

SECTION 03490
GLASS FIBER REINFORCED CONCRETE (GFRC)

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work in this section is subject to requirements of the contract documents including the General Conditions, Supplementary Conditions, and applicable portions of Divisions 0 and 1.
- B. GFRC panel fabrication shall include all labor, materials, equipment, and related services necessary to manufacture and deliver the panels as indicated and described by the contract documents, including the following:
 - 1. GFRC composite panels produced by the spray-up process, including integral metal stud frame.
 - 2. Shop drawings and engineering calculations for panels, stud frame, and attachments to building structure.
 - 3. Provide loose connection hardware, and hardware for embedment in cast-in-place concrete, as indicated or required for panel attachment to building structure.
- C. GFRC panel erection shall include all labor, materials, equipment, and related services necessary for the erection of the panels as indicated and described by the contract documents, including the following:
 - 1. Attaching all loose connection hardware between panel frames and building structural frame.
 - 2. Installation of mockup (if required).
- D. The placement of the hardware in cast-in-place concrete will be the responsibility of that contractor placing the cast-in-place concrete.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Architectural Precast Concrete: Section _____
- B. Cast-In-Place Concrete: Section _____
- C. Structural Steel Framing: Section _____
- D. Metal Fabrications: Section _____

- E. Painting or Coatings: Section _____
- F. Insulation and Firesafing: Section _____
- G. Flashing and Sheet Metal: Section _____
- H. Sealants and Caulking: Section _____
- I. Glazing and Window work (including blocking and nailers for same): Section _____

1.3 REFERENCE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced.
 - 1. Precast/Prestressed Concrete Institute MNL-128: "Recommended Practice for Glass Fiber Reinforced Concrete Panels."
 - 2. Precast/Prestressed Concrete Institute MNL-130-91: "Manual for Quality Control for Plants and production of Glass Fiber Reinforced Concrete Products."

1.4 REFERENCES

- A. ASTM A 27-85 Steel Castings, Carbon, for General Applications
- B. ASTM A 153-82 Zinc Coating (hot dip) on Iron or Steel Hardware
- C. ASTM C 150-85a Portland Cement
- D. ASTM C 260-86 Air-Entraining Admixtures for Concrete
- E. ASTM C 494-86 Chemical Admixtures for Concrete
- F. ASTM C 144 Sand
- G. ASTM C 979 Concrete Pigment
- H. ASTM C 33 Aggregate

1.5 QUALITY ASSURANCE

Aggregate

- A. Design Responsibility: Design of GFRC skin, metal frame, and connections shall be by a registered professional engineer employed or retained by the panel manufacturer and licensed to practice in state of project, using property data generated from manufacturer's actual production. Comply with procedures in Prestressed Concrete Institute's MNL-128 and MNL-130. Panels shall be designed to meet all applicable local and state building codes.
- B. Manufacturer Qualifications

1. Manufacturer shall have been engaged in uninterrupted production of GFRC projects involving the use of panelized GFRC of the quality and scope required for this project for a minimum of five years.
 2. The GFRC manufacturing plant shall be certified by the Precast/Prestressed Concrete Institute as Category "G" prior to bid date.
- C. Acceptable Manufacturers: GFRC 360, LLC. 118 N. Shiloh Road, Garland, Texas 75042, Phone: 972-494-9000.
- D. Alternate Manufacturers: Panels produced by other fabricators may be considered as prior-approved equal panels under the provisions of Section 1600 "Products."
- E. Erector Qualifications: Regularly engaged for a minimum of four years in the installation of GFRC or architectural precast concrete panels similar to those required on this project, and shall have the present erection management capability sufficient to install the required units without causing a delay of the project.
- F. Welder Qualifications: In accordance with AWS D1.1 and AWS D1.3, certified within the last year.
- G. Testing: In accordance with PCI MNL-128, and MNL-130, including the following:
1. Glass content by "wash-out" test
 2. Flexural yield strength
 3. Flexural ultimate strength
 4. Flex anchor/gravity anchor strength
 5. Slurry unit weight test
 6. Slurry slump test
 7. Aggregate gradation testing
- H. Tolerances: Manufacture and install GFRC panels so that tolerances for dimensions and appearance shall be as indicated in PCI MNL-128 and MNL-130.
- I. Records: Keep quality control records available for two years after final acceptance.

1.6 SUBMITTALS

- A. Shop Drawings: Manufacturer of panels shall receive all applicable drawings and specifications including structural, mechanical and related trades. Manufacturer of panels shall submit for approval complete erection drawings showing:
1. Unit shapes (elevations and sections) and dimensions

2. Thickness of facing and GFRC backing
3. Finishes
4. Steel stud frame details
5. Joint and connection details
6. Lifting and erection details
7. Location and details of hardware attached to structure
8. Size, location and details of flex and gravity anchors
9. Other items sprayed in panels
10. Handling procedures
11. Sequence of erection for special conditions
12. Relationship to adjacent material
13. Description of all loose, cast-in, and field hardware
14. Shop drawings shall be submitted in one copy sepia set. Show location of units on shop drawings by same identification marks placed on panels. Manufacturer shall not proceed with fabrication of any panels prior to receiving approval of erection drawings by the architect.

B. Samples

1. Prior to commencement of manufacture, submit samples representative of finished face showing typical range of color and texture.
2. Sample size shall be approximately 12 inches x 12 inches and of appropriate thickness, representative of the proposed finished product.

C. Mix Designs: Submit on request all backup and face mix designs.

D. Engineering Calculations: Submit complete design calculations prepared and sealed by a registered engineer for typical panels including:

1. Loads used in design
2. GFRC Skin design
3. Metal stud frame design
4. Connection hardware design
5. Backup Data: Submit on request, test data on which GFRC design is based and data on GFRC insert and anchor tests.

E. Test Reports: Submit on request 3 copies of all test reports required in section 1.56.

F. Welders Certificates: Submit certification that welders to be employed in work have passed AWS qualification tests within previous 12 months.

- G. Certification of Materials: Submit upon request, certificates of compliance with ASTM standards of all raw materials, including:
1. Aggregates
 2. Admixtures
 3. Fiberglass Reinforcement
 4. Cement
 5. Metal framing components
 6. Connection Hardware
- H. Repair and Cleaning: Submit procedure and patch mix design for repairing and/or cleaning panels.
- I. Mock-up: Prior to installation of the work of this section, erect a sample at location directed by or acceptable to the architect, using specified materials and illustrating range of color, texture and workmanship to be expected in the completed work. Once mock-up has been approved by the architect, retain until the work has been completed and accepted.
1. Configuration: Two full size mock up panels – one to be retained at the plant and one to be retained on the jobsite. The exact panel to be selected by architect.
 2. Mock-up may not be incorporated into the final work; demolish and remove from site when directed by the architect.

1.7 WARRANTY/GUARANTEE

- A. The GFRC contractor shall furnish a written warranty against defects in materials or workmanship for a period of one (1) year after substantial completion of project.

PART 2 - PRODUCTS

2.1 GFRC MATERIALS

- A. Cement: Type I, White Portland Cement of one type, brand, source and lot throughout project, meeting requirements of ASTM C150.
- B. Sand: Fine, clean, dry sand, able to pass a no. 16 sieve, free of contaminants and meeting ASTM C144.
- C. Water: Fresh, clean, potable and free of any deleterious matter that would interfere with color, setting or strength of concrete.

- D. Glass Fibers: High zirconia content (minimum 16%), alkali resistant glass fibers specifically designed for use in concrete. Use 4½% to 6% by weight in GFRC mix design.
- E. Concrete Pigment: Harmless to concrete, sunlight-fast, alkali resistant, conforming to ASTM C979.
- F. Aggregate (if used): Clean, hard, strong, durable, inert and free of deleterious material, conforming to ASTM C33 except for gradation. Size to be less than ½" diameter.
- G. Acrylic Thermoplastic Copolymer: Conforming to the specifications in Appendix F of the Prestressed Concrete Institute MNL-128.
- H. Admixtures: Conforming to ASTM C260 for air entrainment, ASTM C494 for chemical admixtures, and ASTM C618 for fly ash or natural pozzolan admixtures. Do not use admixtures that contain more than .1% chlorid ions.

2.2 STEEL FRAMING MATERIALS

Steel frame system shall be a welded prefabricated frame produced in accordance with approved shop drawings, fabricated to meet design loads, wind loads, handling and erection loads.

A. Metal Studs and Track:

1. Galvanized steel, conforming to ASTM A446.
2. Galvanized coating shall conform to ASTM A525 with a minimum G-60 coating.
3. Studs shall have a min. yield strength of 40 ksi.
4. Track shall have a min. yield strength of 30 ksi.
5. Members shall be 4" x 16 gauge and 6" x 16 gauge or as required per design calculations.
6. Studs shall be indexed and shall be spaced at approx. 24" on center.

B. Structural Tubing: Shall be formed from steel conforming to ASTM A500. Finish – Shop Prime painted

C. Flex Anchors: 3/8" or 1/4" diameter bent rod - ASTM A36, Fy-36 ksi minimum, electroplate galvanized.

D. Miscellaneous Steel (channels, angles, etc.): ASTM A36, Fy-36 ksi minimum, Fu-58 ksi, except tube shapes. Finish – Shop Prime painted

E. Reinforcing (deformed) Bars: ASTM A706 deformed billet steel bars, grade 60. Galvanized rebar to ASTM 767, class II, grade 40.

F. Headed Stud Embed Anchors: ASTM A108, Fy-50 ksi minimum, Fu-60 ksi minimum. Welded per TWR Nelson method.

G. Anchor Bolts: ASTM A307 or ASTM A325.

2.3 PRODUCT CHARACTERISTICS

A. Typical Mixes

1. Combine Portland cement, glass fibers, sand and selected admixtures in proper proportions to meet design requirements.
2. Provide glass content of no less than 4½% and no more than 6%.
3. Provide average yield strength of not less than 900 psi and average ultimate strength of not less than 2,500 psi.

B. Typical Range of GFRC Properties at 28 days:

- Ultimate Flexural Strength (psi) 2500-4000
- Yield Flexural Strength (psi) 900-1500
- Ultimate Tensile Strength (psi)..... 1000-1600
- Yield Tensile Strength (psi)..... 700-1000
- Compressive Strength (edgewise), (psi) 7000-12000
- Shear Strength (interlaminar), (psi) 400-800
- Shear Strength (in-plane), (psi)..... 1000-1600
- Coeff. of Thermal Expansion (in/°F x 10⁶)..... 6-9
- Thermal Conductivity (Btu/in/hr/ft²/°F)..... 3.5-7.0
- Modulus of Elasticity (10⁶ psi) 1.5-2.9

C. Facing Mix: Thickness shall generally be the minimum possible to achieve the desired finish.

D. GFRC Skin

1. Per skin design requirements. In no case shall the panel skin be less than ½" thick.
2. Backup mixes shall have same proportion of pigments as face mixes to eliminate the possibility of bleeding through of a different colored backup.

E. Coloring Agent: The amount of coloring agent shall not exceed 10% of the cement weight.

2.4 FABRICATION

A. Forms

1. Forms for GFRC panels shall be rigid and constructed of materials that will result in finished products conforming to the profiles, dimensions and tolerances indicated by the contract documents and on the approved shop drawings.
2. Release agents shall be applied and used according to manufacturer's instructions. Use release agent compatible with architectural finish and joint sealants.

B. Proportioning and Mixing

1. All measurements of mix constituents shall be carried out in a careful manner to achieve the desired mix proportions.
2. The glass fiber and cement slurry shall be metered to the spray head at rates to achieve the desired mix proportion and glass content. These shall be checked in accordance with standard procedures described in PCI MNL-130.
3. Cleanliness of equipment and working procedure shall be maintained at all times.

C. Hand Spray Application

1. Spray operators shall be trained personnel.
2. A mist coat consisting of the matrix without fiber may, if necessary, be sprayed onto the form. The thickness of this coating shall generally not exceed 1/16 in. in order to avoid an unreinforced surface.
3. Spray-up of the main body of material shall proceed before any mist coat or facing mix has set.
4. Application shall be by spraying such that uniform thickness and distribution of glass fiber and cement matrix is achieved during the application process.
5. Consolidation shall be by rolling or such other techniques as necessary to achieve complete encapsulation of fibers and compaction.
6. Control of thickness shall be achieved by using a pin gauge or other approved method. A minimum of one measurement per each 5 square feet of panel surface shall be made.
7. All hand-forming of intricate details, incorporation of formers or infill material, and over-spraying shall be carried out before the material has achieved its initial set so as to ensure complete bonding.

D. Inserts and Embedments

1. Inserts shall be properly embedded in built-up homogeneous GFRC bosses or bonding pads to develop their strength. Waste material such as over-spray is not acceptable to encapsulate inserts or for bonding pads.
2. Rigid embedded items bonded to the GFRC shall not create undesirable restraint to volume changes.

E. Steel Stud Frame System

1. Steel stud frame shall be a prefabricated welded frame produced in accordance with the approved erection drawings.
2. All accessible welds shall be touched up after welding.

F. Allowable Tolerances: Manufacture units so that each panel complies with the dimensional tolerances listed below. For dimensional tolerances not listed below, those listed in PCI MNL-130, shall apply.

Dimensional Tolerances of Finished Units:

1. Overall height and width of units measured at the face adjacent to the form:
 - (a) 10 ft or under..... $\pm 1/8''$
 - (b) 10 ft and over $\pm 1/8''$ per 10'
2. Thickness:
 - (a) Skin thickness: $\pm 1/4''$, -0''
 - (b) Architectural facing thickness: $\pm 1/8''$, -0''
 - (c) Side return thickness: $\pm 1/2''$, -0''
 - (d) Panel depth from face of skin to back of steel stud or integral rib: $\pm 3/8''$, -1/4''
3. Angular variation of plane of side mold: 1/32'' per 3'' depth or 1/16'' total, whichever is greater.
4. Variation from square or designated skew (difference in length of the two diagonal measurements): 1/8'' per 6' or 1/4'' total, whichever is greater.
5. Length and width of blockouts and openings within one unit: $\pm 1/4''$

Position Tolerances (measured from datum line locations as shown on the approved erection drawings):

1. Steel studs and tracks: $\pm 1/4''$

2. Flashing reglets, at edge of panel $\pm 1/4''$
 3. Reglets for glazing gaskets $\pm 1/8''$
- G. Finishes: Exposed face of panels to match approved sample on file in architect's office. Exposed face of panels shall be manufactured free from joint marks, "grain" or other obvious defects.
- H. Cover: Provide embedded anchors, inserts, and other sprayed-in items with sufficient anchorage and embedment for design requirements.
- I. Curing
1. Immediately after the completion of spraying of the panel, a curing method shall be used to ensure sufficient strength for removing the units from the form.
 2. After initial curing, remove panel from form and place in a controlled curing environment. Panels shall be kept continuously wet for a minimum of 7 days in accordance with manufacturer's standard curing practice. The temperature shall be maintained between 60° F and 120° F during this period. In lieu of moist curing, acrylic thermoplastic copolymer dispersion shall be used as a curing admixture. Only copolymers shown to eliminate the need for moist curing through published independent laboratory test data shall be used.
- J. Panel identification
1. Mark each GFRC panel to correspond to identification marks on shop drawings for panel location.
 2. Mark each GFRC panel with date cast.
- K. Acceptance: GFRC units which do not meet the color and texture range or the dimensional tolerances may be rejected at the option of the architect if they cannot be satisfactorily corrected.

PART 3 - EXECUTION

3.1 PRE-INSTALLATION/INSPECTION

- A. Preinstallation Conference: Prior to installation of work of this section, conduct a meeting at the project site to discuss quality assurance requirements. In addition to the contractor and the installer, arrange for attendance of the following:
1. Other installers affected by the work of this section
 2. The Owner's representative
 3. The architect

4. Manufacturer's representative
5. Supplier
6. Superintendent for the contractor

B. General Contractor's Responsibility

1. The general contractor shall provide building lines, center and grades in sufficient detail to allow installation of the GFRC units.
2. The General Contractor shall provide true, level load-bearing surfaces.
3. The general contractor shall provide for the accurate placement and alignment of anchor bolts, plates, dowels or other items embedded in the concrete structure or that are a part of the structural building frame.
4. Clear, well-drained unloading areas and road access around and in the building (where appropriate) shall be provided and maintained by the general contractor to a degree that hauling and erection equipment for the GFRC units are able to operate under their own power.
5. The general contractor shall provide adequate traffic control, barricades, warning lights or signs to safeguard traffic in the immediate area of hoisting and handling operations.

C. Erector Responsibility

1. Verify that all parts of the supporting structure are complete and ready to receive the panels and that site conditions are conducive to proper installation.
2. Prior to installation of the units, the erector shall check the jobsite dimensions affecting the work under his contract. Any discrepancies between design dimensions and field dimensions which could adversely affect installation shall be brought to the attention of the general contractor and architect.
3. If discrepancies exist, installation shall not proceed until they are corrected or until installation requirements are modified and reviewed by the architect and/or Engineer.

3.2 DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling

1. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses or damage.
2. Lift or support units only at the points shown on the erection shop drawings.

3. Place non-staining resilient spacers of even thickness between units.
4. Support units during shipment on non-staining shock-absorbing material.
5. Protect units from dirt and damage during handling and transport.

B. Storage at Jobsite:

1. Store units to protect them from contact with soil, staining and from physical damage.
2. Store units, unless otherwise specified, with non-staining, resilient supports located in same positions as when transported.
3. Store units on firm, level and smooth surface.
4. Place stored units so that identification marks are easily readable.

3.3 INSTALLATION OF PANELS

Only competent workmen who are properly instructed to handle and erect GFRC shall be employed.

A. Setting

1. GFRC units shall be lifted with suitable lifting devices at points provided by the manufacturer.
2. GFRC units shall be set level, plumb, square and true within allowable tolerances.
3. Panel-to-panel joints shall be a minimum of 1/2".

B. Supports and Bracing

The erector shall provide temporary supports and bracing as required to maintain position, stability and alignment as units are being connected.

C. Fastening

1. Fasten GFRC units in place by bolting or welding or both as shown on the approved erection drawings.
2. Field welding shall be done by qualified welders using equipment and materials compatible to the base material.
3. Shall be completely free and independent of adjacent materials.

- D. Tolerances of Erected Units: Tolerances for location of GFRC units shall be non-cumulative and as listed below. For erection tolerances not listed below, those listed in PCI MNL-130 shall apply.

Tolerance for Face Width of Joint:

Panel dimension 10 ft. or less	± 3/16”
Panel dimension 10 to 20 ft.	± 1/4”
Panel dimension greater than 20 ft.....	± 5/16”

- E. Warpage: Maximum permissible warpage of one corner out of the plane of the other three shall be 1/16" per foot distance from the nearest adjacent corner, or 1/4" total after installation.
- F. Bowing: Not over L/360 with a maximum of 1", where L is the panel length in the direction of the bow. Differential bowing as erected between adjacent members of the same design shall be 1/4".

3.4 PATCHING

- A. Method: Mix and place patch mixture to match color and texture of surrounding concrete. If patching is not possible or if unacceptable to architect, GFRC unit is to be replaced.
- B. Structural Adequacy: Patching will be permitted provided structural adequacy of the unit is not impaired.
- C. Damage: Damage caused by other trades that requires replacement or patching shall be performed by the GFRC manufacturer and paid for by others after written authorization to perform said work.

3.5 CLEANING

- A. Cleaning methods shall be approved by fabricator.
- B. After installation, the manufacturer shall clean any soiled GFRC surfaces with detergent and water, using fiber brush and sponge, and rinse thoroughly with clean water.
- C. Use extreme care to prevent damage to GFRC surfaces and to adjacent materials.
- D. Soiled surfaces must be thoroughly rinsed with clean water immediately after using cleaner.

3.6 PROTECTION OF WORK

- A. The erector shall be responsible for protection of the panels from damage by the erection crews, field welding or cutting operations by providing non-combustible shields as necessary during these operations.
- B. The erector shall be responsible for any chipping, spalling, cracking or other damage to the units after delivery to the jobsite unless damage is caused by others during site storage.
- C. After installation is complete and after any damaged or soiled panels have been cleaned, repaired, inspected and approved, further damage is the responsibility of the general contractor.

3.7 INSPECTION AND ACCEPTANCE

- A. Acceptance: Final inspection and acceptance of erected GFRC panels shall be made by the architect to verify conformance with plans and specifications.
- B. Rejection: Panels may be rejected for any one of the following product defects or installation deficiencies remaining after repairs and cleaning have been accomplished. "Visible" means visible to a person with normal eyesight when viewed from a distance of 20 feet in broad daylight.
 - 1. Nonconformance to specified tolerances
 - 2. Air voids (bug-holes or blowholes) larger than 3/8" (10 mm) in diameter
 - 3. Visible casting lines
 - 4. Visible form joints
 - 5. Visible irregularities
 - 6. Visible stains on panel surface
 - 7. Visible differences between panel and approved sample
 - 8. Visible non-uniformity of textures or color
 - 9. Visible areas of backup concrete bleeding through the facing concrete
 - 10. Visible foreign material embedded in the face
 - 11. Visible repairs or cracks
 - 12. Visible reinforcement shadow lines

***** END OF SECTION *****

**SECTION 01600
PRODUCTS**

The General Conditions, Supplementary General Conditions, and Divisions 1 and 0 are hereby made a part of this section as applicable.

1. GENERAL

1.01 BIDS-GENERAL: The bid as identified in the Proposal submitted by each Bidder shall be submitted in accordance with the requirements and definitions as set forth below.

1.02 PROPRIETARY SPECIFICATIONS: In those instances where only one acceptable manufacturer/product is named, the bid shall be based on that product.

1.03 SEMI-PROPRIETARY SPECIFICATIONS

A. Prior-Approved Equals (Submitted PRIOR to Receipt of Bids)

1. Where the phrase "prior-approved equal" is used in reference to alternate manufacturers/products, it shall be construed to mean a product approved for use on this project by the architect prior to the receipt of bids. Such products shall be, in the sole judgment of the architect, equivalent to those specified in quality and utility, similar in dimensional and utility requirements, shall not involve additional cost to the owner to accommodate them, and shall not materially alter basic architectural design concepts. Complete supportive data for claims of equality shall be submitted to the architect as required for comparison. Otherwise no review will be conducted. Supportive data shall include but not be limited to the system or material construction/composition, thickness, weight, texture/color sample, warranty.
2. All substitution requests and requests for use of "prior approved equals" must be received by the Architect at least FOURTEEN (14) days prior to bid opening. If not approved by the Architect, a second submittal must be received by the Architect at least TEN (10) days prior to bid opening.

B. Approved Equals (submitted AFTER receipt of bids)

1. Where the phrase "approved equal" is used in reference to alternate manufacturer/products, the bid shall be based on the acceptable manufacturer/product or on any one of the referenced alternate manufacturer's products, providing sufficient information regarding equivalency is submitted for review. Unlisted manufacturer/products will not be reviewed.
2. Where the phrase "or approved equal" follows reference to a specific acceptable manufacturer/product, the bid shall be based on the acceptable

manufacturer/product or any equivalent manufacturer/product, providing sufficient information regarding equivalency is submitted for review.

3. Responsibility for submitting adequate supportive information for each "or approved equal" product shall fall on the Contractor. The architect shall evaluate the equivalency of such products with regard to quality, performance, appropriateness and appearance.

1.04 NON-PROPRIETARY SPECIFICATIONS: Where items are specified by a standard of performance, without reference to a specific manufacturer, the bid may be based on the product of any reputable manufacturer meeting, in all respects, the standards of performance specified.

1.05 STANDARDS OF DESIGN AND WORKMANSHIP

- A. The finished work shall be complete in all respects and shall fully conform to the description thereof set forth in the drawings, specifications, and the contract. The standard specifications of any named manufacturer or product are hereby implicitly included in this specification by reference.
- B. The intent of the Specifications is to obtain for the owner first class work in all respects. All components shall be manufactured, fabricated, assembled, and finished with workmanship of the highest quality throughout and in accordance with the best recognized practice. All materials shall be new and suitable for the conditions specified.
- C. Except for equipment and/or material which is normally manufactured only to meet specific requirements, it is the intention of the Architect that all equipment and or material to be furnished hereunder shall be essentially the standard products of manufacturers regularly engaged in their production, and shall be of the type, size, and capacities, and for the kinds of services specified. If the manufacturer's standard equipment does not meet the terms of the Specifications, the Contractor shall so state in his proposal and quote prices on the basis of a suggested suitable alternative.

1.06 SUBSTITUTES

- A. If, in the opinion of the Contractor, a more satisfactory result can be obtained or a finished project of higher quality be insured while reducing the total cost of the work to the owner, by the substitution of material or equipment not specified for that specified, he may recommend such a substitution to the Architect and owner in writing and submit it together with all the required supportive data upon including an itemized listing of all deviations from the characteristics of the specified material or equipment upon which his opinion is based.
- B. Request constitutes a representation that Contractor:

1. Has investigated proposed product and determined that it meets or exceeds, in all respects, specified product.
 2. Will provide the same warranty for substitution as for specified product.
 3. Will coordinate installation and make other changes which may be required for Work to be complete in all respects
 4. Waives claims for additional costs or time which may subsequently become apparent.
- C. The architect and owner will review the request for substitution on the following basis:
1. The architectural and engineering costs of such a review will be separately recorded. The Contractor shall credit the owner with the sum of these costs, for payment to the Architect whether or not the suggested substitution is approved. If the substitution is approved, the Contractor may deduct the sum of the credit for these Costs from the total credit to the owner accruing from the substitution.
 2. If a substitution requires extensive revision of the Contract Documents, the Contractor shall credit the owner with the costs of such revisions for payment to the Architect.
 3. Cost as referred to herein shall be defined as the Architect's direct personnel expense with proportionate benefits, and all reimbursable expenses, including travel (both transportation and living expenses and reproduction, postage and handling of the Contract Documents.
- D. Substitutions will not be considered when they are indicated or implied on shop drawings or product data submittals without separate prior written request.
- E. Requests for time extensions will NOT be approved for delays due to rejected substitutions.
- F. The Architect and owner may, at their discretion, waive any of the requirements of this paragraph in the best interest of the owner and the project.

****END OF SECTION ****