FIBER REINFORCED POLYMER PONTOONS

**From Brookfield BRF FLBR(2)

xx. DESCRIPTION. This work shall consist of designing, detailing, fabricating, furnishing, and installing Fiber Reinforced Polymer (FRP) Pontoons.

xx. DEFINITIONS. The following definitions provide a basis of terms used throughout these provisions. Additional terms not uniquely defined below shall be in accordance with ASTM D3878.

Ballast – A material use to provide stability and targeted density to a floating structure.

Fiber Reinforced Polymer (FRP) – A thermoset polymer (resin) matrix reinforced with fiber or other material with a sufficient aspect ratio (length to thickness) to provide a discernible reinforcing function.

Lamina – A subunit of a laminate consisting of one or more adjacent plies of the same material with identical orientation.

Laminate – Any fiber-reinforced or fabric-reinforced composite consisting of laminae (plies) with one or more orientations with respect to some reference direction.

Ply - The constituent single layer used in fabricating a composite structure.

Pontoon – An individually fabricated water-tight FRP cellular structure.

Raft – A transverse grouping of individual FRP pontoons to form a flotation device that is nominally 23 feet wide, 3 feet deep, and 51 feet long.

Vacuum-Assisted Resin Transfer Molding (VARTM) – A technique that uses vacuum pressure to draw resin into a mold.

xx. MATERIALS.

(a) Resin. Bisphenol-A epoxy-vinyl ester or durable marine grade epoxy based resins shall be used; no other resins will be accepted for use. A maximum of 10% styrene by weight will be allowed to be added to the base resin mixture which itself may already contain styrene. The selected resin shall contain a minimum of 0.30% by weight UV-9 as a UV stabilizer.

The color of the resin shall be gray and in close conformance with Federal Standard 595 Color 26357.

A Type B Certification in accordance with Subsection 700.02 shall be furnished for the resin used in fabrication and all components intended to be added to the resin mixture prior to infusion.

(b) Fiber Reinforcement. Reinforcement shall be an electrical grade glass (E-glass) fabric and shall be in the form of continuous roving, woven roving, stitched, or surface matting.

A Type A Certification in accordance with Subsection 700.02 shall be furnished for each type and delivery of E-glass used in the manufacture of the pontoons.

(c) Structural Steel. Structural steel shall meet the requirements of Section 714 for AASHTO M 270M/M 270, Grade 50 steel. Steel plates shall be Charpy V-notch tested in accordance with Subsection 714.01. Steel shall be hot dip galvanized following fabrication in accordance with Subsection 726.08.

(d) High-Strength Bolts, Nuts, and Washers. Hardware used to connect structural steel field splices to the FRP pontoons shall meet the requirements of Subsection 714.05. Hardware shall meet the requirements of ASTM A325, Type I and be mechanically galvanized in accordance with AASHTO M 298, Class 50, Type I.

(e) Threaded Rods. Threaded rods shall meet the requirements of ASTM A615, Grade 75. Nuts shall be in accordance with ASTM A108 and washers shall be in accordance with ASTM F436. Bearing plates shall meet the requirements of AASHTO M 270M/M 270, Grade 36. All components comprising the threaded rod assembly shall be hot dipped galvanized following fabrication in accordance with Subsection 726.08. Threads along the threaded rods only need to be present near the anchor locations for proper installation.

A Type D Certification in accordance with Subsection 700.02 shall be furnished for all components comprising the threaded rod assembly.

(f) Closed Cell Foam. Closed cell foam shall be expanded polystyrene (EPS), polyisocyanurate, or rigid spray-applied polyurethane meeting the following requirements:

Physical Property	Requirement	Test Method
Water Absorption	3% max.	ASTM D2842
Compressive Strength @ 10% Strain (psi)	< 30 psi	ASTM D1621

A Type D Certification in accordance with Subsection 700.02 shall be furnished for the closed cell foam is required in accordance with Standard Specification 700.02.

(g) Ballast. Ballast material shall be free of voids and of uniform density, such as concrete or galvanized steel. The selected ballast material shall not be reactive with surrounding FRP or foam components in dry or humid/wet environments.

xx. SUBMITTALS. The Contractor shall submit Design Computations, Design Drawings, FRP test sample results, and Fabrication Drawings in accordance with Section 105 and these provisions. Submittals and review periods shall be as follows:

(a) Design Computations and Design Drawings. The Contractor shall submit design calculations and Design Drawings to the Agency that identify the proposed pontoon design, materials to be used, and verify that all Contract requirements are met. The Agency shall have four (4) weeks to review the submitted information. After the review period, the Contractor shall incorporate all comments and resubmit, if necessary. Any subsequent Agency review period shall be two (2) weeks.

(b) FRP Test Sample Results. After acceptance of the Design Computations and Design Drawings submittal, results of the FRP test samples as outlined in these provisions shall be submitted to the Agency for review. The Agency review period for this interim submittal shall be two (2) weeks.

(c) Fabrication Drawings. After acceptance of FRP test sample results, Fabrication Drawings shall be submitted to the Agency for review. Fabrication Drawings shall fully detail all aspects of work, material, and processes necessary to fabricate the pontoons to the requirements of the Contract Documents. The Agency shall have four (4) weeks to review the submitted information. After the review period, the Contractor shall incorporate all comments and resubmit, if necessary. Any subsequent Agency review period shall be two (2) weeks.

The Design Computations and Design Drawings shall be sealed by a Professional Engineer licensed in the State of Vermont. In addition to the requirements of Section 105, the following shall be included within the appropriate submittal:

(a) The dimensions of the sections to be fabricated.

(b) Ballast material, thickness, and location(s).

(c) FRP laminate layup design(s), including:

(1) Resin chemical composition, including additive types, names, and source of materials.

(2) Fiber types, including weave type, weights, orientations, and source of material.

(3) Target fiber to resin volume fraction ratios.

(4) Glass fabric piece dimensions, including any necessary cut-outs for bolt holes and other details.

(d) The infusion process, including intended vacuum pressure, anticipated draw time, number, spacing, and location of infusion and evacuation ports, anticipated cure temperature, and cure time.

(e) The method of keying or roughening adjoining surfaces of adjacent pontoons. The adjoining surfaces of adjacent pontoons shall be keyed or roughened through the use of sandblasting, acid etching, adhesively-applied silica grit, or other method approved by the Engineer. If adjoining surfaces are keyed, the shear key shall

be designed to meet the requirements of these provisions. If adjoining surfaces are roughened, the surface friction shall meet the requirements specified in Table I.

(f) Lab data test results proving required design strengths, stiffnesses, and other properties listed in the following table for each unique FRP laminate or equivalent partial thickness laminate intended for use in the fabrication of the pontoons shall be submitted. Strengths and stiffnesses listed in Table I are minimum requirements, regardless of design requirements. The strengths and stiffnesses required by the Fabrication Engineer's design in excess of those noted in Table II shall become the minimum benchmark for proof tests. The average value of all samples for each test shall exceed the required design value and no individual sample shall be more than 10% lower than the required value. Historic test results may be used provided the samples tested meet all Project requirements, are representative of the laminates needed by design, and test results are less than 5 years old.

Testing for the FRP materials shall be completed at an ISO 17025 certified laboratory approved the Materials and Research Engineer. The approval shall be based upon evidence of a satisfactory Quality System Manual for laboratory operations including systems that report equipment condition and calibration, training, and qualification procedures for employees conducting tests under this Contract. The laboratory must demonstrate compliance with a reasonable schedule for maintenance and calibration of the equipment used in each of the methods, technician proficiency documents (that include training if this is a limited experience staff person), and a narrative that explains sample handling, test result review and reporting, and explanation of chain of custody for the samples.

Testing shall be in accordance with these provisions and shall include, at a minimum, 10 coupon tests of each of the Fabricator-proposed laminates or equivalent partial thickness, if necessary, as follows:

Table I – Prefabrication Proof Testing Requirements			
Physical/Mechanical property		Requirements	ASTM Test Method
Barcol Hardness		> 40	D2583
Water Absorption		< 0.7%	D570
Density		Within ± 5% of theoretical design value	D792
Coefficient of Thermal Expansion (Longitudinal)		< $8x10^{-6}$ in/in/^{o}F	D696
Coefficient of Friction for Adjoining Pontoon Surfaces		> 0.45 (Wet Conditions)	D1894
Fiber Volume Fraction		> 45% by volume	D2584
Tensile Strength	Longitudinal	> 30 ksi	D3039
	Transverse	> 15 ksi	
Tensile Modulus	Longitudinal	> 2,000 ksi	D3039
	Transverse	> 1,500 ksi	

Compressive Strength	Longitudinal	> 30 ksi	D6641
	Transverse	> 15 ksi	
Compressive Modulus	Longitudinal	> 1,800 ksi	D6641
	Transverse	> 1,400 ksi	
Flexural Strength	Longitudinal	> 35 ksi	D7264
	Transverse	> 20 ksi	
Flexural Modulus	Longitudinal	> 1,800 ksi	D7264
	Transverse	> 1,400 ksi	
In-plane Shear Strength		> 12 ksi	D5379
In-plane Shear Modulus		> 600 ksi	D5379
Interlaminar Shear Strength		> 3.5 ksi	D2344
Pin Bearing Strength[1]		> 20 ksi	D953

[1]Pin bearing strength tests shall be conducted with the bolt sizes and types identified in the Plans and the FRP plates intended for use in the fabrication of the pontoons. The 4% deformation criteria noted in ASTM D953 shall be ignored and the tests shall be carried through and reported at ultimate failure.

(g) The design of lifting attachments and corresponding stresses imposed upon the pontoons during handling operations.

(h) Intended method of transportation, handling, and storage details.

(i) The intended installation/erection procedure including methods of post-tensioning with certified calibration charts for intended torque wrench. The erection procedure shall identify stresses imposed on the pontoons and connections due to handling and placement to ensure no damage will be sustained during erection operations.

(j) Within 45 calendar days following Contract Award, the Fabricator shall submit to the Agency a Quality Control Quality Assurance (QCQA) Plan for the fabrication of the FRP Pontoons. The QCQA Plan shall demonstrate the Fabricator's ability and commitment to produce FRP Pontoons to the requirements of this project. A satisfactory QCQA Plan shall, at a minimum, identify:

(1) Quality Control personnel involved in the project.

(2) Inspection procedures, methods of monitoring and logging fabrication and curing of the pontoons, and hold points during fabrication.

(3) Corrective action procedures for both the fabrication facility and project site.

(4) Methods (NDE or other) and frequency of evaluating full wetting, full cure, plate thickness, and other tolerances required herein.

Fabrication of the pontoons and/or the test panels shall not commence until the QCQA Plan has been approved by the Agency.

xx. DESIGN REQUIREMENTS. The FRP pontoons shall be designed by a Professional Engineer licensed in the State of Vermont. The Fabrication Engineer shall take full responsibility for the FRP

component design including, but not limited to, FRP wall thickness determination, stiffener layout and size, connection capacity for bolted steel components, and any other aspect that defines the overall FRP pontoon geometry, strength, and performance.

(a) Design References. The design shall be in accordance with the latest editions of the following documents, in prevailing order:

(1) Criteria noted within these provisions and the Plans

(2) AASHTO LRFD Bridge Design Specifications (AASHTO)

(3) 2010 VTrans Structures Design Manual (SDM)

(4) ASCE Pre-Standard for Load & Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures (Final)

(5) VTrans 2011 Standard Specifications for Construction

(b) Design Demands. Design demands are depicted in the Plans in the form of global design forces and localized connection forces. All loading information within the Plans include applicable dynamic load allowances, multiple presence factors, load modifiers, and load factors in accordance with Load and Resistance Factor Design (LRFD) methodology.

Moment, shear, and torsion diagrams provided in the Plans account for controlling live load placement and combinations of vehicular and pedestrian loading as well as reactions from the approach ramps.

The bridge will be closed during winter months and therefore winter conditions (ice and snow loads) need not be considered simultaneously with vehicular or pedestrian live loads.

Vessel collision, thermal gradients, and snow drift loading need not be considered.

(c) Reduction and Resistance Factors. The following reduction and resistance factors shall be applied to the nominal strength and/or stiffness (where appropriate) of members:

(1) Moisture Reduction Factors (C_M).

Component Strength = 0.85

Component Stiffness = 0.95

(2) Temperature Reduction Factors (C_T). A temperature reduction factor shall not be considered for either strength or stiffness considerations.

(3) Time Effect Factors (λ). Component capacities shall be reduced by time effect factors as follows:

Service Load Combinations = 1.0

Extreme Event Load Combinations = 1.0

Strength Load Combinations = 0.90 (with Live Load)
= 0.40 (Dead Load Only)

(4) Resistance Factors (φ). Resistance factors shall be in accordance with the ASCE Pre-Standard for Load & Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures (Final).

(d) Design Loads. The following project specific loading conditions, as they deviate from AASHTO and/or the VTrans SDM, shall be considered:

(1) Dead Load (DC). Density of FRP shall be per Fabrication Engineer's design.

(2) Ice Load (IC). Only horizontal static ice loads shall be considered; vertical (gravity) ice loads due to hanging ice shelves and dynamic ice loads due to floating ice sheets need not be considered.

The static ice pressure shall be as shown in the Plans, act normal to the applied surfaces, and be applied simultaneously to both sides of the bridge. Ice loads are considered to be an Extreme Event load combination and therefore resistance factors (φ) need not be applied.

(e) Longitudinal Shear Key. If a shear key is used between adjoining pontoons, the shear key shall be designed for a distributed, factored shear force of 0.75 kips/ft. The shear key shall have a minimum root height of 18 inches and a minimum depth equal to 1.5 times the adjoining wall thickness.

(f) Physical Constraints. A finished FRP raft section shall meet the physical constraints specified in Table II. The raft weight requirements of Table I shall account for the maximum and minimum anticipated weights of the FRP components, dry weight of closed cell foam, and ballast. Ballast material, if used, shall be located beneath the closed cell foam and be equally distributed across the width and length of each raft. Long term water absorption need not be considered when meeting the requirements of Table II.

Stiffness properties of the closed cell foam and ballast shall not be considered when meeting the requirements of Table II. Design stiffness properties shall be adjusted by the appropriate Moisture and Temperature Reduction Factors in accordance with this Subsection when meeting the limitations of Table II. Maximum stiffness properties identified in Table II need not apply to the Field Splice Connection Zone Regions identified in the Plans.

Table II – FRP Raft Physical Constraints		
	Minimum	Maximum

Raft Weight (lb)	22,000	33,000
Vertical Bending Stiffness, $E*I_x$ ($kip*in^2$)	260,000,000	355,000,000
Plate Thickness (in)	1/2	N/A
Vertical Neutral Axis Location, Measured from Bottom Fiber (in)	16	20

Overall FRP raft length, width, and depth shall be in general accordance with the Plans. The minimum number of longitudinal cells within a raft, as seen in a transverse section, shall be four (4). The minimum number of transverse cells within a pontoon, as seen in a longitudinal section, shall be four (4).

Adjacent pontoons shall be match-cast to ensure proper fit up and mechanically fastened through the use of full width, continuous threaded rods as shown in the Plans or other method approved by the Engineer.

(g) FRP Layup Requirements. The minimum fiber density shall be 45% by volume. All FRP plates shall be comprised of a balanced and symmetric layup.

The orientation of the fibers within a given laminate shall be proportioned such that the amount of fibers by weight oriented in the 0° bias (longitudinal direction) and the 90° bias (transverse direction) do not differ by more than 20% and no less than 15% of fibers by weight or two layers minimum are oriented in each of the plus and minus 45° biases. At bolt hole locations, the laminate shall incorporate a minimum of four layers of both plus and minus 45° biases, two of which shall be positioned on laminate extremes. A maximum of 10% of fibers by weight may be comprised of randomly oriented strand mat to provide stability to the fabric. Additional non-structural layers of glass veil may be placed between the structural glass layers and form surfaces to enhance resin infusion.

Lap splices in the glass fabrics will be permitted as follows:

(1) The minimum lap length shall be 4 inches.

(2) Lap splices will not be allowed within 3 feet of bolted connection locations.

(3) Lap splices shall be staggered a minimum of 2 fet within a given lamina.

(4) Lap splices within the same fabric run shall be a minimum of 10 feet apart.

(5) No more than 2 lap splices will be allowed at any given location within a laminate.

(6) All lap splice locations shall be shown on the approved Working Drawings.

INSURANCE. The Contractor shall require its designer(s) or subconsultant(s) that engage in design work for the FRP pontoons as required by these provisions to maintain Engineers Professional Liability Insurance with a minimum limit of liability of $2,000,000 Annual Aggregate and $2,000,000 per claim. “Design Work” includes all work that requires design computations. This policy shall cover "Wrongful Acts," meaning negligent acts, errors, or omissions by the Contractor or any entity for whom the Contractor is legally liable, arising out of the performance of, or failure to perform, professional services.

No warranty is made that the coverages and limits required are adequate to cover and protect the interests of the Contractor for the Contractor’s operations. These are solely minimums that must be met to protect the interests of the State.

GENERAL FABRICATION REQUIREMENTS.

(a) Fabricator. The Fabricator shall be able to satisfy and provide verification of the following qualifications:

(1) A record of manufacturing and fabricating structural FRP products with the VARTM for a minimum of five years;

(2) Demonstrate successful project completion of at least three different industrial or commercial structural projects with magnitudes and complexities similar to this project;

(3) An average of no less than 15 full time employees over a 3 year period;

(4) A minimum of 40 years combined FRP experience between the President, Technical Leader, Inspector, and Plant Manager, or similar titles;

(5) A licensed Engineer available on-site as necessary with mechanical or structural engineering background.

The following have been identified as allowable fabricators of FRP pontoons for this project. The Contractor may utilize fabricator(s) not listed below provided the selected fabricator meets all requirements and qualifications specified herein.

Composite Advantage
401 Kiser Street
Dayton, Ohio 45404
Contact: Scott Reeve
Tel.: (937)723-9031
Fax: (937)723-9034

Kenway Corporation
681 Riverside Drive
Augusta, Maine 04330-9714
Contact: Jake Marquis
Tel.: (207)622-6229
Fax: (207)622-6611

Harbor Technologies, LLC
8 Business Parkway
Brunswick, Maine 04011
Contact: Reid Potter
Tel.: (207)725-4878
Fax: (207)721-0971

The Contractor shall submit verification of all required qualifications regardless of the Fabricator selected.

(b) Material Fabrication Facilities. Fabrication facilities shall be enclosed, temperature controlled, and of sufficient space to fabricate the project required pontoons and store unused products. The fabrication facility shall have dedicated, hard-plumbed vacuum piping and pump. An office at the fabrication facility with desk, chair, high speed internet connection, printer, and telephone shall be made exclusively available for Agency personnel during the production of the FRP pontoons.

(c) Pre-Production Meeting. A pre-production meeting shall be held a minimum of seven (7) calendar days prior to beginning the VARTM process. At a minimum, the pre-production meeting shall be attended by the Fabrication Supervisor, Plant Manager, Plant Inspector or Inspector's Supervisor, Fabrication Engineer, and Agency representative. The pre-production meeting shall discuss mold preparation, preform layup, vacuum testing prior to infusion, resin preparation, resin promotion, potential problems to track during production, curing, de-molding, and storing finished products.

(d) Forms. Forms shall be capable of molding the pontoons to the dimensions required by the Contract Documents and the Fabrication Engineer’s design within all tolerances and shall be supported without the use of ties or spreaders within the body of the finished member. Interior forms (closed-cell foam regions) shall be accurately positioned as shown in the Plans and secured to prevent displacement during vacuum infusion. The forms shall be designed to facilitate an airtight chamber capable of withstanding vacuum pressures needed for the infusion process.

Form surfaces shall be sufficiently rigid such that they will remain true to shape under the vacuum infusion pressures. Forms shall be free from rust, grease, or other foreign matter.

Any defects or damage to the finished FRP products due to form work, stripping, or handling may be cause for rejection. Holes and block outs for connections and any other related details shown in the Plans shall be provided for in the members. Holes for bolted connections may be drilled after fabrication. Cutting of finished FRP pontoons, other than drilling bolt holes, will not be allowed.

(e) Closed Cell Foam. Rigid closed cell foam shall be cut to the dimensions shown in the approved Fabrication Drawings. Foam shall fit tightly to the interior of the pontoons without causing pressure on the walls. Gaps between the closed cell foam and adjacent RP walls greater than 1/8 inch shall be filled with

spray-applied foam, approved by the Engineer. Spray-applied foam shall be applied in accordance with the manufacturer's recommendations.

Closed cell foam may be used as formwork for the FRP pontoons provided proper protection is provided to prevent chemical reaction and/or thermal breakdown of the foam due to resin application, and shall be removable to allow inspection of interior walls.

(f) Fabric Preparation. Glass fabrics shall be sheared to the shapes and dimensions indicated on the approved Working Drawings, including any cut-outs necessary for bolt holes or other details. The fabrics shall be cut on a clean cutting surface, free of any deleterious material that could adhere to the fabric. Any cutting of rovings within a piece of glass fabric that exceeds 5% of the dimension parallel to the line of the cut may be rejected.

(g) Vacuum Infusion. Resin shall not be drawn in to the forms until the Agency representative has approved the formwork and planned infusion process. Approval of the forms and infusion process by the Agency in no way relieves the Fabricator of achieving the required tolerances and design requirements set forth in these provisions. Prior to introducing the resin in the forms, the Fabricator shall fully seal the forms and demonstrate that the sealed form can maintain a vacuum pressure equal to that planned for infusion, with no more than a 5% drop in vacuum pressure over a five minute period.

Chemical additives and catalysts to be combined with the resin shall be measured by weight, or the corresponding volume, based on the batch weight of the resin. The Fabricator shall maintain a log of each batch of resin and the weights or volumes of each constituent material included in each batch. Once a batch of resin has been catalyzed, it must be thoroughly mixed and placed in the infusion tank within ten minutes. The Fabricator may request an extension of time on the catalyzed resin, contingent upon providing sufficient test data to demonstrate an extended gel time for the specific composition of the catalyzed resin with a specified quantity of gel time inhibitor. No additional time extensions will be permitted after this.

The infusion tank shall be charged with a sufficient amount of resin at all times to prevent air bubbles from entering the infusion port(s) in the form. Once the resin is introduced in to the form, the infusion process shall continue uninterrupted until it has been demonstrated that all evacuation ports have a surplus of resin flowing past the finished surface of the pontoon and that no less than the predicted volume of resin has been introduced in to the form.

(h) Curing. Allow the resin to cure properly prior to removal of vacuum pressure and forms. In the absence of specific product information, the forms shall remain in-place under full vacuum pressure for a minimum of 6 continuous hours after all evacuation lines have been clamped and the infusion process is considered to have been completed.

(i) Witness Panels. Witness panels of thicknesses that represent the material properties of each distinct laminate, or of a proportional thickness, shall be fabricated with each pontoon to demonstrate consistency of material properties. Witness panels shall be rectangular and shall have minimum edge lengths of 2 feet. Witness panels shall be tested by the Fabricator at the same testing facility used for initial lab testing required under SUBMITTALS of this Section.

The Agency representative shall randomly select witness panel sets created during the fabrication of three different pontoons to be tested by the Fabricator in accordance with Table III, prior to shipment of the pontoons. Selection of the witness panels to be tested will occur within one working day of cure completion. The Agency representative shall observe all witness panel testing, if practical. In the event the Agency representative is unable to observe the witness panel testing, the Agency will perform third party acceptance testing. Pontoons may be shipped prior to knowing the results of Agency acceptance tests. If acceptance tests results do not meet project requirements, the pontoons may be subject to rejection or repair.

Strengths and stiffnesses required by the Fabrication Engineer's design in excess of those noted in Table III shall become the minimum benchmark for proof tests. A minimum of 5 coupon tests per panel per test type are required.

The remaining witness panels shall be stored for the duration of project construction and tested by the Fabricator in the event additional testing is warranted. Any unused witness panels shall be delivered to the VTrans Materials and Research Section in Berlin, VT.

Table III – Witness Panel Testing Requirements			
Physical/Mechanical property		Requirements	ASTM Test Method
Water Absorption		< 0.7%	D570
Density		Within ± 5% of theoretical design value	D792
Fiber Volume Fraction		> 45% by volume	D2584
Flexural Strength	Longitudinal	> 35 ksi	D7264
	Transverse	> 20 ksi	
Flexural Stiffness	Longitudinal	> 1,800 ksi	D7264
	Transverse	> 1,400 ksi	
Pin Bearing Strength[1]		> 20 ksi	D953

[1]Pin bearing strength tests shall be conducted with the bolt sizes and types identified in the Plans and the FRP plates intended for use in the fabrication of the pontoons. The 4% deformation criteria noted in ASTM D953 shall be ignored and the tests shall be carried through and reported at ultimate failure.

(j) Dimensional Tolerances (at 40°F).

(1) Geometry of FRP Pontoon. Dimensional tolerances not specifically identified herein shall be in accordance with ASTM D3917.

a. Length (Each Unit): ± 1/2"

b. Adjacent unit lengths shall not differ by more than 1/2".

c. Depth and Width: ± 1/4"

d. Wall Thickness: + 1/16"; -0”

e. Surface Flatness: ± 1/16" per 48”

f. Sweep: ± 1/8"

g. Camber: + 1/2"; -1/4"

h. Deviation from Diagonals: ± 3/4"

i. Deviation from End Squareness: ± 1/4"

j. Insert or Hole Locations: ± 1/8"

(1) Field Installation.

a. Vertical differential between pontoon surfaces creating a single raft: not to exceed 1/8".

b. Floating span overall length: ± 1/2"

(k) Repairs. Units that contain minor defects as identified by ASTM D 2563, Acceptance Level II caused by manufacturing or handling may be repaired at the manufacturing site provided the defect and subsequent repair do not diminish the strength or serviceability of the final product, as determined by the Engineer. Repair procedures shall be in accordance with the Fabrication Facility’s approved QCQA Plan and require approval by the Engineer.

Presence of defects exceeding the severity limitations of ASTM D2563, Table 1, Acceptance Level II may be grounds for rejection of the unit. Presence of more than 2 defects within a 1 foot radius measured from the center of any given defect may be grounds for rejection of the unit.

Repairs proposed by the Fabricator shall include physical testing or historic evidence of satisfactory performance to validate the intended repair. Repair procedures, if approved, shall be noted on the Working Drawings.

(l) Surface Preparation. Clean surfaces of all contaminants, including mold release agent. All ridges or fins (flash) of resin shall be removed by scraping, grinding, or sanding as required.

(m) Pre-Assembly. Adjacent pontoons and consecutive rafts shall be pre-assembled on land to assure proper fit up prior to launching in Sunset Lake, to the satisfaction of the Agency.

Steel field splice plates shall be used as templates in locating and drilling bolt holes to ensure proper fit-up. Transverse threaded rods need not be tensioned during the pre-assembly.

xx. MARKING, STORING, AND SHIPPING.

(a) Labeling. Each unit shall be clearly labeled on the upstation end wall of each pontoon with the following information:

(1) Fabricator

(2) Date of Manufacture

(3) Mark Number

(b) Fabrication Site Handling. Units shall not be lifted, moved, or otherwise disturbed until the resin has fully cured in accordance with these provisions and the Fabricator's designs and methods.

(c) Storing. Store pontoons flat, off of ground, and protected from UV light. At a minimum, units shall be supported at each transverse diaphragm and at a maximum of 4 foot spaces between diaphragms. Stacking of pontoons is acceptable.

Threaded rods shall be covered and protected from the elements and debris. Any damage to the threaded rods shall be repaired in accordance with Subsection 726.08.

(d) Shipping. Provide proposed shipping plan, including supports, UV protection during transportation, and stacking sequence of units, if any, to the Agency for approval.

Any damage or suspected damage that occurs during storage or shipping shall be reported, investigated by means of nondestructive testing or other methods, and repaired by the Fabricator.

xx. ASSEMBLY. Any damage or suspected damage, as observed by the Engineer, that occurs during assembly shall be reported, investigated by means of nondestructive testing or other methods, and repaired by the Fabricator or Contractor.

(a) General. Pontoons shall be assembled in individual rafts on land, prior to launching in the Lake. The interface between adjacent pontoons shall be cleaned of debris, grease, and other laitance prior to assembly.

(b) Transverse Threaded Rods. Transverse threaded rods shall be tensioned to the magnitude noted in the Plans prior to launching the rafts in the Lake. Tensioning shall be performed using a calibrated torque wrench and corresponding torque tensioning chart. Protective end caps shall be installed at transverse rod anchor locations prior to launching the rafts in the Lake.

(c) Connections and Bolting. Bolts used in the field splice connection shall be tightened in accordance with the Plans. Bolts used to connect the timber deck panels to the FRP pontoons shall be tightened in accordance with the Plans. All bolts shall be fastened with two washers and a double nut.

xx. INSPECTION. Materials furnished and the work performed under these provisions shall be inspected by an Agency representative. The Agency representative will have the authority to reject any material or work that does not meet the requirements of these provisions. Advance notification of at least twenty-one (21) days shall be provided by the Fabricator to the Agency's Engineer indicating the fabrication start date.

Prior to shipment of any pontoons, the Agency's Engineer must have approved all applicable material certifications required in accordance with Subsection 700.02 and results of test requirements in accordance with these provisions.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Fiber Reinforced Polymer Pontoons) to be measured for payment will be on a lump sum basis in the complete and accepted work.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Fiber Reinforced Polymer Pontoons) will be paid for at the Contract lump sum price. Payment will be full compensation for designing, detailing, testing, fabricating, repairing, transporting, storing, handling, and placing the materials specified, including transverse rods and hardware and protective caps, steel field splice plates and hardware, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Hardware and labor necessary for drilling and installing hardware used to attach the nail laminated timber deck panels shall be paid separately.

When Working Design Calculations, Test Sample Documentation, Working Drawings, and Quality Control documents have been submitted and approved in accordance with Section 105 and these provisions, a payment of 10 percent of the lump sum price will be allowed. When the fiber reinforced polymer pontoons have been fabricated and approved for shipment, a further payment of 75 percent of the lump sum price will be allowed. An additional 10 percent of the lump sum price will be paid when the Fiber Reinforced Polymer Pontoons are accepted in place and remaining project efforts are approved to commence. The remaining 5 percent of the lump sum price will be paid after Substantial Completion of the project has been issued.

Payment will be made under:

Pay Item	Pay Unit
900.645 Special Provision (Fiber Reinforced Polymer Pontoons)	Lump Sum