

Part 511 – Design

Subpart C – Instrumentation

511.20 General

- A. Structures, including foundations, abutments, and the surrounding area of influence, are instrumented to facilitate evaluation of their condition and performance during and after construction.
- B. Instruments are installed to measure water levels or pore pressures, earth or rock loads and pressures, settlements, deflections or other movements, ground motions during earthquakes, leakage rates or volumes, and other important items relating to safety and performance.
- C. Instruments are used if it is determined that information is needed for determining one or more of the following:
 - (1) Safe rates of earth fill placement
 - (2) If structural strength is adequate for backfill placement or for shoring removal
 - (3) Safe rates or limits of excavation
 - (4) Water levels and pressures within soil and rock formations
 - (5) Seepage rates or volumes
 - (6) Safe rates of reservoir filling
 - (7) The instability of natural or constructed slopes

511.21 Scope

The use of instrumentation must be considered for all high-hazard dams more than 30 feet in height and any dam that has more than 600 acre-feet of storage. Earth dams and other structures with unique or complex foundations, abutment problems, or uncertain soil conditions must also be considered for performance monitoring with instruments.

511.22 Need for Reliable Instruments

Many types of instruments are commercially manufactured or can be assembled to perform the measurements needed. Only instruments proven to be reliable and serviceable may be included. If NRCS lacks experience in the use of an instrument, check with other users to determine its reliability.

511.23 Use of Instrumentation

- A. The decision on whether to monitor with instruments depends on—
 - (1) Reliability and completeness of the investigation information.
 - (2) Whether soil and rock conditions or criteria used in analyses are sufficiently conservative.
 - (3) The consequences of misjudging these items.
- B. In the design folder, document the process by which the decision to instrument or not to instrument was made and the rationale for that decision.
- C. Instrumentation must be used in all situations in which the effects of treatment have any degree of uncertainty that would result in unsafe conditions or an inadequate structure. All safety conditions, including safety to the construction force, must be considered. The design must include the details and specifications for the instruments and their installation.

D. For earth structures, the design analyses must determine the magnitude of water pressure, physical movement, soil pressure, or other measurable items where potentially unstable or undesirable conditions exist. This information must be included in the design report and used in the development of a plan for reading the instruments.

511.24 Instrumentation Plans

A. Instrumentation designs must include a plan that describes the purpose, layout and location, type of instruments to be used, and limits of loading, pressures, movement, or volumes for satisfactory structure performance. The plan must include installation details and sequence. Instructions must be included that indicate the timing and frequency of reading and recording both during and after construction. Special attention must be given to the critical periods in the life of the structure, such as during the first filling, any rapid raising or lowering of water, and after an earthquake or other disturbance. The plan is part of the design documentation and must have the same review and approval as the other design items.

B. As the instruments are installed and reading procedures are started, the instrumentation plan must be adjusted to include procedures for data reporting and reduction or plotting. Forms for recording data may be developed. Individuals responsible for interpreting the results are to be specified. Emergency procedures must be developed that indicate those individuals to be notified when critical readings are approached and steps to be taken if necessary.

C. When the project is completed and the structure is in operation, the plan may need to be supplemented for use by new personnel who will read and evaluate the instruments or for the different operating personnel and conditions. The plan should also include the location and method of data storage.

511.25 Instrumentation Monitoring and Reporting

A. The State Conservationist provides assistance to ensure that the needed monitoring is performed, recorded, and reported. This may be included in the operation and maintenance agreement.

B. An annual report of the monitoring is a summary to update the instrumentation plan. The report is to be made to the State conservation engineer (SCE) until monitoring is terminated. The Director, Conservation Engineering Division (CED), must receive a copy of this report if any unusual readings are reported.

C. The monitoring program may be terminated on completion of the intended purpose with mutual consent of the SCE and the Director, CED, on class-VIII jobs. A completion report must be prepared.

D. A summary of the site condition and structure performance exhibited by the instrumentation readings must be made on termination of the monitoring program. This summary must include an appropriate graphical array of the readings and interpretations or conclusions regarding the performance. Additional conclusions and recommendations for improvement may be made regarding the instrument's location, performance, and installation.