

Figure 5

SHEAR ENVELOPE FOR CASE I

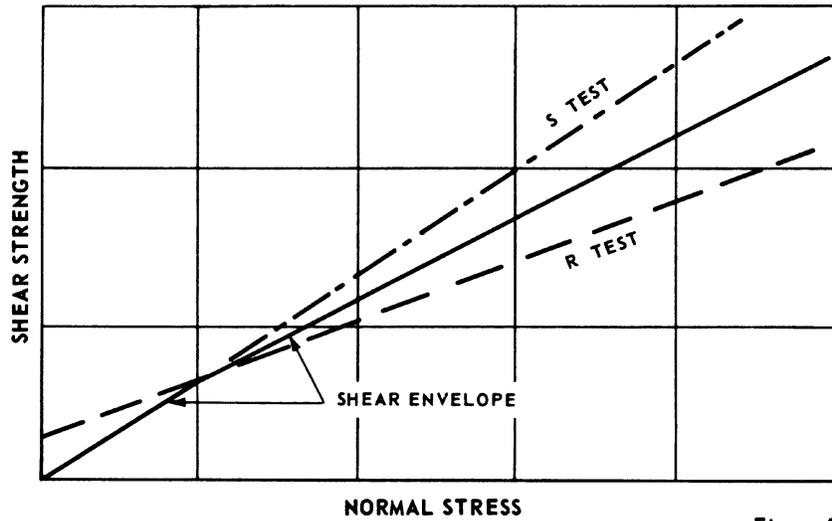


Figure 6

SHEAR ENVELOPE FOR CASES II AND III

APPENDIX I TO APP. D TO §222.6—ENGINEERING DATA to the extent available, included in the DATA

This appendix lists engineering data which should be collected from project records and,

Phase I investigation report. The list is intended to serve as a checklist and not to establish rigid data requirements. Such a compilation should also facilitate future inspections and investigations. Only data readily available will be included in Phase I reports, but data lacking and deemed necessary for an adequate safety evaluation should be identified.

1. *General Project Data.*
 - a. *Regional Vicinity Map* showing the location of the dam, the upstream drainage area and the downstream area subject to potential damage due to failure of the dam and misoperation or failure of the operating equipment.
 - b. *As-Built Drawings* indicating plans, elevations and sections of the dam and appurtenant structures including the details of the discharge facilities such as outlet works, limited service and emergency spillways, flashboards, fuse plugs and operating equipment.
 2. *Hydrologic and Hydraulic Data* including the following:
 - a. Drainage area and basin runoff characteristics (indicating pending changes).
 - b. Elevation of top of conservation pool or normal upper retention water surface elevation, as applicable (base level of any flood impoundment).
 - c. Storage capacity including dead or inactive storage, corresponding to top of conservation or normal upper retention level (cumulative, excluding flood control and surcharge storage).
 - d. Elevation of the top of flood control pool.
 - e. Storage capacity of flood control zone (incremental).
 - f. Elevation of maximum design pool (corresponding to top of surcharge storage or spillway design flood).
 - g. Storage capacity of surcharge zone (incremental, above top of flood control pool or, above normal upper retention level if flood control space not provided).
 - h. Height of freeboard (distance between maximum design flood water surface and top of dam).
 - i. Elevation of top of dam (lowest point of embankment or non-overflow structure).
 - j. Elevation of crest, type, width, crest length and location of spillways (number, size and type of gates if controlled).
 - k. Type, location, entrance and exit inverts of outlet works and emergency draw-down facilities (number, size and shape of conduits and gates, including penstocks and sluices).
 - l. Location, crest elevation, description of invert and abutments (concrete, rock, grass, earth) and length of limited service and emergency spillways.
 - m. Location and description of flashboards and fuse plugs, including hydraulic head (pool elevation) and other conditions re-

quired for breaching, along with the assumed results of breaching.

n. Location and top elevation of dikes and floodwalls (overflow and non-overflow) affected by reservoir. Include information on low reaches of reservoir rim.

o. Type, location, observations and records of hydrometeorological gages appurtenant to the project.

p. Maximum non-damaging discharge, or negligible damage rate, at potential damage locations downstream.

3. *Foundation Data and Geological Features* including logs of borings, geological maps, profiles and cross sections, and reports of foundation treatment.

4. *Properties of Embankments and Foundation Materials* including results of laboratory tests, field permeability tests, construction control tests, and assumed design properties for materials.

5. *Concrete Properties* including the source and type of aggregate, cement used, mix design data and the results of testing during construction.

6. *Electrical and Mechanical Equipment* type and rating of normal and emergency power supplies, hoists, cranes, valves and valve operator, control and alarm systems and other electrical and mechanical equipment and systems that could affect the safe operation of the dam.

7. *Construction History* including diversion scheme, construction sequence, pertinent construction problems, alterations, modifications and maintenance repairs.

8. *Water Control Plan* including regulation plan under normal conditions and during flood events or other emergency conditions. The availability of dam tenders, means of communication between dam tenders and authority supervising water control, and method of gate operation (manual, automatic, or remote control) should be included. Flood warning systems should be described in sufficient detail to enable assessment of their reduction in the flood hazard potential.

9. *Operation Record.*

a. Summary of past major flood events including any experiences that presented a serious threat to the safety of the project or to human life or property. The critical project feature, date and duration of event, causative factor, peak inflow and outflow, maximum elevation of water surface, wind and wave factors if significant, issuance of alert or evacuation warnings and adequacy of project feature involved should be included in the summary of past experience of serious threat to the safety of the project.

b. Records of performance observations including instrumentation records.

c. List of any known deficiencies that pose a threat to the safety of the dam or to human life or property.

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d. History of previous failures or deficiencies and pending remedial measures for correcting known deficiencies and the schedule for accomplishing remedial measures should be indicated.

10. *Earthquake History* including a summary of the seismic data of significant recorded earthquakes in the vicinity of the dam and information on major damage in the vicinity of the dam from both recorded and unrecorded earthquakes. Regional geologic maps and other documents showing fault locations should be collected.

11. *Inspection History* including the results of the last safety inspection, the organization that performed the inspection, the date inspection performed and the authority for conducting the inspection.

12. *Principal Design Assumptions and Analyses.*

a. *Hydrologic and Hydraulic Determinations.*

(1) Quantity, time and area distribution, and reference source of depth-area-duration data of spillway design storm precipitation (point precipitation if applicable).

(2) Maximum design flood inflow hydrograph including loss rates (initial and average for design flood conditions) and time of runoff concentration of reservoir watershed (peak inflow only when applicable).

(3) Maximum design flood outflow hydrograph (maximum outflow only when applicable).

(4) Discharge-frequency relationship, preferably at damsite, including estimated frequency of spillway design flood for small dams, when appropriate.

(5) Reservoir area and storage capacity versus water surface elevation (table or curves).

(6) Rating curves (free flow and partial gate openings) for all discharge facilities contributing to the maximum design flood outflow hydrograph. Also a composite-rating of all contributing facilities, if appropriate.

(7) Tailwater rating curve immediately below damsite including elevation corresponding to maximum design flood discharge and approximate nondamaging channel capacity.

(8) Hydrologic map of watershed above damsite including reservoir area, watercourse, elevation contours, and principal stream-flow and precipitation gaging stations.

b. *Stability and Stress Analysis* of the dam, spillway and appurtenant structures and features including the assumed properties of materials and all pertinent applied loads.

c. *Seepage and Settlement Analyses.* The determination of distribution, direction and magnitude of seepage forces and the design and construction measures for their control. Settlement estimates and steps adopted to compensate for total settlement and to minimize differential settlements.

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APPENDIX II TO APP. D TO § 222.6—INSPECTION ITEMS

This appendix provides guidance for performing field inspections and may serve as the basis for developing a detailed checklist for each dam.

1. *Concrete Structures in General.*

a. *Concrete Surfaces.* The condition of the concrete surfaces should be examined to evaluate the deterioration and continuing serviceability of the concrete. Descriptions of concrete conditions should conform with the appendix to "Guide for Making a Condition Survey of Concrete in Service," American Concrete Institute (ACI) Journal, Proceedings Vol. 65, No. 11, November 1968, page 905-918.

b. *Structural Cracking.* Concrete structures should be examined for structural cracking resulting from overstress due to applied loads, shrinkage and temperature effects or differential movements.

c. *Movement—Horizontal and Vertical Alignment.* Concrete structures should be examined for evidence of any abnormal settlements, heaving, deflections, or lateral movements.

d. *Junctions.* The conditions at the junctions of the structure with abutments or embankments should be determined.

e. *Drains—Foundation, Joint, Face.* All drains should be examined to determine that they are capable of performing their design function.

f. *Water Passages.* All water passages and other concrete surfaces subject to running water should be examined for erosion, cavitation, obstructions, leakage or significant structural cracks.

g. *Seepage or Leakage.* The faces, abutments and toes of the concrete structures should be examined for evidence of seepage or abnormal leakage, and records of flow of downstream springs reviewed for variation with reservoir pool level. The sources of seepage should be determined if possible.

h. *Monolith Joints—Construction Joints.* All monolith and construction joints should be examined to determine the condition of the joint and filler material, any movement of joints, or any indication of distress or leakage.

i. *Foundation.* Foundation should be examined for damage or possible undermining of the downstream toe.

j. *Abutments.* The abutments should be examined for sign of instability or excessive weathering.

2. *Embankment Structures.*

a. *Settlement.* The embankments and downstream toe areas should be examined for any evidence of localized or overall settlement, depressions or sink holes.

b. *Slope Stability.* Embankment slopes should be examined for irregularities in