Preparing Activity: USACE Superseding
UFGS-05 59 20 (August 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 05 59 20

FABRICATION OF HYDRAULIC STEEL STRUCTURES
05/21

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NOTE: This guide specification covers the requirements for general workmanship applicable to the fabrication, assembly and testing of fracture critical Hydraulic Steel Structures.

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).
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PART 1 GENERAL

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NOTE: This specification is intended for the fabrication of NEW Hydraulic Steel Structures. Fracture critical hydraulic steel structures (HSS) are critical life safety structures that require added quality control. Fracture critical HSS or components of HSS are those portions whose failure would lead to collapse of the structure and potential life loss.

The results of the Hydraulic Steel Structures inspection program, undertaken by USACE, has shown that fracture critical fabrication without added oversite has led to a lack of understanding of the

techniques required to ensure life safety.

This guide specification is intended to ensure fracture critical structures are properly manufactured according to updated welding criteria and ensures that quality control is exercised throughout the fabrication process in accordance with ER 1110-2-8157. This specification should be used for the design of fracture critical HSS structures and HSS structures subjected to dynamic loads. Bulkheads/stoplogs or other HSS structures, not fabricated with fracture critical components or subject to static load only, may be fabricated to this specification when an added level of quality control is required. Use of this specification for the repair of existing structures is not recommended and would require numerous modifications to ensure compatibility of existing steel with fracture critical requirements.

Take great care in adding references to additional steels (ASTM A36, A572, A992 etc.) as these steels do not provide toughness requirements for fracture critical structures and are NOT addressed as acceptable base metals in AWS D1.5M/D1.5. The following items are likely manufactured from steels that do not comply with AWS D1.5M/D1.5 and must be specifically addressed with a weld procedure generated for qualification such as:

1. Rub/Guide Blocks
2. Chain
3. Pipe or Tubing for Guardrail etc.
4. Ancillary items such as anode attachments etc.

In all instances where alternate materials, other than A709 steel are used, specific weld procedures must be generated to address the mixing of base metals in a given joint configuration. If the engineer chooses to add alternate basemetals to the list of approved basemetals then he/she must ensure that these metals are only permitted for individual components where these materials are required and must additionally ensure that pre-qualification records and qualified weld procedures for mixing basemetals are specifically required in the submittal section of this guide specification.

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1.1 REFERENCES

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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 INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2016) Code of Standard Practice for Steel Buildings and Bridges
AISC 325	(2017) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN WELDING SOCIETY (AWS)

AWS D1.5M/D1.5	(2020; Errata 1 2022) Bridge Welding Code
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors

ASTM INTERNATIONAL (ASTM)

ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A709/A709M	(2021) Standard Specification for Structural Steel for Bridges
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids

ASTM D573	(2004; R 2019) Standard Test Method for Rubber - Deterioration in an Air Oven
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D1149	(2007; R 2012) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber
ASTM D1630	(2006; R 2012) Rubber Property - Abrasion Resistance (Footware Abrader)
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM E165/E165M	(2018) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E709	(2021) Standard Guide for Magnetic Particle Testing
ASTM F436/F436M	(2019) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
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

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC A348	(2020) RCSC Specification for Structural Joints Using High-strength Bolts

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety -- Safety and Health Requirements Manual

1.2 SYSTEM DESCRIPTION

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NOTE: Insert a list of structures that will be fabricated according to this specification. Note that other Division 05 specifications (Miscellaneous metals etc.) would enable structures to be fabricated according to AWS D1.1 and would permit the use of basemetal without toughness requirements etc. If more than one Division 05 specification is included in the specification package, then any item not listed below will be fabricated to a separate specification.

AWS D1.5M/D1.5 Clause 1.1.3 specifies that all

references to "Engineer" approval in D1.5 refer to the State Bridge Engineer. The paragraph below addresses this to ensure that the proper authority/responsibility is given to the Engineer of record.
****

Submit a detailed Work Plan for fabrication, including descriptions of shop facilities, equipment, number of personnel, and related information prior to the Prefabrication Conference, and procedures for safe conduct of the work, careful removal and disposition of materials, protection of property that is to remain undisturbed, and coordination with other work in progress. Include in the procedures a detailed description of the methods and equipment to be used for each operation, and the sequence of operations in accordance with EM 385-1-1 for all work that occurs on federal property. Include the recommended measuring system for ensuring dimensional tolerances in the Work Plan. Perform the fabrication of the following listed structures under this contract in accordance to this section of the specifications:

1. [Spillway Tainter Gates]
2. [Fishway Intake Bulkheads]
3. [Main Unit Head Gates]

a. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Do not begin welding until welding procedures, inspectors, nondestructive testing personnel, welders, welding operators, and tackers have been qualified and approved. Each Contractor performing welding must maintain records of the test results obtained in welding procedure, and welder, welding operator, and tacker performance qualifications.

b. As it is used in these specifications, "The Engineer" refers to the [District] or [AE] engineer of record. The AWS D1.5M/D1.5 definition of "The Engineer" as specified in AWS D1.5M/D1.5 Application Clause refers to the [District] or [AE] engineer of record in lieu of the state bridge engineer as specified in the Application Clause of AWS D1.5M/D1.5.

c. Schedule a Prefabrication Conference as soon as possible after Notice to Proceed and prior to any fabrication. Include the Prime Contractor, Fabricator, the Fabricator's primary QC representative, the Contracting Officer, and the Engineer of Record for the structure or structures being fabricated in the Prefabrication Conference, at a minimum. Hold the Prefabrication Conference at either the Fabrication Facilities or a similar location as deemed appropriate.

1.2.1 Weld Tracking Log Template

Submit for approval a weld tracking log template, a minimum of 30 days prior to commencement of fabrication, to identify all necessary components to be addressed in the tracking of all welds for the structures in question. A weld tracking log will be developed and maintained as described in the following paragraphs.

1.2.2 Weld Tracking Log

Submit a log capable of individually identifying and tracking every weld on the project. Member identification must follow the numbering scheme

shown on the shop drawings. Include in the log the member to be welded, member type (FCM and Non-FCM), type of weld including temporary and tack welds, welding position, applicable WPS reference, AWS joint preparation designation, name or stamping designation of welder, welding operator or tacker, date and time of completion of welding and/or tacking, name and date of CWI visual inspection, NDT testing performed, including the type of inspection, date(s) of inspection, inspector name, and the acceptance criteria used, description of defects found and reason for non-compliance, corrective action taken, or whether the weld is acceptable. Weld identification on the shop drawing must match weld tracking log identification. Bind together a completed log for each structure and submit two copies to the Contracting Officer immediately upon completion of the fabrication of each structure. Furnish draft copies of NDT testing to the Contracting Officer upon request and have a copy available on the shop floor during any inspection.

1.2.3 Welding Procedure Specifications (WPS)

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NOTE: AWS D1.5 Clause 1.3.7 defines that Ancillary products can be welded without WPS. Ancillary products are defined as products not subjected to tensile stress when subjected to live load. This requires the Contractor to know what components of the structure are in tension. In addition, Clause 12 defines attachments less than 100 mm 4 inches as not fracture critical. Each engineer must define what ancillary attachments he/she is concerned about. An example of this would be the attachment of anodes on the tension flanges of a bulkhead. These attachments are usually short (50 mm2 inches) in length and usually "tack" welded on. Ancillary attachments, either subjected to tension or requiring additional inspection other than visual, need to be defined on the drawings and must be mentioned in the specifications as not being omitted from inspection as permitted in D1.5. Seal backing bars, anodes, guides etc. must be specifically excluded from being treated as ancillary items.

Be extremely careful with what items are added to the list below. Some items may not meet the requirements of AWS D1.5 and may need to be addressed separately.

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Submit a Welding Procedure Specification (WPS), with supporting Procedure Qualification Records and supporting test documentation on forms similar or equivalent to the sample forms in AWS D1.5M/D1.5for each weld, including prequalified welds, in accordance with paragraph Welded Connections approved before fabrication is commenced. Individually identify each Welding Procedure Specification and reference it on the shop drawings. In case of conflict between this specification and AWS D1.5M/D1.5 as applicable, this specification governs. The following items are not considered ancillary items as defined in AWS D1.5M/D1.5 Welding Processes Clause and are subjected to the same level of inspection required for primary welds under AWS D1.5M/D1.5:

a. [Sacrificial Anodes attached to the Gate]

b. [Guide Shoes]
c. [etc.]

1.2.4 Fracture Critical Members (FCM)

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NOTE: Toughness requirements are necessary to prevent fracture and are measured for the base metal and for the weld metal. The following paragraph defines the toughness requirements for the base metal. These tests are conducted in the mill, prior to shipment of the A709 plate to the fabricator. Recognize that the Zone of testing required for both completed welds and basemetal is a function of the service location of the structure. Please recognize that the table provided in EM-1110-2-2105 is out of date. It is recommend referencing the zone requirements of ASTM A709 for fracture critical members. Temperature zones for services temperature of your structure are defined in AASHTO LRFD Temperature Zone Designations for Charpy V-Notch Impact Requirements Table. Specifying a zone in lieu of an energy requirement is beneficial as it ensures that as the AASHTO code changes the energy requirement stays valid.

ALL FCM's must be designated on drawings. All Tension members and members subject to reversal of stress MUST be designated on the drawings. AWS D1.5 specifically requires this in Clause 12. Not specifying members as FCM on the drawings will change the testing requirements even if the specifications you have written here differ. There are numerous instances in AWS D1.5 (specifics include UT testing requirements) where testing must be performed to a certain level of acceptance for tension members - such as required in clause 6 UT testing table Notes regarding the subtracting of 4dB from indications found at the root of a weld "when such welds are designated as "tension welds" on the drawing.". Neglecting to label tension welds on the drawing will negate these code provisions.

Recognize that there may not be a splice or weld in a member as it was detailed, but that such member may later require splicing or attachments that would require welding to this member under modification. Neglecting to label this member as a tension member would preclude these welds from being properly tested according to D1.5.

Note that AWS D1.5 Clause 6 gives the Contractor considerable leeway regarding what percentage of welds are tested unless they are labeled fracture critical. As a result, if you want a weld to be fully tested as fracture critical you must label the weld fracture critical and if you want testing on any other critical welds you should designate the weld testing by item, both on the drawing and in the

specifications. While the standard specifications may require a percentage of welds to be tested, if you want specific welds to be subjected to MT, PT, or UT, ensure that these welds are specified on the drawings. Consider specifying test requirements in the tail of each weld that you want NDT on.

In addition, A709 requires that mill orders for materials designate whether the material is tension or compression (T or F). T refers to non fracture critical, F refers to fracture critical material. Steel that is ordered without the T or F designation will not be certified for toughness.

Note that A673 allows the mill to certify material for a lower service temperature than is being required. Tests may be performed at a lower service temperature in the mill and this is considered acceptable for higher service temperatures.

Refer to AWS D1.5, Clause 12 for minimum preheat requirements. Additionally note that preheat requirements are much higher for repair welds as defined in AWS D1.5, Clause 12 This requires minimum preheat and interpass of 161 degrees C 325 degrees F for material less than 38 mm 1-1/2 inch thickness. This requirement will dictate the heat requirements for the entire job and should be accounted for in construction QA visits. The fabricator must have the facilities to preheat higher than the minimum temperatures discussed below if weld repairs are required.

AWS D1.5 Clause 12 requires both RT and UT for testing of Tension Butt Joints and Repaired Groove Welds. Do not delete one of these two requirements for fracture critical structures. Both RT and UT are required by code.

Be careful of the use of the term "tack" weld. Note that AWS 3.0 does not provide a definition of a length or size for a tack weld. AWS 3.0 defines a tack weld as: "A weld made to hold the parts of a weldment in proper alignment until the final welds are made." Tack welds are permitted in AWS D1.5 and will be used by fabricators. AWS D1.5 does allow tack welds and does permit them to be made without preheat. All tack welds made must be remelted and incorporated into the final weld under SAW methods. This is further detailed in AWS D1.5 Clause 12. While the contractor will use tack welds in fabrication, it is not recommended to use the term tack weld on any drawings due to the ambiguous definition of tack welds described above.

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FCM are shown on the Contract Drawings and include all attachments and connections to these members as defined in AWS D1.5M/D1.5. All materials to be welded must be ASTM A709/A709M, killed steel, grade as specified or

shown on the drawings. Use Grade 50 steelunless otherwise shown or specified. Mill repairs of base metal are prohibited. Unless otherwise indicated or specified, meet toughness requirements for fracture critical members in tension in accordance with ASTM A709/A709M for Zone [1][2][3]. All materials used for the construction of fracture critical components must meet the applicable requirements of ASTM A709/A709M for fracture critical components. Welding for fracture critical members must meet all requirements of AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause.

1.2.4.1 Fracture Control Plan (FCP)

Submit a Fracture Control Plan (FCP) for welding on all Fracture Critical Members (FCM) in accordance with AWS D1.5M/D1.5, AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause. Submit welding Procedures, qualifications, and certifications showing compliance with FCP requirements.

1.2.4.2 Repair Welding

Classify repair welds as "critical repairs" or "non-critical repairs" for all repair welding. Unless specified otherwise, follow the minimum provisions for repair procedures. Repair procedures must be qualified and approved and subject to the same QA/QC inspection requirements as other welds. Follow minimum preheat requirements, as defined in AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause, for repair welding. Consider all weld repairs to fracture critical members critical welds in accordance with AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause and must be approved by the Engineer of Record.

1.3 SUBMITTALS

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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.

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

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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

Shop Drawings; G[, [_____]]

Welding Procedure Specifications (WPS); G[, [_____]]

Fracture Control Plan (FCP); G[, [_____]]

Weld Tracking Log Template; G[, [_____]]

Weld Tracking Log; G[, [_____]]

Qualification of Welders and Welding Operators; G[, [_____]]

Inspector Qualifications; G[, [_____]]

Qualification of Structural Steel Fabricator; G[, [_____]]

NDT Inspector Certification; G[, [_____]]

Welding Repairs - Non-Fracture Critical Members; G[, [_____]]

Welding Repairs - Fracture Critical Members; G[, [_____]]

Performance Qualification Records; G[, [_____]]

Ultrasonic Written Procedure; G[, [_____]]

SD-02 Shop Drawings

Assembly; G[, [_____]]

Delivery/Shipping Plan; G[, [_____]]

Erection Drawings; G[, [_____]]

SD-03 Product Data

Materials Disposition Record

Anti-Galling CompoundG[, [_____]]

SD-06 Test Reports

Certified Test Reports; G[, [_____]]

Witness Points

Repair of Mislocated or Misdrilled Holes; G[, [_____]]

Schedule of Random Testing; G[, [_____]]

Manufacturer Certified Test Reports; G[, [_____]]

Distributor Certified Test Reports; G[, [_____]]

SD-07 Certificates

Work Plan; G[, [_____]]

SD-09 Manufacturer's Field Reports

Control Dimensions; G[, [_____]]

1.4 QUALITY ASSURANCE

Establish Witness Points for the Initial QA Inspection, Intermediate QA Inspections, and Final Inspection as follows and submit a record of all witness points. Start the Initial QA Inspection after the Government has determined that there is substantial completion of components that comprise a reasonable sampling of each significant FCM and non-FCM details. Determine the extent of completion and details and the date of the Initial QA Inspection by the Government at the Prefabrication Conference after discussion with the Contractor. At that time, produce a detailed schedule showing the progression of work and completion of components. This schedule will be updated weekly and provided by e-mail to the Contracting Officer. Give the Contracting Officer two weeks notice prior to the predetermined date for the Initial QA Inspection, including adjustments for changes in schedule. Intermediate QA Inspections will be conducted on an as needed basis and at the discretion of the Government. All QA inspections will follow AWS D1.5M/D1.5. Provide unpainted components for each QA NDT and Visual Inspection. At these stages of construction, give the Contracting Officer three working days to inspect the structure. Do not begin the QA Inspection period until a minimum period of 72 hours after any welding. After the Contracting Officer and the Engineer of Record has inspected the structure, make any changes required to the structure as directed by the Contracting Officer before proceeding with any additional welding. Proceed with the construction until the next witness point is reached, unless it is waived in writing by the Contracting Officer. Each structure fabricated is subject to a Final Fabrication Inspection prior to painting. Conduct a Final Fabrication Inspection after the first structure is completed. Schedule and

coordinate with the Contracting Officer and the Engineer of Record final fabrication inspections of additional structures. Give the Contracting Officer a minimum notice of two weeks prior to the Final Fabrication Inspection.

1.4.1 Qualification of Welders and Welding Operators

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NOTE: AWS D1.5 should remain referenced in this section of the specifications for the qualifications of welders. AWS D1.5 provides additional controls on the qualification of welders to include the prohibition of power tool cleaning between weld passes for the test. In addition, the reference to AWS D1.5 ensures that welders performing fracture critical welds are annually requalified according to AWS D1.5 Clause 12. AWS D1.1 requires a log showing that a welder who is qualified has continued to weld in this process in the past 6 months. AWS D1.5 Clause 12 stipulates that a welder must be qualified by test within 6 months prior to beginning any work. Initial qualification according to AWS D1.5. Clause 12. requires both RT and bend testing of welded samples. Note that Clause 5.23.1.1 allows a welder who follows a WPS produced for testing to be qualified for that weld and is NOT required to follow the initial qualification requirement of hand tools only. This means that a welder can qualify by submitting WPS's for testing and avoid the hand tool restriction if being tested according to AWS D1.5, non fracture critical welds. Referring to AWS D1.1 only ensures that the welder who is performing the welding has qualified at some point in his/her career. Welders working in a shop may have not welded a CJP overhead weld in 10 years but would still be qualified to perform welding provided someone has signed a log book saying that the welder has been using the process in the last 6 months. A welder who performs a 6 mm 1/4 inch fillet weld with FCAW who was previously qualified is still qualified according to perform CJP overhead welds provided that he/she has used the FCAW process in the past 6 months. This is an additional reason for referencing AWS D1.5 requirements.

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Submit welder, welding operator and tacker qualification certification for each welder, welding operator or tack welder for approval before fabrication is commenced in accordance with paragraph Welded Connections. An AWS Certified Welding Inspector (CWI) meeting the specified qualifications must approve all welder qualifications. Limit welders, welding operators, and tack welders to welding procedures for which they are certified. Prepare, weld, and test welds in accordance with the requirements of AWS D1.5M/D1.5. Before assigning any welder, welding operator, or tacker to work under this contract, submit the names and certification that each individual is qualified as specified. State the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is qualified, the date qualified, and the name of the firm and person

certifying the qualification tests on the certification. Keep the certification current for the duration of the contract. Submit welder and welding operator qualification test records on forms similar or equivalent to the sample forms in AWS D1.5M/D1.5. All welders must be qualified in accordance with the Qualification Clause of AWS D1.5M/D1.5. Welders performing fracture critical welds must meet the additional requirements of the AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause of AWS D1.5M/D1.5. Verify all qualifications are current prior to commencing any work. Submit a log for each welder showing that he/she is current in the process and procedures being proposed for this work.

1.4.2 Inspector Qualifications

All inspectors, performing structural steel visual inspection in accordance with these specifications, must be qualified and certified in conformance with AWS QC1. Provide an AWS Certified Welding Inspector (CWI) as the primary point of contact for quality control of welding. Designate one individual as having primary responsibility for all quality control in accordance with AWS D1.5M/D1.5 Inspection Clause when several CWI and NDT technicians are working. Do not use non-certified inspectors and certified associate weld inspectors (CAWI) for inspection under these specifications. All personnel who perform NDT must be qualified in accordance with: ANSI/ASNT CP-189 NDT Level II or III. Provide supervision by personnel possessing a Level III ASNT NDT certification for all personnel performing NDT, in accordance with AWS D1.5M/D1.5 Inspection Clause and the AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause. Submit copies of certificates showing evidence of qualifications or certifications for welding inspectors and NDT personnel.

1.4.3 Qualification of Structural Steel Fabricator

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NOTE: To find AISC certified contractors in the project's region go to:

www.aisc.org

At the first PDT meeting address the need for certified AISC fabricators. AWS D1.5M/D1.5 Clause 12 Certification and Qualification reads as follows: "Contractors must be certified under the AISC (American Institute of Steel Construction) Quality Certification Program Category III, Major Steel Bridges with Fracture Critical Rating, or an equivalent program accepted by the engineer". However, AISC has developed a new fabricator certification specifically for Hydraulic Steel Structures in 2017 that can be used along with ABR, CBR or IBR certification for all projects.

In order to perform fracture critical welding in accordance with AWS D1.5 the Contractor must be certified to this level. Do not wave this requirement.

The Contracting Officer may wish to address the value of this work in comparison to the number of fabricators available to perform this work, often suggesting that the fabrication of a small bulkhead

should be set aside for a small Contractor. Using AISC certified fabricators ensures that the requirements of AWS D1.5 and these specifications are not new to the Contractor.

The AISC fabricator may or may not possess a paint facility and may sub contract this work. The paint specification should be amended to require the paint applicator to either posses an AISC sophisticated paint system endorsement or be a certified contractor in accordance with SSPC as possessing either a QP 1 Certification (Field Application to Complex Industrial and Marine Structures) or QP 3 Certification Program (Shop Painting Certification Program).

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The fabricating plant and fabricator must be certified under the AISC (American Institute of Steel Construction) Quality Certification Program, and must be designated an AISC Certified Plant, Category CBR: Major Bridge Fabrication, IBR: Certified Bridge Fabricator - Intermediate, ABR: Certified Bridge Fabricator - Advanced or HYD: Certified Metal Hydraulic Fabricator with a fracture critical endorsement (FCE) at time of bid and for the duration of the contract. The fabricator or fabrication plant must possess five 5 years documented experience on projects of similar scope. Similar scope means projects of similar size and similar amounts of welding and detail types. Submit copies of the AISC certificate indicating that the fabrication plant meets the specified structural steelwork category and documented experience. The [insert items excluded from this requirement, such as wire rope slings, rubber seals etc.] are excluded from the AISC fabricator certification requirements.

1.4.4 Testing by the Government

Material component parts may be subjected to any form of nondestructive testing, as directed by the Contracting Officer. This may include any test that will thoroughly investigate the part in question. The cost of such investigation will be borne by the Government. Replace and retest all defects that are cause for rejection and rejected materials or parts at the Contractor's expense. The government reserves the right to perform quality assurance at any point during fabrication.

1.4.5 Shop Drawings

Prepare all shop drawings in accordance with AISC 303, AISC 326, AISC 360, and AISC 325. Return elements of fabricated items inadvertently omitted on contract drawings to the Engineer of Record for detailing unless they are to be detailed by the fabricator and so indicated on the shop drawings. Cloud any and all details developed by the fabricator on the shop drawings for separate approval by the Engineer of Record. Any items designed by the Contractor must be prepared and sealed by a Registered Professional Engineer. All splices must be approved bythe Engineer of Record. Make all splices with complete joint penetration groove welds.Identify all field welds on the shop drawings. Provide a unique identifier to permit tracking on the weld tracking log for each weld, both shop and field welds. Prior to performing any fabrication of the HSS structures listed in paragraph System Description above, submit complete, detailed shop drawings for approval. Show complete details of materials, tolerances, connections, and proposed welding sequences on the shop

drawings. Include catalog cuts, templates, fabrication and assembly details, and type, grade, and class of materials, as appropriate in the shop drawings. Identify all FCM, including attachments that meet the FCM definition, on the shop drawings as well as all temporary and tack welds. Identify each member following the numbering scheme shown on the drawings. Provide a table containing a list of all members and a reference to each material certificate and test report that applies to that member. Identify weld procedures and NDE required for each weld on shop drawings. Cloud any and all splices in the shop drawings for engineer approval.

1.4.6 Erection Drawings

Submit erection drawings showing complete information necessary for the erection of each component part of the HSS. Include the following:

a. Dimensions for alignment and elevations of each member.
b. Location of members and attachments by match-marking of piece numbers.
c. Type and location of each field connection.
d. Detail of each field connection or typical connection.
e. Anchor bolts and setting plans.

1.5 DELIVERY, STORAGE, AND HANDLING

Notify the Contracting Officer at least 28 days in advance of delivery of the structures. Shipping of the structures are at the Contractor's expense. Deliver all structures to the [*insert delivery address*]. Coordinate all deliveries through the [*District Name*] District Contracting Officer. Arrange the structures on the delivery vehicles such that no damage occurs during shipping. Direct all sling lifting lugs up. Submit a Delivery/Shipping Plan showing orientation and locations of structures on the delivery vehicles prior to shipment for Government approval. Submit drawings providing descriptions of methods of delivering the completed structural units, including details for support during shipment to prevent distortion or other damages, and orientation and location of the structure on transport equipment. Protect structural steel members and packaged materials from corrosion and deterioration. Store material in a dry area. Support materials stored outdoors above ground surfaces on wood runners and protect with acceptable effective and durable covers.

1.6 FIELD MEASUREMENTS

Consider all field conditions that affect the details and tolerances of the HSS. Contractor is responsible for accuracy and layout of work and must make necessary field measurements prior to preparation of shop drawings for the HSS.

PART 2 PRODUCTS

2.1 FABRICATION

2.1.1 Structural Fabrication

Material must be straight before being laid off or worked. Perform straightening by methods that will not impair the metal. Material will be rejected for sharp kinks or bends. Material with welds will not be accepted except where welding is definitely specified, indicated or otherwise approved. Use approved dies, press brakes or bending rolls to make bends. Take precautions to avoid overheating the metal where heating

is required and allow it to cool in a manner that will not impair the original properties of the metal. Obtain approval prior to flame cutting material, other than structural steel, indicated on detail drawings. Accurately shear material and neatly finish all portions of the work. Provide square and true corners unless otherwise shown. Fillet re-entrant cuts to a minimum radius of 25 mm 1 inch in accordance with AWS D1.5M/D1.5 Workmanship Clause unless otherwise indicated or approved. Provide finished members free of twists, bends and open joints.

2.1.1.1 Dimensional Tolerances for Structural Work

a. 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 sections 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 9 m 30 feet or less in length and by not more than 3 mm 1/8 inch for members over 9 m 30 feet in length.

b. Structure dimensions indicated are based on a structure temperature of 20 degrees C 70 degrees F. Perform dimensional adjustments to compensate for actual temperature variations during construction.

2.1.1.2 Structural Steel Fabrication

Structural steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a surface that is smooth and free from cracks and notches is obtained. Prepare surfaces and edges in accordance with AWS D1.5M/D1.5, Workmanship Clause. Hand-guided cuts must be chipped, ground or machined to sound metal.

2.1.2 Assembly

Submit Assembly Drawings indicating the sequence of fabrication and assembly and provide details for connecting the adjoining fabricated components in the shop. Identify assembly details in the required order of assembly and details of witness points as described in these specifications.

2.1.3 Materials Disposition Record

Submit three copies of all purchase and mill orders, shop orders for materials and work orders, including all new orders placed by Contractors and old orders extended for each supplier. Furnish, at the time of submittal of shop drawings, a list designating the material to be used for each item. Where mill tests are required, purchase orders must contain the test site address and the name of the testing agency. Furnish a shipping bill or memorandum of each shipment of finished pieces or members to the project site, giving the designation mark and weight of each piece, the number of pieces, the total weight, and if shipped by rail in carload lots, the car initial and number. Submit material records before the beginning of fabrication. Additional requirements for this submittal are listed below.

2.1.4 Welded Connections

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NOTE: The provisions outlined in this guide specification govern the construction of NEW HSS using appropriately graded ASTM A709 steel with required toughness and weld provisions. The welding requirements specified may not be arbitrarily applied to older steels or steels not meeting toughness requirements (ASTM A36, ASTM A572, ASTM 992 etc.) Use caution when approving alternate base metals for use with AWS D1.5. Alternate base metals will require additional weld processes and testing for each basemetal and weld metal combination. For each alternate base metal specified, the following requirements must be added to this specification:

1. Charpy Testing in accordance with ASTM A709 Table 11 for the temperature zone where the structure will be used.

2. Base metal scanning for defects in accordance with ASTM A578.

3. Prohibition of base metal repairs as specified in paragraph 6.8 of ASTM A709.

4. Handling requirements to prevent damage

5. Prevention of base metal repairs performed by the mill. Fracture critical members produced in accordance with ASTM A709 are prohibited from having base metal repairs performed by the mill as described in AWS D1.5 in order to ensure that repairs meet toughness requirements. All alternate base metals specified must also be prohibited from base metal repairs performed by the mill and must be certified as being free from repairs.

6. Tracking and labeling requirements in accordance with ASTM A709 to ensure components supplied as tension elements meeting toughness requirements are identified and labeled for quality control tracking purposes.

7. A PQR and WPS for each approved alternate base metal and base metal combinations. Each configuration of combined material such as A709 plate spliced to A572 Grade 50 plate must have a unique PQR and WPS generated which shows that the completed weld meets toughness requirements.

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2.1.4.1 Welding Procedure

a. Perform welding in accordance with the applicable provisions of AWS D1.5M/D1.5. Prior to the start of production welding, submit a complete schedule of welding procedures for a typical structure that conforms to the requirements specified in the provisions of AWS D1.5M/D1.5. Provide detailed procedure specifications and tables or diagrams showing the procedures to be used for each required joint in the schedule.

b. Submit a Welding Procedure Specification (WPS) for each weld to be made. Submit Welding Procedure Specifications and Procedure Qualification Records (PQR) for approval before fabrication is

commenced. Submit for approval copies of the Welding Procedure Specification and the results of the procedure qualification test for each type of welding which requires procedure qualification. Submit the WPS and PQR with the shop drawings. Prepare and qualify each WPS in accordance with the applicable provisions of AWS D1.5M/D1.5. Show types and locations of welds designated or specified to receive nondestructive examination and identify the weld as FCM when applicable in the welding procedure. A WPS is always required, even if the procedure is considered prequalified in accordance with AWS D1.5M/D1.5. Clearly identify each procedure as being either prequalified or qualified by tests. If a PQR is developed, a representative of the Government must witness the test plate welding and the specimen testing. Approval of any procedure, however, will not relieve the Contractor of the responsibility for producing a finished structure meeting all requirements of these specifications. Make copies of the WPS available for reference to the welders, welding operators and tack welders. An AWS CWI meeting the specified qualifications or welding engineer must approve all WPS's and PQR's.

2.1.4.2 Welder Performance Qualification of Welders and Welding Operators

Qualify and requalify welding operators, welders, and tack welders if necessary for the particular type of work to be done. Perform qualification in accordance with AWS D1.5M/D1.5. Before assigning any welder, welding operator, or tacker to work under this contract, submit the names and certification that each individual is qualified as specified. State the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is qualified, and the date qualified on the certification. The company employing the welder must certify by signature that the welder has passed all code required testing and meets the requirements for certification. Submit copies of the Performance Qualification records for approval before fabrication is commenced. The welder and welding operators may have to repeat the qualifying tests when, in the opinion of the Contracting Officer, the work indicates a reasonable doubt as to proficiency. In such cases, the welder must be recertified, as above, after successfully passing the retest; otherwise, he/she must be disqualified until successfully passing a retest. The period of effectiveness for all welder and welding operator performance qualifications must be in accordance with AWS D1.5M/D1.5. All welders performing the work must keep the certification current for the duration of the contract. All expenses are borne by the Contractor in connection with qualification and requalification.

2.1.4.3 Welding Process

Perform welding of structural steel in accordance with applicable provisions of AWS D1.5M/D1.5 by an electric arc welding process using a method which excludes the atmosphere from the molten metal for all welds. Minimize residual stresses, distortion and shrinkage during welding.

2.1.4.4 Welding Technique

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NOTE: AWS D1.5 Clause 12 allows electrodes with an "-R" designation to remain exposed to the atmosphere for up to 9 hours. Once redried, the exposure time reverts to table 4.7. Electrodes are still only allowed to redry once according to AWS D1.5, Clause

12

FCAW wire storage requirements are similar to low hydrogen SMAW electrodes. Requirements for storage are found in AWS D1.5 Clause 12 Duration of exposure times are defined and all wire exposed for 24 hours is not to be used for fracture critical welding.

The SMAW electrodes indicated in Clause 12 are the ONLY procedures prequalified in AWS D1.5 Clause 12 for fracture critical welding. Reference Clause 12 for which electrodes are prequalified.

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2.1.4.4.1 Filler Metal

The electrode, electrode-flux combination and grade of weld metal must conform to the appropriate AWS specification for the base metal and welding process being used or must be as shown where a specific choice of AWS specification allowable is required. Follow the requirements of AWS D1.5M/D1.5 for matching filler metal. Include the AWS designation of the electrodes to be used in the schedule of welding procedures. Use only low hydrogen electrodes for manual shielded metal-arc welding regardless of the thickness of the steel. Maintain low moisture of low hydrogen electrodes using a controlled temperature storage oven at the job site as prescribed by AWS D1.5M/D1.5, AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause. Power controlled temperature storage ovens at all times. Subject FCAW filler metal to the storage and handling requirements defined in AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause. Do not combine filler metals and processes in the same joint or weld.

2.1.4.4.2 Preheat and Interpass Temperature

Perform preheating as required by the applicable provisions of AWS D1.5M/D1.5 for all welds except that the temperature of the base metal must be at least 20 degrees C 70 degrees F. Preheat fracture critical welds in accordance with M 270M/M 270 (A709/A709M) Gr. 250 (36), 345 (50), 345S (50S) Minimum Preheat and Interpass Temperatures Table and the PQR/WPS. Slowly and uniformly heat the weldments that are required to be preheated by approved means to the prescribed temperature, hold at that temperature until the welding is completed, and then permit the weldments to cool slowly as required and in accordance with the approved WPS in order to prevent cracking or distortion.

2.1.4.5 Workmanship

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NOTE: AWS D1.5/D1.5M, Clause 3.13.3 indicates that backing bars parallel to stress or not subjected to stress need not be removed unless specified on the contract drawings. The guide spec should require backing bars to be removed in order to facilitate inspection according to ER-1110-2-8157.

AWS D1.5 Clause 12 allows E7018M and E7018-R electrodes to be used for tack welding without preheat. This should be prohibited to avoid concern

about tack welds or temporary welds or welds of ancillary items on fracture critical members. Low moisture electrodes are acceptable by the code in this instance because they are less likely to produce hydrogen cracking in the HAZ. AWS D1.5 requires that all tack welds be remelted and incorporated into the final weld. In order to ensure that the tack welds are incorporated and properly remelted the maximum size and minimum length are specified to ensure that small tack welds without preheat are not permitted.

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Perform welding in accordance with AWS D1.5M/D1.5, Workmanship Clause for all welds and other applicable requirements of these specifications.

2.1.4.5.1 Preparation of Base Metal

Prior to welding, inspect surfaces to be welded to assure compliance with the applicable Clauses of AWS D1.5M/D1.5.

2.1.4.5.2 Tack and Temporary Welds

Make tack and temporary welds required for fabrication and erection in accordance with AWS D1.5M/D1.5 under the controlled conditions prescribed herein for permanent work. Tack welds that are to be incorporated into the permanent work are subject to the same quality requirements as the permanent welds. Clean and fuse such tack welds thoroughly with the permanent welds. Multiple-pass tack welds must have cascaded ends. Remove defective tack welds before permanent welding. Make all welds using low-hydrogen welding electrodes and with welders qualified for permanent work as specified elsewhere in these specifications. Preheat as required by AWS D1.5M/D1.5 for permanent tack welds except that the minimum temperature must be 20 degrees C 70 degrees F in any case, regardless of electrode used. All tack welds which will be incorporated into the final weldment must be a maximum of 3 mm 1/8 inch with a minimum length of 25 mm 1 inch long spaced at a maximum of 150 mm 6 inch on center. In making temporary welds, arc strikes must not be struck in other than the weld joints. Remove each temporary weld as required by AWS D1.5M/D1.5, Workmanship Clause. Grind out and fill all arc strikes struck outside the weld zone, and inspect in accordance with AWS D1.5M/D1.5.

2.1.4.5.3 Weld Access Holes

Provide weld access hole as shown on contract drawings. Show all required weld access holes on shop drawings.. Notify the Contracting Officer for the approval of weld access hole additions if the oversite of intersecting out-of-plane welds is encountered. Payment for the addition of weld access holes not shown on contract drawings or shop drawings will be the Contractor's responsibility.

2.1.4.5.4 Weld Backing Removal

Unless otherwise indicated, remove all steel weld backing material from welded joints prior to testing.

2.1.5 Bolted Connections

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NOTE: Use of Grade A490M A490 bolts requires the following tension values:

16 mm 5/8 inch	**114 kN 24 kips**
20 mm 3/4 inch	**179 kN 35 kips**
22 mm 7/8 inch	**221 kN 49 kips**
24 mm 1 inch	**257 kN 64 kips**
27 mm 1-1/8 inch	**334 kN 80 kips**
30 mm 1-1/4 inch	**408 kN 102 kips**
36 mm 1-3/8 inch	**595 kN 121 kips**
1-1/2 inch	**148 kips**

The following information is required for Slip Critical Connections. Slip critical connections may exist in gate splices, lifting eyes, dogging brackets etc. These connections MUST be defined as slip critical on the drawings prior to adding these provisions to the specifications.

Bolts:
a. Proof load tests (ASTM F606 Method 1) are required. Minimum frequency of tests is as specified in ASTM F3125/F3125M.

b. Wedge tests on full size bolts (ASTM F606 paragraph 3.5) are required. Minimum frequency of tests is as specified in ASTM F3125/F3125M.

Nuts: Proof load tests (ASTM F606 paragraph 4.2) are required. Minimum frequency of tests is as specified in ASTM A563, paragraph 9.3.

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Install all high strength connections to a tension not less than that given below for ASTM F3125/F3125M Grade A325M A325 Bolts. Use turn-of-nut method, direct tension indicator, calibrated wrench, or alternative design bolt methods for tightening. The installation and verification of all bolted assemblies must follow the requirements of RCSC A348..

16 mm5/8 inch	91 kN19 kips
20 mm3/4 inch	142 kN28 kips
22 mm7/8 inch	176 kN39 kips
24 mm1 inch	205 kN51 kips

27 mm1-1/8 inch	267 kN56 kips
30 mm1-1/4 inch	326 kN81 kips
36 mm1-3/8 inch	475 kN97 kips
1-1/2 inch	118 kips

Tighten all other connections to the snug-tight condition. The snug-tight condition is defined as the tightness attained by either a few impacts of an impact wrench or the full effort of a worker with an ordinary spud wrench that brings the plies into firm contact. Perform snugging in a systematic manner starting at the most rigid part of the joint and working to the outside of the connection or the free edges. Install all bolts in a connection to a snug tight condition prior to pretensioning. Perform pretensioning in the same order as snug-tightening.

2.1.5.1 Bolts, Nuts, and Washers

Provide bolts, nuts and washers of the type specified or indicated. Use ASTM A563 nuts with high strength bolts. Equip all nuts with washers. Where the use of high strength bolts is specified or indicated the materials, workmanship and installation must conform to the applicable provisions of ASTM F3125/F3125M and RCSC Specifications for Structural Joints using Grade A325M A325 or Grade A490M A490 Bolts. Use ASTM F436/F436M washers with high strength bolts.

2.1.5.2 Bolt Holes

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NOTE: AWS D1.5 Clause 3.7.7 allows misdrilled bolt holes to be filled either by welding or by installation of a bolt or may be left open. This provision needs to be addressed in the guide specification to prevent holes in hydraulic structures. In addition, AWS D1.5 C-2.3.3 suggests that plug and slot welds should only be used for the transfer of shear forces due to the high risk of discontinuities in these welds. Reference the discussion above allowing the filling of misaligned holes with either a bolt or to be filled with weld metal. A misaligned overlapped joint with a single bolt hole in it would create a plug weld in this location.

AWS D1.5 Clause 2.9.7 requires that plug welds in material 16 mm (5/8 inch) and greater only need to be welded to 1/2 the thickness of the material but not less than 16 mm (5/8 inch). If Plug welds are being used for any reason, consider whether they need to be fully filled (such as when used as track plates or guides) and preclude the Clause 2.9.7 provisions from applying.

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Accurately locate bolt holes so that they are smooth, perpendicular to the

member and cylindrical.

a. Drill or subdrill and ream holes for regular bolts in the shop not more than 2mm 1/16 inch larger than the diameter of the bolt.

b. Match-ream or drill holes for high strength fitted bolts. Remove burrs resulting from reaming. The threads of bolts must be excluded from the shear plane. Provide the body diameter of holes and bolts with the tolerances specified on the drawings.

c. The provisions of AWS D1.5M/D1.5 Workmanship Clause allowing misdrilled holes do not apply. Repair all misdrilled holes as directed by the Engineer. Submit repair of mislocated or misdrilled holes to the Government for approval.

2.1.5.3 Rotational Capacity Tests

The manufacturer or distributor must perform rotational-capacity tests in accordance with ASTM F3125/F3125M on all black or galvanized (after galvanizing) bolt, nut, and washer assemblies prior to shipping. The Contractor is responsible for assuring the rotational-capacity testing is performed by either the manufacturer or distributor prior to shipping. Submit Manufacturer Certified Test Reports and Distributor Certified Test Reports.

2.1.6 Miscellaneous Provisions

2.1.6.1 Weldments

Portions of the structure include thick weldments where locked in thermal stresses may make final dimensions unstable. Sequence the work and perform post weld heat treatment in accordance with the qualified WPS such that final machining achieves stable specified dimensions and tolerances.

2.1.6.2 Drain Holes

Locate drain holes as shown on the drawings, unless otherwise noted. Drill drain holes. Flame cutting of holes will not be permitted.

2.1.6.3 Seal Welds

Seal welds are required to maintain water tightness. Show and make all seal welds as indicated on the shop drawings. Make seal welds, when called for on the drawings, the minimum size fillet weld as required in AWS D1.5M/D1.5. In addition, seal welds may require weld wrapping around reentrant corners that is specifically prohibited in AWS D1.5M/D1.5. All seal welds on fracture critical members are subject to the minimum preheat requirements of AWS D1.5M/D1.5 Clause 12 as applicable. Subject all seal welds to the same testing requirements required for a fillet weld made to any fracture critical member according to AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause.

2.1.7 Shop Assembly

Perform fabrication and assembly in an indoor, climate controlled shop. Closely check each item to ensure that all necessary clearances have been provided and that binding does not occur in any moving part. All shop testing for assembly must be witnessed by the Government Representative. Immediately remedy disclosed errors or defects without cost to the

Government.

2.1.8 Seals

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NOTE: Define seal requirements in the following paragraph recognizing that seal bars and keeper bars welded to fracture critical members are fracture critical welds.
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Provide each [structure] [_____] with bulb seals, rubber bearing blocks, and bearing seals as indicated. Compound bulb seals, rubber bearing blocks, and bearing seals of ethylene propylene dimonomer (EPDM) or neoprene (CR) conforming to ASTM D2240, ASTM D412, ASTM D573, ASTM D471, ASTM D1149, ASTM D395, ASTM D624 and ASTM D1630. Provide the surfaces of finished splices that are smooth and free of irregularities. Match-drill bolt holes in the rubber seals with the seal support and clamping bars, as applicable; to insure proper fit and spacing between holes of the completed seal assembly. Match finish seal support and clamping bars to conform to the configurations shown on the drawings. Install the seals and blocks after painting has been completed.

2.2 CERTIFIED TEST REPORTS

Submit reports of tests, inspections, and verifications of all materials used under this contract approved by the Government before incorporation into the structure.

2.2.1 General

Have required material tests and analyses performed at the Contractor's expense, to demonstrate that materials are in conformity with the specifications. Tests, inspections, and verifications must conform to the requirements of the particular sections of these specifications for the respective items of work unless otherwise specified or authorized. Conduct tests in the presence of the Contracting Officer. Furnish specimens and samples for additional independent tests and analyses upon request by the Contracting Officer.

2.2.2 Nondestructive Testing

When doubt exists as to the soundness of any material part, such part may be subjected to any form of nondestructive testing determined by the Contracting Officer. The cost of such investigation will be borne by the Government. Any defects will be cause for rejection and rejected parts must be replaced and retested by the same test method that located the defect at the Contractor's expense.

2.2.3 Inspection of Structural Steel Welding

Maintain an approved inspection system and perform required inspections. Inspect welding to determine conformance with the requirements of AWS D1.5M/D1.5 and the approved welding procedures and provisions stated in other sections of these specifications. Clean and carefully visually examine all completed welds for insufficient leg sizes, cracks, undercutting, overlap, excessive convexity or reinforcement and other surface defects to ensure compliance with the requirements of AWS D1.5M/D1.5, Inspection Clause and the additional requirements of

AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause for the Fracture Control Plan. In addition, the Government may choose to hire a third party inspector to perform verification of this work. The Government's third party inspection will occur at various times throughout the duration of fabrication. The Contractor will be advised that third party inspection must be coordinated with the Contracting Officer, and the Contractor for all verification inspections selected by the Government.

2.2.3.1 Visual Examination

Prior to any welding, a certified weld inspector (CWI) supplied by the Contractor must visually inspect and document on the weld tracking log the preparation of material for welding at each weld or joint in order to assure compliance with AWS D1.5M/D1.5 and approved WPS. The CWI must also perform visual inspection on all completed welds throughout the welding process to assure compliance with AWS D1.5M/D1.5 and approved WPS. Clean all completed welds free of oxide, flux, scale, paint spatter, or other foreign matter before inspection. Document all non-destructive testing on the weld tracking log.

2.2.3.2 Nondestructive Examination

Perform the nondestructive examination of welds as specified or described on the drawings or as listed in the following paragraphs. Document all non-destructive testing on the weld tracking log.

2.2.3.2.1 Testing Agency

Perform the nondestructive examination of welds and the evaluation of examination tests as to the acceptability of the welds by a testing agency adequately equipped and competent to perform such services or by the Contractor using suitable equipment and qualified personnel. In either case written approval of the examination procedures is required and the examination tests must be made in the presence of the Contracting Officer. The evaluation of examination tests are subject to the approval of, and all records become the property of, the Government. Qualify and certify Certified Weld Inspectors (CWI) in accordance with the provisions of AWS QC1 and the CWI must be familiar with AWS D1.5M/D1.5 fracture critical member inspection as required in AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause. The laboratory and all personnel performing nondestructive testing must be qualified as specified. Only individuals qualified for NDT Level II or Level III may perform nondestructive testing. The Level III NDT inspector who supervises all NDT must possess a currently valid American Society for Nondestructive Testing (ASNT) Level III certificate for each of the processes for which they are qualified. Include copies of the NDT inspector certifications, including the ASNT certificate of Level III NDT Technician that certified the Level II Technicians in the submittals.

2.2.3.2.2 Examination Procedure and Extent

Perform all nondestructive testing in accordance with AWS D1.5M/D1.5, Inspection Clause or AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause, as applicable. Perform testing as defined in the following paragraph.

2.2.3.2.3 Acceptability of Welds

Welds will be unacceptable if shown to have defects prohibited by

AWS D1.5M/D1.5.

2.2.3.2.4 Examination Procedures

Perform examination procedures to the following requirements:

****

NOTE: List here the type, location and extent of welds to be subject to nondestructive examination. The welds so listed should also be shown using the appropriate designation of AWS A2.4 "Standard Symbols for Welding, Brazing and Nondestructive Examination".

If a weld is to be fully tested as fracture critical it must be labeled fracture critical and if testing on any other critical welds is needed, designate the weld testing by item, both on the drawing and on the specifications. While the standard specifications may require a percentage of welds to be tested, if specific welds are to be subjected to MT, PT, or UT, ensure that these welds are specified on the drawings. Consider specifying test requirements in the tail of each weld needing NDT on.

AWS D1.5M/D1.5 Clause C-2.1.5 indicates that all requirements for special inspections not covered by this code need to be specified in the contract documents. This ensures that required inspections and tests will be performed, avoiding disagreement over minimum weld quality and additional costs as described in D1.5M/D1.5 Clause 6.6.5. AWS D1.5 Clause 6.6.5 says that if NDT other than originally specified in the contract is requested by the Engineer, the Contractor must perform the requested inspection. The costs will be negotiated by the owner and the Contractor. The cost of extra work will be the responsibility of the owner, unless the testing reveals an attempt to defraud the owner. Ensure that all testing requirements are defined on the drawings or listed in these specifications. Do not assume that testing requirements can be amended after award without increased cost. Identifying all testing requirements is defined as the responsibility of the Engineer as referenced above. Specifying testing according to AWS D1.5 without specifically identifying what the Engineer wants tested will not produce a permanent record of the structure in accordance with ER-1110-2-8157.

Ultrasonic testing should be used for groove welds in butt, tee or corner joints.

Radiographic or ultrasonic testing should be used for groove welds in butt joints.

Both UT and RT should be used for fracture critical tension splices.

Magnetic particle inspection may be used for the detection of cracks and other discontinuities at or near the root and for the surface passes and intermediate layers not exceeding 6 mm 1/4 inch thickness of ferrous materials.

Dye penetrant inspection should be used only for detection of discontinuities that are open to the surface and for non ferrous material.

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2.2.3.2.4.1 Ultrasonic Testing (UT)

Perform ultrasonic testing of welds in accordance with the provisions of AWS D1.5M/D1.5. Make a record of each weld tested. Variations in ultrasonic testing procedures, equipment, and acceptance standards not included in Clause 8 of AWS D1.5 may be used with the approval of the Engineer. Such variations include curved scanning surfaces, other thicknesses, weld geometries, transducer sizes, frequencies, couplant, painted surfaces, testing techniques, etc. Record all approved variations in the inspection records.Perform all UT in conformance with a ultrasonic written procedurewhich contains a minimum of the following information regarding the UT method and examination techniques:

a. The types of weld joint configurations to be examined

b. Acceptance criteria for the types of weld joints to be examined.

c. Type of UT equipment (manufacturer, model number, serial number)

d. Type of transducer, including frequency, size, shape, angle and type of wedge.

e. Scanning surface preparation and couplant requirements

f. Type of calibration test block(s) with the appropriate reference reflectors

g. Method of calibration and calibration interval

h. Method for examining for laminations prior to weld evaluation.

i. Weld root index marking and other preliminary weld marking methods

j. Scanning pattern and sensitivity requirements

k. Methods for determining discontinuity location height, length and amplitude level

l. Method of verifying the accuracy of the completed examination. This verification may be by re-UT by others (audits), other NDE methods, macroetch specimen, gouging or other visual techniques as may be approved by the Engineer
.

m. Documentation requirements for examinations, including any verifications performed

n. Documentation retention requirements

2.2.3.2.4.2 Radiographic Testing (RT)

Perform, evaluate and report radiographic testing in accordance with the applicable requirements of AWS D1.5M/D1.5.

2.2.3.2.4.3 Magnetic Particle Inspection (MT)

Perform magnetic particle inspection of welds in accordance with the provisions of ASTM E709 and AWS D1.5M/D1.5, Inspection Clause and AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause where applicable. Requirements of AWS D1.5M/D1.5 Inspection Clause do not apply to these specifications, such that secondary members are subject to MT sampling as required. MT by the prod method is prohibited.

2.2.3.2.4.4 Dye Penetrant Inspection (PT)

Perform dye penetrant inspection(PT) of welds in accordance with the applicable provisions of ASTM E165/E165M.

2.2.4 Welds to be Subject to Nondestructive Examination

2.2.4.1 Structural Steel Non-Fracture Critical Members

Complete Joint Penetration Groove Welds. Inspect welds in conformance with AWS D1.5M/D1.5, Inspection Clause. Perform testing with a representative sample of welds and weld types from all welders and each of the processes each welder used. Spread testing throughout the project. Test [100] [_____] percent of all Complete joint penetration groove welds on non-fracture critical members.

2.2.4.2 Structural Steel Non-Fracture Critical Member Fillet Welds and Partial Penetration Groove Welds

Randomly select a minimum of [50] [_____] percent of all fillet welds and partial penetration welds for examination by magnetic particle and or dye penetrant testing procedures described previously. The random testing includes a representative sample of welds and weld types from all welders and each of the processes each welder used. Spread the random testing throughout the project. Develop and submit a schedule of random testing for approval prior to fabrication.

2.2.4.3 Structural Steel Fracture Critical Member Welds

Test all welds on FCM in accordance with AWS D1.5M/D1.5, AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause. Subject 100 percent of all fracture critical complete joint penetration groove welds on fracture critical members to ultrasonic testing. Inspect all fracture critical welds to the tension criteria of the AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause of AWS D1.5M/D1.5. Perform all testing of fracture critical welds to the tension acceptance criteria of Inspection Clause. Inspect all partial joint penetration groove welds and fillet welds on fracture critical members with 100% MT in additional to visual inspection. Remove weld backing from all fracture critical welds prior to all NDE unless the weld backing member is permanent. The UT report for all groove welds must include non-rejectable indications with defect severity ratings within 5 db of being rejectable and must be fully recorded as to indication, rating, size, and location. In accordance with

AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause, record all discontinuities found by UT.

2.2.5 Test Coupons

The Government reserves the right to require the Contractor to remove coupons from completed work when doubt as to soundness cannot be resolved by nondestructive examination. Repair all replaced members with complete joint penetration groove welds. Submit proposed repair work for approval before commencing work. Develop a plan to reduce residual stress in all repaired weldments. The expense for removing and testing coupons, xrepairing cut members and the nondestructive examination of repairs will be borne by the Government. If the coupons fail testing, repair costs as well as sampling costs, will be borne by the Contractor.

2.2.6 Supplemental Examination

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NOTE: Consider adding Third Party testing in this section in lieu of "allowing" the Government to perform testing at our discretion. Consider stipulating that Third Party testing, either hired by the Contractor or hired by the Government, will be required to confirm inspection findings. Third party inspection can be used to check additional welds when indications are found or to confirm UT findings when questions arise regarding the evaluation of UT findings etc. Consider including both of these requirements in this specification. The problem with the statement "third party" is defining the impartiality of this testing agency. CENWP has had a recent experience where the fabrication shop was extremely busy so they hired an outside testing agency as a subcontractor to work in their fabrication shop. The fabricator then claimed that the testing agency was both the primary and third party testing agency. For this reason, it is recommended that each district hire an independent testing agency for a day to confirm the findings of the fabricators inspector. A typical day of UT inspection costs on the order of $1000. Each district should have a working relationship with the local testing agency from HSS inspections. Decide ahead of time how to handle independent evaluation of testing results. Having the ability to hire a testing agency ensures that the fabricator is aware of the potential to have an outside testing firm on site and allows a neutral party to evaluate inspection findings when a disagreement arises. These requirements for QA are discussed above under witness point but do not address the potential for bringing in outside assistance for conflict resolution. By bringing in an independent testing firm, anonymity can be maintained.

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When the soundness of any weld is suspected of being deficient, due to faulty welding or stresses that might occur during shipment or erection, the Government reserves the right to perform nondestructive supplemental

examinations before final acceptance. The cost of such inspection will be borne by the Government. If welds are found to be defective, repair of the defective work and cost of the reinspection will be borne by the Contractor.

2.2.7 Structural Steel Welding Repairs

Defective welds in the structural steel should be defined as critical repairs or non-critical repairs and must be repaired in accordance with AWS D1.5M/D1.5, Workmanship Clause for non-FCM and AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause for FCM. Make separate submittals for Welding Repairs - Non-Fracture Critical Members and Welding Repairs - Fracture Critical Members. Submit welding repair plans for steel and for fracture critical welds, approved prior to making repairs. Address weld repairs within the weld as well as weld repairs for base metal defects in the welding repair plan. All weld repairs to fracture critical members are considered critical welds in accordance with AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause and must be approved by the Contracting Officer. Weld repairs to mill defects in the base metal, repair of cracks, or a revised design to compensate for deficiencies require approval from the Government. The Contractor may prepare procedures and specifications for the repair of anticipated routine problems and submit them for approval before fabrication begins. Critical weld repairs require a WPS specific to the weld repair. Remove defective weld metal to sound metal by use of air carbon-arc gouging or by mechanical methods. Oxygen gouging for purposes of weld repair is not permitted. Thoroughly clean metal surfaces before welding. Inadequate removal of welds that damages the base metal are subject to replacement of the base metal, or compensation for the deficiency in a manner approved by the Contracting Officer. Retest repaired welds by the same methods used in the original inspection. Except for the repair of members cut to remove test coupons and found to have acceptable welds, costs of repairs and retesting are borne by the Contractor.

2.2.8 Control Dimensions

After fabrication of each structure, but prior to painting, record and submit on the "control dimensions" chart provided, the actual dimensions indicated on drawing [SXX]. Verify control dimensions prior to witness points defined under the schedule of witness points so that they may be verified during inspection and prior to either final assembly, painting, or installation of the structure. Verify and document all control dimensions prior to shipping the structure.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Cleaning

Thouroughly clean all parts to be installed. Remove packing compounds, rust, dirt, grit and other foreign matter. Clean holes and grooves for lubrication. Examine enclosed chambers or passages to make sure that they are free from damaging materials. Where units or items are shipped as assemblies they will be inspected prior to installation. Disassembly, cleaning and lubrication will not be required except where necessary to place the assembly in a clean and properly lubricated condition. Do not use pipe wrenches, cold chisels or other tools likely to cause damage to

the surfaces of rods, nuts or other parts for assembling and tightening parts. Tighten non-Structural bolts and screws firmly and uniformly but care must be taken not to overstress the threads. Place a half nut first when it is used for locking followed by the full nut. Lubricate threads of all bolts except high strength bolts, nuts and screws with an approved lubricant before assembly. Coat threads of corrosion-resisting steel bolts and nuts with an approved anti-galling compoundantigalling compound. Driving and drifting bolts or keys will not be permitted.

3.1.2 Alignment and Setting

Each machinery component or structural unit attached to structures fabricated according to this specification must be accurately aligned by the use of steel shims or other approved methods so that no binding in any moving parts or distortion of any member occurs before it is fastened in place. The alignment of all parts with respect to each other must be true within the respective tolerances required. Shims are to remain with the final installation where called for on the drawings. Apply anti seize compound to laying surfaces where parts are press-fit.

3.2 PROTECTION OF FINISHED WORK

Thouroughly clean machined surfaces of foreign matter. Protect all finished surfaces by suitable means. Oil and wrap with moisture resistant paper unassembled pins and bolts or protect by other approved means. Wash finished surfaces of ferrous metals to be in bolted contact with an approved rust inhibitor and coated with an approved rust resisting compound for temporary protection during fabrication, shipping and storage periods.

3.3 PAINTING

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NOTE: Paint preparation is defined in the paint specifications. Consider that the level of preparation required is directly related to the quality of paint application as well as the cost of the project. Industry standards governing the description of surface preparation categories are published by the Society for Protective Coatings SSPC. For most HSS applications the preparation level should be SSPC-SP5 - White Metal Blast Cleaning. This level of preparation removes all contaminents from the surface of the steel. This preparation has limited exposure time (8 hours or less depending on relative humidity) and is therefore not included in this section. Grinding of plate edges and corners is recommended to remove hardness due to flame cutting. Hardness on the edges of plates (flanges of girder etc.) will result in insufficient roughness to permit proper paint adhesion. Grinding these areas to remove the oxygen cut area will produce proper adhesion and will also reduce the potential for hydrogen embrittlement.

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Paint all exposed surfaces of the structure as specified in Section 09 97 02: PAINTING - HYDRAULIC STRUCTURES. Grind all edges of plate prior to coating. Perform grinding of plate edges before paint preparation in

order to remove hardness as a result of flame cutting. Brake and grind all square edges and holes other than bolt holes to a 2 mm 1/16 inch radius prior to painting.

-- End of Section --