
IEC 60885	Electrical Test Methods for Electric Cables
IEC 60949	Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effect
IEC 61463	Bushings – Seismic Qualifications
IEC 62271	High-voltage switchgear and control gear
IEEE 400	Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems
IEEE 404	Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rates 2500 V to 500 000 V.
IEEE 442	Guide for Soil Thermal Resistivity Measurements
IEEE 693	Recommended Practices for Seismic Design of Substations
IHO No. 44	Standards for Hydrographic Surveys and the Demands of the New Century
ISO 9001: 2008	Quality Management Systems – Requirements
ISO 14001: 2008	Environmental Management Systems – Requirements with Guidance for Use
ISTA 1A	Non-simulation Integrity Performance Tests
ITU-T G.652	Characteristics of a single-mode optical fiber cable
NBC	National Building Code of Canada
NEMA ICS-1	Industrial Controls and Systems: General Requirements
OHSAS 18001	Occupational Health and Safety Management Systems
TIA-598-C	Optical Fiber Cable Color Coding

4.0 REQUIREMENTS

4.1 General Requirements

The cable system shall be designed, manufactured, and tested according to the minimum requirements set forth in this specification. Compliance shall be demonstrated by Approval of the Work by Company, Contractor and Company's Other Contractors, in accordance with the terms of the Agreement.

Contractor shall review and implement any additional criteria defined within the applicable codes, standards, guidelines and regulations required to perform the Work.

Contractor shall provide an optimally designed and manufactured cable system that meets or exceeds the requirements of these specifications. Contractor shall define the cable structural makeup and associated equipment required including terminations, joints, pulling devices, installation aids, corrosion protection, abrasion protection for the described operation, transportation and installation.

Detailed design documents shall state maximum environmental service loads in the as-installed condition and installation loads applicable to each cable design.

The design objectives shall be to maximize reliability and longevity of the cable system, minimize operation and installation cost, and to minimize maintenance requirements, all the while maintaining site specific performance requirements. The cable system supplied by Contractor shall be qualified for service as per the requirements defined herein this Exhibit 1B – Cable Performance Specification. This includes all components of the cable system which form part of the Work.

The following requirements shall be adhered to without limitation:

a) Be capable of continuous operation in the natural and operating environment for the specified design life. Details of the operating environment are provided in Exhibit 6 – Company Supplied Data;

b) Be operable in either bi-pole or mono-pole configuration;

c) Be suitable for power flow in either direction;

d) Be capable of polarity reversal;

e) Be capable of being switched between the positive (+) and negative (-) poles of a bipole system;

f) Be fully compatible with all Company Supplied Items outlined in Exhibit 5 – Company Supplied Items and Company's Other Subcontractor's supplied items;

g) Cables shall be transported in a manner such that no torsional stress is applied to the individual components;

h) The structural strength of the submarine cables shall be such that they can be installed, protected, recovered, or covered with rock berm in the specified water depths;

i) The structural strength of the HVDC land cables shall be such that they can be installed, protected, and recovered as needed without being damaged;

j) Be supplied such that the number of factory and field joints utilized throughout all phases of the Work be minimized;

k) Undergo successful testing which meets the acceptance criteria established in the Agreement;

l) Provide replenishment of mass impregnating fluid as required to protect the cable system for its design life, through a termination reservoir system;

m) Be fully compatible with the installation methods and equipment;

n) Be fully corrosion protected for the design life;

o) Be supplied free of damage; and

p) Be manufactured of new materials only.

4.2 System Requirements

4.2.1 General

Three (3) cables shall be installed between the transition compounds located on either side of the Strait of Belle Isle. The expected operating philosophy will be to have one (1) cable operating on the positive pole, and one (1) cable operating on the negative pole. The third cable will function as a spare, and under normal bi-pole operation will be connected via switching arrangements in parallel to either the positive or negative pole.

Emergency sea electrodes installed by Company will be located remotely from the cable crossing to allow the system to remain operational in mono-pole mode, in the case of a pole loss. There will not be a direct interface between the sea electrodes and the cable terminals.

4.2.2 Design Voltage and Power

The cables and associated accessories will be designed for bi-pole operation, but with the ability to operate in mono-pole mode if required. The cables shall be rated for the

system parameters as specified in section 4.2.11 of this Exhibit 1B – Cable Performance Specification.

4.2.3 Current Ratings

The cables shall be designed to operate at current ratings as defined in the table in section 4.2.11.

Two overload options shall be considered in the proposed designs. These are detailed in the table in section 4.2.11.

4.2.4 Resistance

Cable conductor resistance shall not be greater than 0.014 ohm per km at twenty (20) degrees Celsius.

4.2.5 Reliability

The cables shall be of a proven design that has a high standard of reliability in service, with a minimum of ten (10) years satisfactory operating performance without internal failures of cable or accessories.

4.2.6 Design Life

The HVDC cables shall have a design life of fifty (50) years continuous DC operation at rated capacity.

4.2.7 Design and Manufacturing Validation

Design and manufacture of the cable system shall be validated by test reports and may be verified by an independent verifying body. Test reports shall be supplemented with data from mechanical and electrical tests, material selection justification, and documentation outlined within the Agreement.

4.2.8 Operability and Maintainability

The cable system shall be designed and manufactured such that minimal maintenance is required for the design life of the cables, other than annual external inspections where possible.

4.2.9 Seismic Design Requirements

Seismic designs for the cable system shall be in accordance with IEEE 693 and the NBC, as defined by region-specific seismic loading criteria provided by NRCAN. Seismic design shall apply to the cable termination support foundations, structural steel, and terminations themselves, as well as the whole cable system.

4.2.10 Insulation Coordination

Surge arrestors will be installed by Company. A cable system insulation coordination assessment shall be completed and submitted by Contractor in general accordance with the principles and methods provided in Cigre TB 86, TB 189, TB 268 and IEC 60071. The assessment shall be coordinated and functionally integrated with the HVDC transmission system, including overhead lines and converter stations, culminating in recommendations to Company for the required arrestor ratings and characteristics to purchase and install.

4.2.11 System Design Specifications

4.2.11.1 Strait of Belle Isle System Electrical Specifications

PARAMETER	VALUE
Rated System Voltage	± 350 kV DC
Rated Total Bipole Transmission Capacity (Continuous)	900 MW (450 MW per pole)
Converter Technology	LCC
Case 1 Overload Capacity	Nominal Rating: 1286 A (1 pu per pole) Transient Rating: 2572 A (2 pu) for 5 mins in mono-pole mode
Case 2 Overload Capacity	Nominal Rating: 1286 A (1 pu per pole) Continuous Rating: 1929 A (1.5 pu) Transient Rating: 2572 A (2 pu) for a minimum of 10 mins in mono-pole mode

4.2.11.2 Field Design Conditions

Environmental field design conditions and preliminary details of the conduits are provided in Exhibit 6 - Company Supplied Data.

The cables and associated accessories shall be designed, at a minimum, for these conditions.

4.2.12 Cable Construction

4.2.12.1 Conductor

Each cable shall be single core design. The conductor shall be sized to transmit the required current while meeting the environmental, operational and installation requirements. The conductor shall be designed to withstand the tensions applied to it during all phases of installation including pull-in though the conduits.

The conductor shall be of highly compact circular design, constructed of aluminum or copper keystone wires, manufactured and tested as per IEC 60228.

The conductor screen shall provide an electrically smooth semi-conducting interface between the conductor and insulation.

4.2.12.2 Insulation

The cables shall be insulated with mass impregnated insulation. Insulation shall be high density tapes such as lapped kraft paper, specially selected in width and thickness across the insulation, and to assure high electrical performance for DC applications.

The insulation screen shall provide an electrically smooth semi-conducting interface between the insulation and the overlying sheath.

The insulation shall be fully impregnated using a special degassed, high viscosity insulating compound, developed specifically for HVDC mass impregnated, non-draining cable applications.

4.2.12.3 Metallic Sheath

The metallic sheath shall be resistant to fatigue and be of a 'high creep' ductility material such as lead alloy. The sheath shall be free from all defects following the continuous extrusion process. The cross-sectional area shall be sized such that it is able to withstand all mechanical stresses for all phases of the Work. It shall also be capable

of withstanding fault currents and other abnormal currents associated with converter commutation failures.

4.2.12.4 Jacket

The metallic sheath shall have an extruded anti-corrosion jacket of a material such as polyethylene applied over the entire circumference.

4.2.12.5 Armour

Submarine cables shall be provided with armouring suitable to withstand installation, rock placement protection, and environmental loading. The armouring shall be a torque balanced design.

The requirement for armouring the land cable, if any, shall be determined by Contractor and Approved by Company. As a minimum, the cables shall be designed to accommodate the forces required for installation in land trenches as described in Exhibit 1A – Scope of Work.

Bedding for the armour wires shall be a layer of material such as polypropylene yarn and shall be flushed and coated with a material such as hot bitumen.

The armour wires shall be of a material such as hot dipped zinc galvanized steel and meet the requirements of ASTM A123. Armour wires shall be flushed and coated with a fluid such as hot bitumen to assist with corrosion protection for the required fifty (50) year deign life.

The armouring, in addition to tensile strength, shall provide protection from impact loads due to rock placement for the submarine cables and trench backfill operations for the land cable. Contractor shall review and accept "Rock Placement Specification" as provided in Exhibit 6 – Company Supplied Data.

4.2.12.6 Outer Serving

The outer serving for the submarine cable shall be a strong, abrasion resistant material such as polypropylene yarn. The inner layer shall be flushed with a material such as hot bitumen.

In the conduit installed portions of the submarine cable, the sheathing may alternatively consist of abrasion resistant material such as high density polyethylene, to provide improved performance in wear resistance and reduced friction. Outer serving material shall consider thermal and mechanical aspects of the cable's ability to meet the system

requirements as well as ease of pull-in through the conduits and all other phases of the Work.

The outer serving shall resist abrasion from a long conduit pull-in without separating, wearing through, or causing the cable to jam in the conduit during installation.

The outer serving layer of the submarine cable shall contain markings to improve visibility to ROV cameras regardless of laid orientation on the seabed and to define cable length increments.

The outer serving shall be designed and constructed so that damage to the external sheathing shall not impact the design life integrity of the cable.

Outer serving for the land cable shall be an abrasion resistant material such as high density polyethylene. The external sheathing shall be abrasion resistant to withstand installation in land trenches and contact with ground and rock without failure.

Land cable outer serving shall be provided with appropriate markings.

Outer serving integrity shall not be compromised at any time during the execution of the Work.

4.2.12.7 Control of Voltage Differences between Sheath and Armour

Contractor shall provide calculations describing the voltage differences that could arise between sheath and armour, and methods to limit them to pre-defined safe levels. Calculations and conclusions shall be provided as part of the Insulation Coordination Study described in 4.2.10.

4.2.13 Joints

All factory and field joints shall adhere, as a minimum, to the same requirements and criteria specified for the cable within this Exhibit 1B – Cable Performance Specification.

Transition joints shall be supplied and utilized for the submarine to land cable transition. Armour clamps shall be incorporated as needed. The transition joints shall adhere to the same requirements and criteria specified for the cable.

Contractor shall design and supply appropriate cable anchoring devices on land as required to prevent submarine cable forces from being transmitted to the land cable and terminations.

4.3 DTS and Telecommunications

4.3.1 General Requirements

As per Exhibit 1A – Scope of Work, all cables shall be equipped with embedded fiber optics for DTS and data transfer/telecommunications. Fiber optics shall be provided within tube element(s) of a material such as ANSI 316 Stainless Steel. The tube element(s) shall be manufactured in the longest lengths possible and spliced as necessary for the longest delivered cable lengths. The tube(s) shall be filled with a water blocking compound such as a hydrogen scavenger.

The embedded fiber shall meet the requirements of ITU-T G.652 table 'D' attributes. Testing shall be carried out in accordance with IEC 60793 and IEC 60794. Fiber color coding and components shall be according to TIA-598-C.

The Raman system of measurement or technical equivalent shall be used for the DTS measurement of temperature.

The number of fibers used inside the steel tube element shall be maximized. Fibers which are not utilized in DTS function will be availed upon for data transfer/telecommunication and shall interface with Company's communications and SCADA systems. Contractor shall embed the fiber tube element(s) into the cable and allow for tension, bending, and torsional forces which will act on the cable throughout the Work and design life.

The fiber optic components shall be terminated by Contractor in enclosure panels within the transition compounds.

4.3.2 DTS Specific Requirements

The DTS system shall be supplied to perform the function of continuously monitoring the temperature along the entire length of the cables. The DTS opto-electronics units shall be placed in the transition compound on the Newfoundland side of the Strait of Belle Isle, and shall be interfaced by Contractor to a Company data concentrator or remote terminal unit to provide temperature profile information to a system control center at user defined intervals.

DTS Performance and operating requirements are as follows:

1. Shall provide temperature measurements on all cables for the specified lengths.
2. Spatial resolution for distance measurements shall be appropriately defined by Contractor and Approved by Company for the life of installation requirements.

3. Appropriate temperature resolution shall be defined by Contractor specific to the application and Approved by Company.
4. Shall operate continuously for the service lifetime with minimal requirement for maintenance.
5. Mean time between failures shall be maximized. The system accuracy and resolution shall be preserved for this timeframe.
6. Fiber optic operation and/or failure shall have no effect on cable integrity, throughout the Work and design life.
7. Laser output shall meet IEC 60825 class 1 laser safety requirements.
8. DTS unit shall be operable with 110-120 V, 60 Hz single phase power supply.
9. Shall comply with the ISTA impact test procedure 1A drop method and vibration test method B or equivalent.
10. Software requirements for DTS are as follows:
    a) Software supplied shall be a Company Approved program with graphical user interface for facilitating measurement setup (i.e., cable lengths, zones, trace identification and alarms).
    b) Output data shall be compatible with Company programs to allow for dynamic object linking with other application programs.
    c) Allow for simple user-labeling of zones, including but not limited to; distance and mean, high and low temperatures in zones, hot spot locations, trace annotations and specified alarms for each measurement.
    d) Provide an auto-save feature that allows user controlled, time driven closing of data files as well as all other important parameters (defined by the Contractor) such as fiber attenuation characteristics and OTDR information, etc. Data shall be stored on solid state storage devices and shall be capable of transmission via OPGW to Company designated location.
    e) Permit periodic and automatic monitoring as well as recording of optical attenuation in sensing fibers at user-defined intervals.
    f) Be capable of allowing remote access and control of the DTS unit either via ethernet or telephone dial-in.

4.4 Corrosion Protection

Contractor shall carry out all surface preparation work, apply the surface protection, and install cathodic protection permanent items as appropriate to achieve the required design life of the cable system.

Contractor shall perform quality surveillance on the cathodic protection system and shall perform an electrical continuity check for all cathodically protected items.

Cathodic protection system shall protect the armour wires of all installed cables for the design life. A Cathodic Protection Design Report must be generated and submitted as part of the documentation submittal requirements. Contractor shall calculate the erosion and corrosion rates and demonstrate that the calculated metal loss shall not cause failure of the cable assets in any area of the as-built configuration.

Cathodic protection system shall protect any metallic cable conduits, and all Deliverables of the work while not interfering with any other equipment.

4.5 Spares

Cable system spares shall be supplied as outlined in Exhibit 1A – Scope of Work.

Spare cable and equipment shall be sealed and protected from the environment and be appropriately preserved for the design life of the cable system. This shall include without limitation, protection from moisture, corrosion, ultra violet light and crushing. Contractor shall define all other equipment and accessories requiring spares in addition to those defined in Exhibit 1A – Scope of Work.

Spare terminations shall include all materials necessary to replace a damaged or failed termination.

Spares shall be packaged for fifty (50) years storage life. All packaging must be marked with identification that will last for fifty (50) years of storage.

Recommendations shall be made for spares for the fiber optic system.

4.6 Cable Turntable

A cable turntable/carousel shall be provided for all cable spares. The turntable shall be a metallic storage unit sized to accommodate all spare cable for the Project. If turntable is used to transport the spare cable it shall be designed for ocean going transportation. The design life of the turntable shall be fifty (50) years. It shall be equipped with a removable rigid weather tight cover to protect against cable degradation from the environment, including moisture and ultra violet radiation.

The requirement for heating shall be assessed by Contractor and Approved by Company to ensure integrity of the cable for storage and handling.

The design shall allow for transpooling of the spare cable when required in the event of a repair to the operating cables in the Strait of Belle Isle.

The spare cable turntable shall withstand the seismic design requirements as specified in Section 4.2.9.

4.7 Terminations

The cable terminations shall be of air type and suitable for installation in an enclosed cable transition compound. The terminations shall be designed to meet the same electrical requirements as the cable and to operate in the particular ambient temperature conditions defined in Exhibit 6 – Company Supplied Data.

Exposed metallic parts shall consist of materials that are suitable for a marine environment. Terminations must be equipped with components that do not cause galvanic corrosion between one another.

The terminations shall be equipped with a mass impregnation fluid replenishment reservoir as required to meet the system transmission requirements and design life. Termination oil pressure or volume shall be monitored by a manometer equipped with alarm functions, tied into Company SCADA system for remote warning of fluid conditions detrimental to design life of the cable system.

The terminations shall be provided with base plate support insulators, such as porcelain or technical equivalent, to temporarily isolate the metal base plate from the support structures for testing purposes.

The termination seismic design requirements are as described in 4.2.9.

Contractor supplied support structures shall be designed to withstand all forces exerted on the terminations throughout the design life of the cable system, including seismic forces, and thermal-mechanical forces exerted by the cables throughout their design life. Design calculations shall be provided for review to show that this has been taken into account. Footprints shall be designed to interface with Company provided transition compound. Support structures shall be anchored to the foundation.

Terminations shall be equipped with methods to break out the fiber optic cables from the HVDC cables, to allow termination in the fiber optic enclosure panel.

Cable armour and sheaths shall be normally grounded at the terminations. However, provision shall be made to temporarily isolate sheaths and armour circuits from each other for testing purposes. Provision shall also be made to connect the cathodic

protection system to the armour circuit, in accordance with design details to be submitted by Contractor.

Cable terminations shall interface with the overhead transmission line and system components.

Spacing requirements and clearances shall be determined by Contractor and Approved by Company. Physical electrical and mechanical protection barrier requirements shall also be determined and specified to Company by Contractor.

5.0 TESTING

5.1 General

For all testing, Contractor shall provide arrangements to ensure sensitive testing equipment is not exposed to detrimental moisture or other environmental conditions. All test areas must be made safe by utilizing appropriate barricades and/or health, safety and environmental safeguards.

Recommended test and acceptance criteria for any testing proposed by Contractor and Approved by Company will become part of the Agreement.

Contractor shall perform tests to confirm that the cables and equipment have been manufactured to the applicable codes, standards, and recommended practices, and installed without damage.

5.2 Cable System Testing

5.2.1 General

The following testing requirements apply without limitation:

5.2.2 Type Tests

Type testing shall be required in the instances of change in material, design, or process parameters outside previously type tested designs, such that there are resultant changes in dielectric, mechanical and/or thermal properties of the cable that may affect the design life or requirements of the Work.

Where the cable system has been successfully type tested previously, the complete results of the type testing shall be provided to Company.

Company may request that type testing be repeated for previously type tested designs.

Type tests shall be in accordance with Electra 171 and Electra 189. There may be a requirement by Company to modify the extent of the type testing scope defined within these recommendations to suit the specific needs of the Project.

5.2.3 Routine Tests

Routine tests shall be in accordance with Electra 189 recommendations and will verify that the product meets the design and manufacturing specifications. Contractor shall perform the following routine tests, without limitation:

1. High voltage test: Performed on all manufactured length(s) of cable.
2. Conductor resistance test: Performed on all manufactured length(s) of cable.
3. Capacitance test: Performed on a sample length(s) of manufactured cable.
4. Power factor tests: Performed on a sample length(s) of manufactured cable.

5.2.4 Factory Acceptance Testing

The factory acceptance testing shall be carried out in accordance with the recommendations in Electra 189.

TDR measurements shall also be performed on all delivery lengths of cable.

5.2.5 Special Tests

Special tests will be required at the discretion of Company. However, Contractor may propose specific special tests deemed necessary to accomplish any or all portion of the Work. Tests shall be performed in conditions as close as reasonably practical to the installation and environmental conditions, particularly with respect to ambient temperatures. Special tests may include:

1. Dimensional control test: Shall be performed on sample length(s) of manufactured cable in accordance with IEC 60141.
2. Flexural rigidity tests: Performed on a sample length(s) of submarine cable
3. Torsional rigidity tests: Performed on a sample length(s) of submarine cable
4. Cable conduit pull-in tensile loading test: Performed on a sample length(s) of submarine cable designed for conduit pull-in
5. Cyclic fatigue testing: Performed on a sample length(s) of submarine cable to simulate the forces exerted on the cable at vessel and touchdown points

6. DTS/Fiber optic system tests: Performed on all fiber optic components which form a part of the Work
7. External sheathing abrasion resistance test: Performed on a sample length(s) of submarine cable designed for conduit pull-in
8. Spark test: Performed in accordance with IEC 60229, Section 3.2, on delivery lengths of cable which have an extruded sheathing over the armour wires

For the embedded fiber optics, measurement of the attenuation in the optical fibers shall be performed before and after armoring in the instances where the fibers optics are installed in place of an armor wire. Where fibers optics are embedded in the jacket, the attenuation shall be measured before and after extrusion.

5.3 Post Loadout Testing

Following loadout of cable onto the installation vessel, post loadout testing shall be performed on all supplied cable. This shall consist of a high voltage test with the test conditions of the after laying test described in Electra 189.

TDR measurements shall be performed and recorded on each delivery length with a pulse echo meter.

5.4 Post Installation Testing

High voltage testing in accordance with the Electra 189 after laying test shall be performed on all HVDC cables following installation and landfall of the submarine cables, and prior to rock placement. Appropriate temporary terminations, high voltage test sets, or any other equipment required to complete the testing, shall be provided by Contractor as required.

This testing shall be completed prior to transition jointing of submarine cable with land cable.

5.5 Post Termination Testing

High voltage tests in accordance with Electra 189 shall be performed on all HVDC cables following permanent termination, and rock placement of the cables.

TDR measurements shall be performed and recorded on all HVDC cables following permanent termination at the transition compound.

Appropriate high voltage test and TDR test sets, or any other equipment required to complete the testing shall be provided by Contractor for post installation testing.

Cathodic protection system testing shall be performed following post termination of the cable.

5.6 Commissioning

Commissioning of the HVDC system including OHL and converter stations is currently scheduled to occur after the post termination testing performed by Contractor. During system commissioning the Contractor shall be present if required by Company, and provide support with any commissioning involving the cable system and accessories.

5.7 Results of Tests

All results of tests performed as part of the requirements of the Agreement shall be provided to Company by Contractor.

Contractor shall provide results of type tests which apply to the supplied cable design that have been performed prior to Agreement award, to Company.

5.8 Verification

Company and Company's Other Contractors shall witness and verify testing as deemed required by Company.

EXHIBIT 1C

VESSEL PERFORMANCE SPECIFICATION

TABLE OF CONTENTS

1.0 GENERAL REQUIREMENTS

The installation vessel from Contractor's Spread shall comply with the following specifications and requirements. At a minimum the primary installation vessel as part of the Contractor's Spread shall:

a) Satisfy DP Class II;

b) Include sufficient offshore personnel for twenty four (24) hour operations;

c) Satisfy the vessel assurance criteria defined in this Exhibit 1C – Vessel Performance Specification;

d) Include suitable navigational, survey and communication systems to perform Work;

e) Include a 2 off suitable work class ROVs capable of executing the Work in Worksite environmental conditions;

f) Include a cable lay system capable of installation as per this Exhibit 1C – Vessel Performance Specification;

g) As required, include jointing capabilities and equipment;

h) Comply will regulatory requirements for vessel operations in the vicinity of ice;

i) As required, include lifting capabilities for overboarding and deployment of equipment to seabed;

j) Include a deck/storage space for all permanent and installation equipment required;

k) Include sufficient deck lighting for twenty four (24) hour operations;

l) Include accommodation for Company personnel during operations ;

m) Provision for transport and offloading of spares;

n) Include any additional support vessels or crafts required to perform the Work;

o) A safe boarding system shall be provided to allow safe transfer to and from the Vessel; and

p) Include fast rescue craft as per regulatory requirements for Canadian waters.

2.0 INSTALLATION VESSEL CLASS

The installation vessel from Contractor's Spread shall be designed and constructed to the requirement of an internationally recognized classification society (e.g. Loyds Register, ABS, or DNV) and meet regulatory requirements to allow importation.

In addition the Contractor's Spread shall comply with relevant international regulations and recommendations required for work in Canadian waters.

3.0 COMMUNICATIONS

The Contractor shall supply the mandatory communication equipment required by Safety of Life at Sea (SOLAS)/International Maritime Organization (IMO) for the registration class of and country of origins of the vessels involved.

4.0 SURVEY

The Contractor shall provide all positioning survey systems required for survey and installation operations. The Contractor is responsible for ensuring all survey equipment are in good working condition and the Contractor shall ensure adequate spares and back-up are available in the survey spread at all times to enable uninterrupted survey operations to be carried out. The Contractor shall also be responsible for carrying out regular calibrations of all its equipment.

The survey requirements shall include pre/post lay survey, cable tracking, cable route as-left details and any other miscellaneous surveys required for installation.

All survey equipment shall be calibrated and tested prior to mobilization. Calibrations shall be fully documented and such documentation shall be provided to the Company on request. In the event of replacement or repair of any equipment, calibration procedures shall be repeated in full.

5.0 DYNAMIC POSITIONING SYSTEMS

The Contractor's Spread shall be fitted with dynamic positioning (DP) system with a minimum International Maritime Organization (IMO) Equipment Class 2 based on International Maritime Organization (IMO) circular 645 for DP system designs.

The Contractor's Spread shall have redundant absolute and redundant relative positioning systems making it possible to work up close to other vessels in DP mode. The Contractor's Spread must be manned with qualified DP officers and master on board.

6.0 CABLE LAY SYSTEM

6.1 Turntable/Carousel

The turntable and/or carousel shall satisfy the following requirements:

a) Suitable storage and capacity to best optimize operations for the duration the cable is onboard the vessel;

b) Provide protection such that the cable is not compromised during transportation and/or installation;
c) Redundant and fail safe system such that there is no risk of compromising cable integrity in the event of breakdown; and
d) Cable length tracking system to define amount of product installed and remaining on vessel.

6.2 Tensioner/Capstan

The cable tensioning equipment for control of the suspended cable caternary shall satisfy the following requirements:

a) Maximum and minimum tensions under dynamic operation conditions are not to exceed the prescribed cable stress limits;

b) Redundant system with capability to provide maximum tension. (i.e. dual tensioner system). If this requirement cannot be met then alternate methodology shall be proposed by the Contractor;

c) Equipment shall be capable of displaying and recording realtime and continuous tension values and lay characteristics. This record is to be monitored via lay tables and shall be submitted to the Company in tabular and graphical format;

d) The tensioner/capstan compression values shall not exceed the allowable compressive strength of the cable; and

e) Fail safe system such that there is no risk of compromising cable integrity in the event of breakdown.

Control systems with alarm which triggers when the safe limit is exceeded shall be provided to monitor the tension forces and cable stress. Tensioners shall be calibrated based on the approved procedure and to be performed prior to commencement of cable lay.

6.3 Abandonment and Recovery System

The primary installation vessel shall be equipped with abandonment and recovery system, with minimum requirements as stated below:

a) Sufficient capacity to lay down and recover the cable end in the maximum encountered water depth (single catenary);

b) Sufficient capacity to lay down and recover a damaged portion of the cable for inspection/repair in the maximum encountered water depth (double catenary);

c) A compensated tensioning system that is capable of adjusting tension in response to wave-induced vessel and cable motion;

d) Equipment to deploy and recover light equipment from vessel to deck to/from seabed;

e) Suitable over boarding chute/roller/sheave to allow safe and controlled over boarding of cable; and

f) Redundant and fail safe system such that there is no risk of compromising cable integrity in the event of breakdown.

The winch control system shall allow smooth transfer of tension between winch and cable tensioning system.

7.0 CRANES

The crane shall be of a reputable make and be in good working order throughout the execution of the Work. The Contractor shall supply a crane certificate and crane lift chart showing lift capacity plotted against radius. On the same chart, the hook height vs radius plot should be included. The crane shall be fitted with an automatic safe load indicator giving visual and audible alarms, which shall be demonstrated functioning correctly.

Crane operators shall be medically fit, mature, trained, experienced and qualified in the type of crane they are employed to operate on the Work and shall have attended recognized crane operator's course.

8.0 LIFTING EQUIPMENT

The definition of lifting equipment shall include, but not be limited to, hooks, slings, shackles, eyebolts, runway beams, trolleys, chain blocks and lifting frames.

All lifting equipment used by the Contractor is to adhere to, but not limited to, the following minimum criteria:

a) All lifting equipment shall be certified and subject to inspection by surveyor;

b) Contractor shall be responsible for ensuring compliance with the requirements of this section;

c) All lifting equipment shall have a current valid certificate of test and shall be subjected to inspection, by a competent person at regular intervals;

d) A register of all lifting equipment shall be held and maintained by the Contractor;

e) Lifting equipment shall be checked before use, for any defects, which may affect its safe use;

f) Defective lifting equipment shall not be used and shall be placed in a quarantine area pending repair (if allowable) or replacement, the register shall be updated to record the removal from service and entering into service of all lifting equipment; and

g) The Contractor shall supply all of the required slings and shackles for use with the crane. They must all be certified and colour coded specific to project rigging to ensure identifiable among other non-project rigging.

9.0 ROV REQUIREMENTS

The Contractor shall document that the ROV(s) have been tested and commissioned to the maximum anticipated operating depth and environmental conditions. The ROV unit shall be in fully serviceable condition with a full complement of electrical and mechanical spares to maintain continuity of operation, including spare umbilicals.

Only qualified personnel with job-specific training shall operate the ROVs. Operators shall be familiar with all special tools or hardware with which they will be involved.

Video recorders shall be used to record ROV activities and real-time audio voice-over to document the activities. Video recordings shall be in NTSC format and be available to the Company representative onsite.

A descriptive written log shall be maintained and the video recordings shall be identified and labeled by a distinct number and catalogued to indicate contents. Copies of the video recording logs shall be submitted to the Company. The original video recordings shall be the property of the Company and shall be submitted at the completion of the Work, as part of the As-Built Documentation.

Contractor is to provide a ROV with that adhere to, but not limited to, the following minimum criteria:

a) Color camera with lights to suit camera sensitivity;

b) Low light level camera;

c) Dual camera capability;

d) Manipulators (as required to perform work);

e) Guards on all thrusters;

f) Video overlay for ROV depth, heading, time, date;

g) Professional quality VHS/DVD recorders/monitors;

h) Reliable wired audio and visual communications between ROV, ROV control and Bridge;

i) Obstacle avoidance sonar;

j) Accurate depth gauge;

k) Accurate gyro compass;

l) Cable tracking capability;

m) Acoustic tracking capability; and

n) Station keeping ability in currents identified in Exhibit 6 – Company Supplied Data.

ROV operating procedures and manuals developed by the Contractor for ROV operations are to be submitted and Approved by the Company.

10.0 MONITORING EQUIPMENT

During installation of the cable the following parameters, without limitation, shall be monitored and recorded:

a) Cable top tension and residual bottom tension via redundant calibrated load cells;

b) Cable compressive loads;

c) Cable Line-in/line-out metre;

d) Continuous real time Vessel co-ordinates;

e) Wind and wave speed and direction;

f) Continuous real time cable touchdown co-ordinates and depth;

g) Visual touchdown monitoring and recording;

h) Cable departure angle and departure depth;

i) Abandonment & recovery loads (if required);

j) As-laid cable lay route; and

k) As-built video of all critical operations.

Contractor shall be responsible for subsea and surface systems/signals, computers, software and interfaces required to perform the Work.

11.0 ACCOMMODATION

11.1 Galley

The Contractor shall provide a well-equipped galley to a high standard and capable of providing daily meals for the whole crew on a twenty four (24) hour basis.

11.2 Company Representative Accommodations and Office Requirements

Contractor shall provide accommodation and messing onboard the Contractor's Spread for four (4) Company Representatives in four (4) separate single cabins, with dedicated toilet/shower for the entire offshore Work period. Company Representatives shall have full access to the Contractor's Spread's medical, recreational and laundry services.

The following lists the minimum accommodation and office specifications for the Company on the Contractor's Spread primary installation vessel:

a) Fully furnished and equipped private office accommodation for Company Personnel;

b) Hook up for internet with dedicated printer and scan/fax;

c) Private electronic mail and unblocked internet connection for Company Representative;

d) Access to copying and facsimile transmission and receiving facilities; and

e) Telephone extension via Contractor's own network, with a direct outside line for exclusive use by Company Representative. All costs associated with Company's use of telephone, including calls, shall be included in the Price;

f) Dedicated video feed for ROV including set-up for simultaneous video recording and playback;

g) Standard office type desktop computer with current Microsoft Windows software (English version) with dedicated printer and CD/DVD. Desktop computer shall be provided with all necessary software for review of Contractor's Drawings and/or documents;

h) DP alarms;

i) VHF radio; and

j) Vessel internal intercom.

12.0 OFFSHORE CONSTRUCTION TEAM

The Contractor shall establish a dedicated and experienced offshore construction team, including construction superintendent, to manage and execute the Work on Contractor's Spread.

All marine and construction Personnel shall be fully qualified for their tasks and must, where required, be fully certified by the appropriate Authorities. All key marine and construction Personnel shall be fully instructed during formal briefing/training sessions regarding the installation procedures prior to their involvement in the actual operations.

Contractor shall supply a training matrix for all Contractor Personnel for Company Approval.

The Contractor shall ensure that certificates and curriculum vitae of all offshore Personnel are available for review both at the offshore Worksite and at the Contractor's project management office. The Contractor shall provide this information to the Company upon request.

Crews for Contractor's Spread shall also contain sufficient, trained bridge, engineering and support personnel to safely operate and maintain the ROV on a twenty four (24) hour per day basis for the duration of the Work.

13.0 VESSEL ASSURANCE

13.1 Contractor's Spread Inspection

Contractor's Spread shall, at Company's sole discretion, undergo a Company vessel audit and inspection. The Company shall reserve the right to perform the aforementioned vessel audits at a time agreed with the Contractor:

a) General vessel audit;

b) HSE and quality audit(s);

c) Offshore installation audit; and

d) Onsite transpooling audit;

As part of the vessel audits the Contractor shall make available on each vessel all necessary documents pertaining to the Work including operating and safety procedures, certificates and documentation pertaining to, but not be limited to, the following:

a) Propulsion systems;

b) Power generation systems, including emergency back-ups;

c) Communication, navigation and survey systems;

d) Dynamic positioning systems;

e) Cranes, davits and associated lift equipment;

f) Winches and associated return sheaves/rollers;

g) Tensioner/capstan;

h) Cable conveyors, load cells and controls;

i) Welding, NDT and repair stations and systems;

j) Field joint systems;

k) Cable installation monitoring systems;

l) ROV system;

m) Survey and navigational system;

n) Fast rescue craft; and

o) Firefighting equipment.

Calibration tests for all cable installation equipment and load cells shall be performed and submitted to the Company for Approval, unless the Contractor can demonstrate that the cable installation equipment has been recently tested and calibrated and can provide all certification of such tests to the satisfaction of the Company for Approval.

EXHIBIT 2

COMPENSATION

Commercial Section Not Filed

EXHIBIT 3

SUBCONTRACTORS

Commercial Section Not Filed

EXHIBIT 4

COORDINATION PROCEDURES

Commercial Section Not Filed

EXHIBIT 5

COMPANY SUPPLIED ITEMS

Commercial Section Not Filed

EXHIBIT 6A

FIELD CONDITIONS STRAIT OF BELLE ISLE

Background material filed in Exhibits 33, 34, 35, and Confidential Exhibit CE-44

EXHIBIT 7

DELIVERABLES LIST

Commercial Section Not Filed

EXHIBIT 8

NEWFOUNDLAND AND LABRADOR BENEFITS

CONTRACTOR'S OBLIGATIONS

(EXTRACTS FROM PROPOSAL)

Commercial Section Not Filed

EXHIBIT 9

PERFORMANCE SECURITY

Commercial Section Not Filed

EXHIBIT 10

DECLARATION OF RESIDENCY

(TO BE EXTRACTED FROM THE PROPOSAL)

Commercial Section Not Filed

EXHIBIT 11

MILESTONE SCHEDULE

Commercial Section Not Filed

EXHIBIT 12

CONTRACTOR'S FACILITIES

(TO BE EXTRACTED FROM THE PROPOSAL)

Commercial Section Not Filed