EXHIBIT 2-13-D

GERALD DESMOND BRIDGE

STAY CABLE SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Description

Work described in this Section applies to the entire stay cable system for cable supported bridges. The Design-Builder is responsible for completing a special provision that includes the requirements herein and all necessary additional technical specifications for construction of the Main Span Bridge.

The Work shall consist of designing, furnishing, fabricating, testing, storing, installing, monitoring, stressing, re-stressing, adjusting, and completing the assembly of all components of the complete stay cable system, including cable vibration suppression system and repair and/or replacement of damaged components, if necessary. The stay cable system shall allow control of the tension of the stay cable and facilitate future replacement that does not limit operation of the bridge or compromise bridge integrity.

The complete stay cable system includes, but is not limited to, main tensile elements, selected strand sheathing and/or strand coating, complete anchorage components, wedges, bearing plates, guide pipes, sealing components, stay cable vibration suppression system and components, corrosion protection provisions, temporary corrosion protection provisions during storage and construction, stay cable pipe, elastomeric boots, bolts, nuts, washers, clamping bands, erection devices and equipment, and all permanent and incidental materials and labor necessary to complete the stay cable system in accordance with the Contract requirements.

The stay cable system shall allow control of the tension of the individual strands and future strand replacement. The system should provide independency for the strands regarding anchoring, corrosion protection, installation, tensioning, and replacement.

1.02 REFERENCES

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### 1.03 STANDARDS

A. Stay cables are to be provided and tested in accordance with the PTI Guide Specification, “Recommendations for Stay Cable Design, Testing and Installation”. This Section and the PTI “Recommendations for Stay Cable Design, Testing and Installation” are intended to be complementary. In case of discrepancy or conflict between this Section and the PTI “Recommendations for Stay Cable Design, Testing and Installation”, this Section shall govern.

The following exceptions to the PTI Guide Specification, “Recommendations for
Stay Cable Design, Testing and Installation” are applicable:

1. If HDPE cable pipe is used, it shall be co-extruded with a white colored outer layer (final color to be approved by Port). The outer light colored layer shall have an ultraviolet resistance equivalent to black pipe produced with not less than 2% carbon black. The interior layer shall be black, weather resistant, and contain not less than 2% carbon black. The co-extruded layer shall be fully bonded and the outer layer shall be a minimum of 1/16-inch thick.

1.04 SUBMITTALS

Shop drawings showing all dimensions, materials, and operations for fabrication of the stay cable system components shall be submitted to the Design-Builder’s Engineer for Acceptance. Shop drawings shall show the strand pattern for each cable (symmetrical about vertical and horizontal axis). The Design-Builder shall provide detailed procedures that are recommended by the Supplier for installing all components, insertion of the strands, installation of wedges, stressing and filling of the cable void. Complete shop drawings with supporting calculations shall be submitted showing all equipment (jack, stressing chair, etc.) and procedures required for stay cable force adjustments and for complete de-tensioning. No installation will be permitted by the Design-Builder’s Engineer for any portion of the production stay cables or anchor assemblies until all required submittals of procedures and test reports are made and found to fully conform to the requirements of the Contract Documents.

1.05 QUALITY CONTROL – MANUFACTURING OF STAY CABLES

The Design-Builder is responsible for installing stay cable material in an undamaged condition. In order to assure that only conforming material is introduced into the Work, the Design-Builder shall develop a comprehensive Stay Cable Quality Control Program that covers the procurement, packaging, transport, delivery and storage of all stay cable materials and components of the stay cables. This program shall include, but not be limited to, all procedures and practices necessary for the final installation of stay cables that meet the requirements of this Section and Section 6 of the PTI “Recommendations for Stay Cable Design, Testing and Installation” without residual damage to any component of the stay cable system.

As a minimum, the Stay Cable Quality Control Program shall include the following items:

1. Packaging and shipping for main tension elements and all protective materials
2. Records for traceability and shelf life of all materials
3. Inspection of materials to assure conformance to this Section and to assure the materials are undamaged as they are installed on the bridge
4. Limitations on storage and handling, including time periods for storing materials, temperature and humidity limitations for materials, temporary corrosion
protection, and any limitation on temporary storage or protection that shall be permitted to affect performance of the completed stay design

5. Coiling limitations for materials subject to set or plastic deformations, including prefabricated cables, HDPE pipe, Polyethylene-sheathed strand

6. Limitations on coatings, repairs of coating damage, and supplemental protection for coated materials

The Stay Cable Quality Control Program shall be submitted to the Design-Builder’s Engineer and Port for review. Review by the Design-Builder’s Engineer and Port does not relieve the Design-Builder from the responsibility for the accuracy and adequacy of the Work.

The Stay Cable Quality Control Program shall be approved by the Design-Builder’s Engineer prior to submittal to the Port.

Permanent records shall be established and maintained by the Design-Builder for all procurement, inspection, sampling, testing and installation in accordance with the requirements of Section 6 of the PTI “Recommendations for Stay Cable Design, Testing and Installation”.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Steel - All steel products to be used or supplied in connection with the stay cable system shall be steel products rolled, formed, shaped, drawn, extruded, forged, fabricated, or other similar process or processed by a combination of two or more such operations, from steel by the open hearth, basic oxygen, electric furnace, Bessemer or other steel making process. Parallel solid bars shall not be used for cable stays.

B. Strand - Strand for stay cables shall be 0.60” in diameter, Grade 270, fy = .9fs, weldless grade, low relaxation, seven wire strand conforming to the requirements of ASTM A416 “Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete,” except that it shall be coated with a corrosion inhibiting material. During the process of manufacture of individual wires for “weldless” strand, welding is permitted only prior to or at the site of the last thermal treatment of the rod, for example, patenting or controlled cooling. There shall be no welds in the wire after it has been drawn through the first die in the wire drawing process.

Strand coating shall be of the “filled” type where the interstitial space between individual wires is completely filled with the coating or corrosion inhibiting material meeting the requirements of Table 1 from the PTI “Guide Specification - Specification of Unbonded Single Strand Tendons.”
Epoxy coated strand will not be allowed.

Strands shall be individually sheathed with a corrosion inhibiting material. Acceptable sheathing includes High Density Polyethylene (HDPE) or High Density Polypropylene (HDPP) meeting the requirements of the PTI “Recommendations for Stay Cable Design, Testing and Installation”.

The amount of corrosion inhibiting material shall be sufficient to ensure complete filling of the annular space between the individual wires of the strand and the sheathing material.

The coating, corrosion inhibiting material, and the sheathing shall extend over the entire length of strand. No welds or joints shall be present in the finished strand.

1. Strand Coating in the Vicinity of Wedges - The strand coating must be removed in the vicinity of the wedges. The Design-Builder shall provide recommendations for equipment and procedures required to do so that will not damage the strand. The actual procedures to be used by the Design-Builder during production must be similarly used for the acceptance testing. The Design-Builder shall also propose an acceptable method for providing temporary and permanent corrosion protection of the area where coating has been removed in order to accommodate the wedge grips. The Design-Builder system shall be qualified in accordance with Section 4.1 of the PTI “Recommendations for Stay Cable Design, Testing and Installation”.

2. Cable corrosion protection system shall be a multi-barrier, single-phase system that protects both the temporary and permanent system (from manufacture to its service life). This can be provided by the monostrand greased and sheathed system

C. External Pipe and Cable Guide Pipe – Pipe sections shall meet the requirements of Section 3.5 of the PTI “Recommendations for Stay Cable Design, Testing and Installation. Steel pipes shall not be used for the sheathing of cable stays.

D. Galvanized Components - Bearing Plates and all exposed carbon steel elements of the stay cable system shall be galvanized per ASTM A123.

E. Elastomeric Components - Elastomeric components, such as boots, shall be manufactured of the thickness, shapes and hardness required by the Design-Builder’s stay cable system design. The sole polymer used to manufacture the components shall be 100% virgin chloroprene, which shall be not less than 60% by volume of the total compound. The elastomer shall meet the requirements of ASTM C864.

F. Cap Screws and Bolts - Material for cap screws, used in the cable anchorages, shall be high-strength, low alloy structural steel conforming to ASTM A307. High strength bolts, used in the cable anchorages, shall conform to ASTM A325.
G. Washers and Shims - Material for split washers and split shims, if used in the cable stay anchorage, shall be high-strength, low alloy structural steel conforming to ASTM A709, Grade 50. All split washers and split shims shall be designed with a positive closure detail that will prevent shim loss upon unloading.

H. Material Storage - The storage facility provided by the Design-Build contractor shall provide indoor, protected space for all materials. The storage facility shall provide appropriate temperature controlled space for any and all materials that are temperature sensitive in nature. The Design-Build contractor is responsible for all stay cable system materials (including cost of leasing storage facility). The Design-Build contractor will allow immediate access to the Design-Build’s Engineer and Port personnel to inspect the storage facility at anytime during its use.

2.02 COMPONENT REQUIREMENTS

A. Stay cable system components shall meet the requirements as specified and the acceptance testing of the system. The cable anchor assembly shall consist of an externally threaded steel socket, anchor head, load bearing nut, and protective cap. It must allow for complete de-tensioning of the cables and subsequent removal of the anchorage components (except the load bearing nut) through the guide sleeve. The assembly shall pass, without failure of any component of the support testing outlined elsewhere in these requirements.

B. The anchorage assembly and components shall be protected at all times against corrosion, particularly the wedges and wedge holes. Corrosion protection measures shall be shown on the shop drawings and shall include temporary corrosion protection of areas (if any) where coating is intentionally removed for wedge contact. The permanent protection system shall include a stainless steel or galvanized cap to protect the exposed wedge plate and wedges from corrosion. Prior to the installation of the permanent cap, the wedge plate and exposed strand shall be coated with a suitable grease.

C. The threaded portion of the socket shall be of sufficient length for installation of the cable and future force adjustment of ±2.5% simultaneously in all cables without the use of shims. The assembly shall have a capacity equal to the guaranteed ultimate strength of the cable. Calculations shall be submitted to the Design-Build’s Engineer and Port showing the service stresses in all load bearing components of the assembly.

I. Requirements for Anchorages

The two ends of a stay cable are called the anchorage zones. An anchorage zone consists of:
1. The anchorage head: The systems consisting chiefly of an intermediary mechanical part designed to secure the strands of the cable and transmit their force to the attaching parts of the structure (deck crossbeam, gussets, anchor box, etc.),

2. The transition zone: Extends from the anchorage head to the start of the free length of the stay cable (cable and protective barriers); the transition zone is where the strands fan out, and may comprise deviators, transverse guide systems, internal/external dampers, and sealing systems.

The stay cable supplier shall submit to the Design-Builder’s Engineer the assembly drawings for the sizes and types of anchorages used in the project, showing all dimensions and materials of the main components. The stay cable system proposed shall be a proven solution complying with all qualification and testing requirements of Chapter 4 of the PTI “Recommendations for Stay Cable Design, Testing, and Installation.”

All tests required by this Section whether performed for previous projects or performed for this project must be carried out or witnessed and approved by third parties.

All stay cable systems shall provide for the future addition of at least 5% of capacity through the installation of additional strands in the existing cable without requiring cable and/or anchorage replacement. When specifying cable anchorage capacities, any group three (3) adjacent cables shall have the ability to add 5% capacity globally (thereby allowing some individual cables to be initially installed at or near anchorage capacity).

1. Transfer of Stay Force

Stay cable anchorages shall be designed to individually anchor each strand by a reversible means. Hard material (resin) filling or cement grouting shall not be allowed in the anchorage area.

The anchorage device shall be capable of transmitting the full ultimate tensile force of the cable. All other components such as bearing plates, recess tubes, steel flanges, and deviators shown on the drawings shall be of suitable type and sufficient strength for the intended use.

The stay cable supplier shall submit to the Design-Builder’s Engineer, upon his request, calculations for the justification of these components as well as results of full-scale fatigue, static and water tightness tests.

2. Filtering Out Angular Deviations

The anchorage shall comprise cable guide systems in order to prevent
significant bending stresses due to angular deviations of the strand to extend to the anchorage device or wedges. The design of the cable guide system must take account of transverse and flexural forces resulting from:

a. cable deformations caused by catenary effects and wind oscillations at service and maximum wind speed;
b. deck and pylon anchorage rotation under live loads;
c. inaccuracy of anchorage placing and shuttering tube misalignment;
d. permanent angles due to the fanning out of the strands;
e. bending of strand in the anchorage head due to manufacturing tolerances of anchorage parts.

Guide deviators placed in the transition area, imposing a transverse force on the structure ahead of the stay anchorage in the above cases, are not allowed. The anchorage shall be capable of handling by itself the following combination of deviation angles, as a minimum, without damaging the cable:

a. +/- 20 milliradians static angle or the installation tolerances of the connecting parts (shuttering tube misalignment), whichever is greater;
b. +/- 10 milliradians dynamic angle.

The stay cable supplier shall document the adequacy of anchorages to limit stresses in strands to acceptable levels through full scale testing.

3. Possibility of Tension Adjustment

All stays cables shall have the capability for force adjustments achieved by re-positioning the anchorage with respect to the structure.

This tension adjustment shall be made by means of a threaded tube and ring nut assembly. The use of shims to provide for stay tension adjustments is not permitted.

The adjustment amplitude shall be sufficient to account for the following:

a. uncertainty regarding the “neutral” position of the anchorages;
b. uncertainty of the construction loadings and of the stiffness of the structure (deck and tower);
c. uncertainty of the unstressed length, tension, and temperature of the stay cable;
d. extension of the stay cable to attain the required preloading;
e. provision for future increase in dead load (overlay/ resurfacing, widening), etc.;
f. provision for future increase in the live load;
g. deformation of the structure resulting from concrete creep and shrinkage or constructional inaccuracies, corresponding to mid-span deck deflection of L/1000 where L is the length of the relevant stay;

h. a safety factor to the satisfaction of the Design-Builder’s Engineer.

4. Possibility of Directional Adjustment

The orientation of connecting parts and anchorage heads must take account of the ideal cable-stay alignment (catenary) under the service conditions of the unloaded structure.

The anchorages must be capable of accepting static angular deviations in excess of the installation tolerances of the connecting parts.

Stay cable anchorages shall be designed to individually anchor each strand by a reversible means. Hard material (resin) filling or cement grouting shall not be allowed in the anchorage area.

The anchorage device shall be capable of transmitting the full ultimate tensile force of the cable. All other components such as bearing plates, recess tubes, steel flanges and deviators shown on the drawings shall be of suitable type and sufficient strength for the intended use.

The stay cable supplier shall submit to the Design-Builder’s Engineer, upon his request, calculations for the justification of these components as well as results of full-scale fatigue, static and water tightness tests.

2.03 CABLE DAMPING REQUIREMENTS

This Work shall consist of the design, installation, and testing of a stay cable vibration suppression system when required as specified herein. The stay cable system shall include a vibration suppression system consisting of one or more overlapping systems (dampers (other than neoprene washers), and/or cable surface modifications).

The Design-Builder shall prepare and submit a Stay Cable Wind, Rain, Vibration, and Pedestrian Comfort Study Report that recommends a cable dampening system ensuring that excessive cable vibration will not take place. The proposed dampening system shall be submitted to the Port prior to procuring vibration dampers. The Stay Cable Wind, Rain, Vibration, and Pedestrian Comfort Study Report shall include, at a minimum, the following:

- Introduction
- Wind climate and site analysis including introduction, data sources, methodology, results, conclusions, and recommendations
- Wind load and stability information including the design wind loads and load combinations
- Pedestrian load vibration information including the factors affecting the bridge, the comfort criteria for pedestrian-induced vibrations, excitations from walking, running or jumping and discussion of results
- Cable vibration information including rain-wind excitation and galloping, vortex shedding, cable-deck/tower interaction, assessment summary, motion-induced and parametric excitation of cables, conclusions, and recommendations

The vibration suppression system shall provide a minimum damping ratio (percent of critical) calculated as \((200 + L) / 1200\), where \(L\) is the stay cable length in feet, or higher damping as required to meet the performance specifications.

The Design-Builder shall design and construct the stay cable system to prevent excessive vibration of stay cables due to all affects of operating and environmental loadings over the range of temperature associated with steel design in the AASHTO LRFD Bridge Design Specifications, 4th Edition, with California Amendments. Excessive vibration is defined at two levels:

- Vibration which exceeds \(L/1200\) under normal operating conditions, which includes rain-wind excitation and normal wind conditions up to and including 25 mph.
- Vibration under any service, strength or extreme loading condition that causes damage to or fatigue failure of any strand, cable, appurtenance or bridge component. The acceptable level of vibration and displacement for strength and fatigue limit states shall be established by test.

The Design-Builder shall establish displacement criteria for service, strength and extreme load vibration levels, in addition to the normal operating criteria noted above, that are based on and consistent with cable testing and detailed analysis of cables and bridge components, and submit criteria to Port for approval. The Design-Builder shall, in all cases, provide at least a mass-damping parameter in conformance with the commentary of Section 5.2.3.2 of the PTI “Recommendations for Stay Cable Design, Testing and Installation”.

The Design-Builder shall warrant construction of the stay cable damping system for a period of five (5) years from date of Final Acceptance of the bridge. The Design-Builder shall modify damping system(s), cable surface treatment as required to achieve the performance requirements for cable vibration at no additional cost to Port. The Design-Builder will replace or repair to like-new condition all cable elements, appurtenances, or bridge components damaged by cable vibration or damaged by other environmental loading conditions in combination with cable vibration for the duration of the warranty period.

The Design-Builder shall have an independent laboratory perform on site testing before and after installation of the suppression system to verify that the additional damping
provided by the system meets the specified value. The Design-Build shall also propose a detailed pre-installation qualification plan for the suppression system to demonstrate through physical testing that the system will meet these requirements. The pre-installation qualification plan shall provide detailed methods for remedy of damping value if the post-installation testing indicates that the required additional damping value has not been achieved for each stay cable. Following completion of these tests, the Design-Build shall provide a Cable Damping Evaluation Report that demonstrates that the performance of the vibration suppression system meets or exceeds the required performance level.

Provisions shall be made by the Design-Build to facilitate rapid introduction of temporary suppression measures for stay cable susceptible to vibrations during construction. The cables shall be monitored for vibrations. Monitoring shall take place during erection at the time of major wind events and under the combined action of wind and rain.

PART 3 - EXECUTION

3.01 TESTING (GENERAL)

An independent testing laboratory (or laboratories) selected by the Design-Build and Approved by Port shall test all materials, strands and cable specimen assemblies required for both the initial acceptance-testing phase and the stay cable component fabrication/production phase. The Design-Build shall be responsible for all coordination between the Design-Build’s laboratory (or laboratories), Design-Build’s supplier(s), and Port representatives.

The Design-Build shall furnish, and make available for Port review, all materials and written test procedures, as prepared by the Design-Build’s supplier(s). Each component of the assembly, including items such as wedges, shall have an AASHTO or ASTM material and test specification. The Design-Build’s supplier(s) and laboratory (or laboratories) shall prepare separate Testing Reports. Each of these reports shall independently describe all the testing data and testing results. All reports shall be submitted for each test as an independent record of the testing. The Design-Build shall be responsible for subcontracting and coordinating with the Design-Build’s laboratory (or laboratories) and Design-Build’s supplier(s) for all testing laboratory services.

Material or cable-supported bridge system components tested during the acceptance-testing phase shall not be incorporated into the actual structure. All items, which comprise the permanent production stay cable system, shall be identical in nature, origin, and composition to those that were the basis of the stay cable system acceptance tests. The Design-Build’s supplier(s) shall provide written and detailed Stay Cable Handling Recommendations to the Design-Build regarding storage, handling, transporting, assembly, stressing, and re-stressing of the cable-supported bridge system components that conform to PTI, as a minimum standard.
3.02 CABLE TESTING

The Design-Builder is responsible for delivery of all materials to the laboratory and fabrication of test specimens in a timely fashion. Fabrication of any anchors, components or stay cable strands for permanent installation in the structure shall not begin until all initial phase tests are successfully completed and written approval is given by the Design-Builder’s appropriate Quality Control Manager. The Design-Builder shall also allow for review and comment of materials and test specimens by the Design-Builder’s Engineer prior to fabrication.

The Design-Builder shall provide an initial Proposed Cable Stay Schedule for the cable system testing that includes the following milestones:

- Delivery of materials and conducting the first axial fatigue test on a specimen. Upon completion of this test the leak test shall be performed on the specimen. This specimen will not be tested for ultimate post-fatigue strength and static load testing.
- Delivery of materials and conducting base strand tests and single strand friction tests
- Delivery of materials and conducting the second axial fatigue test. This specimen will be tested for ultimate post-fatigue strength and static load testing.

A. Acceptance of Prior Tests of Cables – When the cable tests (or similar cable tests) have been conducted for previous projects on specimens identical in material supply, design and details to those proposed for this project, the previous tests may, at Port's sole discretion, be used as the basis for the cable-supported bridge system approval for this project. However, the quality control tests outlined in Section 3.2 of the PTI “Recommendations, Support Cable Design, Testing and Installation” shall establish that the strand supplied for this project has fatigue characteristics equal or better than the strand used in the acceptance tests of the support cable (or stay cable) specimens in the previous project. Further, the load bearing anchorage and wedge hardware shall be the same as in the previous tests.

B. Individual Sheathing Acceptance Test – HDPE, HDPP and corrosion inhibiting material shall meet the requirements of the PTI “Recommendations, Support Cable Design, Testing and Installation.” The resultant acceptable values of the primary properties for HDPE and HDPP material shall be tested and meet the requirements of the values found in Table 3.2 of the PTI “Recommendations, Support Cable Design, Testing, and Installation.”

1. HDPE Sheathing Requirements - The Design-Builder shall furnish to the Design-Builder’s Engineer a certified test report prepared by an independent laboratory documenting compliance of the HDPE with the following requirements:
HDPE material shall meet the specific requirements of ASTM D 4976 "Standard Specification of Polyethylene Plastics Molding and Extrusion Materials”

- The material shall be UV stabilized and suffer no property degradation for a minimum exposure period of six (6) months. In applications where the PE sheathed strand may be exposed to UV radiation for periods in excess of six (6) months, the requirements of Section 3.5.3.2C of the PTI “Recommendations for Stay Cable Design, Testing and Installation” shall apply.

- HDPE material shall not react with the pre-stressing steel corrosion inhibiting coating material or any other material it is permitted to come in contact with as part of the stay cable sheath and shall be free of water soluble chloride.

- HDPE material shall be chemically stable without embrittlement or softening over the anticipated exposure temperature and service life of the structure.

2. HDPP Sheathing Requirements - The Design-Builder shall furnish to the Design-Builder’s Engineer a certified test report prepared by an independent laboratory documenting compliance of the HDPP with the following requirements:

- HDPP material shall meet the requirements of ASTM D 4101 "Standard Specification for Propylene Plastic Injection and Extrusion Materials."

- The material shall be UV stabilized and suffer no property degradation for a minimum exposure period of six (6) months.

- HDPP material shall not react with the pre-stressing steel corrosion inhibiting coating material or any other material it is permitted to come in contact with as part of the stay cable sheath and shall be free of water soluble chloride.

- HDPP material shall be chemically stable without embrittlement or softening over the anticipated exposure temperature and service life of the structure.

C. Coating Test Requirements for all Strand - The Design-Builder shall furnish to the Design-Builder’s Engineer for review and comment, a test report prepared by an independent laboratory documenting compliance with the following tests:

1. Chemical Resistance. The chemical resistance of the coating shall be evaluated in accordance with ASTM G 20 by immersing coated strands in each of the following: distilled water, a 3 M (Molar) aqueous solution of CaCl2, a 3 M (Molar) aqueous solution of NaOH, and a solution saturated with Ca(OH)2. Tests with specimens without holidays and specimens with...
intentional 0.25" diameter holes drilled through the coating shall be performed at 75±4°F Fahrenheit. Minimum test time shall be forty-five (45) Days. The coating must not blister, soften, lose bond, nor develop holidays during this period. The intentionally made holes shall exhibit no undercutting during the 45-Day period.

2. Chloride Permeability. The chloride permeability characteristics of the films of cured coatings having the minimum thickness as proposed for use shall be measured by the methods outlined in FHWA RD 74 18. The test shall be performed at 75±4°F Fahrenheit for forty-five (45) Days. The accumulative concentration of chloride ions permeating through the film shall be less than 0.0039 inches of total penetration.

3. Impact Test. The resistance of a strand coating to mechanical damage shall be determined by the falling weight test. A test apparatus similar to that described in ASTM G 14 shall be used along with a 4 lb tup. Impact shall occur on the crown areas on the coated strand. The test shall be performed at 70°F. With an impact of 80 in-lbf, no shattering, cracking, or bond loss of the coating shall occur except at the impact area, that is, the area permanently deformed by the tup.

4. Salt Spray Fog Test. Coated strand specimens shall be tensioned to 70% of the maximum ultimate tensile strength and exposed to salt fog for 3,000 hours in accordance with ASTM B117. Care shall be taken to protect the end anchorage used from salt fog or corrosion so as not to influence the test results. Observation for signs of corrosion shall be made and recorded every 250 hours. After 3,000 hours of exposure, no evidence of rust shall be present, and the specimen shall be holiday free. After the salt spray test is completed, the specimen shall undergo a tensile strength test, in accordance with AASHTO T244 to determine if the ultimate tensile strength of the strand has been affected. The tensile strength of the strand after being exposed to the salt spray shall satisfy the requirements of Section 6, ASTM A416. No cracks visible to the unaided eye shall occur in the HDPE or HDPP up to an elongation of 1% (yield point). Results from previous tests for a current project may be submitted for acceptance provided the testing complied with all of the procedures and requirements mentioned above.

The Design-Builder shall have an independent testing laboratory (not the primary Laboratory contracted by the Design-Builder) perform project specific tests defined in tests A through D above. The Design-Builder shall submit the certified test results from the independent testing laboratory that all aspects of these requirements have been met. All above tests shall be completed prior to completion of the testing of the full size specimens and shall show that all strand requirements are met by the individually sheathed strand to be supplied. The Laboratory shall perform tests on all
material, strands and cable specimen assemblies required for both the acceptance testing phase and the cable component fabrication/production phase as defined by the Strand Acceptance Test and Fatigue Strength Testing of Cables of this Section. The Design-Builder is responsible for the supply and delivery of all testing materials to the laboratory. Coated strand represented by test samples that do not meet all requirements of the Contract shall be rejected.

D. Strand Acceptance Test

The following conditions shall be met:

1. One (1) 16-foot long sample strand shall be taken for every ten (10) tons of strand produced from each heat of steel. This sample shall be used for both fatigue and ductility testing.

2. All strands and test samples shall be marked in such a manner to ensure traceability during production, transit, storage and testing.

3. The test strands shall be protected from failure in the gripping zone. Should any test strand fail in the gripping zone, the test will be discarded and another test specimen made from the same sample.

4. One test for each manufactured length shall be made for the following:

   - Minimum guaranteed ultimate tensile strength: \( f_s = 270 \text{ ksi} \)
   - Minimum yield strength: \( f_y = 0.90 f_s \)
   - Young’s Modulus: \( E = 28,600 \text{ ksi } +/- 5\% \)

Strand shall be fatigue tested as follows:

1. One tensile fatigue test shall be conducted on an approximately 4' long test specimen from each sample. Minimum length shall be 36" face-to-face of grips.

2. The test strand shall withstand without wire failure 2 million cycles of stress variation from 98.6 ksi to 121.5 ksi.

3. After successful completion of the fatigue testing, each test specimen shall withstand a minimum static load of 95% of the guaranteed ultimate tensile strength of the strand without wire failure.

4. Rejection Criteria: If the first valid test strand from each sample fails, two additional tests shall be made from the same samples. If failure occurs in either of these tests, the strand represented by that sample shall be rejected. Retesting shall not be permitted.
5. A "one-pin" ductility test shall be conducted on each sample. The details and method of the test shall be as defined in Appendix "A" of the PTI "Recommendations for Support Cable Design and Testing and Installation." For acceptance, the tensile force in the sample during the one-pin test shall equal at least 80% of the tested ultimate strength of the sample.

The above strand acceptance tests shall be performed for materials to be incorporated into the stay cable test specimens and for production materials to be incorporated into the permanent structure.

E. Fatigue Strength Testing of Cables

1. Test Specimens - For cable stayed bridges, three (3) complete, fully assembled stay cable specimens with multiple strands shall be fabricated for axial load testing in accordance with Section 4.2 of PTI "Recommendations, Support Cable Design, Testing and Installation". The three testing specimens shall represent the largest, the smallest and the average sizes of the proposed production cables. Each specimen shall be fully representative of all materials, details, number of strands, fabrication and assembly procedures proposed for production anchorages. One of the fully assembled stay cable specimens shall be tested in accordance with Section 4.1 of PTI "Recommendations, Support Cable Design, Testing and Installation" unless prior testing of the identical stay system is approved by the Design-Builder’s Engineer and Port in lieu of project specific testing.

3.03 HANDLING AND INSPECTION

A. Strand

The Design-Builder’s Engineer and Port shall have unrestricted access to all manufacturing, fabrication, and testing performed at the supplier’s facilities, laboratories and shipping and storage facilities. The Design-Builder shall furnish to the Design-Builder’s Engineer for approval, complete test reports and certificates that are prepared by the Supplier for the strand from each production lot number, including stress-strain curves and modulus of elasticity of the coated strand. The strand will be furnished in coils and shall have padded contact areas, wherever possible. Each coil will identify the cable into which it is to be installed and the length of strand on the coil. Each coil shall be protected by a supplier-approved method to ensure a uniformly sheathed and coated strand having no adhering foreign matter or damage to the coating, including that from ultraviolet exposure. The ends of the strand shall be sealed at all times.

At all times, the strand shall be properly stored in a weatherproof enclosure. A
weatherproof enclosure shall be considered to be a fully enclosed building complete with floor or a fully enclosed container with wooden or metal roof, sides and floor capable of protecting the strand reels and packing from exposure to rain, wind, snow/ice and sunlight. All strands shall similarly be shipped in closed bed trucks or containers to avoid exposing packing to weather. Each coil shall also be marked with the order number, coil number and heat number. The starting end of each coil shall also be marked. The Design-Builder shall minimize unnecessary bends in the field when uncoiling strands. Handling resulting in sharp kinks or short radius bends less than the spool radius shall be cause for rejection. If, as determined by the Design-Builder’s Engineer, the kink or short radius bend was inherent in the coil, it shall be immediately replaced by the Design-Builder.

All systems for handling coated strands shall have added contact areas. All bundling bands shall be padded or suitable banding shall be used to prevent damage to the coating. All reels of coated strand shall be lifted with a strong back, spreader bar, multiple supports, or a platform bridge to prevent abrasion. The reels and strand shall not be dropped or dragged.

All strand ends shall be sealed with approved patching materials by the end of the same day that the strand is cut.

Any damage to the coating shall be repaired by the Design-Builder utilizing project approved materials, procedures and personnel. It is imperative that the strand coating be undamaged over the full length of cable in order to provide long-term protection to the strands.

B. Sheathing

The Design-Builder shall use padded points of contact during storage, handling, fabrication and erection. Care shall be taken at all stages of the construction process to avoid damage to the finish. The Design-Builder shall immediately repair any damage to the surface finish. The visible grain of the finish shall be uniform in appearance and direction.

These handling/finish requirements shall also apply to exposed portions of any guide pipes.

C. Anchorage and Miscellaneous Components

The anchorage components and miscellaneous components shall remain in their original shipping containers as supplied by the Supplier until ready for immediate use unless specified otherwise by the Supplier. These components shall be kept in appropriate weatherproof enclosures. During handling, fabrication, erection and all construction operations, the Design-Builder shall use the utmost in care to protect the components from any damage. Any and all damage shall be repaired by the Design-Builder utilizing previously approved procedures for this project.
and/or shall replace damaged components.

3.04 FABRICATION OF STAY CABLES

A. Cables shall be fabricated in a manner consistent with the design and testing requirements for the cable-supported bridge system as indicated in this Section. Appropriate measures shall be taken to ensure that all strands are installed parallel to each other.

B. The Design-Builder shall develop and implement procedures to assure that stay cable components will not be damaged during handling. All stay cable components shall be protected from corrosives, heat, abrasion and other harmful effects throughout the fabrication and installation.

C. Spreader bars and slings or other appropriate devices shall be used to handle all cable and sheathing components. Slings or similar devices shall be positioned on the cable to carry both the anchor and adjacent cable in a tangent position, preventing bending of the cable at the anchor. Slings and spreader devices shall be padded to prevent damage to the cable sheath.

D. All damage to cables or any components thereof shall be evaluated and remedied by the Design-Builder, to the satisfaction of the Design-Builder’s Engineer, prior to installation of the cable. Damaged strand shall be replaced. Damage to non-load carrying components shall be repaired or replaced to the Design-Builder’s Engineer’s satisfaction prior to the installation of the cables. Any damage occurring after installation shall similarly be evaluated and immediately remedied by the Design-Builder to the satisfaction of the Design-Builder’s Engineer.

E. Storage, handling, fabrication, assembly, erection, stressing and completion of all stay cable system components shall follow without deviation the procedures, details, methods and equipment used as presented in the Design-Builder’s approved shop drawings and detailed, step by step erection manual.

F. Guide Sleeve and Bearing Plate. The Design-Builder shall install and align the guide sleeve and bearing plate assemblies during construction. The manual of geometric controls to be developed by the Design-Builder for the Design-Builder’s Engineer’s review and comment shall include a detailed survey and alignment procedures for such alignment. The construction manual shall include detailed equipment and procedures used to secure the guide sleeve and bearing plate assemblies during concrete placement and curing.

G. The Design-Builder shall follow the approved welding details and procedures. All fusion welds of HDPE pipe shall conform to ASTM D2657. Welding of steel pipe, if used, shall conform to AWS B2.1 and AWS D1.5. All pipe splices shall develop the full yield strength of the pipe cross section.
H. No welding of the pipe shall take place with the coated strands inside. Finishing of all welds to the required finish shall principally occur prior to installation of the strands into the pipe. Any remaining finish repair to the weld or other areas shall be conducted in a manner that will not heat the pipe at any point to more than 150° Fahrenheit.

I. Strand Installation. Installation of strands shall follow the fully engineered procedures contained in the Design-Builders shop drawings and detailed step-by-step erection manual. Deviations from procedures, methods, details or equipment shall not be permitted. The resulting installed strands shall be parallel and damage free.

J. Anchorage and Miscellaneous Components. The anchorage components and miscellaneous components shall be installed following the fully engineered procedures contained in the Design-Builders shop drawings and detailed step-by-step erection manual. Deviations from procedures, methods, details or equipment shall not be permitted. The installed anchorage and miscellaneous components shall be damage free. Flame cutting of strands is not permitted.

3.05 CABLE STRESSING

A. Accurate calibration of the cable jacks and gauges is critical to the geometry control of the structure and the resulting state of stress in the structure. Jacks and gauges for cable installation shall be match calibrated using a load cell or calibrated static load machine by an independent laboratory within one month prior to the beginning of the cable installation, and every six (6) months thereafter, for the duration of the cable installation. Calibration shall be accomplished with the jack actively applying load to the machine, not the machine applying load to the jack. Prior to use after each calibration, each field gauge shall be calibrated against the master gauge for reference purposes. Any internal work performed on the jack shall require recalibration.

B. The detailed cable installation procedure, contained as part of the Erection Manual, shall prescribe force, cable elongation and deck elevations for each jacking operation, and shall establish the priority of force or geometry for control of the jacking operation. This procedure shall stipulate the permissible variance between force and elongation and deck elevation for each cable to be installed.

C. The cable stressing procedures shall include detailed provisions for monitoring the installation of each cable.

D. Permanent Stay Cable Installation Records shall be established and provided by the Design-Builders for each cable installation. Such records shall include survey records; date, time and ambient temperatures; cable forces; cable elongation measurements; ring nut setting; deck loading conditions; and all other special notations necessary and sufficient to establish the conditions under which the
cable was installed. This record shall include the as built profile grade elevation of the deck along each web and atop each cable anchor block immediately prior to and immediately after each stressing operation. Copies of this data shall also be provided by the Design-Builder to the Design-Builder’s Engineer within twenty-four (24) hours of completing each cable stressing operation.

3.06 SUPPLEMENTAL PROTECTION FOR STAY CABLES AND STAY CABLE COMPONENTS

A. A supplemental waterproof protection system shall be provided near deck level to prevent rain and other deleterious substances from coming into contact with the stay cable (defined for purposes of this requirement to be the individual strands and the stay cable pipe enclosing the strands) and with the stay cable end anchorage. Such protection shall extend from the lower anchorage to the top of the guide pipe.

B. In addition, a vandal resistant guide pipe shall be provided from the lower anchorage to a height of twenty feet above the top of the deck Surface measured vertically from the deck surface. The Design-Builder shall determine the appropriate guide pipe thickness as part of the design. The vandal resistant guide pipe may be part of the supplemental waterproof protection system.

C. Both protection systems shall include provisions for removal and replacement to facilitate inspection.

D. The details of both supplemental protection systems shall be submitted with design drawings and to The Design-Builder’s Engineer for Acceptance including a list of reusable components for each protection system.

3.07 PAINTING

All ferrous metal surfaces, other than stainless steel and hot dipped galvanized surfaces of the stay cable system, shall be painted with an approved zinc primer and top coats. Finish coat color shall be in accordance with the visual quality process. Bearing plates, guide pipes, and tower deviation pipes shall be galvanized in accordance with AASHTO M 111M (ASTM A123M), Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, six (6) kilograms per square meter.

END OF EXHIBIT