DEPARTMENT OF THE ARMY ER 10-1-53
U.S. Army Corps of Engineers
CECW-CE Washington, DC 20314-1000

Regulation
No. 10-1-53 30 April 2015

Organizations and Functions
ROLES AND RESPONSIBILITIES
HYDROELECTRIC DESIGN CENTER

1. Purpose. This regulation updates the roles and responsibilities of the U.S. Army Corps of Engineers District, Portland, Hydroelectric Design Center (HDC) as the Mandatory Center of Expertise (MCX) for hydroelectric power economic evaluation, engineering and design and a Technical Center of Expertise (TCX) for pumping plant engineering and design. It also prescribes the requirements for the level of involvement by HDC in U.S. Army Corps of Engineers (USACE) hydropower work provides guidance for interfacing the resources of HDC with those of the requesting USACE command.

2. Applicability. The regulation is applicable to all USACE commands including HQUSACE elements, major subordinate commands (MSC), districts, laboratories, and field operating activities having planning, engineering and design, construction, and/or operation and maintenance responsibility for hydroelectric and/or pumping plants, including hydropower generation for station service, non-Federal hydropower at USACE facilities, and hydropower support to military installations and customers of the International and Interagency Services program.

3. Distribution. This document is approved for public release; distribution is unlimited.

4. References.

a. ER 5-1-10, Corps-wide Areas of Work Responsibility

b. ER 1105-2-100, Planning Guidance Notebook

c. ER 1110-1-12, Quality Management

d. ER 1110-1-8155, Engineering and Design Specifications

e. ER 1110-1-8158, Corps-wide Centers of Expertise Program

f. ER 1110-2-1150, Engineering and Design for Civil Works Projects

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This regulation supersedes ER 1110-2-109, dated 1 November 2001.

g. ER 1110-2-1454, Corps Responsibilities for Non-Federal Hydroelectric Power Development under the Federal Power Act

h. ER 1130-2-510, Hydroelectric Power Operations and Maintenance Policies

i. EM 1110-2-1701, Hydropower Engineering Manual

j. EC 1165-2-214, Civil Works Review (or successor document)

k. Memorandum dated 8 July 1996 establishing the Hydropower Analysis Center as the USACE Mandatory Center of Expertise for Hydropower System – Economic Evaluation

l. Memorandum dated 25 August 2003 establishing Planning Centers of Expertise

m. Memorandum dated 23 October 2006 establishing Policy and Procedural Guidance for the Approval of Modification and Alteration of Corps of Engineer Projects

n. Memorandum dated 17 November 2008 establishing Clarification Guidance on the Policy and Procedural Guidance for the Approval of Modifications and Alterations of Corps of Engineers Projects

5. Establishment. The planning, economic evaluation, engineering and design, and forensic failure analysis of hydropower plants require highly specialized expertise. The hydroelectric power workload within USACE and the need to preserve USACE hydroelectric economic and engineering expertise made it necessary to consolidate that workload at centralized offices. HDC was first designated as a center of expertise by the Chief of Engineers in 1980. The Hydropower Analysis Center (HAC) was designated as an MCX for the economic evaluation of hydropower in 1996 and as a Planning Center of Expertise for Hydropower in 2003. In 2001, HDC was designated as an MCX responsible for hydroelectric power plant engineering and design and a TCX for pumping plant engineering and design. In 2008 HDC and HAC merged. In 2012, HDC was recertified as an MCX for hydroelectric power plant economic evaluation, engineering and design and a TCX for pumping plant engineering and design. This update of the regulation includes business process updates, adds the roles and responsibilities of HDC for economic evaluation, and revises some responsibilities for hydropower engineering and design.

6. Responsibilities.

a. General. Under the oversight of HQUSACE and MSCs, HDC shares the responsibility for hydroelectric and pumping plant engineering and design with the USACE commands that own and operate the plants or provide support to customers that own and operate plants. HDC in collaboration with HQUSACE, MSCs and USACE Commands, also share responsibilities applicable to the support for training, maintaining technical competence, execution of lessons learned, update and management of policy and guidance. Mandatory and optional work to be performed by HDC is listed in paragraph 7. The level of HDC's involvement in the mandatory work is specified in paragraph 7 (and further defined in Appendix A) as level 1, level 2, or level 3. The responsibility for execution of each level of work is as follows:

(1) For level 1 work, HDC and the USACE command will jointly scope the work. HDC has the responsibility for executing the work and will determine whether the work will be performed in-house by HDC, by an Architect-Engineer (A-E) firm, or by a USACE command. Prior to a USACE command executing any level 1 HDC work, a detailed scope of work will be jointly developed by the USACE command and HDC and approved by HDC. Regardless of the entity that performs the work, HDC will perform the District Quality Control (DQC) of all level 1 interim products and the DQC and approval of all level 1 final products. The organization that prepared the plans and specifications will generally perform engineering during construction (EDC).

(2) For level 2 work, the USACE command and HDC will jointly scope the work. The USACE command has the responsibility for executing level 2 work and may perform the work in-house or by A-E or may request HDC to perform the work. Prior to the USACE command or an A-E performing the work, HDC will approve the scope of work. HDC will also perform the DQC of all level 2 interim products and the DQC and approval of all level 2 final products. The organization that prepared the plans and specifications will generally perform EDC.

(3) For level 3 work, the USACE command will notify HDC by email or telephone of plans to execute level 3 work prior to initiating it. HDC will discuss the proposed work with the USACE command and exchange knowledge and lessons learned to minimize inadvertent or unanticipated consequences and potentially reveal better options for the proposed maintenance and repair or replacement-in-kind work. The district may also request HDC to perform the level 3 work.

b. HQUSACE. The Chief of Engineering and Construction Division, Civil Works Directorate (CECW-CE) is assigned oversight responsibility of HDC. CECW-CE will coordinate all actions that involve operation and maintenance issues and hydropower business line management with the Chief of Operations Division (CECW-CO) and all actions that involve planning and policy issues with the Chief of Planning and Policy Division (CECW-P). The HQUSACE proponent is responsible for the duties identified in ER 1110-1-8158 is CECW-CE.

c. MSC. In accordance with ER 1110-1-8158, each MSC is responsible to monitor and to ensure that HDC has been used for the planning, economic evaluation, engineering and design activities of their districts as required by this regulation. The MSC is also responsible to ensure any proposed exceptions to the use of HDC services are coordinated with HDC. If HDC does not approve a proposed exception, the MSC will review the exception prior to submitting it to HQUSACE (CECW-CE) for approval.

d. Hydroelectric Design Center.

(1) Hydroelectric Design Center will maintain adequate in-house resources and A-E contracts to provide the mandatory and optional economic evaluation, design, and engineering services for hydroelectric power and pumping plants to requesting USACE commands.

(2) HDC will maintain the capability and proficiency required for the planning, evaluation, engineering, design, and criteria development for all existing and new hydroelectric power and pumping plants, the addition of hydropower generators to existing non-hydropower dams and facilities, and for evaluating those actions which will alter hydropower production. HDC will maintain expertise in the valuation of hydropower outputs and keep abreast of emerging technologies for hydroelectric power and pumping plants.

(3) To accomplish work, HDC has the option to use in-house HDC resources, A-E services, the resources of the requesting command, or, with the concurrence of the requesting USACE command, the resources of another available and capable USACE command. HDC can also use resident expertise at USACE laboratories to perform physical or numerical model studies. HDC will coordinate their resourcing decision with the requesting USACE command and will always consider using the in-house and A-E resources of the requesting USACE command prior to contracting the work or assigning the work to another USACE command.

(4) Hydroelectric Design Center will furnish to the requesting USACE command the best possible cost estimate for its services commensurate with the scope of work, risk and contingency levels agreed upon and the best possible technical design consistent with the stated requirements. HDC will coordinate its evaluation, engineering, and design efforts with the requesting USACE command and will keep that command fully informed regarding the pertinent features and status of the evaluation and design through periodic progress reports. Any HDC coordination that may be required with the USACE command's non-Federal sponsor, power marketing agency, or preference customer will be done through the USACE command.

(5) Prior to commencing work, HDC will review the latest scope of work with the requesting USACE command to ensure agreement and understanding of scope, schedule, and budget (SSB). A written agreement (such as an SSB document or detailed scope of work) will then be prepared by HDC confirming the work to be accomplished, the schedule, and the budget. Both the requesting command and HDC must agree in writing to any revision, requested by either party, to the original schedule or design cost for proposed work and for work in progress. This includes schedules and design costs for work to be done by in-house HDC resources, A-E or another USACE command. HDC will keep the requesting USACE command informed about problems which could delay completion of the design or impact other aspects of the project or work item and potential cost overruns. HDC will also provide a list of technical data needed from the requesting USACE command and a schedule of when the data are required. If needed and after consultation with the requesting USACE command, HDC may establish priorities based on workload and project or work item requirements. However, emergency services will always have high priority.

(6) In accordance with EC 1165-2-214 (or its successor document) and Policy Guidance HDC 104, Hydroelectric Design Center will participate in the development of review plans and

quality control plans for the services that it provides, and conduct reviews (including DQC) as appropriate. The HDC will ensure that the principles of independence are maintained in the Agency Technical Review process, and that all decisions on the review team composition are justified and documented in the approved Review Plan.

(7) Hydroelectric Design Center will provide the proponent with updated electronic data for posting on the HQUSACE homepage as needed. The data will include information identified in ER 1110-1-8158.

(8) Hydroelectric Design Center will submit an annual report to the HQ proponent. The annual report will contain all metrics required by ER 1110-1-8158. The report will identify six categories to measure its contributions and value added - effectiveness, efficiency, collaboration and coordination, consistency, competency development and quality improvements. In the report a description of its organization, an overview of its program and accomplishments will be included along with the outlook for future workload, and an analysis of the size and competencies of staff. As an example of competency development and quality improvements, the report will identify how the center maintains capability and proficiency, how it keeps abreast of emerging technologies and how well its quality control program is working. It will present a summary of customer satisfaction surveys and any subsequent actions resulting from the surveys. The report will also identify the percentage of work contracted to the private sector and work done for other organizations. All the information will be appropriately supplemented with charts, tables and graphs.

(9) Professional engineer registration at HDC is required for the positions that have direct oversight of the technical engineering design functions at the branch level.

e. USACE Command.

(1) The USACE command responsible for managing the work as defined in a Project Management Plan will:

(a) For the work listed in paragraph 7, notify, coordinate with, and obtain the services of HDC as specified in this guidance.

(b) Notify HDC of failures, faults or other abnormal operations in critical power train equipment and systems as soon as practicable and engage HDC in any forensic failure study. Critical power train equipment and systems consist of anything in the power generation chain from water intake to the generator step-up or switchyard transformers including critical plant auxiliaries, station service systems, protection and control systems and powerhouse bridge, intake, and tailrace cranes.

(c) In accordance with ER 1110-1-8158, include a statement in their project documentation that HDC has been appropriately used in the planning, design, and execution of the project; and document any HQUSACE approved exceptions to its use.

(d) Retain overall responsibility including project management, compliance with current review policy, funding, scheduling, contracting and construction management and oversight, including administrative contracting officer (ACO) and contracting officer's representative (COR) responsibilities.

(e) Routinely discuss upcoming work with HDC and coordinate scheduling of projects at the earliest practical date. Work with HDC in development of project schedules to take into account prior commitments of HDC as well as the needs of the requesting command.

(f) Prior to requesting funds for the execution of HDC mandatory work, provide HDC with the preliminary scope, schedule, and estimated total project costs so HDC can provide feedback and a rough order of magnitude cost estimate for the required engineering services.

(g) Coordinate with HDC, at the time of initial scheduling, an update of the scope, schedule and engineering services cost estimate and a detailed scope of work if required prior to commencement of the work. Fund HDC for its participation in this phase of the work.

(h) Coordinate with HDC, at the time of initial scheduling, the inclusion of HDC as a project delivery team member for studies that require the evaluation of hydropower outputs.

(i) Fund HDC for the services to be performed, furnish necessary project information, and complete project delivery team and other reviews in time to permit HDC to complete the evaluation or design on schedule.

(j) Inform HDC of any anticipated changes that the USACE command would like to make to the completed economic evaluation or engineering and design. The USACE command will only make changes to HDC approved work if agreed to by HDC.

(k) When the work approved by HDC becomes part of a larger report, contract or design document, furnish HDC the completed report, contract or document for review to ensure proper coordination of HDC's work prior to approval of the report or advertising or executing the work.

(l) Invite HDC to be a member on all source selection evaluation boards for contracts to execute hydropower economic analysis and engineering and design products.

(m) Execute the construction, rehabilitation, or repair of the powerhouse or pumping plant, and procure and install the equipment.

(2) Routine maintenance and repair of most powerhouse equipment and systems are the responsibility of the requesting USACE commands (see Appendix A, paragraph A-3.b for exceptions). Routine testing and evaluation of major equipment, except for turbine performance testing, will remain with the requesting USACE command. North American Electric Reliability Corporation (NERC) and regional compliance requirements, cyber security, and power reviews are also the responsibility of the requesting USACE command.

(3) All planning, engineering and design functions not listed in paragraph 7, including overall Project Management, will remain the responsibility of the USACE command. The functions that are the responsibility of the USACE command include, but are not limited to, environmental analysis and coordination, permitting, hydraulic and hydrologic, structural (except as herein identified), geotechnical, cost engineering, and preparation/validation of needed as-builts prior to the initiation of design.

(4) USACE commands planning the installation of a new hydroelectric unit to furnish station service power at existing or new flood risk management, navigation and other non-hydropower facilities must collaborate with HDC to establish engineering requirements.

(5) USACE commands that operate hydropower plants are strongly encouraged to work with HDC to develop a joint Memorandum of Understanding (MOU) to better define how the command and HDC will work collaboratively to ensure optimal mission execution.

f. Portland District. HDC is a Corps-wide resource and is attached to the U.S. Army Corps of Engineers Portland District for day-to-day administrative oversight and administrative support. The director of HDC reports to the district commander.

7. <u>Work to be Performed by HDC</u>. This paragraph describes both the mandatory and optional services that will be performed by HDC when requested by HQUSACE or a USACE command.

a. Mandatory services. Except for the USACE command responsibilities identified in paragraph 6, HDC has mission responsibility to provide engineering and design and support services for hydroelectric power plant equipment and/or systems identified in Appendix A. HDC also has mission responsibility for the economic evaluation of hydropower project outputs and economic benefit evaluations of all existing and new hydroelectric power plants. USACE commands must involve HDC in the following mandatory hydropower planning, engineering and design services:

(1) Input to the electrical and mechanical portions of reconnaissance reports, decision support documents, and other preauthorization or customer funded pre-approval studies; prepare design reports; prepare studies for the up rating, rehabilitation, or replacement of equipment or systems; and provide engineer estimates as input for preliminary cost estimates (level 1).

(2) Electrical and mechanical engineering and design and related work. This includes (but is not limited to) hydraulic transient analysis and design, fabrication and testing of models, development of the operating (cam) tables used to establish gate opening – blade angle relationship for governors, studies required to provide and periodically review protective relay settings, and station service studies including selective coordination, short circuit, and arc flash hazard analysis. HDC will have technical responsibility for engineering and design of powerhouse fire suppression systems (see Table A-1 in Appendix A).

(3) Structural engineering services to coordinate hydropower plant layout and structural engineering and design for foundation support for mechanical and electrical equipment structural

modifications and/or additions, and crane replacement or rehabilitation (see Table A-1 in Appendix A).

(4) Forensic failure analyses and other emergency forensic services for faults, failures, and other abnormal operations. Emergency forensic services include the study required to determine the cause of equipment or protection system abnormal operation or failure, recommendations for restoring original equipment or system design performance, design, preparation of contract documents, and consultation services necessary to restore and/or replace failed power plant equipment to initially an interim functional state then through major repair or replacement to full original design operational capability (level 1).

(5) Contract plans and technical specifications. Provide input to the requesting command for the non-technical portions of the contract and the supply and install or construction cost estimate (see Table A-1 in Appendix A).

(6) Technical assistance to the contracting officer's representative during contract period, including participation as a member on source selection evaluation boards (see Table A-1 in Appendix A).

(7) Engineering services during construction (often referred to as engineering during construction (EDC) and includes engineering services provided for supply and install contracts). These services include (but are not limited to) technical review of shop drawings that include engineering or design work completed by the contractor, recommending the approval of various contractor submittals to the contracting officer or designated representative, insuring that the design meets the equipment specification, participating in post-award and/or partnering meetings, monitoring and certifying contractor design progress, resolving technical conflicts, responding to requests for information (RFIs), proposing contract modifications to the contracting officer, attending all shop and field tests including model tests, technically approving equipment for delivery, participating in development of commissioning plans, and witnessing site acceptance testing (see Table A-1 in Appendix A).

(8) Non-Federal Hydroelectric Power Development, HDC must participate in the DQC review. In accordance with ER 1110-2-1454, Corps Responsibilities for Non-Federal Hydroelectric Power Development under the Federal Power Act, review of the transient analysis and the design of the structural, mechanical and electrical features of proposed non-Federal hydropower plants at USACE projects for the following:

(a) Penstocks

(b) Vents

(c) Bifurcations

(d) Gates

(e) Valves and their controls

(f) Features that interface with the USACE facility

(g) Features that affect the integrity and safety of USACE projects. (Level 1)

HDC subject matter experts must be included for ATR participation when applicable in accordance with the review plan for the project.

(9) Engineering and design services for the planning and installation of station service hydroelectric units (see Table A-1 in Appendix A).

(10) Turbine performance testing such as ASME and IEC field performance (index & Gibson) testing (level 1).

(11) Power system model validation studies and provide associated reports required by NERC and regional reliability entities' regulations (level 2).

(12) Hydropower economic elements of major system studies, major rehabilitation analyses, miscellaneous power plant studies, cost allocations, and storage allocation or reallocation studies (level 1).

b. Optional services. At the request of HQUSACE or a USACE command, HDC will perform the following services:

(1) Prepare or assist in preparation of individual equipment or system O&M manuals.

(2) Maintain the Hydropower Engineering Manual, EM 1110-2-1701.

(3) Provide support for hydroelectric and pumping plant training courses and programs involving engineering and design.

(4) Provide support on hydroelectric and pumping plant matters. This includes preparation of new criteria and operational bulletins, update or revision of existing criteria, and execution of special studies to determine equipment condition indicators and/or reliability projections.

(5) Assist in periodic inspections.

(6) Test and evaluate the performance and condition of existing major equipment.

(7) Review the testing and evaluation of existing major hydroelectric equipment performance performed by others.

(8) Develop commissioning plans and participate as lead or supporting commissioning engineer in the start-up commissioning of major power plant equipment.

(9) Provide engineering services for hydroelectric equipment not identified in Appendix A.

(10) For pumping stations:

(a) Perform engineering and design services.

(b) Provide input to the electrical and mechanical portions of reconnaissance reports and other preauthorization studies.

(c) Prepare studies and design reports for rehabilitation or replacement of equipment or systems.

(d) Prepare contract plans and technical specifications. Provide input to the requesting command for the non-technical portions of the contract and the supply and install or construction cost estimate.

(e) Provide technical assistance to the contracting officer's representative during contract period.

(f) Provide engineering services during construction (often referred to as engineering during construction (EDC) and includes engineering services provided for supply and install contracts). These services include technical review of shop drawings that include engineering or design work completed by the contractor, recommending the approval status of various contractor submittals to the contracting officer or the contracting officer's representative (COR), ensuring that the design meets the equipment specification, participating in post-award and/or partnering meetings, monitoring and certifying contractor design progress, resolving technical conflicts, responding to requests for information (RFIs), proposing contract modifications to the contracting officer, attending all shop and field tests, including model tests, technically approving equipment for delivery, and witnessing site acceptance testing.

(11) Provide assistance to the value engineering officer on hydropower or pumping plant value engineering studies.

8. Method of Operation. The following lists HDC's method of operation and specific operational requirements for both HDC and the requesting USACE command.

a. Quality management and review: The requirements of EC 1165-2-214 (or its successor document), ER 1110-1-12, and ER 1110-2-1150 will be followed for products and services provided by HDC.

b. Workload Resourcing. HDC will evaluate requests and will assign work to accomplish the mission while maximizing the use of its resources and maintaining its technical capability and expertise. HDC will coordinate with the requesting command before determining whether level 1 hydropower engineering and design work will be performed in-house by HDC, by A-E, or by a USACE command.

(1) When HDC decides that the use of A-E services is required for the mandatory work identified in this document, the USACE command can either have HDC contract for the A-E services or directly contract for the A-E services. If the USACE command opts to directly contract for A-E services, HDC will approve the technical requirements for the contract or task order scope of work, participate in price negotiation and quality assurance review, and approve final acceptance of the contracted A-E deliverable products.

(2) If a USACE command decides to establish its own contract for hydropower engineering and design A-E services, HDC must be involved in setting the scope, included in the A-E selection process as a voting member in assessing the A-E's technical competency, and have technical oversight and technical approval authority for the mandatory work identified in this document.

(3) If the USACE command decides to use an ongoing indefinite delivery contract to produce mandatory work identified by this document, HDC must review the A-E technical qualifications and the contract scope. If found not qualified or not within scope, the command can either restart the process to select another A-E or contract an A-E firm through HDC.

(4) When HDC decides to use the resources of a USACE command to execute the mandatory work identified in this document, HDC will maintain their responsibilities for scoping, DQC and approval of the product in accordance with paragraph 6.

c. Activity scheduling. HDC will meet at least once per year with MSCs and districts to discuss anticipated needs for HDC services in terms of dollar value of design effort or assistance for the ensuing one to three year period. HDC will follow up with districts to discuss upcoming line items in the budget and customer funded work plans that could impact HDC's workload.

d. Funding for HDC services. HDC will develop a cost estimate for its services based on the scope and schedule agreed to between HDC and the requesting USACE command. The parties involved must mutually agree to any revisions made to the cost estimate. HDC will not begin any work including development of formal scope/schedule/budgets until funding has been received from the USACE command. Each USACE command also has the option to establish a "small-on-call" account with HDC. This account will facilitate a rapid response to emergencies and can provide initial funding for the development of scopes of work, schedules and cost estimates for its services. HDC will charge to this account only when specifically authorized by the requesting USACE command and excess funds will be returned in the fourth quarter of each fiscal year or when requested by the USACE command.

e. Detailed scopes of work. The requesting USACE command and HDC will jointly develop detailed scopes of work if requested by either the USACE command or HDC.

f. After Action Review. HDC will participate in after action reviews conducted by the requesting command and may conduct its own after action reviews. The after action review will be a check on how well the process worked and where improvements are needed to develop a quality product on time and within budget.

g. Customer Satisfaction Survey. Representatives of USACE commands requesting services by HDC will be provided a customer satisfaction survey at least annually. The survey is an opportunity for the requesting office to provide feedback to HDC.

h. Conflict resolution. Conflicts or differences should be resolved between HDC and the USACE command. If a conflict or difference develops that cannot be resolved by mutual agreement between the parties involved, it should then be elevated to the command's MSC for resolution. Finally because HDC is a Corps-wide asset, HQUSACE (CECW-CE), if requested by either HDC or the MSC, will resolve the conflicts or differences.

9. Research and Development (R&D). HDC will participate in defining future technology requirements, prioritize technology investments, facilitate technology transition to the field, and provide strategic guidance in the research program development for hydropower R&D. Specifically, HDC will participate in review, or monitor research and development work unit activities for hydroelectric power plants and pumping plants. HDC will participate with other field users in identifying Civil Works research and development needs. HDC may also conduct joint research, development, and demonstration projects with USACE laboratories as directed by the Engineer Research and Development Center (ERDC)

10. Exceptions. A request for an exception to the requirements of this regulation will be fully justified and submitted to HQUSACE (CECW-CE) in accordance with ER 1110-1-8158.

11. Recertification. HDC will be recertified as an MCX every five years according to the appropriate requirements of ER 1110-1-8158. Six months prior to its recertification date, HDC shall provide the HQUSACE proponent a draft evaluation of the continuing need for the CX against the performance statements.

12. Agency Representation. HDC is authorized to represent USACE on industry technical committees related to hydroelectric power and pumping plants.

FOR THE COMMANDER:

Michael D. Peloquin

Appendix A
HDC's Hydropower Engineering
and Design Mission Responsibility

MICHAEL D. PELOQUIN
COL, EN
Chief of Staff

APPENDIX A

HDC's Hydropower Engineering And Design Mission Responsibility

A-1. Purpose. This appendix identifies the nature and extent of HDC's involvement in hydropower engineering and design work.

A-2. Definitions.

a. Level 1. Level 1 work is defined as engineering and design related to the basic design, function and operating criteria of systems, equipment, and component integration that are either so critical or so complex that thorough and specialized knowledge is required to assure the equipment will operate as expected and/or guaranteed and achieve its design life. Design for power generation and transmission equipment involves close coordination among component characteristics and ratings, adjustments and settings, governing standards, established practices, changing technologies, and marketplace conditions including the shifting roles of the relatively few manufacturers available. HDC provides awareness of national Corps-wide experience, consistent Corps of Engineers practice, implementation of standard design approach and policies. Inadequate design or coordination among the various components can easily cause failures resulting in long-term outages.

b. Level 2. Level 2 work is defined as engineering and design of components and systems that have a direct interface with the critical and complex systems and equipment defined as level 1 and can affect powerhouse operations.

c. Level 3. Level 3 work is defined as engineering and design to support routine maintenance and repair of powerhouse systems and equipment. It includes replacement-in-kind of powerhouse equipment, which is defined as replacements that involve no changes in operation, size, rating, technology (e.g., analog to digital controls, breaker technology, etc.) or functionality. Note: power plant equipment replacement-in-kind is often not possible, is rarely recommended, and rarely occurs.

d. Major Work. Major work includes equipment or system replacement or rehabilitation, major repair, and system configuration or operational modification. This includes infrequent, costly structural replacement or rehabilitation of equipment that is intended to improve reliability or efficiency of a USACE project or a principal feature thereof. Major repair is defined as work that is beyond routine preventative maintenance requirements. System configuration or operational modification is defined as work that involves a fundamental change in the way a powerhouse or pumping plant system is configured or operated. Representative examples of system configuration or operational modifications include:

(1) Adding a new back-up source of water to the generator cooling water system.

(2) Changing a rotating excitation system to a static excitation system.

(3) Changing the transformer or switchyard configuration.

(4) Changing powerhouse crane control systems.

(5) Adding new wall penetrations, through existing structure, below pool or tailwater.

(6) Changing pump start/stop elevations.

(7) Replacing or modifying start/stop and other unit or generation system controls.

(8) Repairing and/or replacing equipment or systems on an emergency basis due to an in-service failure.

e. Routine Work. Routine work includes routine equipment and system maintenance and repairs and replacements-in-kind that are normally the responsibility of project operations.

A-3. Responsibility.

a. Level 1 work is HDC's mandatory mission work and will be performed by HDC unless HDC agrees otherwise. In all cases, HDC is fully responsible for the scoping, District Quality Control (DQC), and approval of Level 1 work. Level 2 work may be performed by a district's engineering staff or optionally may be performed by HDC if the district requests. In all cases, HDC is fully responsible for the scoping, DQC, and approval of Level 2 work. Prior to performing Level 3 work, the district will inform HDC of the work and discuss the scope of work with HDC to gain the benefit of HDC's related experience.

b. Matrix of work. Table A-1 displays the level for major and routine engineering and design for various hydropower plant equipment and systems. Paragraph A-3.c provides a detailed description of the equipment and systems identified in Table A-1.

Table A-1

Hydropower Plant Equipment or System	Engineering and Design for Major Work	Engineering and Design for Routine Work
Turbines	Level 1	Level 2
Governors	Level 1	Level 3
Intake & tailrace closure systems	Level 1	Level 3
Intake gates, intake bulkheads, and tailrace bulkheads	Level 1 or 2 *	Level 3
Submerged mechanical equipment in or in front of the water passageway.	Level 1	Level 3
Structural modifications to the powerhouse and/or structural modifications or additions in or in front of the turbine intakes	Level 1	Level 3

Powerhouse cranes	Level 1	Level 3
Mechanical peripheral equipment – Group A	Level 1	Level 3
Mechanical peripheral equipment – Group B	Level 2	Level 3
Generation and transmission system and equipment (including switchyards)	Level 1	Level 3
Control, protection, and communication systems	Level 1	Level 3
Station service power systems	Level 1	Level 3
Powerhouse auxiliary electrical equipment – Group A	Level 1	Level 3
Powerhouse auxiliary electrical equipment – Group B	Level 2	Level 3
Other powerhouse equipment and systems	Level 3	Level 3

* Refer to the description below for details on the level designation.

c. Equipment or System Description.

(1) Turbines include the component parts of the turbine and pump turbine. These components include embedded and formed parts (turbine intakes, spiral cases, spiral case extensions, penstocks, stay vanes, discharge rings, draft tubes, and piezometer taps). Also included are all rotating parts and non-rotating parts (head covers, vacuum breakers, packing boxes, wicket gates, seals, bearings, bushings, servomotors, wicket gate operating mechanisms, oil heads, wearing rings, and manual and automatic gate lock systems).

(2) Governors are the turbine control unit and include all mechanical and electrical control parts, distributor valve, control valves, oil tanks, piping, pumps, valves, actuator and sump, electronic and digital control systems, transducers, and instrumentation.

(3) Intake and tailrace closure systems are used to shut off water to the unit in the event the governor loses control of the turbine or when flooding of the powerhouse may otherwise occur. Intake and tailrace closure system components can include intake gates, gate hoists, gantry cranes, butterfly valves and spherical valves.

(4) Intake gates, intake bulkheads, and tailrace bulkheads may be treated as level 2 work, provided the gate weight, the hydraulic shape, the method of handling, and method of sealing remain as originally designed. Any changes to intake gates or any bulkhead gate that is used as part of an emergency closure system that may impact emergency closure system function is level 1 work. When classified as level 2 work, HDC will review new intake/tailrace gates/bulkheads in order to assure no adverse impact to function of intake/tailrace closure systems.

(5) Submerged mechanical equipment in or in front of the water passageway includes the fish guidance systems and other components that are in or in front of the turbine intakes. This equipment can increase hydraulic losses across the turbine and affect turbine performance. Risk analysis has shown that a failure of these components will result in damages to the turbine,

wicket gates, head cover, or the discharge ring. The potential for a turbine runaway is highest from these failed components.

(6) Structural modifications to the powerhouse whether separate or integral with a dam, and structural modifications or additions in or in front of the turbine intake can directly impact the structural integrity or operational adequacy of the powerhouse. Structural modifications may be intended to satisfy major rehabilitation, seismic retrofit, environmental enhancements, or improvements for fish passage requirements as examples. Structural modifications may include increased loads compared to original design loads, removal of portions of the structure, penetrations through the structure, additions to the structure, and modifications which may impact rotational stability. Structural work subject to HDC purview does not include architectural systems and features, or geotechnical aspects of the powerhouse/dam. Responsibility for dam safety remains with the district engineer. Should the need for structural modification to the powerhouse arise out of the dam safety program, HDC will review the proposed modification to determine if the work is level 1 or level 2.

(7) Powerhouse cranes (bridge, intake, and tailrace) are used for the assembly and disassembly of the main unit generators and turbines and maintenance purposes. Cranes includes the power supply and crane rails.

(8) Mechanical peripheral equipment in group A directly affects the ability of a powerhouse to successfully produce power on a reliable basis. A brief description of each system follows.

(a) Generator cooling water system provides cooling water to the generators for the removal of waste heat.

(b) Bearing cooling water system provides cooling water to the turbine and generator guide bearings and the generator thrust bearing coolers to remove excess heat.

(c) Turbine gland water system provides clean water to the turbine shaft packing to cool the packing and to prevent damage from silt laden river water.

(d) Powerhouse fire suppression systems that directly affect the ability of a powerhouse to successfully produce power on a reliable basis include the generator fire protection system, transformer deluge system, and oil storage room system.

(e) Brake air system supplies a reliable source of compressed air and controls for operating the generator brakes during unit shutdown. The generator brakes are required to release on unit start up and actuate on unit shutdown.

(f) Piezometers, flow meters, and level gauges provide critical feedback systems for unit condition and operation.

(g) Draft tube water depression system injects a large quantity of compressed air into the turbine draft tube so that the unit can be used for condensing.

(h) Air admission systems for improving dissolved oxygen levels downstream of plant.

(i) Governor air system provides high-pressure compressed air to the governor tank to form the air blanket on top of the governor oil.

(j) Oil system incorporated in powerhouses provides for the storage and purifying of lubrication, governor and transformer insulating oil.

(k) Engine-generator sets are diesel engine-driven and provide emergency backup power to the powerhouse for black-start operation.

(9) Mechanical peripheral equipment in group B are systems that are not considered critical to power generation and include the following.

(a) Service water system normally feeds multiple systems not directly related to power production such as deck wash and air compressor cooling. The system is often tied together with the generator and turbine cooling water and/or transformer deluge as a backup source of water.

(b) Service air system provides compressed air for maintenance purposes, trash rack bubblers and float well bubblers. This system is the source of compressed air for the generator brake system.

(c) Drainage system collects and removes water that leaks into the powerhouse. Power for the drainage pumps is normally on the station service power system. Failure of this system could lead to powerhouse flooding.

(d) Unwatering and fill system provides for the removal of water from the turbine water passages for maintenance access, and refilling of the turbine prior to unit operation. System failure or improper operation can cause powerhouse flooding.

(10) Generation and transmission system and equipment includes systems and components that are designed and rated for the specific site needs to function as a coordinated power conversion and transmission chain. The equipment and systems in this category are discussed below.

(a) Generators are the primary electrical component in the power generation chain. Generator equipment typically includes everything located above the turbine shaft coupling, e.g., thrust and guide bearings, stator frame, laminated core, rotor, stator and amortisseur windings, partial discharge coupling capacitors, wedges, field poles, and cooling system.

(b) Excitation system equipment typically includes shaft driven pilot exciters, amplidynes, field rheostats and breakers, voltage regulators, power potential transformers, static excitation devices, and power system stabilizers.

(c) Transmission, switching, and monitoring equipment includes main unit bus and circuit breakers, neutral grounding equipment, transformer low-voltage bus, high voltage bus and switching equipment, grounding and surge protection, metering and relaying instrument transformers, and line coupling devices.

(d) Power transformer equipment includes the transformer, tap changers, high and low side bushings, insulating oil, and all associated protective devices.

(e) Switchyard equipment includes the connections between transformers, buses, and lines by various combinations of switches and circuit breakers, with associated metering, relaying, protection, control and communication devices.

(11) Control systems integrate the operations of the powerhouse major electrical and mechanical components. This integration results in diverse assemblies such as governors, exciters, auxiliaries, and turbine-generator units working together to achieve the desired results. Control incorporates the monitoring of the controlled equipment's status, operation and the overall protection design for the controlled equipment. Control systems provide automatic and/or operator interface to the controlled equipment for performing such functions as unit or auxiliary systems start/stop, adjusting unit loading, and providing transfers to backup or redundant systems. Monitoring of the equipment's status and operation is by analog or digital metering, lighted window annunciation, status lights, chart recorders, and, where applicable, by the digital control system's status and alarm monitoring and archiving software.

(a) Powerhouse control equipment typically includes potential and current transformers and transducers that develop the control signals, panels of switches, local and centralized control switchboards or panels, annunciators, and display instruments (analog and digital), relay logic schemes, digital signal input/output devices, signal transducers, automatic sequences (both discrete hardwired relay and programmable logic controllers (PLCs)), and feedback control circuits. Control equipment also includes remote supervisory control and data acquisition (SCADA) systems for centralized control, computer based data acquisition and control systems (DACS) for automatic control, and reporting systems including cyber-secure communication paths, wide area, local area and other digital networks, sequence of event (time tagging) recorders, video display terminals for data display and operator command (man-machine interface) input.

(b) Protection systems incorporate a variety of diverse devices that detect mechanical or electrical abnormal conditions and typically provide automatic and very rapid responses to limit damage associated with abnormal operation. Protective equipment includes both analog and digital protective relays.

(12) Station service power system consists of the power supply, distribution and controls. Station service power is supplied from station service generators, taps from the main generator or high voltage buses, or from outside sources. Station service equipment typically includes station service hydro and/or emergency engine generators and their auxiliaries, main generator bus or high voltage bus tap equipment, step-down transformers, disconnect switches, current limiting reactors, numerous types of bus or cables, switchgear with circuit breakers, emergency backup

battery systems, preferred ac systems including invertors, controls, metering and relaying, and temporary connection facilities.

(13) Powerhouse Auxiliary Electrical Equipment - Group A directly affects the ability of a powerhouse to successfully produce power on a reliable basis. Generally, it consists of the equipment that provides power and control to the Mechanical Peripheral Equipment - Group A.

(14) Powerhouse Auxiliary Electrical Equipment - Group B includes systems that are not considered critical to power generation. Group B includes lighting and, in general, all other equipment that provides power and control to the Mechanical Peripheral Equipment - Group B.

(15) Other powerhouse equipment and systems include those not directly or indirectly related to power production. Representative examples of equipment and systems that are not directly or indirectly related to power production include:

(a) Powerhouse elevators

(b) Power house HVAC systems

(c) Powerhouse fire protection systems that are not considered critical to power generation such as storage area sprinkler systems (except oil storage rooms), fire extinguishers and hose stations, and smoke detection and ventilation.

d. Non-Federal Hydropower at USACE facilities. The design, construction and operation of all power facilities which would affect the structural integrity and operational adequacy of a Federal dam, including construction procedures and sequence, must be approved by USACE. HDC must participate in the DQC review. HDC will review the applicant’s transient analysis and the design of the structural, mechanical and electrical features of proposed non-Federal hydropower plants at USACE projects for the following:

(1) Penstocks

(2) Vents

(3) Bifurcations

(4) Gates

(5) Valves and their controls

(6) Features that interface with USACE facilities.

(7) Features that affect the integrity and safety of USACE projects.

HDC subject matter experts must be included for ATR participation when applicable in accordance with the review plan for the project.

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