DETAILED SCOPE OF WORK
IN-STREAM TIDAL GENERATING PLANT
TISEC COLLECTOR CIRCUITS DEVELOPMENT

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1. GENERAL

1.1 OVERVIEW

The general purpose of this project is to provide civil and electrical contractor services, including supply of certain materials as specified, to develop the infrastructure required to allow for the interconnection of power, control and SCADA cables between the FORCE (Fundy Ocean Research Centre for Energy) Substation Control Building, located in Substation 429N, located approximately 12km east of Parrsboro, Nova Scotia, on the Old Black Rock Road, and the shore end of four (4) composite, submarine cables; one for each Tidal In-Stream Energy Converter (TISEC) which will terminate in Cable Vault No. 1, located near the Black Rock beach.

The work will generally include:

.1 The installation of twelve (12) precast concrete cable vaults.
.2 The supply and installation of a drainage system at six (6) of the cable vaults
.3 The supply and installation of nine (9) ground electrode systems.
.4 The supply and installation of a ground bus system at ten (10) of the cable vaults and in the Substation Control Building Cable Tray Vault.
.5 The supply and installation of concrete encased duct banks between each cable vault and the Substation Control Building Cable Tray Vault.
.6 The supply and installation of conduits and ground rods at an existing NSPI utility (riser) pole, located on the south side of the West Bay Road.
.7 The supply and installation of a cable tray system in three (3) of the cable vaults and in the Substation Control Building Cable Tray Vault.
.8 The supply and installation of a cable support system in ten (10) of the cable vaults.
.9 The supply and installation of NEMA 4X junction boxes (complete with accessories) at Cable Vault No. 1 and in the Substation Control Building Cable Tray Vault.
.10 The installation of 350kcmil, 35kV 133% EPR insulated power cable (four sets of 3 x 1C for each cable set) from Cable Vault No. 1 to the Substation Control Building Cable Tray Vault.
.11 The supply and installation of thirty-six (36) 35kV in-line cable splices.
.12 The installation of and termination of one (1) 20C, 10AWG, 600V tray cable.
.13 The installation of two (2), 48 strand, single-mode optical fiber cables.

1.1/

All work will be carried out on properties owned by or leased to FORCE or within right of way belonging to the Nova Scotia Department of Transportation and Infrastructure Renewal (NSDOTIR).

Distances, areas and volumes indicated on the drawings may not be exact and should not be used for the procurement of materials or the cutting of cables, conduit or cable tray. The Contractor shall confirm all dimensions on site and shall be responsible for the lengths and quantities of materials specified herein.

1.2 PREPARATORY WORK CARRIED OUT BY OTHERS

The following preparatory work has been carried out by Others:

.1 Installation of the pre-cast concrete dead-end Submarine Cable anchor.
.2 Installation of Cable Vault Nos. 1, 2, 3 and 4, including the installation of a ground electrode system around the perimeter of each cable vault and the installation of a concrete encased duct bank between Cable Vault No. 1 and Cable Vault No. 2, between Cable Vault No. 2 and Cable Vault No. 3, between Cable Vault No. 3 and Cable Vault No. 4 and the stub-out of conduit from the north side of Cable Vault No. 4.
.3 Clearing, grubbing and leveling of the FORCE Substation 429N.
.4 Clearing, grubbing and leveling of the underground cable system access route on property owned by FORCE running from the West Bay Road to the FORCE Substation 429N.

1.3 MATERIALS TO BE SUPPLIED BY THE OWNER

Fundy Ocean Research Centre for Energy (FORCE) has pre-purchased the following materials for installation by the Contractor:

.1 Six (6) pre-cast concrete Cable Vaults
.2 Three (3) pre-cast concrete Utility Supply vaults
.3 Three (3) pre-cast concrete Telecoms Supply Vaults
.4 Four (4) armoured, composite submarine cables
.5 12,000 m of 350kcmil, 35kV 133% EPR, Copper Tape Shielded Power Cable
.6 5,500 m of 4/0AWG bare copper grounding conductor
.7 4,000 m of 2AWG, 600V XLPE insulated green bonding conductor
.8 1,000 m of 20 conductor, 10AWG, 600V XLPE insulated control cable
.9 2,000 m of 48 strand, single-mode, all-dielectric optical fiber cable

1./

1.4 PROJECT SCHEDULE

.1 The purchase of all Contractor supplied equipment associated with the TISEC Collector Circuits development can proceed immediately following award of the contract. The Contractor shall submit shop drawing and/or product data sheets for review by the Owner's Engineer for all Contractor supplied materials.

.2 The installation of Cable Vault Nos. 5, 6 and 7 and their associated ground electrode systems, concrete encased duct banks and drainage systems shall not proceed until a Breaking of Soils Permit is granted by the Nova Scotia Department of Transportation and Infrastructure Renewal (NSDOTIR). Contact Greg Frail, Operations Supervisor – Parrsboro, Nova Scotia.

.3 The installation of Cable Vault Nos. 8, 9 and 10 and their associated ground electrode systems, concrete encased duct banks and drainage systems may proceed as soon as the cable vaults and grounding conductor are received by the Owner.

.4 The installation of Utility Supply Vault Nos. 3, 4 and 5, Telcoms Vault Nos. 4, 5 and 6 and the NSPI riser pole conduits and their associated grounding system and concrete encased duct banks may proceed as soon as the cable vaults and grounding conductor are received by the Owner.

.5 The installation of cable tray or cable support structures and ground bus systems may proceed as soon as the cable vaults are received by the Owner.

.6 The installation of 35kV power cable, 35kV in-line cable splices, 20C tray cable, single-mode optical fiber cable and associated junction boxes may proceed as soon as the cables are received by the Owner.

.7 The installation of the Collector Circuits infrastructure and associated grounding system, power, control and optical fiber cables and junction boxes shall be completed no later than 1 July 2011.

.8 The installation and termination of the four (4) armoured composite submarine cables (3x1C, 350kcmil 35kV power conductors, 1x4C, 10AWG pilot cable and 12 strand single-mode optical fibre cable) into Cable Vault No. 1 may proceed following installation of the submarine cables, presently scheduled for August 2011.

.9 The supply, installation and termination of all TISEC Collector Circuits electrical systems associated with this project shall be completed by 9 September 2011.

1./

1.5 PROJECT DRAWINGS / REFERENCES

The following electrical drawings have been prepared by Strum Engineering Associates Ltd. for this project:

.1 Drawing No. 023-478-E-3008, Rev. B01
.2 Drawing No. 023-478-E-3009, Rev. B01
.3 Drawing No. 023-478-E-3010, Rev. B01
.4 Drawing No. 023-478-E-3011, Rev. B01
.5 Drawing No. 023-478-E-3012, Rev. B01
.6 Drawing No. 023-478-E-3013, Rev. B01
.7 Drawing No. 023-478-E-3014, Rev. B01
.8 Drawing No. 023-478-E-3015, Rev. B01
.9 Drawing No. 023-478-E-3016, Rev. B01
.10 Drawing No. 023-478-E-3017, Rev. B01
.11 Drawing No. 023-478-E-3018, Rev. B01
.12 Drawing No. 023-478-E-3019, Rev. B01

2. INSTALLATION OF PRE-CAST CONCRETE VAULTS

2.1 GENERAL

.1 Drawing No. 023-478-E-3008, Rev. B01 shows in plan, the location and proposed orientation of Cable Vault Nos. 5, 6, 7, 8, 9 and 10, Utility Supply Vault Nos. 3, 4 and 5 and Telecoms Supply Vault Nos. 4, 5 and 6.
.2 Drawing Nos. 023-478-E-3019, Rev. B01 provides a detailed Bill of Material proposed for the Collector Circuits development.
.3 Cable Vault Nos. 1, 2, 3 and 4, Utility Supply Vault Nos. 1 and 2 and Telecoms Supply Vault Nos. 1, 2 and 3 and their associated ground electrode systems, concrete encased duct banks and drainage systems were installed by Others as part of Phase 1 of the project.
.4 Pre-cast concrete Cable Vault Nos. 5, 6, 7, 8, 9 and 10 (Bill of Material Item No. 2), Utility Supply Vault Nos. 3, 4 and 5 and Telecoms Supply Vault Nos. 4, 5 and 6 (Bill of Material Item No. 3) have been pre-purchased by FORCE. The temporary storage location for the sectionalized cable vaults is still to be determined; however, it can be assumed that the cable vaults will be stored within 10 km of the project site (Town of Parrsboro, NS).

2./

2.2 INSTALLATION OF CABLE VAULT NOS. 5, 6 AND 7

.1 Cable Vault Nos. 5, 6 and 7 will be placed below finished grade within the 20.1m (66') NSDOTIR right of way of the West Bay Road.

.2 Prior to commencing any work, a ***Breaking of Soils Permit*** shall be submitted to NSDOTIR. All fees and deposits associated with the ***Breaking of Soils Permit*** shall be paid by the Contractor. No work may commence until a approved/signed ***Breaking of Soils Permit*** is granted by NSDOTIR. A copy of the ***Breaking of Soils Permit*** shall be forwarded to the Engineer.

.3 The proposed location of each cable vault is shown on Drawing No. 023-478-E-3008, Rev. B01. The exact location of Cable Vault Nos. 5, 6 and 7 shall be determined following consultation with the Engineer and NSDOTIR.

.4 The Contractor shall be responsible for ensuring the normal flow of traffic along West Bay Road during the course of the project. Signs, flagging personnel, barriers, lights, etc. shall be employed to ensure safe passage along the roadway during construction periods, at night and on weekends. Temporary widening of the West Bay Road on its north side shall be carried out to NSDOTIR specifications, if required, to maintain a minimum road width of 6.6m (21'-6").

.5 The Contractor shall excavate a hole of sufficient size to accommodate each cable vault and its perimeter ground electrode system. The Contractor shall ensure the open trench is clearly marked and barriers are installed to protect personnel. The setting depth of Cable Vault Nos. 5, 6 and 7 shall be such to ensure that the top of the steel frame and cover assembly are a minimum of 300mm (12") below the finished grade of the roadway. This will ensure no damage to the frame and cover during road grading and plowing.

.6 A drainage ditch shall be excavated from the location of each cable vault sump pit to a point 10m (33') away from the cable vault sump pit, sloping away from the vault. The drainage ditch shall be confined to the NSDOTIR right of way. 300mm (12") of NSDOTIR Class B gravel shall be placed on the base of the ditch. 100mm (4") diameter weeping tile pipe shall be laid on the gravel base and then a second layer of 300mm (12") of NSDOTIR Class B gravel shall be placed over and around the weeping tile.

.7 300mm (12") of compacted NSDOTIR Class B gravel shall be placed on the base of the excavation to form a firm, dry level foundation for the cable vault. The cable vault base, intermediate and top slab sections and the grade ring and steel frame and cover assembly shall be placed on the gravel foundation using an adequately rated crane and slings supplied by the Contractor.

2.2/

.8 Waterproofing membranes, supplied by the cable vault manufacturer, shall be placed between each cable vault section during installation.

2.3 INSTALLATION OF CABLE VAULT NOS. 8, 9 AND 10

.1 Cable Vault Nos. 8, 9 and 10 will be placed below finished grade in the 7.5m (25') wide FORCE property which runs from West Bay Road to the Substation site.

.2 The proposed location of each cable vault is shown on Drawing No. 023-478-E-3008, Rev B01. The exact location of Cable Vault Nos. 8, 9 and 10 shall be determined following consultation with the Engineer.

.3 The Contractor shall excavate a hole of sufficient size to accommodate each cable vault and its perimeter ground electrode system. Set the depth of Cable Vault Nos. 8, 9 and 10 to ensure that the steel frame and cover are at finished grade, as indicated on the drawings.

.4 A drainage ditch shall be excavated from the location of the cable vault sump pit of each vault to a point 10m (33') away from the vault, sloping towards West Bay Road and away from the vault sump pit. 300mm (12") of NSDOTIR Class B gravel shall be placed on the base of the ditch. 100mm (4") diameter weeping tile pipe shall be laid on the gravel base and then a second layer of NSDOTIR Class B gravel shall be placed over and around the weeping tile.

.5 300mm (12") of compacted NSDOTIR Class B gravel shall be placed on the base of the excavation to form a firm, dry level foundation for the cable vault. The cable vault base, intermediate and top slab sections and the grade ring and steel frame and cover assembly shall be placed on the gravel foundation using an adequately rated crane and slings supplied by the Contractor.

.6 Waterproofing membranes, supplied by the cable vault manufacturer, shall be placed between each cable vault section during installation.

2.4 INSTALLATION OF UTILITY SUPPLY VAULT NOS. 3, 4 AND 5

.1 Utility Supply Vault Nos. 3, 4 and 5 will be placed below finished grade in the 7.5m (25') wide FORCE property which runs from West Bay Road to the Substation site.

.2 The proposed location of each utility supply vault is shown on Drawing No. 023-478-E-3008, Rev. B01. The exact location of Utility Supply Vault Nos. 3, 4 and 5 shall be determined following consultation with the Engineer.

2.4/

.3 The Contractor shall excavate a hole of sufficient size to accommodate each utility supply vault and its perimeter ground electrode system. Set the depth of Utility Supply Vault Nos. 3, 4 and 5 to ensure that the steel frame and cover are at finished grade, as indicated on the drawings.

.4 A drainage ditch shall be excavated from the base of the utility supply vault to a point 10m (33') away from the vault, sloping towards West Bay Road and away from the vault. 300mm (12") of NSDOTIR Class B gravel shall be placed on the base of the ditch. 100mm (4") diameter weeping tile pipe shall be laid on the gravel base and then a second layer of NSDOTIR Class B gravel shall be placed over and around the weeping tile.

.5 300mm (12") of compacted NSDOTIR Class B gravel shall be placed on the base of the excavation to form a firm, dry level foundation for the utility supply vault. The utility supply vault, grade ring and steel frame and cover assembly shall be placed on the gravel foundation using an adequately rated crane and slings supplied by the Contractor.

2.5 INSTALLATION OF TELECOMS SUPPLY VAULT NOS. 4, 5 AND 6

.1 Telecoms Supply Vault Nos. 4, 5 and 6 will be placed below finished grade in the 7.5m (25') wide FORCE property which runs from West Bay Road to the Substation site.

.2 The proposed location of each telecoms supply vault is shown on Drawing No. 023-478-E-3008, Rev. B01. The exact location of Telecoms Supply Vault Nos. 4, 5 and 6 shall be determined following consultation with the Engineer.

.3 The Contractor shall excavate a hole of sufficient size to accommodate each telecoms supply vault and its perimeter ground electrode system. Set the depth of Telecoms Supply Vault Nos. 4, 5 and 6 to ensure that the steel frame and cover are at finished grade.

.4 A drainage ditch shall be dug from the base of the telecoms supply vault to a point 10m (33') away from the vault, sloping towards West Bay Road and away from the vault. 300mm (12") of NSDOTIR Class B gravel shall be placed on the base of the ditch. 100mm (4") diameter weeping tile pipe shall be laid on the gravel base and then a second layer of NSDOTIR Class B gravel shall be placed over and around the weeping tile.

2.5/

.5 300mm (12”) of compacted NSDOTIR Class B gravel shall be placed on the base of the excavation to form a firm, dry level foundation for the utility supply vault. The telecoms supply vault, grade ring and steel frame and cover assembly shall be placed on the gravel foundation using an adequately rated crane and slings supplied by the Contractor.

3. INSTALLATION OF CONCRETE VAULT PERIMETER GROUND ELECTRODE

3.1 GENERAL

.1 Drawing Nos. 023-478-E-3013, -3014, -3015, -3016, -3017 and -3018, Rev. B01 show the location, arrangement and Bill of Material item numbers of the perimeter ground electrode system required at each cable vault.
.2 Drawing No. 023-478-E-3008, Rev. B01 shows the location, arrangement and Bill of Material item numbers of the perimeter ground electrode system required at Utility Supply Vault Nos. 1, 2, 3 and 4 each utility supply vault.
.3 Drawing Nos. 023-478-E-3019, Rev. B01 provides a detailed Bill of Material proposed for the Collector Circuits development.
.4 The perimeter ground electrode system for Cable Vault Nos. 1, 2, 3 and 4 was installed by Others as part of Phase 1 of the project.
.5 The 4/0AWG bare copper grounding conductor (Bill of Material Item No. 6) has been pre-purchased by FORCE. The temporary storage location for the grounding conductor is still to be determined; however, assume that the material will be stored within 10 km of the project site, (Town of Parrsboro, NS).

3.2 INSTALLATION OF CONCRETE VAULT PERIMETER GROUND ELECTRODE SYSTEM

.1 At each of Cable Vault Nos. 5, 6, 7, 8, 9 and 10, a ground electrode system, comprising four (4) 3000mm long ground rods, 4/0AWG bare copper grounding conductor and compression type connectors shall be installed around the perimeter of each vault.
.2 At each of Utility Supply Vault Nos. 3, 4 and 5and 10, two (2) ground rods shall be added to the 4/0AWG bare copper grounding conductor (running under the utility supply ducts) to enhance the grounding system.
.3 A ground rod shall be installed approximately 1m diagonally from each corner of the vault. The ground rods shall be driven vertically to refusal.

3.2/

.4 At each ground rod, a continuous loop of 4/0AWG bare copper grounding conductor shall be run through a rod-cable compression connector. Ensure both ends of the loop are in excess of 5m long to allow extension into each cable vault and utility supply vault. The connector shall be compressed using a compression tool sized and rated for the connector.

.5 Where the 4/0AWG grounding conductors overlap, a cable to cable compression connector shall be used to join the two conductors. The connector shall be compressed using a compression tool sized and rated for the connector.

.6 Insert the two ends of the 4/0AWG bare copper grounding conductor through the 38mm conduit sleeves and into each cable vault for termination on the cable vault ground bus and into each utility supply vault for utilization by NSPI.

4. INSTALLATION OF CONCRETE ENCASED DUCT BANKS

4.1 GENERAL

.1 Drawing Nos. 023-478-E-3013, -3014, -3015, -3016, -3017 and -3018, Rev. B01 show the location, arrangement and Bill of Material item numbers of the concrete encased duct banks to be run between cable vaults.

.2 Drawing No. 023-478-E-3008, Rev. B01 shows the location, arrangement and Bill of Material item numbers of the concrete encased duct banks to be run between each utility supply vault and telecoms supply vault.

.3 Drawing Nos. 023-478-E-3019, Rev. B01 provides a detailed Bill of Material required for the Collector Circuits development.

.4 The concrete encased duct banks between Cable Vault Nos. 1 and 2, Cable Vault Nos. 2 and 3 and Cable Vault Nos. 3 and 4 were installed by Others as part of Phase 1 of the project. At Cable Vault No. 4, the ducts to Cable Vault No. 5 were stubbed out of the cable vault approximately 3m (10') and capped; however these ducts were not concrete encased.

.5 The 4/0AWG bare copper grounding conductor (Bill of Material Item No. 6) has been pre-purchased by FORCE. The temporary storage location for the grounding conductor is still to be determined; assume that the material will be stored within 10 km of the project site, (Town of Parrsboro, NS).

4./

4.2 INSTALLATION OF CONCRETE ENCASED DUCT BANKS BETWEEN CABLE VAULTS

.1 Concrete encased duct banks shall be installed consecutively between Cable Vault Nos. 4, 5, 6, 7, 8, 9, 10 and the Substation 429N Control Building. Each concrete encased duct bank shall be comprised of four (4), 129mm (5") ID PVC ducts, two (2), 103mm (4") ID PVC ducts, duct spacer system, steel reinforcing, plywood power/communication divider and continuous 4/0AWG bare copper grounding conductor buried under the power cable side of the duct bank.

.2 A trench, measuring approximately 1000mm wide x 1600mm deep shall be excavated between each consecutive set of cable vaults. The Contractor shall ensure the open trench is clearly marked and barriers are installed to protect personnel.

.3 A 4/0AWG bare copper grounding conductor shall be laid in the native soil under the center of the power cable side of the concrete encasement and buried with 100mm of native backfill. Each end of the 4/0AWG bare copper grounding conductor shall be run through a 38mm conduit sleeve and into the cable vault; for termination on the cable vault ground bus.

.4 The four (4), 129mm (5") ID PVC ducts and two (2), 103mm (4") ID PVC ducts shall be installed in a duct spacer system laid on the base of the trench. Duct spacers shall be installed every 1800mm (6') to ensure ducts do not sag during the concrete pour. The top of the duct spacer shall be a minimum of 1000mm (39") below finished grade.

.5 10M steel reinforcing bars shall be installed longitudinally in the four corners of each consecutive duct spacer to form a continuous reinforcing system. 10M steel reinforcing bars shall be added as required to strengthen the duct bank.

.6 A 19mm thick plywood divider shall be run continuously along the length of the duct bank to provide a physical separation between the power ducts and communication ducts.

.7 At Cable Vault No. 4, the existing stubbed-out conduits shall be extended, using conduit couplings. The concrete encased duct bank between Cable Vault Nos. 4 and 5 will cross over or under the existing PVC water pipe and PVC duct, containing the electrical cable to the submersible well pump, serving the Interpretive Centre. A decision to relocate the water pipe and/or pump electrical duct will be made following excavation of the site.

4.2/

.8 Each of the pre-cast concrete cable vaults is fitted with 129mm (5") and 103mm (4") PVC conduit sleeves in the arrangement and orientation indicated on the drawings. At each cable vault, the Contractor shall interface the duct bank ducts with the cable vault conduit sleeves using solvent cement to form a waterproof joint.

.9 On the inside wall of each cable vault, each duct shall be clearly identified, using a permanent marker system, with the duct ID number as indicated on the drawings.

.10 Each duct shall be thoroughly swabbed to remove any dirt and foreign material. A 3mm (1/8") stranded polyethylene rope shall be installed in each duct running between each cable vault.

.11 The entire duct bank system shall be encased with concrete. The concrete mix data shall be submitted for review by the Engineer prior to preparation of the first concrete batch. The minimum compressive strength of the concrete shall be 27.5MPa (4000psi) after 28 days. Test cylinders shall be obtained, and stored, at site during the pour for each batch of concrete. The minimum concrete cover over the duct spacers shall be 38mm (1-1/2"), all-around.

.12 The concrete encasement shall remain exposed to the air and allowed to cure for at least 24 hours before backfilling with the native excavated material. The backfilled material shall be compacted, to 95% Proctor Density, in 150mm (6") lifts on layers.

.13 A continuous warning tape marker shall be laid approximately 300mm (12") below finished grade over the full length of each concrete encased duct bank.

.14 The surface grade shall be leveled and compacted. Between Cable Vault Nos. 4 and 5, the finished grade shall be landscaped to match the surrounding grounds of the Interpretive Centre. Between Cable Vault Nos. 5 and 8, the quality of the finished road surface and the finished grade shall meet the requirements of the NSDOTIR. Between Cable Vault Nos. 8 and 10, the finished grade shall be hydro-seeded to prevent surface erosion.

4.3 INSTALLATION OF UTILITY AND TELECOMS DUCTS AT NSPI RISER POLE

.1 Two (2), 103mm (4") diameter rigid PVC, 90º long-sweep utility bends shall be supplied and installed at the NSPI utility (riser) pole adjacent to Cable Vault No. 7 on the West Bay Road. The Contractor shall arrange and pay for all required permits with NSPI and Bell-Aliant to access the utility (riser) pole.

4.3/

.2 A ground rod shall be driven adjacent to the pole and shall be interconnected to the NSPI system neutral conductor and the duct bank grounding conductor.

.3 The conduits shall be secured to the utility pole, then concrete encased per the riser pole detail (Detail 4) shown on Drawing No. 023-478-E-3008, Rev. B01.

4.4 INSTALLATION OF CONCRETE ENCASED DUCT BANKS BETWEEN UTILITY RISER POLE AND UTILITY SUPPLY VAULTS AND TELECOMS SUPPLY VAULTS

.1 Concrete encased duct banks shall be installed consecutively between the NSPI utility (riser) pole and Utility Supply Vault Nos. 3, 4 and 5, between the NSPI utility (riser) pole and Telecoms Supply Vault Nos. 4, 5 and 6 and the Substation 429N Control Building and a single concrete encased duct shall be installed between Cable Vault No. 5 and existing Telecoms Supply Vault No. 1. A 129mm (5") diameter hole shall be core drilled through the north wall of existing Telecoms Supply Vault No. 1 to allow for the installation of the 103mm (4") diameter concrete encased duct bank from Cable Vault No. 5.

.2 Each concrete encased duct bank shall be comprised of one (1) or two (2), 103mm (4") ID PVC ducts, duct spacer system, steel reinforcing, plywood power/communication divider and continuous 4/0AWG bare copper grounding conductor buried under the duct bank.

.3 A trench, measuring approximately 500mm wide x 1600mm deep shall be excavated between each consecutive utility supply vault. The Contractor shall ensure the open trench is clearly marked and barriers are installed to protect personnel.

.4 A 4/0AWG bare copper grounding conductor shall be laid in the native soil in the center of the trench and buried with 100mm of native backfill. Each end of the 4/0AWG bare copper grounding conductor shall be run through a 38mm conduit sleeve and into the Utility Supply Vault for utilization by NSPI, if required. A 4/0 AWG grounding conductor is not required beneath the telecoms concrete encased duct banks.

.5 The two (2), 103mm (4") ID PVC ducts shall be installed in a duct spacer system laid on the base of the trench. Duct spacers shall be installed every 1800mm (6') to ensure ducts do not sag during the concrete pour. The top of the duct spacer shall be a minimum of 1000mm (39") below finished grade.

4.4/

.6 10M steel reinforcing bars shall be installed longitudinally in the four corners of each consecutive duct spacer to form a continuous reinforcing system. Transverse 10M steel reinforcing bars shall be added as required to strengthen the duct bank.

.7 A 19mm thick plywood divider shall be run continuously along the length of the duct bank to provide a physical separation between the power ducts and communication ducts.

.8 Each of the pre-cast concrete utility and telecoms supply vaults are fitted with 103mm (4") PVC conduit sleeves in the arrangement and orientation indicated on the drawings. At each utility and telecoms supply vault, the Contractor shall interface the duct bank ducts with the vault conduit sleeves using solvent cement to form a waterproof joint.

.9 On the inside wall of each cable vault, each duct shall be clearly identified, using a permanent marker system, with the duct ID number as indicated on the drawings.

.10 Each duct shall be thoroughly swabbed to remove any dirt and foreign material. A 3mm (1/8") stranded polyethylene rope shall be installed in each duct running between each cable vault.

.11 The entire duct bank system shall be encased with concrete. The concrete mix data shall be submitted for review by the Engineer prior preparation of the first concrete batch. The minimum compressive strength of the concrete shall be 27.5MPa (4000psi) after 28 days. Test cylinders shall be obtained, and stored, at site during the pour for each batch of concrete. The minimum concrete cover over the duct spacers shall be 38mm (1-1/2"), all-around.

.12 The concrete encasement shall remain exposed to the air and allowed to cure for at least 24 hours before backfilling with the native excavated material. The backfilled material shall be compacted, to 95% Proctor Density, in 150mm (6") intervals.

.13 A continuous warning tape marker shall be laid approximately 300mm (12") below finished grade over the full length of each concrete encased duct bank.

.14 The surface grade shall be leveled and compacted. The finished grade shall be hydro-seeded to prevent surface erosion.

5. INSTALLATION OF CABLE VAULT INFRASTRUCTURE

5.1 GENERAL

.1 Drawing Nos. 023-478-E-3009, -3010, -3011, -3012, -3013, -3014, -3015, -3016, -3017 and -3018, Rev. B01 show the location, arrangement and Bill of Material item numbers of the infrastructure to be installed inside each cable vault.

.2 Drawing Nos. 023-478-E-3019, Rev. B01 provides a detailed Bill of Material proposed for the Collector Circuits development.

5.2 INSTALLATION OF GROUND BUS SYSTEM

.1 A copper ground bus system, consisting of a 610mm (24") long x 100mm (4") wide x 6mm (1/4") thick copper bus bar and two (2) 600V polymer standoff insulators complete with stainless steel mounting hardware is required for each cable vault except Cable Vault No. 10, which shall be fitted with two (2) ground bus systems.

.2 The ground bus system shall be mounted 300mm (12") above the floor of the cable vault, in the location indicated on the drawings.

.3 The copper bus bar shall be drilled on site to suit the connection of grounding and bonding conductor connectors.

5.3 INSTALLATION OF METAL FRAMING CHANNEL

.1 Each cable vault will be fitted with 41mm x 41mm (1-5/8" x 1-5/8") galvanized steel framing channel, mounted vertically on the inside wall of the cable vault.

.2 The metal framing channels shall be secured to the interior cable vault walls using stainless steel inserts and stainless steel hardware. The layout of the metal framing channels shall be as indicated on each detailed cable vault drawing.

.3 The metal framing channels shall be fitted with spring nuts, as required to accommodate the mounting of cable trays and cable support arms.

5.4 INSTALLATION OF CABLE SUPPORT SYSTEMS – CABLE VAULT NOS. 1, 4 AND 8

.1 Cable Vault Nos. 1, 4 and 8 shall be equipped with four (4) tiers of 457mm (18") wide aluminum ladder cable tray. The 457mm wide cable trays shall be used to support the 35kV in-line cable splices required in these cable vaults.

5.4/

.2 The cable trays shall be mounted on a metal framing channel support structure built inside the cable vault specifically to support the cable trays. Each tray shall be attached to the metal framing channels using cable tray hold-down clamps. The layout of the cable trays shall be as indicated on each detailed cable vault drawing.

.3 Cable Vault Nos. 1, 4 and 8 shall also be equipped with non-metallic cable support arms to support the 35kV power cables between the duct entries and the cable trays and to support the pilot wire and optical fiber cables between the duct entries and the junction boxes.

.4 The cable support arms shall be mounted on a metal framing channel support structure built inside the cable vault. Each cable support arm shall be attached to the metal framing channels using spring nuts and stainless steel hardware. The layout of the cable tray support arms shall be as indicated on each detailed cable vault drawing.

5.5 INSTALLATION OF CABLE SUPPORT SYSTEMS –CABLE VAULT NOS. 2, 3, 5, 6, 7, 9 AND 10

.1 Cable Vault Nos. 2, 3, 5, 6, 7, 9 and 10 shall be equipped with non-metallic cable support arms to support the 35kV power cables, pilot wire cables and optical fiber cables which run between the duct entries.

.2 The cable support arms shall be mounted on a metal framing channel support structure built inside the cable vault. Each cable support arm shall be attached to the metal framing channels using spring nuts and stainless steel hardware.

.3 The layout of the cable tray support arms shall be as indicated on each detailed cable vault drawing.

5.6 INSTALLATION OF PILOT CABLE AND OPTICAL FIBER CABLE JUNCTION BOXES

.1 Two (2) waterproof, corrosion resistant (NEMA 4X) junction boxes shall be installed in Cable Vault No.1 to house the conductor terminations of the pilot cables and the fusion splices of the optical fiber cables.

.2 Each junction box shall be mounted on metal framing channels secured to the interior wall of Cable Vault No. 1. The junction boxes shall be attached to the metal framing channels using spring nuts and stainless steel hardware.

.3 The mounting location for the junction boxes shall be as indicated on each detailed cable vault drawing.

5.6/

.4 The pilot cable junction box (JB1) will be used to terminate the four (4), 10AWG conductors from each of the composite submarine cable pilot cables and the 10AWG copper, twenty (20) conductor control cable running from the FORCE Substation Control Building Cable Tray Vault. Four (4), 6-pole terminal blocks shall be supplied and installed in the pilot cable junction box for the termination of the pilot cable and control cable conductors, shield and ground wire.

.5 The optical fiber cable junction box (JB2) will be used to house the fusion splices of the twelve (12) optical fiber strands from each of the four (4) composite submarine cable twelve fiber optical fiber cables and the forty-eight (48) fiber optical fiber cable running from the FORCE Substation Control Building to Cable Vault No. 1.

6. INSTALLATION AND SPLICING OF 35kV POWER CABLES

6.1 GENERAL

.1 Drawing Nos. 023-478-E-3008, Rev. B01 to 023-478-E-3018, Rev. B01, inclusive, show the routing, arrangement and Bill of Material item numbers of the 35kV submarine and terrestrial power cables and associated in-line splice kits and cable ties.

.2 Drawing Nos. 023-478-E-3019, Rev. B01 provides the Power Cable Schedule and the detailed Bill of Material proposed for the Collector Circuits.

.3 The composite submarine cable consisting of three (3) 350kcmil copper, 35kV 133% EPR insulated, copper tape shielded, power cores, pilot wire and optical fiber cable (Bill of Material Item No. 4) and the 350kcmil copper, 35kV 133% EPR insulated, copper tape shielded, single conductor power cable (Bill of Material Item No. 5) have been pre-purchased by FORCE. The cable will be distributed on twenty-seven (27) wooden cable reels; 12 reels @ 350m, 12 reels @ 400m and 6 reels @ 500m. The cable distribution has been designed to allow the setup of three reels for each cable run. The temporary storage location for the 35kV power cable is still to be determined; however, assume that the material will be stored within 10 km of the project site, (Town of Parrsboro, NS).

.4 Insulation resistance (hi-pot) testing of the 35kV power cables will be carried out by Strum Engineering Associates Ltd. The Contractor shall provide the services of one (1) electrician to assist in the testing program.

6./

6.2 INSTALLATION OF SUBMARINE COMPOSITE CABLE IN CABLE VAULT NO. 1

.1 Four (4), 35kV composite submarine cables (Bill of Material Item No. 4) will be run from Cable Vault No. 1 to each of the four pre-determined TISEC locations by IT International Telecom. IT International Telecom will run the submarine cables past Cable Vault No. 1, allowing sufficient length for anchoring and entering into the cable vault by the Contractor.

.2 Each 35kV composite submarine cable is a double steel wire armoured, cable system consisting of three (3), 350kcmil copper, 35kV 133% EPR insulated copper tape shielded power cores, one (1), four conductor 10AWG copper, XLPE (RW90) insulated control cable (pilot cable) and one (1), twelve fiber single-mode optical fiber cable.

.3 Each composite submarine cable shall be laid in a cradle in the concrete deadend cable anchor, located on the south side of Cable Vault No. 1.

.4 A double eye, double weave cable pulling grip (Bill of Material Item No.29), sized to accommodate the outside diameter of the composite submarine cable, shall be installed over each cable. The cable pulling grip shall be secured to the deadend cable anchor using a 3/4" shackle bolted through the deadend cable anchor eyebolts.

.5 The Contractor shall enter each composite submarine cable into Cable Vault No. 1, through one of the 155mm (6") diameter conduit sleeves, allowing sufficient length inside the cable vault to breakout the power conductors, pilot cable and optical fiber cable for splicing with the terrestrial cables.

.6 On the inside of Cable Vault No. 1, the composite submarine cable shall be broken-out into its power conductors, pilot cable and optical fiber cable. Care shall be taken to ensure the pilot cable and optical fiber cable are not damaged during the disassembly of the composite cable. The two (2) layers of woven galvanized steel wire armour shall be cut back, one set to approximately 450mm (18") from the conduit sleeve and the second set cut back to approximately 300mm (12"), to allow for the installation of a grounding clamp over each armour layer.

.7 The pilot cable shall be secured to cable support arms using black nylon cable ties then entered into the Pilot Cable Junction Box (JB1). A strain relief connector, sized for the outside diameter of the pilot cable, shall be installed in the bottom of Junction Box JB1.

6.2/

.8 The optical fiber cable shall be secured to cable support arms using black nylon cable ties then entered into the Optical Fiber Cable Junction Box (JB2). A strain relief connector, sized for the outside diameter of the optical fiber cable, shall be installed in the bottom of Junction Box JB2.

.9 The 350kcmil, 35kV power conductors shall be secured to cable support arms using black nylon cable ties then laid in one of the 610mm wide cable trays for connection to the terrestrial power conductors.

6.3 INSTALLATION OF TERRESTRIAL POWER CABLES

.1 Three (3) continuous runs of 350kcmil copper, 35kV 133% EPR insulated, copper tape shielded, single conductor power conductors (Bill of Material Item No. 5) shall be installed in each 129mm (5") diameter duct between Cable Vault No. 1 and Cable Vault No. 4, between Cable Vault No. 4 and Cable Vault No. 8 and between Cable Vault No. 8 and the Substation Control Building Cable Tray Vault.

.2 The cable distribution on the twenty-seven (27) wooden cable reels (12 reels @ 350m, 12 reels @ 400m and 6 reels @ 500m) has been designed to allow for the setup and installation of three (3) 350kcmil power conductors and one (1) 2AWG green insulated bonding conductor (Bill of Material Item No. 7) per duct.

.3 The estimated cable lengths between splice points are as follows:

i. Cable Vault No. 1 to Cable Vault No. 4 ≈ 250m
ii. Cable Vault No. 4 to Cable Vault No. 8 ≈ 350m
iii. Cable Vault No. 8 to Substation Control Building ≈ 400m

.4 The Contractor shall supply and install all necessary cable pulling equipment; including but not limited to: cable pulling eyes, cable pulling grips, cable pulling machine, sheaves, rollers, pulling rope and duct lubricants.

.5 Each conductor cable shall be phased, using colored PVC electrical tape. Color coding shall be Red (ØA), Yellow (ØB) and Blue (ØC).

.6 The Contractor shall prove the phasing and megger all power cables and record the results on standard field test forms for review by the Engineer.

.7 Metal cable ID tags shall be attached to each conductor at the entry and exit of each cable vault.

6./

6.4 SPLICING OF SUBMARINE AND TERRESTRIAL CABLES IN CABLE VAULT NOS. 1, 4 & 8

.1 In Cable Vault No. 1, the three power conductors from each of the four (4), 35kV composite submarine cables (Bill of Material Item No. 4) and the three power conductors from each of the four collector circuit cables (Bill of Material Item No. 5) shall be spliced using 350kcmil copper crimp-type compression connector (Bill of Material Item No. 11) and 35kV cold-shrink, in-line cable splice kits (Bill of Material Item No. 10).

.2 In Cable Vault Nos. 4 and 8, the three conductors from each of the four collector circuit cables shall be spliced using 350kcmil copper crimp-type compression connector (Bill of Material Item No. 11) and 35kV cold-shrink, in-line cable splice kits (Bill of Material Item No. 10).

.3 The copper tape shield (conductor screen) of each individual in-line splice shall be brought out from one end of the splice for interconnection to the copper tape shield of the appropriate conductors of each 35kV power cable set, as indicated in the following Tables.

.4 A 2AWG green insulated conductor shall be used as a cross-bonding link. The cross-bonding arrangement in Cable Vault Nos. 1, 4 and 8 shall be as indicated on the drawings and the following Tables:

Cable Vault No. 1 Power Cable Shield Bonding & Grounding				
		Cable No. P-B*-1 Shields		
		Phase Red	Phase Yellow	Phase Blue
Cable No. P-B*-1-4 Shields	Phase Red	X		
	Phase Yellow		X	
	Phase Blue			X
	Ground	X	X	X

Cable Vault No. 4 Power Cable Shield Bonding				
		Cable No. P-B*-1-4 Shields		
		Phase Red	Phase Yellow	Phase Blue
Cable No. P-B*-4-8 Shields	Phase Red			X
	Phase Yellow	X		
	Phase Blue		X	
	Ground	Isolated (See Note 2)		

6.4/

Cable Vault No. 8 Power Cable Shield Bonding				
		Cable No. P-B*-4-8 Shields		
		Phase Red	Phase Yellow	Phase Blue
Cable No. P- B*-8-429N Shields	Phase Red			X
	Phase Yellow	X		
	Phase Blue		X	
	Ground	Isolated (See Note 2)		

Control Building Cable Tray Vault Power Cable Shield Bonding & Grounding				
		Cable No. P-B*-8-429N Shields		
		Phase Red	Phase Yellow	Phase Blue
At 35kV Deadbreak Junctions	Phase Red	X		
	Phase Yellow		X	
	Phase Blue			X
	Ground	X	X	X

Notes: 1. B* represents B1, B2, B3 and B4. Refer to the Cable Schedule on Drawing No. 023-478-E-3019, Rev. B01.
2. The cross-bonding conductor shall be effectively isolated from ground in Cable Vault Nos. 4 and 8.

.5 Each cable splice shall be laid in the cable tray and secured to the tray ladders using black nylon cable ties, in an X-pattern.

.6 Metal cable ID tags and colour coding tags shall be attached to each conductor at the entry and exit of each cable vault and on either side of each in-line splice.

.7 Insulation resistance (hi-pot) testing of each 35kV cable will be carried out by Strum Engineering Associates Ltd. with the assistance of the Contractor.

6./

6.5 TERMINATION OF TERRESTRIAL CABLES IN CONTROL BUILDING CABLE TRAY VAULT

.1 In the Substation Control Building Cable Tray Vault, twelve (12), 35kV, 600A three-way deadbreak junctions (Bill of Material Item No. 45) shall be supplied and installed on the east interior wall in the basement level, arranged in a staggered configuration as indicated on Drawing No. 023-478-E-3008, Rev. B01.

.2 Each deadbreak junction shall include 35kV rated plastic caps for the isolation of each 35kV bushing.

.3 A 50mm wide x 6mm thick x 8m long copper ground bus shall be supply and mounted on 600V standoff-insulators. The ground bus shall be connected to the building/substation ground grid using a 4/0 AWG bare copper conductor, a 4/0 AWG copper one-hole, long-barrel crimp-type compression connector and 4/0 AWG to 4/0 AWG copper compression ground tap ('c' tap).

.4 Each 35kV, 600A three-way deadbreak junction frame (grounding bushing) shall be bonded to the ground bus using a 4/0 AWG bare copper conductor and 4/0 AWG copper one-hole, long-barrel crimp-type compression connector.

.5 762mm (30") wide aluminum cable tray shall be supplied and installed horizontally along the south wall of the Substation Control Building Cable Tray Vault. The cable tray shall be supported by 41mm x 41mm metal framing channels approximately 300mm (12") above the finished floor. The 4/0 AWG bare copper grounding conductor from under the concrete encased duct bank shall be run in and bonded to the cable tray using a cable tray ground connector.

.6 As they emerge from the underground concrete encased duct bank, each 350kcmil, 35kV three core set of power conductors shall be secured in the cable tray in a trefoil configuration using black nylon cable ties. Each set of three conductors shall be run to one of the three deadbreak junctions mounted on the south wall of the cable tray vault.

.7 The end of each 350kcmil, 35kV conductor shall be terminated using a 35kV, 600A deadbreak, separable connector (Bill of Material Item No. 46). The copper tape shield of each conductor shall be brought-out of the separable connector and connected to the ground bus using a 2 AWG green insulated bonding conductor.

6.5/

.8 Each 35kV deadbreak, separable connector shall be plugged into one of the deadbreak junction cable adapter terminals (terminal on the west side of each junction).

.9 A 35kV elbow surge arrester (Bill of Material Item No. 47) shall be supplied and installed in the center terminal of each deadbreak junction. The 4 AWG grounding pigtail provided with each surge arrester shall be connected directly to the ground bus using a 4 AWG copper crimp-type compression connector. The grounding pigtail shall be installed as straight and be as short as possible.

7. INSTALLATION AND TERMINATION OF PILOT AND OPTICAL FIBER CABLES

7.1 GENERAL

.1 Drawing Nos. 023-478-E-3008, Rev. B01 to 023-478-E-3018, Rev. B01, inclusive, show the routing, arrangement and Bill of Material item numbers of the pilot cable, optical fiber cable and associated junction boxes, cable supports and cable ties.

.2 Drawing Nos. 023-478-E-3019, Rev. B01 provides the Pilot and Optical Fiber Cable Schedule and the detailed Bill of Material proposed for the Collector Circuits.

.3 The composite submarine cable power cores, pilot wire and optical fiber cable (Bill of Material Item No. 4), the multi-conductor pilot cable (Bill of Material Item No. 8) and the optical fiber cable (Bill of Material Item No. 9) have been pre-purchased by FORCE.

.4 Both the multi-conductor pilot cable and the optical fiber cable will be provided on one (1) wooden cable reel, with approximately 1,000m of cable on each reel. The temporary storage location for the pilot and optical fiber cable is still to be determined; however, assume that the material will be stored within 10 km of the project site, (Town of Parrsboro, NS).

.5 The Contractor shall identify and megger each conductor of the multi-conductor pilot cable and record the results for review by the Engineer. The Contractor shall identify each strand of the optical fiber cable.

7./

7.2 INSTALLATION AND TERMINATION OF THE PILOT CABLES

.1 A twenty (20) conductor, 10AWG multi-conductor pilot cable shall be run continuously between the Substation Control Building Cable Tray Vault and Cable Vault No. 1 through 103mm (4") diameter ducts C10 to C1.

.2 In each cable vault, the pilot cable shall be routed around the vault and secured to cable support arms using black nylon cable ties, as indicated on the drawings.

.3 At Cable Vault No. 1, the multi-conductor pilot cable shall be entered into Pilot Cable Junction Box (JB1). A strain relief connector, sized for the outside diameter of the multi-conductor pilot cable, shall be installed in the bottom of Junction Box JB1.

.4 In the Substation Control Room Cable Tray Vault, the twenty (20) conductor pilot cable shall be entered into Pilot Cable Junction Box (JB3). A strain relief connector, sized for the outside diameter of the multi-conductor pilot cable, shall be installed in the bottom of Junction Box JB3.

.5 In Junction Box JB1, the pilot cable from each of the composite submarine cables and the 20 conductor pilot cable shall be terminated on the 6-pole terminal blocks, as indicated on the drawings. Each group of four insulated copper conductors of the 20 conductor cable shall be terminated on a terminal corresponding to a copper conductor from each of the pilot cables from the composite submarine cable. The overall cable shield shall be terminated on a terminal corresponding to a shield from one of the submarine pilot cables. All cable shields shall be joined together and grounded. The ground conductor shall be terminated on a terminal corresponding to a ground wire from one of the submarine pilot cables and grounded.

.6 In Junction Box JB3, the 20 conductor pilot cable shall be terminated on the 6-pole terminal blocks, as indicated on the drawings. The overall cable shield shall be terminated on a terminal and the shield shall be grounded. The ground conductor shall be terminated on a terminal and grounded.

.7 Insulated, crimp type ring terminals shall be used to terminate the conductors, shield and ground wire.

7./

7.3 INSTALLATION AND TERMINATION OF THE OPTICAL FIBER CABLES

.1 A forty-eight (48) strand, single-mode, all-dielectric optical fiber cable shall be run continuously between the Substation Control Building Cable Tray Vault and Cable Vault No. 1 through 103mm (4") diameter ducts OF10 to OF1.

.2 A second forty-eight (48) strand, single-mode, all-dielectric optical fiber cable shall be run continuously between the Substation Control Building Cable Tray Vault and the Interpretive Centre Building through 103mm (4") diameter ducts OF10 to OF5 then through ducts OF11 to Telecoms Vault Nos. 1, 2 and 3.

.3 In each cable vault, the optical fiber cable shall be routed around the vault and secured to cable support arms using black nylon cable ties.

.4 At Cable Vault No. 1, the 48 strand optical fiber cable shall be entered into Optical Fiber Cable Junction Box (JB2). A strain relief connector, sized for the outside diameter of the optical fiber cable, shall be installed in the bottom of Junction Box JB2.

.5 In the Substation Control Building Cable Tray Vault, the optical fiber cable shall be entered into Optical Fiber Junction Box (JB4). A strain relief connector, sized for the outside diameter of the optical fiber cable, shall be installed in the bottom of Junction Box JB4.

.6 In Junction Box JB2, the 12 strand optical fiber cable from each of the composite submarine cables and the 48 strand optical fiber cable shall be fusion spliced, as indicated on the drawings.

.7 In Junction Box JB4, the 48 strand optical fiber cable shall be terminated on a 48 port optical fiber splice box (Bill of Material Item No. 51) for future interconnection by Others.

.8 The testing of the integrity and dB loss of each fiber, fusion splice and fiber connector shall be carried out by Others; however, the Contractor shall be responsible for re-fusing the optical fibers if the original fusion splice is found to be improperly made or the dB losses are greater than 0.3dB per ANSI/TIA/EIA Standard 568 B.3.

8. TERMINATION OF GROUNDING AND BONDING CONDUCTORS

8.1 GENERAL

.1 Drawing Nos. 023-478-E-3008, Rev. B01 to 023-478-E-3018, Rev. B01, inclusive, show the general routing, arrangement and Bill of Material item numbers of the 4/0 AWG bare copper grounding conductor and the 2 AWG green insulated bonding conductors.

.2 Drawing Nos. 023-478-E-3019, Rev. B01 provides the detailed Bill of Material proposed for the Collector Circuits.

.3 The 4/0 AWG bare copper grounding conductor (Bill of Material Item No. 6) and the 2 AWG green insulated bonding conductor (Bill of Material Item No. 7) have been pre-purchased by FORCE.

.4 The 4/0 AWG grounding conductor shall be provided on eleven (11) wooden cable reels, with approximately 500m of conductor on each reel. The 2 AWG bonding conductor shall be provided on four (4) wooden cable reels, with approximately 1,000m of conductor on each reel. The temporary storage location for the grounding and bonding conductors is still to be determined; however, assume that the material will be stored within 10 km of the project site, (Town of Parrsboro, NS).

.5 The Contractor shall identify and megger each conductor for continuity and record the results for review by the Engineer. Where the conductor enters the cable vault, the Contractor shall identify each conductor as a Grounding or Bonding conductor.

8.2 TERMINATION OF 4/0 AWG BARE COPPER GROUNDING CONDUCTORS

.1 The 4/0 AWG bare copper grounding conductor serving each cable vault ground electrode shall enter each cable vault through a 38mm diameter conduit sleeve and shall be terminated on the bare copper ground bus using a 4/0 AWG copper crimp type compression connector.

.2 The 4/0 AWG bare copper grounding conductors used to ground each of the two sets of galvanized steel armour of the composite submarine cable shall be terminated on the 150mm diameter ground clamp connected to each composite submarine cable and shall be terminated on the bare copper ground bus using a 4/0 AWG copper crimp type compression connector.

8.2/

.3 The 4/0 AWG bare copper grounding conductor serving the cable trays in Cable Vaults Nos. 1, 4 and 8 and in the Substation Control Building Cable Tray Vault shall be terminated on each cable tray using a cable tray grounding connector and at the bare copper ground bus using a 4/0 AWG copper crimp type compression connector.

.4 The 4/0 AWG bare copper grounding conductor running between each cable vault under the concrete encased duct banks, shall enter each cable vault through a 38mm diameter conduit sleeve and shall be terminated on the bare copper ground bus using a 4/0 AWG copper crimp type compression connector.

8.3 TERMINATION OF 2 AWG GREEN INSULATED BONDING CONDUCTORS

.1 A 2 AWG green insulated bonding conductor shall be used to cross-bond the copper tape shields of each of the single phase 35kV in-line cable splices in Cable Vault Nos. 1, 4 and 8. In Cable Vault No. 1 a 2 AWG green insulated bonding conductor shall be connected to the cross-bonded copper tape shields and shall be terminated on the bare copper ground bus using a 2 AWG copper crimp type compression connector.

.2 In Cable Vault No. 1, a 2 AWG green insulated bonding conductor shall be installed and terminated to the steel back panel of Pilot Cable Junction Box JB2, then be run and terminated on the bare copper ground bus using a 2 AWG copper crimp type compression connector.

.3 The 2 AWG green insulated bonding conductor installed with the 35kV power cable sets inside each power cable duct, shall enter each cable vault through the 129mm diameter duct and shall be terminated on the bare copper ground bus using a 2 AWG copper crimp type compression connector.

.4 A 2 AWG green insulated bonding conductor shall be installed and terminated to each 41mm x 41mm metal framing channel supporting aluminum cable tray or non-metallic cable support arms and shall be terminated on the bare copper ground bus using a 2 AWG copper crimp type compression connector.

.5 All miscellaneous metallic equipment installed inside the cable vaults as part of this project, shall be bonded to the bare copper ground bus using 2 AWG green insulated bonding conductor, unless otherwise accepted by the Engineer.

9. TESTING AND COMMISSIONING

.1 The Contractor shall assist Strum Engineering Associates Ltd. personnel during the testing and commissioning of the 35kV power cables, pilot cables, optical fiber cables, grounding and bonding systems and associated equipment.
.2 The Contractor should allow a total of 30 man-hours to assist in the testing program.

10. NAMEPLATES

.1 The Contractor shall supply and install new lamicoid nameplates (white face, black lettering) for all new electrical equipment, junction boxes and power distribution circuits installed as part of this project.
.2 Metal cable ID tag shall be attached at both ends of all 35kV power cables, pilot cable and optical fiber cables.
.3 Lamicoid nameplate lettering shall be subject to approval by the Engineer.

11. AS-BUILT DRAWINGS

.1 The Contractor shall provide one set of red-marked design drawings for this project indicating As-Built information to the Engineer.

DETAILED SCOPE OF WORK
IN-STREAM TIDAL GENERATING PLANT
TISEC COLLECTOR CIRCUITS DEVELOPMENT

SCHEDULE OF PRICES

ITEM	DESCRIPTION	PRICE
1	Installation of Pre-Cast Concrete Cable Vault Nos. 5, 6, 7, 8, 9 and 10, Utility Supply Vault Nos. 3, 4 and 5 and Telecoms Supply Vault Nos. 4, 5 and 6	$_____
2	Supply and Installation of Concrete Vault Perimeter Ground Electrode Systems	$_____
3	Supply and Installation of Concrete Encased Duct Banks Between Cable Vault Nos. 4, 5, 6 and 7	$_____
4	Supply and Installation of Concrete Encased Duct Banks Between Cable Vault Nos. 8, 9 and 10	$_____
5	Supply and Installation of Concrete Encased Duct Banks Between Utility Riser Pole, Utility Supply Vaults and Telecoms Supply Vaults	$_____
6	Supply and Installation of Cable Vault Infrastructure (Metal Framing, Cable Supports, Cable Tray, Ground Bus Systems, Junction Boxes)	$_____
7	Installation and Splicing of Composite Submarine Cables, 35kV Power Cables and Bonding Conductors in Cable Vault Nos. 1 to Substation Control Building Cable Tray Vault	$_____
8	Installation and Termination of Pilot Cables and Optical Fiber Cables	$_____
9	Balance of Work	$_____
	TOTAL (Excluding HST)	$_____

Signature: _____ **Date:** _____

FORCE

DETAILED SCOPE OF WORK
IN-STREAM TIDAL GENERATING PLANT
TISEC COLLECTOR CIRCUITS DEVELOPMENT

LIST OF PROPOSED SUB-CONTRACTORS

	SUB-CONTRACTOR	TRADE
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Signature: _____ **Date:** _____