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JEA

High Voltage Cross-Linked Polyethylene Underground Cable System

Brandy Branch T2 Addition

Document No 308008-00329 - BB18-SP-463201

2018-07-30

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EcoNomics

Synopsis

This specification defines the minimum requirements for the engineering, material supply, installation and testing of the HV cross-linked polyethylene (XLPE) Cable System for JEA as part of the Brandy Branch T2 230kV/26kV Transformer Addition.

Disclaimer

PROJECT 308008-00329 - BB18-SP-463201 – High Voltage Cross-Linked Polyethylene Underground Cable System

Rev	Description	Original	Review	WorleyParsons Approval	Date	Customer Approval	Date
0	Issue for Use	R. Coby	T. Betros	R. McAlister	2018-07-30	N/A	

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Appendices

1. General

1.1 Project Summary

JEA will be installing a new 50MVA 230kV/26kV Transformer T2 at the existing Brandy Branch Substation located within the Brandy Branch Generating Station in Jacksonville. The 230kV line position will connect to the new transformer position via underground 230kV XLPE cable system.

The project site is located within the Brandy Branch Generating Station (BBGS) at 15701 Beaver Street W, Jacksonville, FL 32234.

1.2 Stakeholders

1.2.1 Owner - JEA

Project Manager
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Contract Administrator
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1.2.2 Consultant Engineer - WorleyParsons

Project Engineer
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1.3 References

The latest edition and published addenda of the following publications in effect on the date of Contract Award are a part of this Section and, where referred to by title or by basic designation only, are applicable to the extent indicated by the specific reference:

1.3.1 Insulated Cable Engineers Association (ICEA)

1. ICEA P-45-482 - Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cables.
2. ICEA S-108-720 - Standard for Extruded Insulation Power Cables Rated above 46kV through 345kV.

1.3.2 Association of Edison Illuminating Companies (AEIC)

1. AEIC CG4 - Guide for Installation of Extruded Dielectric Insulated Power Cable Systems Rated 69kV through 138kV.
2. AEIC CG5 - Underground Extruded Cable Pulling Guide
3. AEIC CS9 - Specification for Extruded Power Cables and Their Accessories Rated Above 46kV through 345kV.

1.3.3 Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE C2-NESC - National Electrical Safety Code
2. IEEE 48 - Standard for Test Procedures and Requirements for Alternating Current Cable Terminations used on Shielded Cables Having Laminated Insulation Rated 2.5kV through 765kV or Extruded Insulation Rated 2.5kV through 500kV.
3. IEEE 404 - Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2.5kV to 500kV.
4. IEEE 575 - Guide for Bonding Shields and Sheaths of Single-Conductor Power Cables Rated 5kV through 500kV.

1.3.4 International Electrotechnical Commission (IEC)

1. 62067 - Power cables with insulation and their accessories for rated voltages above 150kV (Um=170kV) up to 500kV (Um=550kV) - Test methods and requirements.
2. 60811 – Common Test Methods for Insulating and Sheathing Materials Electric Cables and Optic Cable.

1.4 Submittals

1.4.1 With Bid:

1.4.1.1 Proposal

1. Each Bidder shall populate the attached Pricing Matrix for the T2 transformer cable system at the site. For bid purposes, the cable lengths are estimated; pricing will be adjusted once cut lengths are finalized by the successful bidder.
2. Bidders shall provide a comprehensive schedule including critical milestones for engineering, identification of all major anticipated submittal packages, submittal acceptance durations, manufacturing, and product delivery dates. The successful bidder (Manufacturer) must meet the Cable Installation and Termination dates as indicated in Table 1 - Milestone Table.

1.4.1.2 Cable

1. Cable Data Sheets (including cut sheet showing cable construction details)
2. Cable Qualification Test Reports/ Factory Test Plan
3. Cable Quality Control & Inspection Procedures
4. Sample Cable Production Test Report

1.4.1.3 Cable Accessories

1. Termination Data Sheets
2. Termination Qualification Test Report/ Factory Test Plan
3. Termination Quality Control & Inspection Procedures
4. Sample Termination Production Test Report
5. System Bonding Diagram
6. Ground Conductor Data Sheet(s)
7. Link Box Data Sheets & Drawings
8. Sheath Voltage Limiter Data Sheets

1.4.2 After Award:

1. Cable System Ratings
    a. Cable ampacity calculations
    b. Positive, negative, and zero sequence impedance calculations

2. Cable System Engineering Documentation
    a. System Bonding and Grounding Detail drawings
    b. The Cable manufacture shall provide drawings of the sheath bonding/ grounding system and calculated sheath voltages and currents
    c. Layout Coordination Review - provide formal review comments and concurrence of the cable route, raceway details, and termination stands
    d. Cable pulling calculations that confirm Manufacturer's design concurrence with all aspects of the raceway to be installed.
    e. Mandrel detail data sheet
    f. Detailed Bill of Material
    g. Cable Pulling Plan drawing/sketch - prior to construction, provide sketch for equipment laydown and cable pull setup for construction coordination.
3. Installation Plan narrative to describe and quantify level of effort, on a per-day basis, the anticipated schedule activities including but not limited to: setup, duct proofing, pulling, installation, termination, testing.
4. Cable Production Test Reports
5. Termination Production Test Reports
6. Worker Certifications/ Resumes

1.4.3 During Construction:

1. Mandrel & Swab Report
2. Installation Reports
3. Hi-Pot Test Report

1.4.4 Final:

1. Final Data Sheets in AutoCAD format (where available). The Owner's Design Engineer will incorporate the datasheets and drawings as Vendor Drawings into the final drawing set.
2. Submit an electronic copy of all final submittals, reports, data sheets, drawings, etc. as listed above, in PDF format.

1.5 Design Requirements

The cable and accessories furnished hereunder shall be rated for 3-phase operation at 230kV 60Hz solidly grounded neutral systems.

1.5.1 Voltage

The voltage rating of the cable system shall be a nominal 230kV phase to phase. The maximum operating voltage may exceed the rated nominal voltage by five (5) percent during continuous operation. The cable system shall be designed for an emergency phase to phase operating voltage, which could exceed the rated voltage by ten (10) percent for durations not more than fifteen (15) minutes for each occurrence.

1.5.2 Basic Impulse Level

The furnished cable system shall have a guaranteed BIL of 1050 kV.

1.5.3 Current

The Ampacity of the cable system shall be at minimum 200 amperes at normal continuous operation, and shall be capable to withstand a minimum short circuit current of 50kA for one half second.

The Manufacturer shall also provide the Owner in writing the ampacity of the cable at the emergency operating temperature.

1.5.4 Temperature

The temperature for normal operation is applicable to operating load cycles typical of electrical power systems. Operations at the emergency overload temperature shall meet the requirements of Section 1.9 of AEIC CS9. The temperature for short circuit operation represents the highest conductor temperature attained by any part during a short circuit level. Maximum conductor temperature operations are as follows:

- Normal Operation 90˚C
- Emergency Operation 105˚C
- Short Circuit Operation 250˚C

1.5.5 Operating Conditions

The cable shall be suitable for installation in schedule 40 PVC conduit. The cable shall operate satisfactorily in both wet and dry conditions.

1.5.6 Raceway

The six-inch (6”) schedule 40 PVC duct bank and associated raceway, with Manufacturer concurrence of engineering, will be specified onto construction drawings and installed by Others. A portion of the raceway was installed in 2016 as part of the T1 transformer addition as the T1 and T2 circuits are parallel

for much of the length. The ends of the raceway for the T2 transformer circuit will be installed as part of this project.

The Manufacturer shall work with the Owner and Owner's Engineer to review and ensure the entirety of the proposed raceway will be satisfactory to install the Manufacturer-supplied cable system. This requires formal calculations performed by the Manufacturer and submitted to the Owner, as well as review and acceptance by the Manufacturer of the existing and new portions of the raceway design, including ensuring the proper diameter conduit, bending radii, etc.

The cable system shall be designed by the Manufacturer with this raceway system information; calculations shall be performed by the Manufacturer to verify acceptability of the pulling tensions and sidewall pressures. The Manufacturer shall specify any reasonable raceway requirements, thermal requirements (i.e. thermal backfill), attachments, mounting provisions, installation provisions, etc. to be included in the final design drawings.

It shall be noted that the site has a high water table and much of the conduit system can and likely will have standing water. During construction, the civil contractor will be responsible to proof and swab the conduit system. However, the cable installer will also be responsible to proof and swab the conduit system until clean and ready for cable install. Standing water in the conduit shall be no means for additional claims by the Manufacturer/installer.

There is a cable trench at the west riser near the 230kV bus connection. The Manufacturer shall design and provide associated cable clamps within the trench to properly secure the cable and provide adequate spacing.

1.5.7 Terminator Stands

Terminator stand structures will be designed, fabricated, and installed by Others. However, the Manufacturer shall work with the Owner and Owner's Engineer to ensure the structures are satisfactory to install the Manufacturer-supplied cable system. This requires the Manufacturer to, in a timely manner, supply detailed information for incorporation of design elements into the Owner's structure design, as well as providing review and acceptance of the general layout, including ensuring the proper cable support and mounting/positioning for link boxes and grounding cable as well as the mounting patterns for terminators.

1.6 Performance Requirements

1.6.1 Engineering

1. The Manufacturer shall be responsible for the entirety of the electrical engineering of the cable system from end to end, including the design of the cable, terminations, cable system bonding/grounding, and cable pulling calculations.

2. All civil, structural, and layout engineering will be performed by Others. The cable raceway will be designed from one riser to the other within six-inch (6”) schedule 40 PVC duct-bank. **The Manufacturer will be required to formally review and accept the circuit layout and terminator structure drawings to ensure compatibility of cable system and identify any foreseeable**

installation challenges. The Manufacturer will be required to formally review and accept the conduit system in the field prior to commencement of cable pulling activities.

1.6.2 Material Supply

The Manufacturer shall supply and install all material required for a complete and operable cable system between terminations including but not limited to:

1. Cable
2. Splice Materials
3. Ground Conductor(s) and Hardware
4. Cable Terminations with NEMA four hole pads
5. Cable Clamps
6. Link Boxes

1.6.3 System Installation

1. It shall be noted that this is an active station with live high voltage buswork. The Manufacturer shall plan, coordinate, and schedule all tasks with the Owner to ensure work will be performed within safe electrical clearances.
2. The Manufacturer shall be responsible for the cable system installation from end to end including, but not limited to: the pulling in the cable, ground conductor, installing cable terminations, and link boxes, and all required testing and acceptance thereof.
3. The raceway, termination structures, and foundations will be constructed by Others. Connections of the cable system to the 230kV bus, high voltage lightning arrestors and structure grounding taps to the existing ground grid will be installed by Others.

1.6.4 Milestone Schedule

Below is a milestone schedule with fabrication and construction tasks that represent any applicable electrical clearance outage durations to perform the work. Due to the proximity of the new equipment to existing equipment at the station, outages to install the new cable system are not anticipated.

The Manufacturer shall coordinate and schedule all tasks with the Owner to ensure work will be performed within the allotted timeframes to meet project needs. Outage windows, if required, are approximate, and subject to change based on conditions of the Bulk Electric System.

Table 1 - Milestone Table

MILESTONE	DURATION	DATE
Notice to Proceed	1 Day	10/29/18
Kick-Off	1 Day	11/02/18
Engineering Submittal	3 Weeks	11/26/18
Construction		
Manufacturer Mobilization & Inspection	5 Days	07/09/19
Cable & Accessory Delivery & Setup	3 Days	07/17/19
Cable Installation	4 Days	07/23/19
Terminations	5 Days	07/30/19
Hi-Pot Testing	1 Day	07/31/19
Jumper connections, Low Voltage, etc.	5 Days	08/09/19
System Soak (24hr)	2 Days	08/11/19
Energize to Serve Load	1 Day	09/20/19

1.6.5 Quality Assurance Program

The Manufacturer shall have a current quality assurance program in place for each factory and Subcontractor engaged in the Work. The Program shall conform to the requirements of AEIC CS9 and as stated in this Specification. The Manufacturer shall submit a copy of the quality assurance plans with his bid proposal.

1.6.6 Detailed Inspection and Test Plan

The Manufacturer shall submit a detailed Inspection and Test Plan with his bid proposal. The Inspection and Test Plan shall contain details of quality assurance activities to be performed for all materials, manufacturing and handling processes. At a minimum the Report shall include:

1. Material or Parameter to be controlled
2. Method of Inspection/ Tests and Equipment used
3. Frequency of the Inspection/ Test
4. Reference documents governing the QA activity
5. QA Record Form

1.6.7 Witness Testing

The Owner may elect to attend some or all witness/ hold points, as agreed mutually. At least three (3) weeks written notice, prior to each established witness/ hold point, shall be given to allow for arrangements to be made for the Owner's attendance. However, any quality assurance inspection carried out by the Owner shall in no way relieve the Manufacturer of the full responsibility for the quality, character or performance of the completed Work.

1.6.8 Certified QA Reports

The Manufacturer shall submit certified copies of final quality assurance reports covering any or all of items listed in AEIC CS9.

1.6.9 QA Documentation Access

When requested, the Manufacturer shall provide timely access to, and copies of Quality Assurance and Test Documents in terms of AEIC CS9.

1.6.10 QA Sub-Manufacturers

If sub-Manufacturers are employed, the Inspection and Test Plan shall indicate the portion of Work that will be undertaken by them, including their inspection and testing.

1.6.11 Warranty

Manufacturer shall warranty the cable, terminations and system accessories to be free from defects and provide satisfactory service under the conditions indicated for a period not less than five-(5) years after substantial completion.

2. Products

2.1 Cable

2.1.1 Conductor

1. Conductors shall be as described in ICEA S-108-720. The material shall be soft drawn copper or electrical grade aluminium wire before stranding with circular cross section. The stranding configuration shall be compact round or compact segmental.
2. Binder tapes, if used in compact segmental, shall be nonmagnetic and shall conform to ICEA S-108-720.
3. The Manufacturer shall take into consideration the skin effect of the conductors and de-rating factor as necessary.

2.1.2 Conductor Shield

1. The conductor shield shall be as described in ICEA S-108-720; the conductor shield shall pass the Wafer Boil Test. The shield shall be of extruded, ultra-smooth, thermosetting material that is semiconducting in nature and compatible with all cable component materials with which it is in contact. Allowable operating temperatures shall be equal to or higher than those of the insulation.
2. The outer surface of the shield shall be cylindrical and shall be firmly bonded to the overlying insulation. The shield shall be easily removable from the conductor.
3. A semiconducting tape may be used between the conductor and the extruded conductor shield but cannot be considered as part of the extruded shield thickness.

2.1.3 Insulation

1. The insulation system shall be composed of cross-linked polyethylene (XLPE) and shall conform to material, insulation thickness, and insulation requirements as described in ICEA S-108-720. The nominal insulation thickness shall be determined using cable electrical stress as a basis.
2. The insulation shall be capable to withstand all electrical stresses when the cable is energized and fully loaded to the maximum emergency temperature. It shall also withstand the mechanical and thermal forces that occur during installation and operation.
3. XLPE insulation shall be extruded together with the extruded conductor shield and extruded insulation shield, in one common triple head extruder. The three layers shall be cross-linked in a dry curing process.
4. XLPE insulation material shall be inspected for contaminants using a continuous sampling plan. The plan must sample a minimum of 2 percent of the insulation volume material making sure that material not inspected by the compound supplier is included in the 2 percent rate by the

Manufacturer. If requested, the Manufacturer shall furnish a statistical analysis of the size and number of contaminants found per weight of insulation inspected.

5. The ac test maximum stress levels for insulation shall be:

   a. Nominal Internal 250 V/mil (10kV/mm)

   b. Nominal External 100 V/mil (4kV/mm)

2.1.4 Insulation Shield

1. The insulation shield shall conform to ICEA S-108-720 - the shield shall be of extruded, thermosetting, semiconducting material compatible with all cable components with which it is in contact. The extruded shield shall be readily distinguishable from the insulation and plainly identified as semiconducting. The insulation shield shall be bonded continuously to the insulation.
2. The insulation shield shall pass the Wafer Boil Test.
3. The insulation shield shall be in direct contact and adhere well to the insulation under all operating conditions. It shall be designed to conduct the insulation charging current to the overlying bedding layer and metallic shield or sheath. It shall exhibit long-term chemical stability and compatibility with adjacent cable components and its allowable operating temperatures shall be at least as high as the insulation.
4. To ensure uniform, continuous, smooth, concentric contact between the insulation and the metallic screen and to prevent concentration of electric field, an interface of a thermosetting semi-conducting XLPE material shall be provided.

2.1.5 Bedding and Longitudinal Water Blocking

1. The bedding and longitudinal water blocking shall conform to ICEA S-108-720 - a continuous semi-conducting bedding layer shall be applied between the insulation system and metallic shield/ sheath to protect the insulation from deformation due to thermal radial expansion of the core and lateral pressure at bends at normal and emergency operating temperatures.
2. The cable shall be designed such that the bedding layer functions to limit the maximum deformation of the insulation to 5% of its thickness.
3. Tapes shall be applied longitudinally in contact with the underlying semiconducting layer. All joints in the tape shall be made electrically continuous through welding or an equivalent process producing the same result.
4. If longitudinal water blocking is not prevented by the bedding layer, then an additional layer of continuous semi-conducting water swelling tapes shall also be applied.
5. Details of any components if used as an impediment to longitudinal water penetration shall be provided by the Manufacturer with the bid.

2.1.6 Metallic Shield/ Sheath

1. The metallic shield/ sheath shall comply with ICEA S-108-720 - a nonmagnetic metallic shielding consisting of a shield, sheath, or combination thereof shall be applied over the non-metallic semi-conducting layer.
2. The metallic shield/ sheath shall make continuous electrical contact with the underlying semi-conducting layers to provide a concentric conducting path for insulation charging and leakage current, as well as neutral current, phase unbalance current, fault current, and surge current.

2.1.7 Outer Jacket

1. The cable jacket shall be as described in ICEA S-108-720. Specifically, the jacket shall be polyethylene, black in color, and shall be suitable for exposure to sunlight. The thermoplastic polyethylene compound can be of low, linear low, medium, or high-density configuration. The jacket compound shall be compatible with all cable component materials with which it is in contact.
2. A continuous graphite coating or extruded semi-conducting layer shall be applied over the jacket to form an electrode for Production Tests, dc testing during installation, and for periodic maintenance testing after commissioning.

2.1.8 Cable Identification

2.1.8.1 Outer Surface Markings

The outer jacket surface of the cable shall be durably marked as described in ICEA S-108-720. The surface printing shall be in contrasting color, sharply defined, clearly visible along its length and shall contain the following information:

1. Cable Manufacturer's name or trademark
2. Size of Conductor
3. Conductor material
4. Type of insulation
5. Voltage Rating
6. Nominal Insulation Thickness
7. Year of Manufacture

2.1.8.2 Interior Markings

A marker tape conforming to ICEA S-108-720 indicating the manufacturer, the year of manufacture and sequential length indicator shall be installed. The marker tape(s) shall remain permanently legible.

2.1.9 Cable Samples

The Manufacturer shall submit six (6), one (1) inch samples to the Owner upon shipment of cable.

2.2 Cable Accessories

2.2.1 Outdoor Terminations

Outdoor-type terminations shall be provided by the Manufacturer to be used for connecting the solid dielectric power cable to aerial cables/conductors. Terminations shall conform to AEIC CS9 and be qualified to IEEE 48.

2.2.1.1 Bushings

The bushings shall be standard creepage, and shall be constructed of commercial-grade composite material with all surfaces free from imperfections. The color shall be grey. Each composite component bushing that has an internal pressure shall comply with IEEE C37.09 latest edition.

2.2.1.2 Ratings

Terminations shall be capable of carrying the same rated current as the cable without undue heating.

2.2.1.3 Connections

The bushing connection to an overhead line, bus or transformer lead shall be NEMA CC 1 latest edition, standard four inch four-hole tinned bronze pad. Aerial lugs shall be provided for each termination. The connectors shall have NEMA four hole spacing and be capable of carrying the emergency operating current for 40˚C ambient air temperature, with sun and no wind.

2.2.2 Earthing Systems

Sheath Bonding/ Grounding system shall be a single point bonded system consisting of boding cables, link boxes, and sheath voltage surge arrestors, shall conform to AEIC CS9.

2.2.3 Cable Clamps

Cable clamps shall be provided as necessary to support any suspended cable in approximately three (3) feet intervals.

2.2.4 Hardware

All mounting hardware shall be stainless steel.

2.3 Material Testing

2.3.1 Qualification Tests

1. Qualification tests included in this section are intended to demonstrate the capability of the

Manufacturer to furnish high quality cable and accessories with the desired performance characteristics.

2. The Manufacturer shall provide, with his bid, complete listing of qualification tests that the Manufacturer intends on providing, testing requirements and material evaluation procedures including detailed descriptions of the tests, the test levels and definitions of pass/fail for each of the tests.

3. Cable qualification test shall conform to AEIC CS9 and ICEA S-108-720. The Manufacturer shall test, or have tested, a sample of cable similar in construction and wall thickness and identical in materials (insulation, jacket, shields) and shield design as compared to the cable that will be supplied under this specification using the same standards.

4. Termination qualification tests shall conform to IEEE 48 and AEIC CS9.

2.3.2 Production Test

1. All cable shall undergo production tests at the factory to determine their compliance with the requirements of this specification. The cable production tests shall comply with ICEA S-108-720.

2. All samples for testing shall be provided by the Manufacturer and all test procedures and test schedules shall be submitted prior to the start of testing.

3. The Manufacturer shall allow the Owner or his representative to witness any and all tests. Manufacturer shall give three (3) weeks advance notice of the scheduled tests.

4. For tests requiring tabulation of data, the Manufacturer shall provide copies of the tabulation when so requested.

5. The Manufacturer shall make available test reports or manufacturing logs for review by the Owner from Manufacturer's production run that fails any test during or after production. As a result of a failed test, the Manufacturer shall pay for all of the expenses of the Owner or his representative to witness a re-test.

6. A length of production cable shall not be shipped, except as otherwise agreed to by the Owner, unless all required tests have been completed and the results show compliance with all the requirements of this Specification and all other applicable portions of specifications and standards referenced.

2.3.3 Test Reports

The Manufacturer shall provide certified test reports (CTRs), including test values, data tabulations, dimensional measurements and data acquired for engineering purposes, on all tests required by this Specification and, if applicable, all other standards and specifications referenced by this Specification. All test reports shall use Manufacturer's standardized test report forms and shall be accurately labelled to include at least the following:

1. Date of test

2. Name of test
3. Test procedure including pass/fail criteria
4. Standard or specification which is the source of the test and procedures (noting exceptions where applicable)
5. Frequency of testing
6. Test values
7. An indication of successful completion of the test
8. Reference to the Owner's and the Manufacturer's order numbers and, as applicable, the particular length of cable.

2.4 Packaging & Delivery

2.4.1 Cable Reels

The cable reels shall be galvanized or painted steel and in good condition free of sharp projections that may harm the cable. The maximum allowable reel size shall be determined by the cable manufacturer and shall comply with Section 10.1.2 of AEIC CS9. The Manufacturer shall provide the spare reel and terminator dimensions and weights to the Owner before shipping.

2.4.1.1 Reel Fastenings

Each end of the cable shall be firmly and properly secured to the reel in a manner to prevent cable damage and unreeling during shipment. Care shall be taken to prevent looseness of the reeled cable. The inner or drum end of the cable, when allowed to project through the flange of the reel pocket, shall be protected against damage by means of a suitable cover.

2.4.1.2 Reel Identification

Non-corrosive metal identification tags with embossed lettering shall be firmly affixed to each reel. Reel tag information shall include:

1. Manufacturer's name and serial number
2. The gross and tare weights
3. The size, type, stranding, length and net weight of the conductor
4. The Owner's catalog, purchase order, and release numbers
5. Coding so test data can be correlated to each reel

2.4.1.3 Reel Position

All reels shall be shipped on open top trucks and standing upright. Reels arriving at the destination lying on their side will not be accepted by the Owner.

2.4.2 Cable Handling, Storage & Protection

2.4.2.1 Preservation

Immediately after factory tests both ends of each length of cable shall be completely sealed to prevent water and air entry. There shall be no water and no corrosion on the conductor in the completed cable when the reel is received at its destination.

2.4.2.2 Protection

The cable shall be protected on the reel against physical damage, contamination and weathering in transit, storage and ordinary handling. The Manufacturer shall be responsible for any damage to the cable or accessories during transit. The external protection of cable on reels shall consist of at least one layer of pressure treated wooden lags, nominally 2”x4”. Any reel on which the cable is within six (6) inches of the outer edge of the reel flange, the lagging shall consist of a double layer of wooden lags – nominally 2”x4”.

2.4.3 Containers, Boxes, and Pallets

1. Each component shall be packed as a self-sufficient kit. It shall contain packing lists, instructions and all permanent and consumable materials, as required for installation by qualified cable splicers, under the supervision of the manufacturer’s representative. The Manufacturer will be responsible to receive all shipped material on-site.
2. In general, packaging and shipping shall conform to AEIC CS9.
3. Handling, Storage & Protection

The Manufacturer shall be responsible for adequate material laydown and storage areas and facilities.

3. Execution

3.1 General

1. The Manufacturer shall be responsible for the cable system installation including, but not limited to: the pulling in the cable, ground conductor, installing cable terminations, link boxes, and bonding cables as required for a complete cable system.
2. The Manufacturer will be required to work in parallel to other contractors and tradesmen during the course of construction and cable installation. Detailed coordination will be required with the Contract Administrator for installation tasks and material and equipment laydown.

3.2 Inspection and Preparation

3.2.1 Raceway Inspection

The Manufacturer shall pull a mandrel and swab train through each duct before cable pulling operations may commence. The mandrel shall be sized to prove roundness of the pipe. The Manufacturer shall schedule each inspection with the Contract Administrator. Where evidence of the lack of smoothness or roundness is discovered, all measures necessary shall be taken to eliminate the irregularities. Under no circumstances shall any roughness be permitted to remain within the installed pipe.

It shall be noted that the site has a high water table and much of the conduit system can and likely will have standing water. During construction, the civil contractor will be responsible to proof and swab the conduit system. However, the cable installer will also be responsible to proof and swab the conduit system until clean and ready for cable install. Standing water in the conduit shall be no means for additional claims by the Manufacturer/installer.

3.2.2 Reel Inspection

Upon arrival of each shipment from the Manufacturer and before unloading and taking delivery, a thorough visual inspection shall be made of each reel to determine whether any damage may have occurred in preparation for shipment or during transit. Any damage detected shall be reported immediately to the carrier's claim agent and the Contract Administrator.

3.2.3 Cable Handling

The Manufacturer shall be responsible for unloading cable reels from their carriers and for any damage to the cable or reels. In particular, reels containing cable must not be dropped or allowed to roll uncontrolled down skids or runways in the process of loading or unloading. Reels shall be rolled only in the direction specified by the manufacturer so as not to loosen the cable. Either a suitable lifting device or a power winch employing a rope sling, skids, or horses shall be used. Reels shall not be rolled over obstructions that may break the lagging or injure the cable.

3.2.4 Cable Storage

Storage of the cable prior to installation is the responsibility of the Manufacturer and shall be coordinated with the Owner. The cable supplied under this specification will be stored outdoors as no provisions exist at the jobsite for indoor storage.

3.3 Installation Requirements

3.3.1 Weather

The cable shall be installed only during clear and unthreatening weather. If the weather conditions are favourable and should not, in the opinion of the National Weather Service, deteriorate from the estimated time required to install and seal the intended pulling length, pulling preparations may be undertaken.

3.3.2 Cable Pulling

3.3.2.1 Cable Reel Arrangement

The cable reels shall be arranged in a suitable formation such that the feed into the conduit does not exceed the minimum cable bending radius.

3.3.2.2 Cable Pulling Apparatus

The Manufacturer shall only utilize equipment in the best mechanical condition and that shall function with the utmost dependability. Apparatus of questionable reliability, in the opinion of the Owner, shall not be used on any phase of the cable Work. Prior to preparing for a cable pull, the pulling winch shall be tested to determine that it can develop 125 percent of the calculated pulling tension in a controlled manner.

In addition to that normally required, the following equipment shall be utilized for all cable pulling operations:

1. A variable speed pulling winch
2. An accurately calibrated dynamometer, which will indicate tensions and has a means for chart recording of pulling tension with respect to length pulled.
3. Reliable radio connections between all strategic positions during pulling operations.
4. A pulling wire rope cable of strength compatible with the winch capabilities and of a size and stranding to eliminate any abrasive action on the internal pipe wall.

3.3.2.3 Cable Guiding

During pulling, the cable shall not form loops having a radius which might cause kinking or damage to the insulation or shielding of the cable.

3.3.2.4 Pulling Tension

The maximum pulling tension for the cable, as determined by the cable manufacturer data sheets, shall not be exceeded. A dynamometer on the pulling cable shall be utilized to monitor the tension on the conductors. During the installation of cable, the dynamometer and strain on the pulling rigging must be continuously watched, and if any excessive strain develops, the pulling operation MUST be stopped at once and the difficulty determined and remedied. The condition of the leading end of the cable as it emerges from the pipe shall be one of the indications of the effect of the pulling tension on the cable.

3.3.2.5 Cable Inspection

A thorough, continual visual inspection for flaws, breaks, or abrasions of the exterior of each cable shall be made as it leaves the reel. The inspector shall be equipped with direct communication with the pulling winch operator. Pulling operations shall be immediately stopped upon detection of any irregularities. The Owner's Representative and the Manufacturer's representative on the job shall be immediately informed of these irregularities. The pulling speed shall be slow enough to allow for this inspection. The pulling speed shall not at any time exceed 40 feet per minute.

3.3.2.6 Lubrication

The Manufacturer shall use only poly-water lubricating liquid for the installation of cable. The pipe liquid shall be free of any contaminants which may affect the cable or pipe. Procedures for handling the liquid and checking the purity of the liquid shall be acceptable to the Owner.

3.3.3 Terminator Installation

Each terminator shall be installed in accordance with the instructions and drawings issued by the cable and the terminator manufacturers.

1. Mounting installation shall conform to AEIC CS9 Section 3.2.
2. Install the aerial connector NEMA pad lugs for each termination.

3.4 Personnel Requirements

1. The Manufacturer shall utilize at least one experienced splicer and at least one experienced splicer helper for each terminator to be made. The splicers and helpers shall have satisfactorily terminated cable of a comparable type and size on a previous job. Resumes of splicer and splicer helper credentials shall be made available for the Contract Administrator upon request. Carelessness in handling cable, performing any operation, or in handling any apparatus, material, tool, or device in their Work will not be tolerated under any circumstances. Smoking will not be allowed during cable terminating.
2. The Manufacturer shall have a manufacturer Representative onsite to observe the splicing operations. In addition, the Manufacturer shall afford the Contract Administrator every opportunity to have at least two of their employees observe cable splicing operations.

3.5 Post Installation Testing

3.5.1 AC High Pot

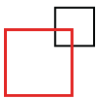
Cable AC High-Pot test consist of energizing each cable per Clause 15.2 of IEC 60840 – for 60 minutes. The voltage applied will be sinusoidal and have a frequency between 20 Hz and 300 Hz.

3.5.2 System Soak

Prior to the system carrying load and after successful post installation testing, the cable system shall be energized with no system load for twenty-four (24) hours. The Manufacturer shall be available during this testing period.

Appendix A. Drawing List

Drawing Number	Drawing Description
BB182GA1	General Arrangement
BB182EP1	230kV Electrical Plan
BB182EP2	26kV Electrical Plan
BB182E93	230kV Electrical Sections
BB182E52	26kV Electrical Sections
BB182CP1	230kV Conduit Plan
BB182CP2	26kV Conduit Plan
BB182CD2	Conduit Details
BB182ST1	Terminator Stand



Appendix B. Pricing Matrix

PRICING MATRIX							
Project	BRANDY BRANCH 230kV/26kV T2 ADDITION						
The information required below will be utilized to establish Total Price as basis for applying incremental material or labor due to any alterations in the scope of work to be performed in accordance with the Specification which this is appended. The Bidder shall add Other labor/material costs as necessary in order to establish the total bid price if it is deemed the list is incomplete with respect to necessary components to provide a complete and operable system that meets the minimum requirements of the Specification.							
No.	Description	Quantity		Material Unit Price	Sub-Total Material	Labor Price	Line Total
A. Cable and Accessories							
1	230kV XLPE Cable	2,500	FT	$ -	$ -	$ -	$ -
2	230kV XLPE Cable Terminator	6	EA	$ -	$ -	$ -	$ -
3	Three Phase Link Box	1	EA	$ -	$ -	$ -	$ -
4	Three Phase Link Box w/ SVL	1	EA	$ -	$ -	$ -	$ -
5	Ground Continuity Cable (600V)	775	FT	$ -	$ -	$ -	$ -
6	Bonding Cable (600V)	200	FT	$ -	$ -	$ -	$ -
7	Cable Clamps	30	EA	$ -	$ -	$ -	$ -
B. Other							
1	SPARE 230kV XLPE Cable	900	FT	$ -	$ -	$ -	$ -
2	SPARE 230kV XLPE Cable Terminator	1	EA	$ -	$ -	$ -	$ -
3				$ -	$ -	$ -	$ -
TOTAL PRICE					$ -	$ -	**$ -**