UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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SECTION 35 20 15

FRP COMPOSITES FOR LOW-HEAD WATER CONTROL STRUCTURES
08/18, CHG 1: 08/20

NOTE: This guide specification covers design-build gates and stop logs or boards made from fiber reinforced polymer (FRP) composite materials for use in low-head water control structures and weirs. Structures covered by this specification are to have a maximum static hydraulic head of 6.1 meters20 feet, accounting for overflow, a maximum height of 3.7 meters12 feet and a maximum width of 3.7 meters12 feet. This guide specification is not applicable if catastrophic failure of the water control structure would create a life safety risk as per ER 1110-2-1156. This specification covers the performance requirements for composite gates and stop logs or boards as well as appurtenant components such as seals, guide frames, anchors and fasteners.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

Units of work normally included should be FRP items which require specific fabrication to meet the desired project requirements.

PART 1 GENERAL

****

NOTE: The scope section may be edited by the User as needed. However, the maximum design head and maximum width must not be increased.

****

1.1 SCOPE

This guide specification covers low-head FRP water control structures, such as gates, valves or stoplogs, and any appurtenant features defined in the Contract Drawings that have a maximum static hydraulic head of 6.1 meters20 feet, accounting for overflow, a maximum height of 3.7 meters12 feet and a maximum width of 3.7 meters12 feet.

1.2 UNIT PRICES

Payment must constitute full compensation for furnishing all plant, labor, materials and equipment and performing all operations necessary for fabricating and installing the [Stoplogs] [Vertical Lift Gate] [_____] as specified.

1.2.1 Unit of Measure

Unit of measure: lump sum.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN COMPOSITES MANUFACTURER'S ASSOCIATION (ACMA)

ACMA Code	(2011) Code of Standard Practice: Industry Guidelines for Fabrication and Installation of Pultruded FRP Structures

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.2	(2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C563	(2014) Fabricated Composite Slide Gates

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A193/A193M	(2020) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A276/A276M	(2017) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A320/A320M	(2017b) Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A709/A709M	(2018) Standard Specification for Structural Steel for Bridges
ASTM A992/A992M	(2020) Standard Specification for Structural Steel Shapes
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B308/B308M	(2010; R 2020) Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D572	(2004; R 2019) Rubber Deterioration by Heat and Oxygen
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1894	(2014) Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2563	(2008) Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
ASTM D3917	(2015a) Standard Specification for Dimensional Tolerance of Thermosetting Glass-Reinforced Plastic Pultruded Shapes
ASTM D4020	(2011) Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials
ASTM D4329	(2013) Standard Practice for Fluorescent UV Exposure of Plastics
ASTM D4385	(2010) Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products
ASTM E488/E488M	(2015) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
ASTM F436/F436M	(2019) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F844	(2007a; R 2013) Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	(2018) Standard Specification for Anchor

	Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
ASTM G154	(2016) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC S348	(2014; Errata 2015) RCSC Specification for Structural Joints Using High-strength Bolts

1.4 DEFINITIONS

1.4.1 Design Head

The maximum differential head that will actually be applied to the gate (from AWWA C563).

1.4.2 Failure Critical Member

Any member for which failure would cause collapse, partial collapse or loss of functionality of the structure.

1.4.3 Fracture Critical Member

A steel member (or component thereof) that is in tension and whose failure would result in collapse or partial collapse of the structure

1.4.4 FRP Composites

A Fiber Reinforced Polymer (FRP) member composed of fibers and resin systems, including fillers and additives. These members are manufactured via pultrusion, filament winding, vacuum infusion, hand lay-up or other methods and may contain foam or wooden cores, metal frame members, other previously produced FRP composites or other materials. This includes structural shapes, sandwich panels, boards, or other members made of FRP.

1.4.5 Low-Head Water Control Structure

A gate, valve or stoplog structure with a maximum design head of 6.1 meters 20 feet, a maximum height of 3.7 meters12 feet, and a maximum width of 3.7 meters12 feet.

1.4.6 Stoplog

Horizontal members placed on top of each other fitting into a frame, groove or channel on each side channel in the water control structure.

1.4.7 Vertical Lift Gate

A gate that opens upward to allow water to flow under the gate. Vertical lift gates may also be referred to as sluice gates or slide gates.

1.4.8 Weir Dam

A dam to control water level by flowing water over the top of the structure; may include a control mechanism made of stoplogs or movable gates.

1.5 SEQUENCING AND SCHEDULING

Before the work is commenced, submit the approved sequencing and scheduling plan which illustrates that work affecting [railroads] [roadways] [utilities] [appurtenances][_____] has been coordinated with [_____]. The plan must include schedules, lists of labor or materials to be provided to the affected [company] [agency], and any other aspects of the work that may impact on the operations of these entities. The plan must clearly demonstrate how all [railroad tracks] [public or private roads, streets, or highways] [appurtenances] will be kept open to traffic at all times during the construction period, except as otherwise specified or directed or approved.

1.6 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Additional submittal requirements may be added by

the User as needed.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor, Manufacturer, and Engineer Qualifications; G[, [_____]]

Sequencing and Scheduling Plan; G[, [_____]]

Quality Control Plan

SD-02 Shop Drawings

Detail Drawings; G[, [_____]]

SD-03 Product Data

[Slide Gate][Stop Log] Technical Data Sheet; G[, [_____]]

Materials variances G[, [_____]]

SD-05 Design Data

Design Documentation; G[, [_____]]

SD-06 Test Reports

Test Reports; G[, [_____]]

Include test reports to verify all material properties used in design following ASTM or other specification bodies where possible.

SD-07 Certificates

Date and type of manufacture including constituent materials; G[, [_____]]

FRP Composites ; G[, [_____]]

Certification of State Product Approval; G[, [_____]]

Anchorage System; G[, [_____]]

SD-08 Manufacturer's Instructions

Shipping, Handling, Storage, Installation Procedures; G[, [_____]]

SD-09 Manufacturer's Field Reports

Certification of Installation; G[, [_____]]

Field Leakage Test; G[, [_____]]

SD-10 Operation and Maintenance Data

Care and Maintenance Instructions; G[, [_____]]

SD-11 Closeout Submittals

Warranty ; G[, [_____]]

Operation and Maintenance Manual; G[, [_____]]

Data Book; G[, [_____]]

1.7 MAINTENANCE MATERIAL SUBMITTALS

1.7.1 Spare Parts

****

NOTE: Include a list of all spare parts required. This information should be provided on the contract drawings.

****

[_____]

1.8 QUALITY CONTROL

1.8.1 General

The Contractor is responsible for quality control and must establish and maintain an effective quality control system [in accordance with Contract Clauses 52.236-6 SUPERINTENDENCE BY THE CONTRACTOR and 52.236-5 MATERIAL AND WORKMANSHIP and with SECTION H, SPECIAL CONTRACT REQUIREMENTS]. The quality control system must consist of plans, procedures, and organization necessary to produce an end product which complies with the requirements of this contract. The system must cover all design, fabrication, painting, and delivery operations. The Contractor must submit a written Contractor quality control plan for approval.

1.8.2 Regulatory Requirements

****

NOTE: Include all regulatory information.

****

[_____]

1.8.3 Contractor, Manufacturer, and Engineer Qualifications

****

NOTE: If an engineer of record is close to the minimum or if the user has concerns about the nature and extent of the engineer's experience, the user may request a record of specific projects performed by the engineer in order to ensure the engineer

possesses adequate qualifications to perform the proposed work.
****

Provide documentation from manufacturer having a minimum of [five][_____] years' experience in the manufacture of similar products and systems. Additionally, if requested, provide a record of at least [five][_____] previous, separate, similar successful installations in the last [five][_____] years. Submit Manufacturer's catalog data to include two copies of specifications, load tables, dimension diagrams, and anchor details for the following low-head water control structures and components.

Provide documentation from Engineer of Record having a minimum of [five] [_____] years' experience in the design of [five] [_____] similar products and systems and copy of current license. Additionally, if requested, provide a record of at least [five][_____] previous, separate, similar successful installations in the last [five][_____] years.

1.9 DELIVERY, STORAGE, AND HANDLING

1.9.1 General

Submit recommendations for shipping, handling, storage, installation procedures, and care and maintenance instructions. Deliver manufactured materials in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Ensure all related adhesives, resins and their catalysts and hardeners are crated or boxed separately, and noted as such to facilitate their movement to a dry indoor storage facility under controlled temperature and humidity.

1.9.2 Handling and Storage

Handle all materials to prevent abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Store adhesives, resins and their catalysts in dry indoor storage facilities following MDS requirements.

1.10 PROJECT/SITE CONDITIONS

1.10.1 Design Parameters

****
NOTE: This information is to be provided by the user. The items suggested below are not necessarily all inclusive nor will all be necessary in all situations. User to edit this section as appropriate to include all relevant site conditions for the project and should be included with the scope of work or contract drawing documents.
****

****
NOTE: Provide information on the following items: type of water control structure; height and width of opening; design head (including operating head); bearing conditions (embedded metals condition and layout); type of actuator preferred to operate gate; type of frame (conventional, self-contained thrust reaction) and installation (surface mounted,

in-channel wall mounted, embedded in wall, etc.); frequency of operation; debris and ice loads; corrosive, acidic or alkaline water conditions; operational limits (lifting, handling, etc.); and other items listed in AWWA C563.
****

[_____]

1.11 WARRANTY

****
NOTE: Designated appurtenances of the gate assembly may be guaranteed for a minimum period of 1 year from the date of acceptance thereof, either for beneficial use or final acceptance, whichever is earlier, against defective materials and workmanship. Such guarantees will require the Contractor to furnish and install new replacement parts immediately upon receipt of notice from the Government of the failure of any part of the guaranteed items during the warranty period. These warranty requirements will be covered in the CONTRACT CLAUSES and this paragraph should be deleted from this section of the specifications.
****

Furnish manufacturer's no-dollar-limit warranty for the FRP composite low-head water control structure or components. The warranty period is to be no less than [1] [5][10][15][20] years from the date of acceptance of the work and be issued directly to the Government. The warranty must provide that, if within the warranty period, the composite low-head water control structure or components show evidence of deterioration resulting from defective materials and/or workmanship, correcting of any defects is the responsibility of the manufacturer. Repairs that become necessary because of defective materials and workmanship while the composite low-head water control structure or components are under warranty are to be performed within [32][_____] hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within [32][_____] hours of notification will constitute grounds for having emergency repairs performed by others and will not void the warranty.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****
NOTE: This section should be modified to account for the specific type of water control structure. The materials listed are suggestions showing most commonly used for such structures. Unsuitable materials for a particular application can be removed. Specify similar metals or provide dielectric insulators as necessary.
****

Provide [vertical lift gate] [stop logs] [_____] composed of fiber reinforced polymer composites [and embedded metal frame] in qualities,

quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified on the contract drawings and specifications.

Provide reinforcement in the form of glass or carbon fibers, mats, or fabrics to meet the design requirements and dimensions as specified. Select the reinforcement format for failure critical FRP components according to the mechanical requirements of the application and the geometry/shape of the part. Confirm selected reinforcements are compatible with selected resin matrix system to ensure proper adhesion/load transfer and long-term performance of the component in its intended physical-chemical environment of use. Ensure all surfaces of FRP composite items and fabrications are smooth, resin-rich, free of voids, and without dry spots, cracks, and un-reinforced areas as per quality requirements herein. Ensure all reinforcing fibers are completely covered during manufacturing with resin to a depth of 0.25 to 0.51 mm 0.01 to 0.02 inches to protect against their exposure to wear, water immersion, or weathering. Seal over fasteners that penetrate the FRP skin, end cuts, and penetrations in a way that prevents delamination and water ingress. Use mechanical fasteners or mechanical plus adhesive for built up FRP members connected in tension after manufacturing. Provide documentation showing core materials are resistant to decay and attack by fungus and bacteria.

Embedded frames made of [FRP] [galvanized steel] [T-[_____] stainless steel] [aluminum] may be used to provide added stiffness to meet the specified requirements, but must be submitted to the Contracting Officer or their approved representative for approval and have a minimum of 1/4 inch thick FRP on each side. [Metal frames made of [galvanized steel][T-[_____] stainless steel] [aluminum] must meet ASME/ASTM standards, be fully encapsulated in the FRP structure, and design submittals must account for the potential for the FRP to delaminate from the frame][Metal frames must be detailed to prevent galvanic corrosion if carbon is used in FRP]. Specification section [_____] must be referenced when embedded metals are used in conjunction with the composite structure. Provide anchored guide frames made of [carbon steel] [T-[_____] stainless steel] [FRP] [aluminum] [or approved material] that attach into the sidewalls of the water control structure. [Galvanize or epoxy coat carbon steel frames as per AWWA C563.] Provide anchors which match the frame material and provide dielectric insulators to secure the guide frame into the surrounding water control structure. As necessary, coat anchors to inhibit corrosion.

2.1.1 Design Requirements

****

NOTE: A factor of safety of 5 is suggested based on the typical response of FRP composites under sustained loads. This can be adjusted based on the site conditions of the structure and the associated risks. The design life is the same as HSS, but it should be noted that FRP composites do not have the performance data needed to calibrate design codes. Thus, the determination of the parameters that affect the design life would be based on the judgment of the designer of record.

****

The water control structure must be designed in accordance with this specification to achieve the objectives of constructability, safety, serviceability, with due regard to issues of inspectability, and economy. The structural system must be proportioned and detailed to ensure the development of significant and visible inelastic deformations at the strength and extreme event limit states before failure. Load-path redundant structures should be used unless there are compelling reasons to not do so.

Submit design documentation showing the water control structure is capable of meeting a factor of safety of [5] [_____] defined as the ratio of ultimate stress to the working or allowable stress using allowable stress design prior to commencement of work. Maximum sustained stress cannot exceed one-fifth of failure stress and account for creep and the effects of water adsorption. Design life should be assumed to be [100] [_____] years assuming routine inspection and maintenance. All design computations are to be stamped by a registered professional engineer who will be identified as the Engineer of Record. All design computations must also be initialed by an additional registered professional engineer who will be identified in the design documents as having provided design quality control. See paragraph 3.5.2 "Data Book" for additional requirements."

2.1.1.1 Mechanical Anchorage

Mechanical anchorage system to be designed to meet the load requirements as outlined in ASCE 7-16 and paragraph 1.10.1 Design Parameters. Anchorage calculations are stamped by a Registered Professional Engineer. Expansion anchors are not permitted.

2.1.2 Performance Requirements

****

NOTE: Delete columns as appropriate based on gate type. Leakage requirements should only be included for instances where leakage is considered a critical issue. Leakage tests can be performed in the shop or in the field, though testing may not be practical based on the size and head on the gate.

****

Submit documentation including [Slide Gate][Stop Log] Technical Data Sheet showing the full gate system is capable of meeting the following performance requirements prior to commencement of work.

Test	Vertical Lift Gates	Stoplogs
[Leakage (AWWA C563)]	[Less than 1.3 lpm/m 0.1 gpm/ft of seating perimeter]	[Less than 0.62 lpm/m 0.05 gpm/ft of seating perimeter]
Gate Deflection	Less than 1/720 of the gate width at maximum head water	Less than 1/360 of the gate width, max of 6.4 mm 1/4 inch at maximum head water

Test	Vertical Lift Gates	Stoplogs
Yoke Deflection	Less than 1/360 of the gate width, max 6.4 mm 1/4 inch at maximum head water	[not applicable]

2.2 MANUFACTURED UNITS

Miscellaneous materials and standard articles must conform to the respective standards or specifications below when that type of material is furnished. Where material requirements are not specified, materials furnished must be suitable for the intended use and are subject to approval. Submit date and type of manufacture including constituent materials. Submit materials variances for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.1 Bolts, Nuts and Washers

Provide bolts, nuts, and washers of the material, grade, type, class, style and finish indicted or best suited for the intended use.

2.2.1.1 Bolts

Where the use of high strength bolts is required, the materials, workmanship, and installation must conform to the applicable provisions of ASTM F3125/F3125M and RCSC S348. Bolts for low-temperature applications must conform to ASTM A320/A320M. Bolts for non-high strength applications must conform to the applicable provisions of ASTM A307, Grade A.

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.1.2 Nuts

All nuts to be used with high strength bolts must conform to ASTM A563 and ASME B18.2.2

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.1.3 Washers

All nuts must be equipped with washers. Washers to be used with high strength bolts must conform to ASTM F436/F436M. Plain washers must conform to ASME B18.22M or ASME B18.21.1, Type B as applicable. Lock washers must conform to ASME B18.21.1.

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.2 Anchorage

****

NOTE: For most jobs, ASTM F1554 248 MPa 36 ksi anchor bolts are used. If high tensile loads are anticipated, the designer should consider the use of 379 MPa 55 ksi or 724 MPa 105 ksi ASTM F1554 anchor bolts. If stainless steel is considered, the designer should select from material in ASTM A193/A193M.

****

2.2.2.1 Anchor Rods

ASTM F1554 [Stainless steel Gr 36 [55] [105], Class 1A [2A]. ASTM A193/A193M.]

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.2.2 Anchor Nuts

ASTM A563, Grade A, hex style. [Stainless steel ASTM A193/A193M.]

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.2.3 Anchor Washers

ASTM F844. [Stainless steel [Type 304][Type 316] conforming to ASTM A276/A276M.]

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.2.4 Anchor Plate Washers

ASTM A36/A36M [Stainless steel [Type 304][Type 316] conforming to ASTM A276/A276M.]

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.2.5 [Sleeve Anchors][Adhesive Anchors]

Provide [_____] mm [_____] inch diameter [sleeve anchors][adhesive anchors]. Minimum concrete embedment must be [_____] mm [_____] in. Design values listed must be as tested according to ASTM E488/E488M.

a. Minimum [ultimate][allowable] pullout value: [_____] kN [_____] lb.

b. Minimum [ultimate][allowable] shear value: [_____] kN [_____] lb.

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.3 EQUIPMENT

[Provide [manual] [powered] actuators to lift the gate as per AWWA C563]. [Provide lifting beams and storage racks for stop logs.]

2.4 MATERIALS

Miscellaneous materials and standard articles must conform to the respective standards or specifications below when that type of material is furnished. Where material requirements are not specified, materials furnished must be suitable for the intended use and are subject to approval. Submit materials variances for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.4.1 FRP Composites

****

NOTE: A wide range of strength properties for FRP composites are possible and depend on the fiber volume fraction, resin type, cross section, and manufacturing method. There is no need to specify a minimum design strength, as the manufacturer must design the low-head water control structure to meet the specified requirement. A manufacturer could use a weak material in bulk, or smaller quantities of a much stronger material. The key for the government is to ensure that the strength of the supplied FRP composite meets or exceeds the design values.

For reference, pultruded FRP composite structural shapes often have tensile, compressive and flexural strength design values at ultimate around 207 Mpa 30 ksi and tensile modulus around 17.2 Kpa 2.5 Msi in the lengthwise direction. Pultruded plates range from one half to two thirds of these values. FRP rods and bars are often two to three times stronger than structural shapes in tension and flexural. Properties of honeycomb members, sandwich panels and other shapes made via process other than pultrusion can vary significantly.

****

Submit documentation showing FRP composites meet the material properties used in the design as per the applicable [ASTM] [_____] test requirements. [Submit samples to permit verification testing for FRP composites made via hand-layup].

Submit documentation showing that FRP composites show no evidence of damage including breaks, cracks, blistering, delamination, exposure of fibers, or combination thereof, after being subjected to ASTM D4329 or ASTM G154 for a minimum of 720 hours.

Allowable visual defects of FRP Composite members must meet conditions as per ASTM D4385 for pultruded members, Level II of ASTM D2563 for laminates or a similar appropriate specification for other types of FRP composites. Dimensional tolerances for pultruded components must meet ASTM D3917.

2.4.2 Structural Steel

****
NOTE: If structural steel is not permitted to be used, omit this section.
****

Use non-fracture critical steel members conforming to ASTM A36/A36M or ASTM A992/A992M.

Use fracture critical steel members conforming to ASTM A709/A709M, Grade 50 (F) for temperature Zone 2 or ASTM A992/A992M, Grade 50 with a minimum average Charpy V-Notch (CVN) impact test value of 34 N-m 25 ft-lbs when tested at 4.4 degrees Celsius 40 degrees Fahrenheit.

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.4.3 Stainless Steel

****
NOTE: If stainless steel is not permitted to be used, omit this section.
****

Use stainless steel bars and shapes conforming to ASTM A276/A276M, UNS [S20910,] [S30400,] [S40500,] [S31600,] [_____] Condition A, hot-finished or cold-finished, Class C; or ASTM A564/A564M, UNS [S17400,] [S45000,] Condition A, age-hardened heat treatment, hot-finished or cold-finished, Class C.

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.4.4 Aluminum

****
NOTE: If aluminum is not permitted to be used, omit this section.
****

Use aluminum bars and shapes conforming to [ASTM B209][ASTM B308/B308M][_____].

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.4.5 Rubber Seals

****
NOTE: If fluorocarbon (Teflon) clad seals are not used, omit paragraphs FABRICATION OF RUBBER SEALS AND TESTING OF RUBBER SEALS.
****

Use [fluorocarbon (Teflon) clad rubber seals of the mold type only]

[compounded of natural rubber, synthetic polyisoprene, or a blend of both, and must contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers]. Submit documentation showing the seals meet the following requirements prior to commencing work:

PHYSICAL TEST	TEST VALUE	TEST METHOD
Tensile Strength	17.2 MPa 2500 psi (min.)	ASTM D412
Elongation at Break	450 percent (min.)	ASTM D412
300 percent	6.2 MPa 900 psi (min.)	ASTM D412
Durometer Hardness (Shore Type A)	60 to 70	ASTM D2240
Water Absorption	5 percent by weight (max.)	ASTM D471
Compression Set	30 percent (max.)	ASTM D395
Tensile Strength (after aging 48 hrs)	80 percent of tensile strength (min.)	ASTM D572

The "Water Absorption" test must be performed with distilled water. The washed specimen must be blotted dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees 158 degrees F plus of minus 4 degrees F for 22 hours plus or minus 1/4 hour. The specimen must then be removed, allowed to cool to room temperature in air, and weighed. The weight must be recorded to the nearest 1 mg as M subscript 1 (M subscript 1 is defined in ASTM D471). The immersion temperature must be 70 degrees C plus or minus 1 degree 158 degrees F plus of minus 2 degrees F and the duration of immersion is to be 166 hours.

Rubber seals must have a fluorocarbon film vulcanized and bonded to the sealing surface of the bulb. The film must be [0.726 mm] [1.524 mm] [0.030 inch] [0.060 inch] thick Huntington Abrasion Resistant Fluorocarbon Film No. 4508, or equal, and must have the following physical properties:

Tensile strength	13.8 MPa 2,000 psi (min.)
Elongation	250 percent (min.)

The outside surface of the bonded film must be flush with the surface of the rubber seal and be free of adhering or bonded rubber. Strips and corner seals must be molded in lengths suitable for obtaining the finish lengths shown and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be tested, the fluorocarbon film must be masked during bonding to prevent a bond for a length sufficient to hold the film securely during testing.

Submit variances of these suggested materials and test methods for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.4.6 Ultrahigh Molecular Weight Polyethylene (UHMWPE)

****
NOTE: If UHMWPE is not permitted to be used, omit this section.
****

If used, ultrahigh molecular weight polyethylene (UHMWPE) must conform to the following physical properties:

PROPERTY	TEST VALUE (+/- 10 percent)	TEST METHOD
Specific gravity	0.93 g/cm3 0.034 lbs/in3 (minimum)	ASTM D792
Tensile strength	27.6 Mpa 4,000 psi (minimum)	ASTM D638
Durometer	D68 (minimum)	ASTM D2240
Coefficient of friction	0.20 (maximum)	ASTM D1894

If the UHMWPE material is to be exposed to sunlight, the material must be stabilized for ultraviolet radiation via 2.5 percent carbon black or other equivalent stabilizer. The fabricated form must be from virgin resin. The virgin resin must be a homopolymer of ethylene and have an intrinsic viscosity (IV) between 22.0 and 28.0 dl/g per ASTM D4020.

2.5 FABRICATION

Follow the ACMA Code for pultruded FRP composites.

2.5.1 Drawings and Specifications

Submit detail drawings, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, conforming to the specified requirements [_____] days prior to starting fabrication. The structure design is communicated to the Government through the required submittals designated in these specifications. All information necessary to fabricate the structure as intended in the design is depicted in these documents. Denote failure critical members on all drawings with the abbreviation FC. Denote fracture critical members on all drawings with the abbreviation FCM. The notation of FC and FCM on the drawings provides critical information to the Government for the structural response of the structure. Drawings must not be reproductions of the Government furnished contract drawings.

2.5.2 Fabrication Drawings

Fabrication drawings must show complete details of materials, dimensions, tolerances, connections.

2.5.3 Fabrication Tolerances

Measure dimensions by an approved measuring system. Submit the measuring system for approval with the work plan (i.e. calibrated steel tape of approximately the same temperature as the material being measured). The overall dimensions of an assembled structural unit must be within the tolerances indicated on the drawings or as specified for the item of work. Where tolerances are not specified in other section of these

specifications or shown, a variation of 0.8 mm 1/32-inch is permissible in the overall length of component members with both ends milled and component members without milled ends must not deviate from the dimensions shown by not more than 1.6 mm 1/16-inch for members 3.7 meters 12 feet or less in length.

2.5.4 Delivery Drawings

Delivery drawings must provide descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit certified material test reports with all material delivered to the site. Tests, inspections, and verifications for materials and fabricated items must conform to the requirements specified.

2.6.1 General

Tests, inspections, and verifications for materials must conform to the specified requirements. Submit certified test reports for material tests, with all materials delivered to the site.

2.6.2 Inspection

****
NOTE: This paragraph must be edited to fit the project.
****

Inspect shop assembled components for accurate fit and compliance with dimensional tolerances. Sealing, guiding, and connecting surfaces must be inspected to determine if their planes are true, parallel, and in uniform contact with opposing surfaces.

2.6.3 Operation Tests Prior to Installation

****
NOTE: This paragraph is only applicable to slide gates.
****

[The operation of the shop-assembled gate assembly must be tested by opening and closing the gate several times by use of the operating machinery. The force used to operate the gate must be the minimum required to open and close the gate. Since the sill of the unembedded gate frame is not fully supported during the operation tests, special precaution must be taken to prevent the application of excessive force on the gate leaf and frame when the gate is closed. The operation of the lifting beam must be tested by engaging and disengaging the lifting beam several times. Adjustments must be made as required until operations are satisfactory as determined by the Contracting Officer or their approved representative.]

****
NOTE: The shop hydrostatic leakage test outlined below may not be practical due to the size or head requirements of the gate. This test should only be required if gate leakage is considered a critical

issue.
****

[The gate assembly must be tested hydrostatically prior to installation by applying a hydrostatic pressure of [_____] Mpa [_____] psi, measured at the sill of the gate frame, to the upstream side of the gate leaf in the closed position. Under hydrostatic testing, the gate seals must prevent water leakage meeting paragraph 2.1.2.]

PART 3 EXECUTION

3.1 EXAMINATION

Gate will be inspected when delivered to site. When Government inspections result in product rejection, promptly segregate and remove rejected material from the premises. The Government may also charge an additional cost of inspection or testing when prior rejection makes re-inspection or retesting necessary.

3.2 PREPARATION

3.2.1 Protection

Protect the surrounding water control structure to prevent damage during the installation of the gate. Install temporary water control structures if replacing an existing gate to ensure water control is maintained.

3.3 INSTALLATION

Installation must conform to the requirements specified. Gate and appurtenant items must be assembled for installation in strict accordance with the contract drawings, approved installation drawings, and shop match-markings. Bearing surfaces requiring lubrication must be thoroughly cleaned and lubricated with an approved lubricant before assembly and installation. Submit certification of installation. Submit Certification of State Product Approval.

3.4 FIELD QUALITY CONTROL

3.4.1 Tests

****
NOTE: The field leakage test outlined below may not be practical due to the size or head requirements of the gate. This test should only be required if gate leakage is a critical issue. Consideration should be given to the ability to apply head to the gate in the field.
****

[Conduct a field leakage test including [operating the gate][removing and replacing stoplogs] to ensure the as-built gate meets the requirements of paragraph 2.1.2.]

3.5 CLOSEOUT ACTIVITIES

3.5.1 Demonstration and Training

Demonstrate gate operation and provide training for [USACE] [owner]

[_____] employees for a maximum [8] [_____] hours.

Provide an operation and maintenance manual to [USACE] [owner] [_____].

3.5.2 Data Book

Compile and maintain a "Data Book" throughout the duration of the contract. The "Data Book" consists of copies of all Requests for Information (RFI's) with Government responses, Material Orders, Mill Certification Reports and Certification Letter's. Use tabs to separate each specific item identified above and a Table of Contents to identify which tab corresponds to which item. The in-progress "Data Book" must be available to the Government to review during shop inspections of the project.

When final revisions have been completed, prepare a "Certificate of Conformance" on their company letterhead certifying that: 1) all materials and workmanship included in the project were detailed, designed, manufactured, tested, inspected and documented as specified in the contract requirements; and 2) the requirements of applicable codes, standards, specifications and drawings have been complied with and that all required quality assurance documentation verify conformance to the contract documents have been submitted, signed by the Contractor's Quality Control System Manager and Engineer of Record.

Submit a draft copy of Final "Data Book" for review and approval within fifteen (15) calendar days following the completion of fabrication activities. Within thirty (30) calendar days of receipt of the Final "Data Book", the Government will return one copy annotated with any necessary corrections. Within fourteen (14) calendar days the Contractor must revise the "Data Book" accordingly at no extra cost and submit the Final Copy of the Final "Data Book" including the "Certificate of Conformance" to the Government. Approval and acceptance of the Final "Data Book" is required before final payment to the Contractor.

3.6 WARRANTY

****

NOTE: For USACE projects, delete the first two subparagraphs and utilize the tailored option.

****

3.6.1 Manufacturer's Warranty

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

3.6.2 Contractor's Warranty for Installation

Submit contractor's warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

3.6.3 Contractor's Five (5) Year No Penal Sum Warranty

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY FOR COMPOSITE LOW-HEAD WATER CONTROL STRUCTURE
STRUCTURE DESCRIPTION:
STRUCTURE NUMBER:
CORPS OF ENGINEERS CONTRACT NUMBER:
CONTRACTOR
CONTRACTOR:
ADDRESS:
POINT OF CONTACT:
TELEPHONE NUMBER:
OWNER
OWNER:
ADDRESS:
POINT OF CONTACT:
TELEPHONE NUMBER:
CONSTRUCTION AGENT
CONSTRUCTION AGENT:
ADDRESS:
POINT OF CONTACT:
TELEPHONE NUMBER:

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY FOR COMPOSITE LOW-HEAD WATER CONTROL STRUCTURE (continued)
The composite low head water control structure or component installed on the above named structure is warranted by [_____] for a period of [5][10][20] [_____] years against workmanship and material deficiencies, wind damage and structural failure within project specified design loads[, and leakage exceeding paragraph 2.1.2]. The composite low-head water control structure and components covered under this warranty includes, but is not limited to, the following:
Framing and structural members, opening mechanisms including motors, storage racks, accessories, trim, miscellaneous closure items, connectors, components, and fasteners, and other system components and assemblies installed to enable operation of the composite low-head water control structure; and items specified in other sections of these specifications that become part of the composite low-head water control structure.
All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads and water leaks must be repaired as approved by the contracting officer.
All material deficiencies, structural failure, and leakage associated with the composite low-head water control structure covered under this warranty must be repaired as approved by the contracting officer.
This warranty covers the entire cost of repair or replacement, including all material, labor, and related markups. The above referenced warranty commenced on the date of final acceptance on [_____] and will remain in effect for stated duration from this date.
Signed, dated, and notarized (by company president) _____ (Company President) (Date)

-- End of Section --