US Army Corps of Engineers

ENGINEERING AND CONSTRUCTION BULLETIN

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SUBJECT: Clarification of Policies and Guidance Associated with the Welding of Hydraulic Steel Structures (HSS)

CATEGORY: Policy and Guidance

1. References:

a. Engineer Manual (EM) 1110-2-2107, Design of Hydraulic Steel Structures, 1 AUG 2022.

b. EM 1110-2-6054, Inspection, Evaluation and Repair of Hydraulic Steel Structures, 1 DEC 2001.

c. Engineer Regulation (ER) 1110-1-8152, Professional Registration and Signature on Design Documents, 24 JAN 2012.

d. ER 1110-2-1150, Engineering and Design for Civil Works Projects, 31 AUG 1999.

e. ER 1110-2-1156, Safety of Dams - Policy and Procedures, 31 MAR 2014.

f. ER 1110-2-8157, Responsibility for Hydraulic Steel Structures, 15 JUN 2009.

g. ER 1165-2-217, Civil Works Review Policy, Water Resource Policies and Authorities, 1 MAY 2021.

h. ER 1180-1-6, Construction Quality Management, 20 MAR 2025.

2. Definitions.

The Engineer. The Engineer (also referred to as the Engineer of Record "EOR"), as defined in ER 1110-2-8157, is the individual responsible for the HSS, with direct oversight of the design or evaluation. The Engineer is designated by, and acts on behalf of, the District's Chief of Engineering Division and ensures the HSS meets all the requirements of ER 1110-2-8157.

Hydraulic Steel Structures (HSS). Hydraulic steel structures are structures which control or regulate water as defined in ER 1110-2-8157.

Repair. Repairs are actions that restore the structure to its original, pre-damaged condition and function. Repairs are limited to localized or specific defects and would not significantly extend the service life of the structure. Examples of repairs include spot painting, crack repairs, and replacement of damaged parts.

Rehabilitation. Rehabilitation is a comprehensive effort that is intended to extend the service life

of the HSS and/or ensure it can resist the original design criteria as well as meet current standards. Rehabilitation can include strengthening, replacement of major components, and possibly complete replacement.

Quality Control (QC). The system to manage, control, and document work activities to comply with specified requirements.

Quality Assurance (QA). The system by which the Government fulfills its responsibility to be certain that QC functions effectively and the end product complies with the specified requirements.

3. Purpose.

a. This Engineering and Construction Bulletin (ECB) amends and clarifies the intended use of EM 1110-2-2107, and summarizes key policies, roles, guidance, and procedures with respect to welding quality associated with ER 1110-2-8157, EM 1110-2-2107, and EM 1110-2-6054. The purpose of this ECB is to ensure qualified personnel within Operations and Engineering are responsibly designing, executing, and inspecting welded fabrication associated with rehabilitation and repairs to hydraulic steel structures (HSS) in a coordinated, collaborative, and consistent manner.

b. The guidance provided in this ECB addresses the roles and responsibilities of the designated Engineer or Engineer of Record (EOR) ("the Engineer") such that HSS are fabricated, rehabilitated, or repaired per ER 1110-2-8157 requirements. While additional engineering disciplines, including mechanical and electrical, are typically included in HSS design, this ECB does not address those requirements. The Engineer must ensure that proper coordination of all required disciplines from Engineering, Operations, and Construction are included in the design of new HSS as well as in the rehabilitation or repair of existing structures.

4. Applicability. This ECB applies to U.S. Army Corps of Engineers (USACE) Engineering and Construction (E&C) personnel working within the Civil Works Program.

5. Background.

a. The intent of ER 1110-2-8157 is to ensure a qualified engineer, the Engineer, is reviewing and approving the design, rehabilitation, and repair of all HSS. As per ER 1165-2-217 and ER 1110-2-8157, the District's Chief of Engineering has ultimate signature authority on all HSS documentation, thereby approving final fabrication, rehabilitation, and repair at the direction of the Engineer – ultimately certifying on behalf of USACE that each HSS has been properly documented per ER 1110-2-8157 requirements.

b. Recent modifications and repairs to HSS have been conducted without coordination with the Engineer. Work was completed by uncertified welders without the use of a welding procedure specification (WPS) and without appropriate quality control (QC) and quality assurance (QA) being performed. Per ER 1110-2-8157, all welding to HSS (new or existing) must be performed by certified welders with an applicable WPS per code of fabrication (i.e.,

AWS D1.1 or AWS D1.5) and must have proper QC and QA testing in accordance with ER 1180-1-6. Guide specification 05 59 20 Fabrication of Hydraulic Steel Structures provides the standard practice for fabrication, including requirements for welder qualifications, inspector qualifications, and other QC and QA.

6. Policy.

a. The District Chief of Engineering function designates a qualified engineer to be the Engineer for all HSS. The Engineer's role requirements are detailed in ER 1110-2-8157.

b. To meet ER 1110-2-8157 requirements, all welding on new or existing HSS must be conducted under the review and approval of the Engineer. Welding must be performed by certified welders that have been qualified to the code of fabrication (AWS D1.1 or AWS D1.5), utilizing applicable WPS and required QC and QA.

c. In all cases, the intent of any evaluation of new or existing HSS is to ensure the safe and reliable operation in accordance with ER 1110-2-8157. For new HSS and existing HSS that require rehabilitation, the Engineer must evaluate the HSS in accordance with and for the load cases specified by EM 1110-2-2107. When HSS require repairs, evaluation in accordance with EM 1110-2-2107 is not required. The Engineer shall, however, review original design loads and load cases, and compare to existing guidance as well actual loading conditions. The Engineer, in coordination with Operations, shall determine the appropriate extent of repair, or if rehabilitation or replacement of the structure is required. Refer to the definitions for repair and rehabilitation.

d. The fabrication of new HSS, as well as the rehabilitation and repair of existing structures, must be completed with the appropriate QC and QA necessary, with particular attention to welded fabrication, to meet ER 1110-2-8157 requirements. Mandatory inspection requirements, including additional nondestructive testing (NDT), such as Magnetic Particle (MT), Dye Penetrant (PT), Ultrasonic (UT) and Radiographic testing (RT), as well as visual inspection of welds must be completed. Documentation of the NDT for QC and verification testing for QA is a mandatory requirement of ER 1110-2-8157.

e. Documentation detailing mandatory NDT is the responsibility of the Engineer and must be recorded and stored in the HSS database. The web-based HSS database (https://apps1.nww.ds.usace.army.mil/hss/) managed by NWW should be used to store and manage inspection information associated with each HSS. The point of contact for the web-based HSS database is Bryan Mason, Bryan.C.Mason@usace.army.mil, CENWW-ECD-S.

7. Guidance.

a. The guidance and attachments of this ECB summarize qualification requirements and outline responsibilities and processes associated with the fabrication of new HSS and the rehabilitation or repair of existing HSS. The attachments include flow charts that identify individual roles and responsibilities associated with ensuring new and existing hydraulic steel structures are properly designed, fabricated, rehabilitated, or repaired to meet ER 1110-2-8157 requirements.

b. It is not the intent of EM 1110-2-2107 that existing HSS currently in service, be repaired to meet the standards contained in EM 1110-2-2107 and UFGS 05 59 20. However, these documents must be applied to new HSS to ensure the requirements of ER 1110-2-8157 have been met and that all new HSS are delivered with documentation confirming they are certified for use and do not require an additional initial HSS inspection. To clarify technical requirements for repair of HSS, a new guide specification will be authored that addresses the repair work per ER 1110-2-8157 requirements. To improve the application of guidance, EM 1110-2-2107 is amended as follows:

(1) Amend Section 1 by striking the words "and repair" from the purpose of the manual. See amended excerpt below:

"Purpose. This manual prescribes guidance for the design of Hydraulic Steel Structures (HSS) by load and resistance factor design (LRFD). This includes design of new structures, replacement, and rehabilitation."

(2) Amend Section 1.1 by striking the words "and repair" from the purpose of the manual. See amended excerpt below:

"Purpose. This manual prescribes guidance for the design of Hydraulic Steel Structures (HSS) by load and resistance factor design (LRFD). This includes design of new structures, replacement, and rehabilitation."

c. ER 1110-2-8157 requires the District's Chief of Engineering function to designate a qualified engineer ("the Engineer") for all HSS. Since the Chief of Engineering could be a Professional Engineer from a non-structural engineering discipline (e.g., electrical or hydraulic) and may not be familiar with structural steel design and fabrication, this formal designation of a qualified engineer ensures all HSS requirements are met per ER 1110-2-8157. The Engineer must:

(1) Be a structural engineer with at least 5 years of experience in the design, inspection and evaluation of HSS,

(2) have completed course work in structural steel design, welding, fatigue and fracture analysis, and

(3) have experience with structural steel fabrication.

Additionally, the Engineer is responsible for informing the District Chief of Engineering if ER requirements are not met. In all instances (new HSS fabrication, rehabilitation, or repair), the Engineer must ensure the HSS meets ER 1110-2-8157 requirements.

d. The Engineer, Operations staff, and Construction staff must coordinate in advance of and throughout an HSS project to make certain the requirements of ER 1110-2-8157 are met. The Engineer must solicit input from Operations staff to ensure operational needs, lessons learned and experience in operating and utilizing the HSS are incorporated into the project. The Project must provide adequate funding for the Engineer, Construction, and Operations staff to

ensure proper QC and QA are conducted throughout all phases of fabrication, rehabilitation, or repair.

e. Quality Control (QC) shall be performed throughout the entirety of welded fabrication whether for new, rehabilitation, or repair of HSS. QC is the responsibility of the fabricator, whether that is a Contractor, USACE staff, or the use of other federal agencies. QC includes both continuous and periodic inspection of the work by a CWI and/or qualified inspectors using various non-destructive testing (VT, PT, MT, UT, and RT) and/or destructive testing in accordance with UFGS Section 05 59 20, and applicable industry standards. QC shall be thoroughly documented by the fabricator and submitted to the Engineer for review and acceptance.

f. Quality Assurance (QA) of welding is an activity performed by the Government and the Engineer, independent from QC, that ensures the quality of the end product. QA for HSS fabrication and repairs generally involves verifying that qualified personnel are performing work in accordance with the appropriate procedures, and verifying that the appropriate level of QC is being performed effectively. Additional QA activities will include independent inspection, either by a third-party inspector or utilization of the Welding and Metallurgy TCX QA staff, of the fabrication. The Engineer should be onsite for all QA activities to verify proper QC is being conducted in accordance with ER 1110-2-8157 requirements.

g. Detailed guidance and recommendations for new HSS fabrication, rehabilitation, and repair are provided as attachments to this ECB. These are intended to be general "roadmaps" for proper execution and should be reviewed prior to and throughout all HSS projects.

8. Updates. New requirements will be included in updates to EM 1110-2-2107, ER 1110-2-8157, and EM 1110-2-6054 to reinforce these requirements upon expiration of this ECB.

9. Point of Contact. The HQUSACE E&C Point of Contact for this ECB is Ms. Mary Billings, CE-EC, (540) 665-2686.

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Encl.
Attachment A – Fabrication of New Hydraulic Steel Structures
Attachment B – Rehabilitation of Existing Hydraulic Steel Structures
Attachment C – Repair of Existing Hydraulic Steel Structures

ATTACHMENT A: FABRICATION OF NEW HYDRAULIC STEEL STRUCTURES

ABBREVIATIONS

AASHTO	American Associate of State Highway and Transportation Officials
AISC	American Institute of Steel Construction
AMPP	The Association for Materials Protection and Performance
ASNT	American Society of Nondestructive Testing
ATR	Agency Technical Review
AWS	American Welding Society
CoP	Community of Practice
CWI	Certified Welding Inspector
CX	Center of Expertise
DQC	District Quality Control
EDC	Engineering During Construction
EM	Engineering Manual
ER	Engineering Regulation
FCM	Fracture Critical Member
FCP	Fracture Control Plan
HDC	Hydroelectric Design Center
HSS	Hydraulic Steel Structure
HYD, HYDA	Hydraulic Fabricator, Hydraulic Fabricator Advanced
INDC	Inland Navigation Design Center
MSC	Major Subordinate Command
MT	Magnetic Particle Testing
NDT	Nondestructive Testing
PDT	Project Delivery Team
PQR	Procedure Qualification Record
PT	Penetrant Testing (Dye Penetrant Testing)
QA	Quality Assurance
QC	Quality Control
RCSC	Research Counsel on Structural Connections
RFI	Request for Information
RMC	Risk Management Center
RMO	Review Management Organization
RT	Radiographic Testing
TCX	Technical Center of Expertise
USACE	U.S. Army Corps of Engineers
UT	Ultrasonic Testing
VE	Value Engineering
VT	Visual Testing (Visual Inspection)
WPQR	Welder Performance Qualification Record
WPS	Welding Procedure Specification

ECB No. 2023-10
Subject Clarification of Policies and Guidance Associated with the Welding of Hydraulic Steel Structures

The general requirements outlined below are necessary for the design and fabrication of new HSS.

GENERAL

1. All new HSS shall meet the requirements of ER 1110-2-8157 and EM 1110-2-2107, and as modified in this ECB.

2. The design and fabrication of new HSS shall be under the strict supervision of the Engineer. The District's Chief of Engineering must designate the Engineer for each HSS; the qualifications to function as the Engineer are detailed in ER 1110-2-8157, paragraph 6.c.

3. In accordance with USACE ECB 2023-4 Engaging Centers of Expertise (CX) in Project Delivery Teams and New Website-- Category: Directive and Policy the Engineer must engage and utilize CXs as detailed and described in ER 1110-1-8158.

Typical CXs involved in HSS include (but are not limited to): Corrosion Control and Cathodic Protection TCX, Welding and Metallurgy TCX, and the Paint Technology Center TCX.

DESIGN REQUIREMENTS

4. All new HSS shall meet the requirements of ER 1110-2-8157. All new HSS shall be designed in full accordance with EM 1110-2-2107.

5. All variances from the mandatory design standards provided in EM 1110-2-2107, including rationale, must be documented in a memorandum in coordination with CX or CoP Lead. The request must be reviewed by the ATR team. The Chief of the Engineering function must sign the request and submit to RMO with a curtesy copy to the applicable MSC Chief of the Engineering function. If the RMO concurs, the request along with any comments or dissenting opinions is to be forwarded to the CoP Lead for routing. Approval of variances is with HQUSACE. Engineering and Construction Director is the approval authority for ER variances and this authority can be delegated to Civil Works Engineering Chief.

6. Justification for variances from mandatory design standards in EM 1110-2-2107 must include a risk assessment. All variances must be clearly identified in the decision documents and design reports and must be deliberately called out within the review plan as a specific charge for the review.

7. Coordination with Operations Division(s), project site personnel, end users, and/or other stakeholders is required during all design phases.

8. Design review requirements must be followed in accordance with ER 1110-2- 1150, ER 1110-2-1156, and ER 1165-2-217, ensuring DQC and ATRs are completed for all structures. Ensure all review plans are coordinated through the appropriate RMO. The RMO for a structure must be determined according to ER 1165-2-217, Table 2.1. The RMO may be the RMC, INDC, or the MSC, as appropriate, based on the type of work.

FABRICATION REQUIREMENTS

9. All new HSS shall be fabricated in accordance with UFGS 05 59 20 and applicable industry standards. Key requirements of ER 1110-2-8157 are included in UFGS 05 59 20, which amends and augments the minimum requirements of AWS D1.5 to meet ER 1110-2-8157 requirements. The Engineer may include additional requirements, such as increased welding inspection or verification testing, but the minimum provisions should not be reduced without the Engineer's review and approval.

10. The critical provisions of UFGS 05 59 20 have been summarized here with additional details.

11. All fabricators of new HSS shall meet AWS D1.5 code requirements and actively participate in the AISC Certification Program for Steel Bridge Fabricators or HYDA Fabricators with the Fracture Control Endorsement, (as required by AWS D1.5 Clause 12). USACE has partnered with AISC to establish the certification category "Supplemental requirements for Hydraulic Fabricators (HYD, HYDA)" to ensure sufficient fabricators meet the technical requirements necessary to fabricate HSS according to Clause 12.

a. A fabricator who has not previously performed work to AWS D1.5, Clause 12, and is therefore unfamiliar with the recording requirements of an existing QC program, would be placed at a considerable disadvantage that could create a situation where USACE would have difficulty performing QA.

b. A key requirement in AISC certification ensures that the head of the QC department reports to the owner of the company instead of the head of production. This requirement ensures that the QC department maintains quality as the top priority.

c. Additional AISC certification includes maintaining a robust QC program; AISC certified fabricators are accustomed to documenting necessary QC requirements that meet ER 1110-2-8157.

12. All Fracture Critical Members (FCM) of HSS must include a Fracture Control Plan (FCP). An FCP reduces the risk of fracture in a structure by ensuring the material, welds, and completed fabrication include the necessary QC and QA requirements. AWS D1.5, Clause 12, is the only fabrication code which contains an FCP. Utilizing AWS D1.5 removes the burden of authoring an FCP from the Engineer.

a. Utilizing a code other than AWS D1.5 for fabrication of a new HSS that has FCMs would require a new FCP authored by the Engineer as part of the specific contract. USACE would then enforce those requirements on the Fabricator.

b. The Engineer must include in the contract specifications any specific requirements that must be addressed in the FCP. Examples of specific requirements may include:

- the prohibition of splices,

- field welds, or
- for individual components to be shop assembled before field installation.

c. The Engineer must review the submitted FCP to ensure the Contractor has addressed all fracture critical requirements, including:

- base metal,
- welding consumable storage requirements and exposure limits,
- preheat,
- proper material handling requirements to prevent damage, and
- testing requirements.

13. In accordance with AWS D1.5, Clause 12, and ER 1110-2-8157, the Engineer must approve all repairs to FCMs and fracture critical welds for new HSS.

a. For typical repairs to FCM, the Engineer must approve a welding repair plan and the WPS used for repairs that incorporates additional preheat requirements and post heating to minimize the potential for hydrogen cracking, verify defect removal with MT, and verification of NDT following weld repair completion. This ensures the Engineer is:

- reviewing and approving repairs,
- verifying multiple repair cycles are not occurring on the same weld/member, and
- being given the option to replace components in lieu of repair.

b. The Engineer must be available to perform shop visits during fabrication or must delegate these duties to qualified onsite QA staff.

QUALITY CONTROL / QUALITY ASSURANCE

14. QC and QA requirements for field work are no different than the requirements for shop fabrication. Onsite QC and QA of field fabrication are still mandatory. The contractor performing installation and field work is often not the same contractor who performed shop fabrication. A new set of submittals from the prime/field contractor associated with the welding requirements, including many of the submittals previously identified, will be required specific for the work to be performed in the field.

15. The quality of new fabrication must start at design and continue through fabrication and use of the HSS. Quality for fabrication of new HSS is a team approach. In addition to the Contractor and USACE Construction Office, the Engineer has a considerable role in performing QA for new HSS. It is critical that the Engineer clearly establishes those roles and responsibilities in

close collaboration with Construction staff, and it is essential for the Engineer to become part of the QA team for the fabrication and erection of a new HSS.

16. The Engineer must establish required witness points for inspection and ensure contractor QC and USACE QA is occurring throughout the fabrication process. UFGS 05 59 20 provides additional guidance within the notes of the guide specification and has been tailored to include the minimum submittals and testing required per ER 1110-2-8157.

17. The Engineer is responsible for the following tasks during the fabrication phase of new HSS:

- shop drawing review and approval,
- review of all critical fabrication submittals,
- construction site visits,
- review of Value Engineering (VE) proposals and contract modifications,
- answering Requests for Information (RFIs) and clarification of plans and specifications,
- final inspection of completed HSS, and

18. The Engineer must be on-site for all erection, installation, and testing through completion of the contract. Field and final adjustments are often required during installation and testing, and the Engineer must be onsite for approving any modifications to the structure (as applicable).

19. The Engineer must prepare an engineering during construction (EDC) budget that addresses the required engineering involvement in QA and the necessary QA staff to perform the mandatory verification inspections to meet the requirements of ER 1110-2- 8157. The budget must address QA activities, including:

- prefabrication conference(s),
- routine construction progress meetings,
- periodic onsite QA in the fabrication shop,
- engineering and QA support during and after delivery, field erection activities, and operational testing,
- travel costs required for attending fabrication shop visits, meetings, and field installation visits, and
- the hiring of QA personnel with the technical skills required to perform QA verification testing.

20. Quality Control (QC) is to be performed by the fabricator. There must be 100% visual inspection of all welding by an approved Certified Welding Inspector (CWI) before, during, and after welding. Visual inspection of welding is a continuous, through-process inspection that requires the CWI to ensure:

- approved materials are used,
- approved WPS is being utilized and adhered to,
- proper fit up,
- proper welder settings,
- proper preheat,
- interpass temperature, and
- other applicable requirements, as necessary.

The visual inspection of welds does not only occur after all welding is complete.

21. Additional QC includes NDT inspection of completed welds using MT, UT, or RT methods, and must be performed by an approved Level II inspector. Inspectors shall be an ASNT CP-189 certified technician in the required testing method. NDT inspections may require a third-party inspection contract if ASNT certified technicians are not available through existing staff resources.

22. Quality Assurance (QA) is to be performed by the Engineer and the Government. QA of welding is an independent activity which must occur after all QC is complete. QA will typically involve independent visual and NDT inspection of the welds using the same methods specified by the Engineer. QA inspections may require a third-party contractor or utilization of the Welding and Metallurgy TCX QA staff.

23. QA activities include the use of Certified Welding Inspectors (CWIs), ASNT NDT technicians, and The Association for Materials Protection and Performance (AMPP) (Formerly NACE/SSPC) Certified Coating Inspectors. These services may require a contract with a third-party contractor or the utilization of QA personnel from the Welding and Metallurgy TCX.

INSTALLATION & TESTING

24. The completed structure(s) shall be installed and tested as practicable. The Engineer shall be present on-site to witness the functional testing. If any issues are discovered during functional testing, the Engineer, Contractor, and PDT shall develop a plan for remediation.

DOCUMENTATION & CLOSE OUT

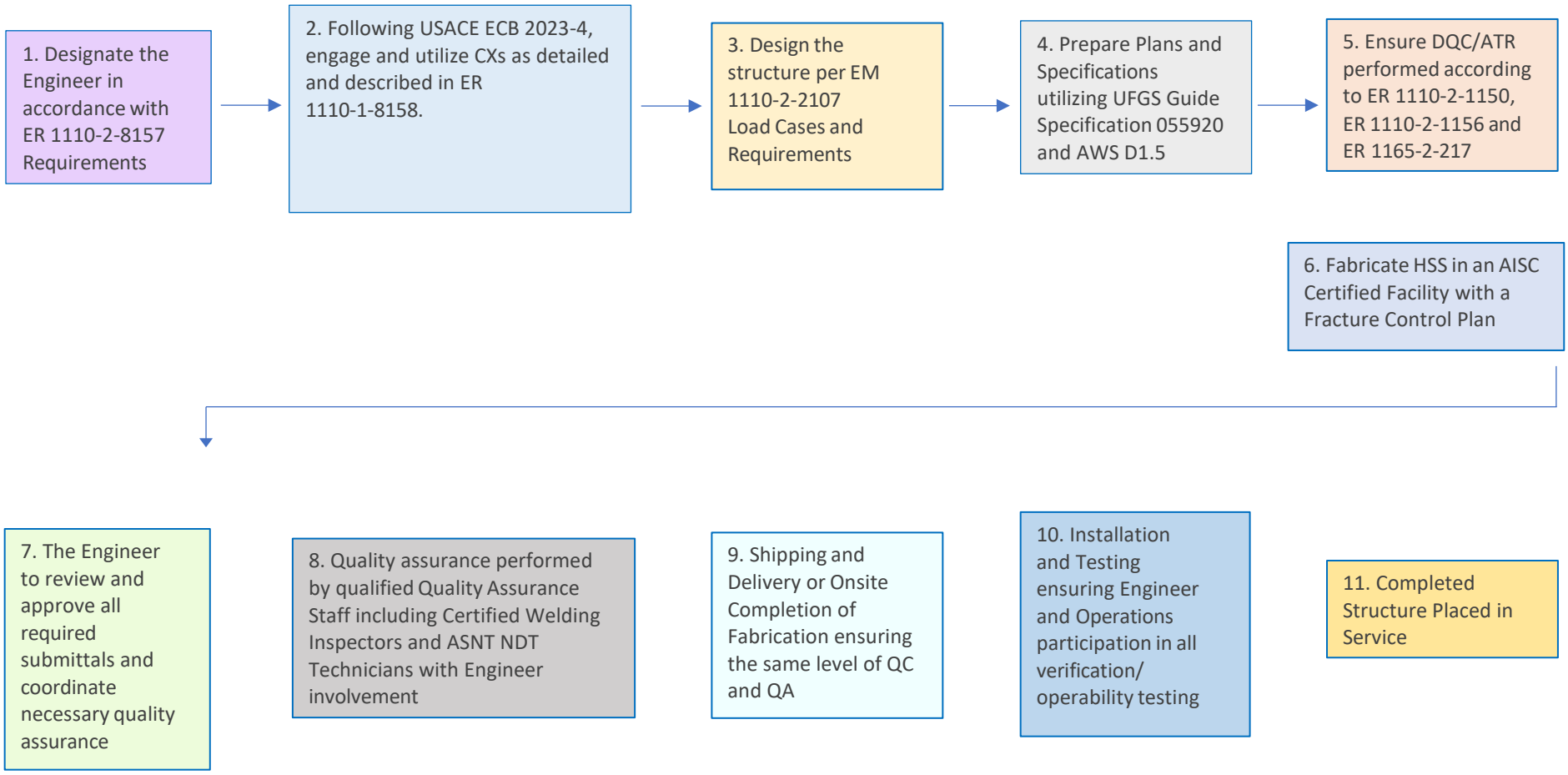
25. Upon successful completion of all QC and QA, the Engineer will provide a memo to certify

the structure to confirm it meets all ER 1110-2-8157 requirements.

26. The Engineer will ensure a permanent record of all repairs and required NDT documentation are stored in the HSS database. Use of the web-based HSS database (developed by NWW) is encouraged.

27. The Engineer shall provide a copy of all complete fabrication and inspection documentation to Operations for their records.

Fabrication of New HSS Flow Chart



ATTACHMENT B: REHABILITATION OF EXISTING HYDRAULIC STEEL STRUCTURES

ABBREVIATIONS

AASHTO	American Associate of State Highway and Transportation Officials
AISC	American Institute of Steel Construction
AMPP	The Association for Materials Protection and Performance
ASNT	American Society of Nondestructive Testing
ATR	Agency Technical Review
AWS	American Welding Society
CoP	Community of Practice
CWI	Certified Welding Inspector
CX	Center of Expertise
DQC	District Quality Control
EDC	Engineering During Construction
EM	Engineering Manual
ER	Engineering Regulation
FCM	Fracture Critical Member
FCP	Fracture Control Plan
HDC	Hydroelectric Design Center
HSS	Hydraulic Steel Structure
INDC	Inland Navigation Design Center
MSC	Major Subordinate Command
MT	Magnetic Particle Testing
NDT	Nondestructive Testing
PDT	Project Delivery Team
PQR	Procedure Qualification Record
PT	Penetrant Testing (Dye Penetrant Testing)
QA	Quality Assurance
QC	Quality Control
RCSC	Research Counsel on Structural Connections
RFI	Request for Information
RMC	Risk Management Center
RMO	Review Management Organization
RT	Radiographic Testing
TCX	Technical Center of Expertise
USACE	U.S. Army Corps of Engineers
UT	Ultrasonic Testing
VE	Value Engineering
VT	Visual Testing (Visual Inspection)
WPQR	Welder Performance Qualification Record
WPS	Welding Procedure Specification

ECB No. 2023-10
Subject Clarification of Policies and Guidance Associated with the Welding of Hydraulic Steel Structures

The general guidance below is necessary for rehabilitating existing HSS:

GENERAL

1. Rehabilitation of existing HSS entails a more comprehensive scope, in comparison to repairs, that are intended to strengthen and/or extend the service life of the structure. Rehabilitation does not include routine maintenance activities such as recoating, seal replacement, and replacement of cathodic protection.

2. ER 1110-2-8157 Section 9.b. "Modifications and Repairs" requires that, "all modifications and repairs to HSS and any modification or repair to an FCM must be designed by the Engineer…". Rehabilitation of existing HSS, including design and fabrication, shall be under the strict supervision of the Engineer. The District's Chief of Engineering must designate the Engineer for each HSS; the qualifications to function as the Engineer are detailed in ER 1110-2-8157, paragraph 6.c.

3. The Engineer, Operations, and other stakeholders (Water Management, Fisheries, Navigation, etc.) must perform a lifecycle cost analysis to determine if rehabilitation is more advantageous than replacement. Although routine maintenance is not considered rehabilitation, it may still require a significant investment, and a lifecycle cost analysis may still be warranted.

4. In accordance with USACE ECB 2023-4 Engaging Centers of Expertise (CX) in Project Delivery Teams and New Website-- Category: Directive and Policy the Engineer must engage and utilize CXs as detailed and described in ER 1110-1-8158.

Typical CXs involved in HSS include (but are not limited to): Corrosion Control and Cathodic Protection TCX, Welding and Metallurgy TCX, and the Paint Technology Center CX.

REHABILITATION DESIGN

5. The Engineer must design the rehabilitation and detail specific needs to ensure the requirements of ER 1110-2-8157 are being met. The criticality of the component needing rehabilitation will dictate the necessary technical requirements. Specific examples will be provided below regarding recommended practices.

6. Rehabilitation must, at a minimum, be evaluated for fitness-for-service in accordance with EM 1110-2-6054, and all appropriate load cases outlined in EM 1110-2-2107. Additional load cases may be considered based on actual loading experienced in use. The intent of rehabilitation is to ensure that the rehabilitated structure meets all current and modern reliability and performance criteria, and that all appropriate load cases and in-service loads being experienced by the structure are being appropriately addressed.

a. Include a fatigue evaluation to ensure sufficient fatigue life of the structure remains after rehabilitation, and that rehabilitating an existing structure to meet the 100- year design life requirements of EM 1110-2-2107 are feasible. The extended design life of rehabilitated HSS must be identified by the Engineer and concurred with by appropriate Operations Manager in design documentation.

b. Required load cases must be evaluated using a risk-informed design philosophy that incorporates appropriate DQC and ATR requirements. It may not be possible to rehabilitate the existing structure to meet current EM 1110-2-2107 loads and load cases. The structure must be evaluated through the entire load path, incorporating a holistic evaluation of all required components including structural, electrical, and mechanical operating systems.

7. All variances from the mandatory design standards provided in EM 1110-2-2107, including rationale, must be documented in a memorandum in coordination with CX or Community of Practice (CoP) Lead. The request must be reviewed by the ATR team. The Chief of the Engineering function must sign the request and submit to RMO with a curtesy copy to the applicable MSC Chief of the Engineering function. If the RMO concurs, the request along with any comments or dissenting opinions is to be forwarded to the CoP Lead for routing. Approval of variances is with HQUSACE. Engineering and Construction Director is the approval authority for ER variances and this authority can be delegated to Civil Works Engineering Chief.

8. Justification for variances from mandatory design standards in EM 1110-2-2107 must include a risk assessment. All variances must be clearly identified in the decision documents and design reports and must be deliberately called out within the review plan as a specific charge for the review.

9. Coordination with Operations Division(s), project site personnel, end users, and/or other stakeholders is required during all design phases.

10. Prior to designing rehabilitation, it is advisable to acquire material samples to verify mechanical properties of the steel. Many existing HSS were fabricated prior to the adoption of ER 1110-2-8157 and UFGS 05 59 20 requirements and utilized older steels that do not meet modern ASTM A709 standards for strength and toughness. Prior to designing repairs, verifying the mechanical properties of the steel by acquiring material samples is highly recommended. Material properties (including chemistry, yield strength, tensile strength, and elongation) can be determined through lab testing.

a. The utilization of a 1.25” annular cutter (Hougen bit) in a magnetic-based drill can remove 1.25” samples for testing. These samples can be subjected to sub-sized testing per ASTM A370 to provide mechanical properties used for the design of the required repair. The number and locations of all required samples to be removed shall be approved by the Engineer to ensure structural integrity remains after sampling (e.g. take samples from the neutral access of the web of a girder or the skin plate above normal water line). Repair sample locations by installing a fully pretensioned F3125 Grade A325 bolt.

b. Samples can typically be acquired by Operations staff then submitted for testing at a local lab via purchase order/credit card purchase.

c. Instances of existing steel not meeting minimum yield or tensile strength requirements have occurred. Instances of substituted steel being present on an existing structure have also occurred. For these reasons, sampling the existing steel in multiple locations is always advisable prior to analyzing a structure for repair.

11. Design review requirements must be followed in accordance with ER 1110-2- 1150, ER 1110-2-1156, and ER 1165-2-217, ensuring DQC and ATRs are completed for all structures. Ensure all review plans are coordinated through the appropriate RMO. The RMO for a structure must be determined according to ER 1165-2-217, Table 2.1. The RMO may be the RMC, INDC, or the MSC, as appropriate, based on the type of work.

FABRICATION REQUIREMENTS

12. Rehabilitation of existing HSS not fabricated to current AWS D1.5 standards and UFGS 05 59 20 will require the Engineer to develop plans and specifications to address welding on existing steel structures that contain steels not considered pre- approved in current editions of either AWS D1.1 or D1.5.

Note: There is currently no UFGS guide specification for rehabilitation of existing structures. A new UFGS guide specification for rehabilitation and repair of existing HSS is required. Presently, UFGS 05 59 20 should not be utilized for rehabilitation of existing structures without considerable modification of the specification.

13. All fabricators performing rehabilitation of HSS shall meet AWS D1.5 code requirements and actively participate in the AISC Certification Program for Steel Bridge Fabricators or HYDA Fabricators with the Fracture Control Endorsement, (as required by AWS D1.5 Clause 12). USACE has partnered with AISC to establish the certification category “Supplemental requirements for Hydraulic Fabricators (HYD, HYDA)” to ensure sufficient fabricators meet the technical requirements necessary to fabricate HSS according to Clause 12.

a. A fabricator who has not previously performed work to AWS D1.5, Clause 12, and is thereby unfamiliar with the recording requirements of an existing QC program, would be placed at a considerable disadvantage that could create a situation where USACE would have difficulty performing QA.

b. A key requirement in AISC certification ensures that the head of the QC department reports to the owner of the company instead of the head of production. This requirement ensures that the QC department maintains quality as the top priority.

c. Additional AISC certification includes maintaining a robust QC program; AISC certified fabricators are accustomed to documenting necessary QC requirements that meet ER 1110-2-8157.

14. All Fracture Critical Members (FCM) of HSS must include a Fracture Control Plan (FCP). An FCP reduces the risk of fracture in a structure by ensuring the material, welds, and completed fabrication include the necessary QC and QA requirements.

a. AWS D1.5, Clause 12, is the only fabrication code which contains an FCP. AWS D1.1 does not include an FCP. For this reason, the Engineer must author all requirements of the FCP within the specifications used for rehabilitation. Key portions of AWS D1.5, Clause 12, can be utilized in rehabilitation specifications to ensure proper QC occurs. The Engineer must specify in the contract specifications any specific requirements that must be addressed in the FCP.

b. The Engineer must include in the contract specifications any specific requirements that must be addressed in the FCP. Examples of specific requirements may include:

- the prohibition of splices,
- field welds, or
- for individual components to be shop assembled before field installation.

c. The Engineer must review the submitted FCP to ensure the Contractor has addressed all fracture critical requirements, including:

- base metal,
- welding consumable storage requirements and exposure limits,
- preheat,
- proper material handling requirements to prevent damage, and
- testing requirements.

d. Development of a plan to qualify welding by testing in accordance with code requirements. This is required when welding any non-approved base metal. Many existing USACE HSS were fabricated from base metal that is no longer produced or approved in welding codes. Further discussion of this can be found in EM 1110-2-6054.

- Many materials such as Fed Spec QQ-S-741A steel, ASTM A441 Steel, ASTM A373 Steel, and others are no longer produced and are not considered pre-approved base metals in AWS D1.1. The welding of these steels will typically require a sampling plan to identify the material based on chemistry and mechanical testing.

- Upon verification of the material, a procedure can be qualified by testing for the position and process of welding required to perform the rehabilitation. This may necessitate more than one position or joint detail requirement for procedure qualification. The intent of this qualification is to ensure that the WPS followed for performing repairs will be successful to code without visual defects (e.g., porosity or lack of fusion) and will meet intended mechanical requirements for strength and ductility.

- The development of a WPS qualified by testing will require the ENGINEER to identify locations where existing base metal can be removed from the structure to permit procedure qualification testing. Qualifying procedures by testing is used within AWS D1.1 and AWS D1.5 to increase the potential for successful welding or to minimize the risk of weld incompatibility being identified after production welding begins. The intent is to ensure welds are certified/qualified on sample plates/parts instead of the final production components (which minimizes the risk of unsuccessful welds occurring during rehabilitation).

15. The Engineer must approve all repairs to FCMs and fracture critical welds for new HSS.

a. For typical repairs to FCM, the Engineer must approve a welding repair plan and the WPS used for repairs that incorporates additional preheat requirements and post heating to minimize the potential for hydrogen cracking, verify defect removal with MT, and verification of NDT following weld repair completion. This ensures the Engineer is:

- reviewing and approving repairs,
- verifying multiple repair cycles are not occurring on the same weld/member, and
- being given the option to replace components in lieu of repair.

b. The Engineer must be available to perform shop visits during fabrication or must delegate these duties to qualified onsite QA staff.

QUALITY CONTROL / QUALITY ASSURANCE

16. QC and QA requirements for field work are no different than the requirements for shop fabrication. Onsite QC and QA of field fabrication are still mandatory. The contractor performing installation and field work is often not the same contractor who performed shop fabrication. A new set of submittals from the prime/field contractor associated with the welding requirements, including many of the submittals previously identified, will be required specific for the work to be performed in the field.

17. The quality of new fabrication must start at design and continue through fabrication and use of the HSS. Quality for fabrication of new HSS is a team approach. In addition to the Contractor and USACE Construction Office, the Engineer has a considerable role in performing QA for new HSS. It is critical that the Engineer clearly establishes those roles and responsibilities in close collaboration with Construction staff, and it is essential for the Engineer to become part of the QA team for the fabrication and erection of a new HSS.

18. The Engineer must establish required witness points for inspection and ensure contractor QC and USACE QA is occurring throughout the fabrication process. UFGS 05 59 20 provides additional guidance within the notes of the guide specification and has been tailored to include the minimum submittals and testing required per ER 1110-2-8157.

19. The Engineer is responsible for the following tasks during the fabrication phase of new HSS:

- shop drawing review and approval,
- review of all critical fabrication submittals,
- construction site visits,
- review of Value Engineering (VE) proposals and contract modifications,

- answering Requests for Information (RFIs) and clarification of plans and specifications,

- final inspection of completed HSS, and

20. The Engineer must be on-site for all erection, installation, and testing through completion of the contract. Field and final adjustments are often required during installation and testing, and the Engineer must be onsite for approving any modifications to the structure (as applicable).

21. The Engineer must prepare an engineering during construction (EDC) budget that addresses the required engineering involvement in QA and the necessary QA staff to perform the mandatory verification inspections to meet the requirements of ER 1110-2- 8157. The budget must address QA activities, including:

- prefabrication conference(s),

- routine construction progress meetings,

- periodic onsite QA in the fabrication shop,

- engineering and QA support during and after delivery, field erection activities, and operational testing,

- travel costs required for attending fabrication shop visits, meetings, and field installation visits, and

- the hiring of QA personnel with the technical skills required to perform QA verification testing.

22. Quality Control (QC) is to be performed by the fabricator. There must be 100% visual inspection of all welding by an approved Certified Welding Inspector (CWI) before, during, and after welding. Visual inspection of welding is a continuous, through-process inspection that requires the CWI to ensure:

- approved materials are used,

- approved WPS is being utilized and adhered to,

- proper fit up,

- proper welder settings,

- proper preheat,

- interpass temperature, and

- other applicable requirements, as necessary.

The visual inspection of welds does not only occur after all welding is complete.

23. Additional QC includes NDT inspection of completed welds using MT, UT, or RT methods, and must be performed by an approved Level II inspector. Inspectors shall be an ASNT CP-189 certified technician in the required testing method. NDT inspections may require a third-party inspection contract if ASNT certified technicians are not available through existing staff resources.

24. Quality Assurance (QA) is to be performed by the Engineer and the Government. QA of welding is an independent activity which must occur after all QC is complete. QA will typically involve independent visual and NDT inspection of the welds using the same methods specified by the Engineer. QA inspections may require a third-party contractor or utilization of the Welding and Metallurgy TCX QA staff.

25. QA activities include the use of Certified Welding Inspectors (CWIs), ASNT NDT technicians, and The Association for Materials Protection and Performance (AMPP) (Formerly NACE/SSPC) Certified Coating Inspectors. These services may require a contract with a third-party contractor or the utilization of QA personnel from the Welding and Metallurgy TCX.

INSTALLATION & TESTING

26. The completed structure(s) shall be installed and tested as practicable. The Engineer shall be present on-site to witness the functional testing. If any issues are discovered during functional testing, the Engineer, Contractor, and PDT shall develop a plan for remediation.

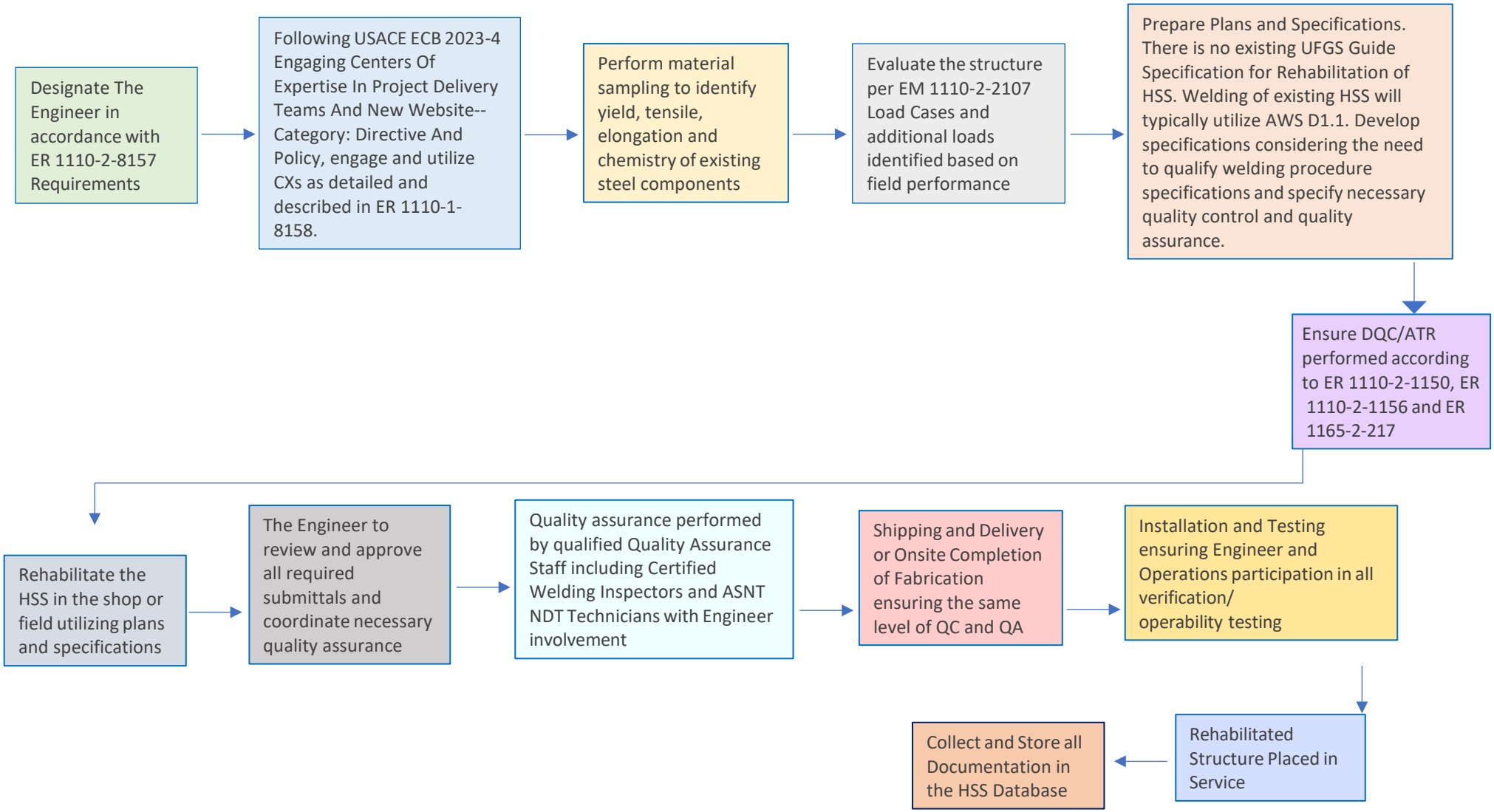
DOCUMENTATION & CLOSE OUT

27. Upon successful completion of all QC and QA, the Engineer will provide a memo to certify the structure to confirm it meets all ER 1110-2-8157 requirements.

28. The Engineer will ensure a permanent record of all repairs and required NDT documentation are stored in the HSS database. Use of the web-based HSS database (developed by NWW) is encouraged.

29. The Engineer shall provide a copy of all complete fabrication and inspection documentation to Operations for their records.

Attachment B - Rehabilitation of Existing HSS Flow Chart



ATTACHMENT C: REPAIR OF EXISTING HYDRAULIC STEEL STRUCTURES

ABBREVIATIONS

AASHTO	American Associate of State Highway and Transportation Officials
AISC	American Institute of Steel Construction
AMPP	The Association for Materials Protection and Performance
ASNT	American Society of Nondestructive Testing
ATR	Agency Technical Review
AWS	American Welding Society
CoP	Community of Practice
CWI	Certified Welding Inspector
CX	Center of Expertise
DQC	District Quality Control
EDC	Engineering During Construction
EM	Engineering Manual
EOR	Engineer of Record
ER	Engineering Regulation
FCM	Fracture Critical Member
FCP	Fracture Control Plan
HDC	Hydroelectric Design Center
HSS	Hydraulic Steel Structure
INDC	Inland Navigation Design Center
MSC	Major Subordinate Command
MT	Magnetic Particle Testing
NACE	National Association of Corrosion Engineers
NDT	Nondestructive Testing
PDT	Project Delivery Team
PQR	Procedure Qualification Record
PT	Penetrant Testing (Dye Penetrant Testing)
QA	Quality Assurance
QC	Quality Control
RCSC	Research Counsel on Structural Connections
RFI	Request for Information
RMO	Review Management Organization
RT	Radiographic Testing
TCX	Technical Center of Expertise
USACE	U.S. Army Corps of Engineers
UT	Ultrasonic Testing
VE	Value Engineering
VT	Visual Testing (Visual Inspection)
WPQR	Welder Performance Qualification Record
WPS	Welding Procedure Specification

The general requirements below are necessary for repairing existing hydraulic steel structures (HSS). These requirements are applicable regardless of who is performing the repair work, whether by Operations staff, a Contractor, or other entities.

GENERAL

1. Repair of existing HSS may be necessary to restore function to a structure. The need for repair may be from damage, defects identified by an engineering inspection, or observations by Operations personnel.

2. The repair of existing HSS, including design and execution of repairs, shall be under the strict supervision of the Engineer. The District's Chief of Engineering must designate the Engineer for each HSS; the qualifications to function as the Engineer are detailed in ER 1110-2-8157, paragraph 6.c.

3. The Engineer, Operations, and other stakeholders (Water Management, Fisheries, Navigation, etc.) must make an initial evaluation whether repair is feasible. A lifecycle cost analysis may need to be performed. Many structures cannot be easily repaired. The cost of repair, including risk associated with unknown and/or unidentified defects often makes replacement the only viable option to meet EM and ER requirements. Guidance for repairs are included herein, guidance for rehabilitation or replacement are covered in other parts of this ECB.

4. If at any point it is determined that repair is not feasible, the structure may need to be removed from service. The Engineer shall immediately provide written notice to Operations, the Chief of Engineering, and other key stakeholders for the removal of the structure.

5. In accordance with USACE ECB 2023-4 Engaging Centers of Expertise (CX) in Project Delivery Teams and New Website-- Category: Directive and Policy the Engineer must engage and utilize CXs as detailed and described in ER 1110-1-8158.

Typical CXs involved in HSS include (but are not limited to): Corrosion Control and Cathodic Protection TCX, Welding and Metallurgy TCX, and the Paint Technology Center CX.

REPAIR DESIGN

6. ER 1110-2-8157, Section 9.b. "Modifications and Repairs" requires "All modifications and repairs to HSS and any modification or repair to a FCM must be designed by the Engineer…". In either case, the Engineer must detail repair requirements, and ensure all required QC and QA is sufficiently performed and documented. Operations must fund the Engineer and alert them to any required repairs before any repairs are performed. In accordance with ER 1110-2-8157, the Chief of Engineering must ensure the Engineer is available for all site visits necessary to perform the duties as required in support of Operations.

7. Many existing HSS were fabricated prior to the adoption of ER 1110-2-8157 and UFGS 05 59 20 requirements and utilized older steels that do not meet modern ASTM A709

standards for strength and toughness. Prior to designing repairs, verifying the mechanical properties of the steel by acquiring material samples is highly recommended. Material properties (including chemistry, yield strength, tensile strength, and elongation) can be determined through lab testing.

a. The utilization of a 1.25" annular cutter (Hougen bit) in a magnetic-based drill can remove 1.25" samples for testing. These samples can be subjected to sub-sized testing per ASTM A370 to provide mechanical properties used for the design of the required repair. The number and locations of all required samples to be removed shall be approved by the Engineer to ensure structural integrity remains after sampling (e.g. take samples from the neutral access of the web of a girder or the skin plate above normal water line). Repair sample locations by installing a fully pretensioned F3125 Grade A325 bolt.

b. Samples can typically be acquired by Operations staff then submitted for testing at a local lab via purchase order/credit card purchase.

c. Instances of existing steel not meeting minimum yield or tensile strength requirements have occurred. Instances of substituted steel being present on an existing structure have also occurred. For these reasons, sampling the existing steel in multiple locations is always advisable prior to analyzing a structure for repair.

8. The Engineer shall evaluate the repair with respect to the structure's ability to function according to original design criteria, original function, and consideration of actual loading conditions. The evaluation may also consider the requirements of EM 1110-2-2107. This is not required for repair, as previously discussed, but may be prudent to consider with respect to the lifecycle cost analysis and potential need for further rehabilitation.

9. The Engineer shall develop the repair plan. The repair plan shall cover:

a. selection and specification of the appropriate welding code, which will typically be AWS D1.1 for existing structures.

b. required weld joint details to include selection of appropriate weld type (fillet, partial joint penetration groove, complete joint penetration groove).

c. weld sequencing to minimize distortion,

d. fracture control plan, and other requirements as covered herein.

10. Submit analysis and repair plan described above for DQC and ATR as appropriate. All designs require DQC and additional review. The need for additional ATR requirements and the use of DrChecks should be determined based on a risk- informed analysis of the required repairs. Perform DQC, and ATR if applicable, in accordance with ER 1110-2-1150, ER 1110-2-1156, and ER 1165-2-217.

FABRICATION

11. The Engineer shall be actively engaged with the execution and implementation of repairs.

The Engineer shall review and approve all critical welding submittals as identified herein. The Engineer is responsible for ensuring that all QC and QA is effectively performed in accordance with ER 1110-2-8157.

12. Critical Pre-Construction Submittals are listed below. These submittals shall be developed by the Contractor. If repairs are performed by Operation's staff, Operation's and the Engineer shall work collaboratively to develop the necessary documents prior to the start of any work.

a. Welding Procedure Specifications (WPS). including:

- fit-up tolerances,
- required preheat,
- interpass temperature,
- cooling rate,
- post weld heat treatment, or
- any other essential variable required (if considered prequalified per AWS D1.1).

b. Procedure Qualification Records (PQRs). For older HSS using non-A709 steels, the WPS will need to be qualified by testing. Development of a plan to qualify welding procedures by testing in accordance with code requirements. Material may need to be sampled from the structure for WPS qualification testing. Further discussion of this can be found in EM 1110-2-6054.

(a) Many materials such as Fed Spec QQ-S-741A steel, ASTM A441 steel, ASTM A373 steel, and others are no longer produced and are not considered pre-approved base metals in AWS D1.1. The welding of these steels will typically require a sampling plan for identifying the material based on chemistry and mechanical testing.

(b) Upon verification of the material, a procedure can be qualified by testing for the position and process of welding required to perform the repairs. This may require more than one position or joint detail requirement for procedure qualification. The intent of this qualification is to ensure that the WPS followed for performing repairs will be successful to code without visual defects (e.g., porosity or lack of fusion) and will meet the intended mechanical requirements for strength and ductility.

(c) The development of a WPS qualified by testing will require the Engineer to identify locations where existing base metal can be removed from the structure to permit procedure qualification testing. Qualifying procedures by testing is used within AWS D1.1 and AWS D1.5 to increase the potential for successful welding or to minimize the risk of weld incompatibility being identified after production welding begins. The intent is to ensure welds are certified/qualified on sample plates/parts instead of the final production components (which minimizes the risk of unsuccessful welds occurring during repairs).

(d) A risk-informed design approach will be utilized when selecting the need to qualify a WPS by testing. In some instances, it is possible to author a repair procedure not requiring a WPS qualified by testing, provided certain essential variables can be controlled.

For example, the pitting repair of a Tainter Gate skin plate could be accomplished on older Fed Spec or ASTM steels with the use of SMAW welding with 70ksi low hydrogen electrodes incorporating proper increased preheat and techniques to slow the cooling rate of the repairs to minimize the potential for hydrogen cracking to occur. Prescriptive repair plans that verify steel materials, carbon equivalency and increased heating/cooling requirements in accordance with the Annexes of AWS D1.1 may be sufficient to ensure proper repairs on a non- fracture critical skin plate. Note, however, that a WPS is always required in instances of repair.

c. Certified welders in the required welding process, position, and thickness must be utilized for all welding repairs. Welding repairs performed to AWS D1.1 requirements must utilize welders who are certified to AWS D1.1. This is an AWS Code requirement.

(a) In accordance with AWS D1.1, certification requirements include initial certification testing and verification of welding continuity with no breaks in the welding process greater than six months from initial certification.

(b) Initial certification and a continuity log showing no breaks in the process greater than six months must be reviewed by the Engineer. Failure to provide required continuity will necessitate requalification of the welder.

d. Fabrication shop drawings to be used by Operations staff or a contractor for performing required repairs.

13. The Engineer shall conduct a pre-work conference with the fabricator performing the repair work to review all the established procedures and expectations. All critical welding submittals should be submitted and approved prior to the pre-work meeting.

QUALITY CONTROL / QUALITY ASSURANCE

14. Quality Control (QC) is to be performed by the fabricator. There must be 100% visual inspection of all welding by an approved Certified Welding Inspector (CWI) before, during, and after welding. Visual inspection of welding is a continuous, through-process inspection that requires the CWI to ensure:

- approved materials are used,
- approved WPS is being utilized and adhered to,
- proper fit up,
- proper welder settings,

- proper preheat,
- interpass temperature, and
- other applicable requirements, as necessary.

The visual inspection of welds does not only occur after all welding is complete.

15. Additional QC includes NDT inspection of completed welds using MT, UT, or RT methods, and must be performed by an approved Level II inspector. Inspectors shall be an ASNT CP-189 certified technician in the required testing method. NDT inspections may require a third-party inspection contract if ASNT certified technicians are not available through existing staff resources.

16. The Engineer must determine the appropriate acceptance criteria for visual inspection. In general, the use of AWS D1.1, Table 8.1, "Visual Inspection Acceptance Criteria" (Cyclically Loaded Nontubular Connections) is appropriate to be used for VT, PT, and MT. In general, the use of AWS D1.1, Table 8.3, "UT Acceptance- Rejection Criteria" for Cyclically Loaded Nontubular Connections in Tension is appropriate acceptance criteria for UT inspection.

17. Quality Assurance (QA) is to be performed by the Engineer and the Government. QA of welding is an independent activity which must occur after all QC is complete. QA will typically involve independent visual and NDT inspection of the welds using the same methods specified by the Engineer. QA inspections may require a third-party contractor or utilization of the Welding and Metallurgy TCX QA staff.

18. The Engineer must also serve as part of the QA team and will need to be onsite prior to, during, and after all weld repairs to ensure QC and QA has occurred.

INSTALLATION & TESTING

19. Upon completion of repair, the repaired structure shall be installed and tested as soon as practicable. The Engineer shall be present on-site to witness the functional testing. If any issues are discovered during functional testing, the repair plan shall be revised and additional repairs may be needed.

DOCUMENTATION & CLOSE OUT

20. Upon successful completion of all QC and QA, the Engineer will provide a memo to certify the structure to confirm it meets all ER 1110-2-8157 requirements.

21. The Engineer will ensure a permanent record of all repairs and required NDT documentation are stored in the HSS database. Use of the web-based HSS database (developed by NWW) is encouraged.

22. The Engineer shall provide a copy of all repair documentation to Operations for their records.

Attachment C - Repair of Existing HSS Flow Chart