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U.S. Army Corps of Engineers
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Engineer Regulation* 1110-2-103

Effective 3 February 2024

CECW-EC

Engineering and Design

Strong-Motion Instruments for Monitoring and Recording Earthquake Motions

FOR THE COMMANDER:

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Chief of Staff

Purpose. This engineer regulation provides policies and requirements for installing, upgrading, maintaining, and servicing strong-motion (seismic) instruments for recording earthquake site response (whether naturally occurring or induced) on United States Army Corps of Engineers dam and navigation structures. Measured site-specific ground motion information is necessary for assessing potential damage to United States Army Corps of Engineers dams and navigation structures, initial near-real-time notification of a seismic event, coordinating and prioritizing post-event responses, performing regional or portfolio-wide analysis of facilities in comparable seismotectonic regions, and for assessing facilities with comparable expected seismic performance.

Applicability. This regulation applies to United States Army Corps of Engineers-owned dams and navigation structures. This regulation does not apply to construction vibration monitoring for blasting, pile driving, and other activities unrelated to earthquake ground motions.

Distribution Statement. Approved for public release; distribution is unlimited.

Proponent and Exception Authority. The proponent of this regulation is the Headquarters, United States Army Corps of Engineers, Engineering and Construction Division (CECW-EC). The proponent has the authority to approve exceptions or waivers to this regulation that are consistent with controlling law and regulations. Only the proponent of a publication or form may modify it by officially revising or rescinding it.

*This regulation supersedes ER 1110-2-103 dated 11 June 2020.

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Summary of Change

1. Purpose

This engineer regulation provides policies and requirements for installing, upgrading, maintaining, and servicing strong-motion (seismic) instruments for recording earthquake site response (whether naturally occurring or induced) on United States Army Corps of Engineers (USACE) dam and navigation structures. Measured site-specific ground motion information is necessary for assessing potential damage to USACE dams and navigation structures, initial near-real-time notification of a seismic event, coordinating and prioritizing post-event responses, performing regional or portfolio-wide analysis of facilities in comparable seismotectonic regions, and for assessing facilities with comparable expected seismic performance.

2. Distribution statement

Approved for public release; distribution is unlimited.

3. References

See Appendix A.

4. Associated publications

- a. ER 1110-2-1802 for post-earthquake inspections and reporting for civil works project features.
- b. ER 1110-2-1806 for Design and performance objectives and criteria for civil works projects.
- c. EM 1110-2-1908 for Instrumentation and performance monitoring for civil works projects.

5. Records management (recordkeeping) requirements

The records management requirement for all record numbers, associated forms, and reports required by this ER are addressed in the Army Records Retention Schedule – Army (RRS-A). Detailed information for all related record numbers is located in the Army Records Information Management System (ARIMS)/RRS-A at <https://www.arims.army.mil>. If any record numbers, forms, and reports are not current, addressed, and/or published correctly in ARIMS/RRS-A, see DA Pam 25-403, Guide to Recordkeeping in the Army, for guidance.

6. Responsibilities

a. Headquarters responsibilities:

- (1) Maintain an interagency “Memorandum of Agreement (MOA) between USACE and the U.S. Department of Interior”, (latest version, June 2020). This MOA addresses collaboration regarding goods and services between USACE and U.S. Geological Survey (USGS).
- (2) Review and approve waivers submitted by the major subordinate command (MSC) from districts for exemptions to the standard USACE seismic installation methods and reporting requirements consistent with this ER.

b. Major subordinate command responsibilities:

(1) Submit to Headquarters, USACE (HQUSACE), civil works waivers from districts for exemptions to the standard USACE seismic installation methods and reporting requirements in accordance with this ER.

(2) Verify that districts include the status of seismic instrumentation in the Annual Instrumentation Reports submitted by districts.

(3) Perform quality assurance to verify that districts are complying with the regulations of this ER in a timely fashion.

c. District responsibilities:

(1) Report the status of seismic instrumentation and earthquake events in the Annual Instrumentation Reports.

(2) District Dam Safety Program Managers must coordinate with the Operations Division and through the USGS point of contact to plan new seismic instruments or to maintain, repair, troubleshoot, replace, or update seismic instruments.

(3) The District Dam Safety Officer will determine the need for instruments for conditions stated in paragraph 8c.

(4) Request maintenance and other instrumentation-related funding through the annual operations and maintenance budget submissions.

(5) Supply broadband, power, and backup power (solar and battery bank and associated accessories).

(6) Submit waivers for exemptions to the standard USACE seismic installation methods and reporting requirements to the MSC.

7. Background

The objective of this ER is to update and standardize seismic instrumentation across USACE, consistent with USGS state-of-practice instruments and procedures. This ER requires the use of state-of-practice procedures for near-real-time ground motion data collection and event reporting. This ER facilitates a partnership with the USGS to leverage their expertise in the installation and monitoring of strong-motion instruments. The advantages of using the USGS state-of-practice are the following:

a. Leverages USGS protocols of remote data recording and near-real-time data reporting capability in modern seismic devices.

b. Allows remote monitoring of the status of seismic devices to facilitate timely maintenance and repair and decrease the likelihood of devices malfunctioning during ground motion events.

c. Sustains the USACE seismic monitoring program through access to USGS seismic monitoring resources and allows USACE and USGS to partner to improve seismic monitoring at project sites.

d. Allows informed prioritization of resources for post-earthquake response, seismic repair/upgrade alternatives, and risk assessments.

8. Seismic instrumentation requirements

a. Seismic instrumentation is required where the peak ground acceleration (PGA) at free field is greater than 0.1g (975-year return period) and the existing USGS strong-motion network near the project is insufficient to provide site-specific motion data.

(1) A minimum of one (abutment or free-field) seismic instrument is required for sites where the estimated free-field PGA is greater than or equal to 0.1g but less than 0.2g (975-year return period).

(2) A minimum of four instruments (including one abutment or free-field) are required for sites where the estimated free-field PGA is equal to or greater than 0.2g (975-year return period).

b. Seismic instrumentation is not required for projects where a site-specific comprehensive seismic study has been completed within the last 10 years, and that study has demonstrated the site has low seismic hazard and consequence potential.

c. Districts are to use risk-informed decision-making. For projects where the PGA is less than 0.1g, consider screening site-specific seismic hazards at the project site using USGS National Seismic Hazard Mapping Program (NSHMP) tools or site-specific Probabilistic Seismic Hazard Analysis, past performance of facilities during earthquake events, state and federal policies and priorities, and risk assessment findings. The use of USGS NSHMP tools, including areas of induced seismicity, must utilize the most recent USGS update and/or accepted updates by state agencies.

d. Where site-specific shear wave velocities are known, they should be used for classifying and adjusting the PGA. Where there is limited information, the PGA will be determined using NSHMP tools based on a 975-year return period adjusted for the representative site classification (ASCE 7-16).

9. Site-specific instrumentation locations

a. Where seismic instrumentation is required, at least one instrument must be installed to measure the abutment or free-field ground motions in order to establish baseline ground motions. Abutment and free-field instruments are to be located on bedrock or dense or stiff overburden at locations that are less susceptible to amplification/de-amplification of ground motions. The measurement directions of the instrumentation must be cross-canyon, upstream-downstream, and vertical directions.

b. Where more than one seismic instrument is required, in addition to the abutment or free-field instrument, instrumentation must be installed to measure the dynamic response of the project features. Potential locations for these instruments are:

- (1) On the lock or dam crest.
- (2) At the downstream toe in the maximum section of the dam.
- (3) Locations of significance for structure-specific dynamic response.
- (4) In the drainage gallery.
- (5) On the appurtenant structures.

c. For high-risk seismic failure modes, additional instruments could be necessary to measure structural response of critical project features such as dam piers, gates, and intake towers.

d. Design and performance objectives of civil works project features must comply with ER 1110-2-1806

10. Upgrading/Installing seismic instrumentation

a. The goals of strong-motion instrumentation are to provide immediate seismic data to assess potential damage to USACE dams, guide emergency response and post-earthquake inspection, improve the portfolio-wide characterization of seismic

hazard and facility seismic response, and assess facilities with comparable expected seismic performance.

b. Purchase and installation of new seismic instruments are to be coordinated with the USGS strong-motion team before procurement to ensure system-wide compatibility at state-of-practice capabilities. All instruments must meet the requirements for inclusion into the USGS Advanced National Seismic System (ANSS). All devices must be installed consistent with USGS requirements and meet USGS-USACE trigger threshold. Guidelines for USGS ANSS seismic monitoring of engineered civil systems are available in USGS Open-File Report 2005-1039.

Appendix A References

Section I

Required Publications

Unless otherwise indicated, all U.S. Army Corps of Engineers publications are available on the USACE website at <https://publications.usace.army.mil>.

ASCE 7-16

Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
(Available at <https://doi.org/10.1061/9780784414248>.)

EM 1110-2-1908

Instrumentation of Embankment Dams and Levees.

ER 1110-2-1802

Post Earthquake Inspections and Reporting for Civil Works Structures.

ER 1110-2-1806

Earthquake Design and Evaluations for Civil Works Projects.

U.S. Department of Interior and U.S. Army Corps of Engineers

Memorandum of Agreement Between the U.S. Department of Interior and USACE, 5 June 2020 (Request a copy by email: DLL-HQ-CoP-GGM-HQ@usace.army.mil)

USGS National Seismic Hazard Mapping Program.

<https://earthquake.usgs.gov/hazards/interactive/>

USGS Open-File Report 2005-1039

Guideline for ANSS Seismic Monitoring of Engineered Civil Systems.
(Available at <https://doi.org/10.3133/ofr20051039>.)

Section II

Prescribed Forms

This section contains no entries.

Summary of Change

ER 1110-2-103

Strong-Motion Instruments for Monitoring and Recording Earthquake Motions

This revision, dated 3 January 2024

- Modifies requirements for seismic instrumentation to (1) emphasize on site conditions and (2) lower earthquake return periods for site peak ground acceleration assessment for seismic instrumentation (975-year return period instead of 2,475-year return period) (paragraph 8).
- Changes instrumentation requirement based on site-specific conditions from peak ground acceleration of 0.2g to 0.1g (in paragraph 8c) to make the requirement consistent with paragraph 8a.
- Clarifies site specific instrumentation location description (paragraph 9).
- Clarifies role of District Dam Safety Officer in determining the need for instrumentations for certain conditions (paragraph 6).