

REPORT

MASTER

TO THE

FEDERAL ENERGY REGULATORY COMMISSION

WALTER BOULDIN DAM FAILURE  
AND RECONSTRUCTION

SEPTEMBER 1978



FEDERAL ENERGY REGULATORY COMMISSION  
OFFICE OF ELECTRIC POWER REGULATION  
WASHINGTON, D.C. 20426

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## PREFACE

Walter Bouldin is one of several hydroelectric developments of Alabama Power Company licensed as Project No. 2146. On February 10, 1975, an earth embankment section of Walter Bouldin Dam was breached, causing total evacuation of the forebay reservoir and rendering the 225-megawatt power plant inoperable.

The Commission 1/ instituted an investigation of the dam failure. The investigation was conducted by the technical staff of the Commission's Bureau of Power 2/, and a report on the investigation was published in February 1976. Subsequently, an evidentiary hearing was held before an administrative law judge who issued his initial decision on August 19, 1976. The Commission, on April 21, 1977, issued its Opinion No. 795 in which it adopted the initial decision with modifications and terminated the investigation of failure of Walter Bouldin Dam.

Opinion No. 795 directs the staff of the Bureau of Power to prepare, for the future guidance of the Commission, a report on the deficiencies which were found in its investigation, together with advice as to how such deficiencies have been and should be remedied. Also, it directs the staff of the Bureau of Power to address certain general recommendations included in the initial decision.

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1/ On October 1, 1977, pursuant to the provisions of the Department of Energy Organization Act (DOE Act), Public Law 95-91, 91 Stat. 565 (August 4, 1977) and Executive Order No. 12009, 42 Fed. Reg. 46267 (September 15, 1977), the Federal Power Commission ceased to exist and its functions and regulatory responsibilities were transferred to the Secretary of Energy and the Federal Energy Regulatory Commission (FERC) which, as an independent commission within the Department of Energy, was activated on October 1, 1977.

2/ Effective November 7, 1977, the Bureau of Power became the Office of Electric Power Regulation.

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This report was prepared by the staff of the Office of Electric Power Regulation in response to the directives noted above. It was not prepared for adoption or approval by the Commission, and in no way does it commit or prejudice later Commission action.

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## GLOSSARY OF TECHNICAL TERMS

cutoff trench - A trench excavated below the general level of the base of the dam to connect the impervious embankment zone to a suitable impervious foundation stratum.

draft tube - An extension of the wheel passages in a hydraulic turbine from the point where the water leaves such passages down to the tailrace level.

layer or lift thickness - A relatively thin layer of compacted soil in an earth embankment, generally less than 1 foot in thickness.

lenses - Local lens-shaped deposits within a formation, generally up to 2 feet in thickness.

piezometer - An instrument used for measuring water pressure head in soil.

riprap - A layer of broken stone or boulders placed on the upstream slope of an embankment as protection against wave action, erosion, or scour.

sheetpiling - Interlocking members of wood, steel, concrete, etc., subject to lateral pressure, driven individually to form an obstruction to percolation.

Tainter gate - A crest gate whose face is a section of a cylinder, which rotates about a horizontal axis downstream from the gate.

weir - An overflow structure used to measure the rate of flow.

zoning - The use of selected materials having different degrees of permeability in designated zones within an earthfill-type dam.

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OFFICE OF ELECTRIC POWER REGULATION

WALTER BOULDIN DAM FAILURE AND RECONSTRUCTION

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## CHAPTER I

### INTRODUCTION

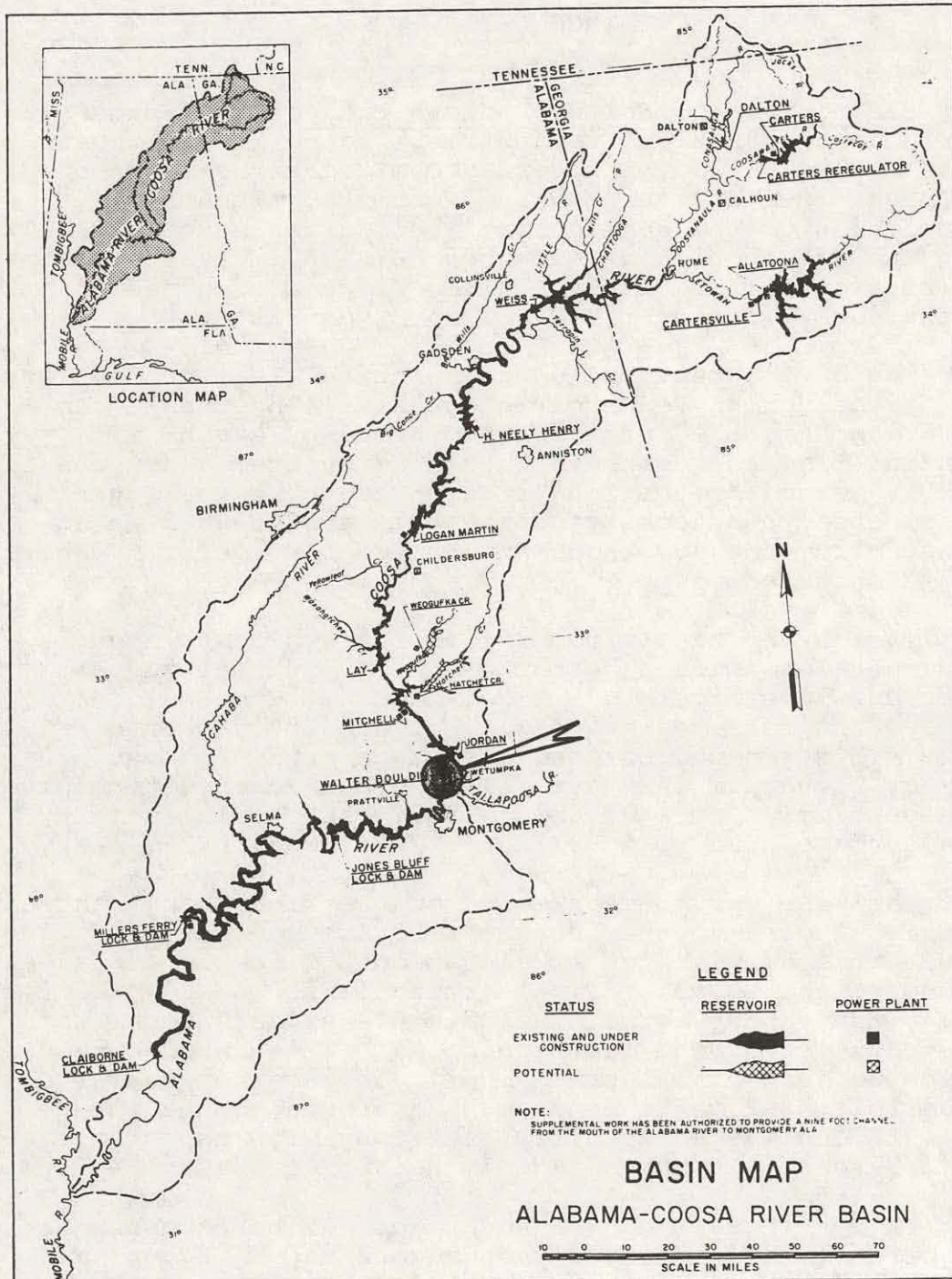
1-01 Description of Walter Bouldin Project. Alabama Power Company's Bouldin Project is located on a plateau about 2 miles west of the Jordan Dam, near the mouth of the Coosa River and the town of Wetumpka, Alabama. Construction of the development was started August 20, 1963, and was completed September 30, 1967. Plate 1 shows the location of the Walter Bouldin Project with respect to other dams in the Alabama-Coosa River Basin.

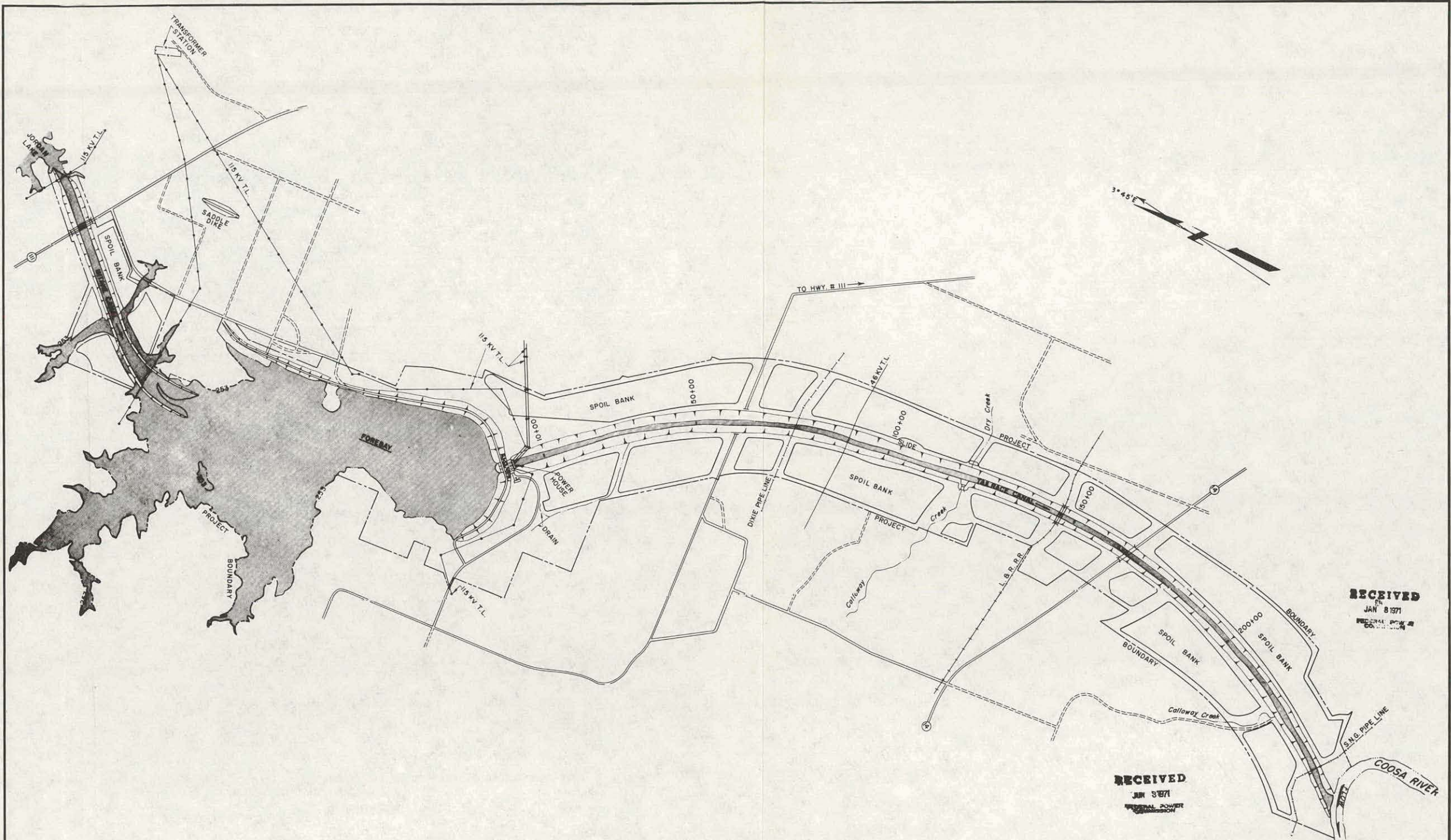
The development included an intake canal on the west bank of the Jordan Reservoir about 1 mile upstream from the Jordan Dam; the forebay pond formed by earth dikes extending from the concrete intake structure; a powerhouse which is joined to the intake structure by three concrete encased steel penstocks; and the tailrace channel which extended from the powerhouse to the Coosa River. A general plan is shown on Plate 2.

The intake canal from Jordan Reservoir was about 7,000 feet long with a bottom width of 210 feet and side slopes cut 1 vertical to 1.5 horizontal. The Bouldin forebay pond received drainage from about 7.5 square miles. This impoundment had a surface area of about 920 acres at elevation 252 feet. The Jordan Reservoir receives drainage from an area of about 10,165 square miles. It has a surface area of 5,887 acres at elevation 252 feet.

The west earth embankment, on the right bank, extended from high ground to the intake structure and was about 2,320 feet long with top at elevation 265 feet. It had a maximum height above original ground level of about 65 feet, but 140 feet above normal tailwater level as a result of the excavation of the tailrace canal. This canal extends 5 miles to join the Alabama River. The east embankment, on the left bank, extends from high ground to the intake structure and was about 5,120 feet long with top at elevation 265 feet. It had a maximum height of about 164 feet.

Except where the embankment joined the concrete structure, fairly moderate slopes were used. A typical section of the earth dike is included on Plate 3. The





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DEPARTMENT OF THE ARMY  
 Approved in accordance with the provisions of Section 4(a) of the Federal Power Act, insofar as the plans affect the navigable capacity of any navigable waters of the U.S.  
 19 May 1971 *[Signature]*  
 Lt. Col. Chief of Engineers  
 20 May 1971 *[Signature]*  
 Secretary of the Army

THIS EXHIBIT IS PART OF THE APPLICATION FOR APPROVAL OF REVISION NO. TWO OF LICENSE EXHIBIT L FOR THE WALTER BOULDIN DEVELOPMENT OF PROJECT 2146, MADE BY THE UNDERSIGNED THIS 23rd DAY OF DECEMBER, 1970.

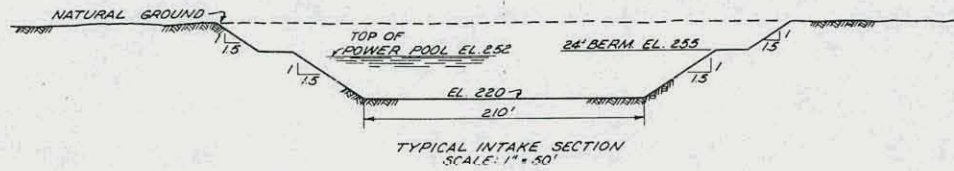
ALABAMA POWER COMPANY  
 BY *[Signature]*  
 VICE-PRESIDENT

EXHIBIT-L REVISION NO. TWO  
 GENERAL DESIGN DRAWINGS  
 (AS CONSTRUCTED)

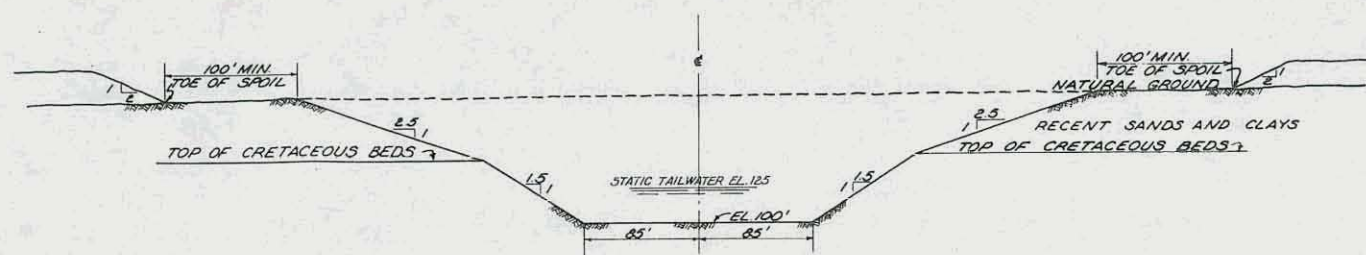
ALABAMA POWER COMPANY BIRMINGHAM, ALA.	
SUBJECT: COOSA RIVER DEVELOPMENT - FPC PROJECT NO. 2146	
DETAIL: WALTER BOULDIN DAM - GENERAL PLAN	
DRAWN: W.E.S.	TRACED BY: B. CRUCE
APPROVED: <i>[Signature]</i>	DATE: 12-23-70
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ELEVATIONS ARE U.S.C. & G.S. M.S.L. DATUM

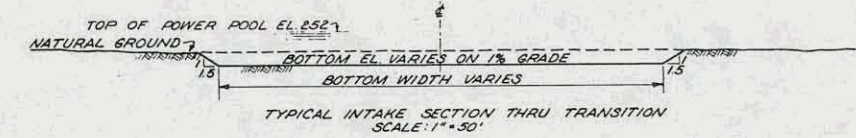
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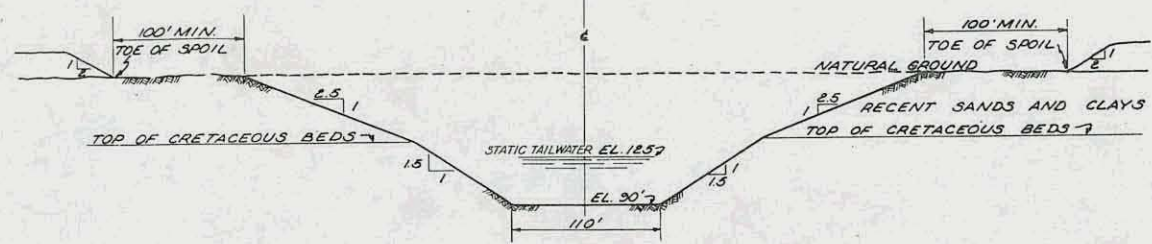
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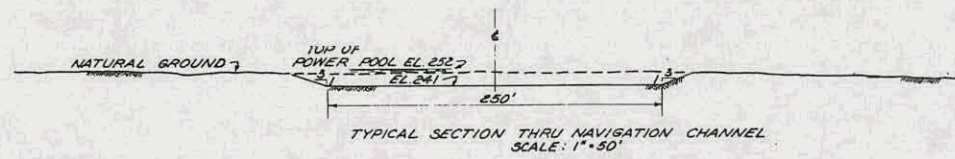
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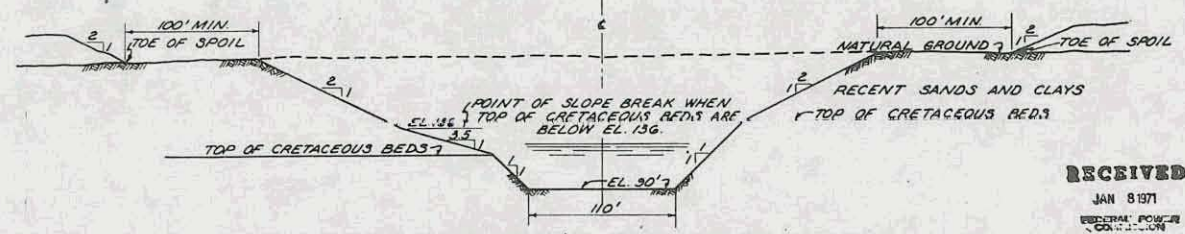
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TYPICAL TAILRACE SECTION  
AT BRIDGE LOCATIONS  
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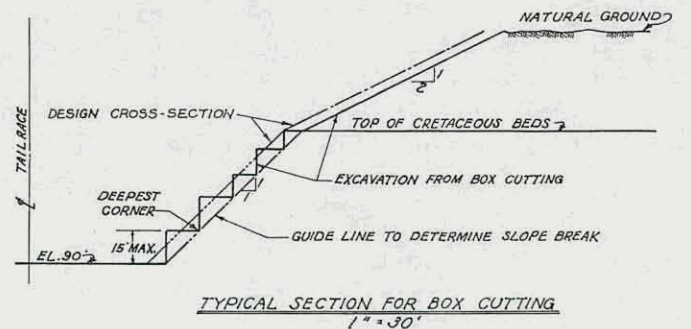


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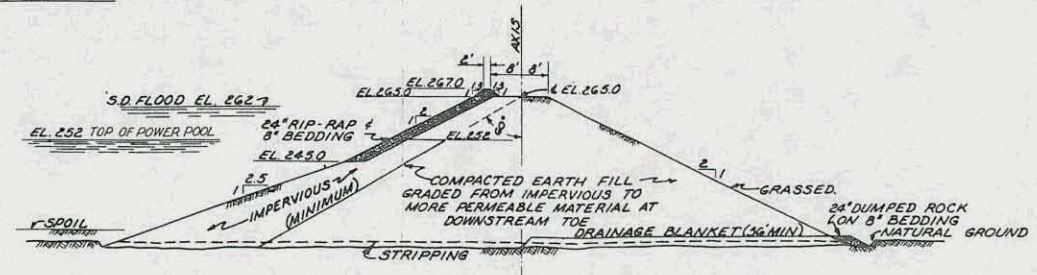


TYPICAL SECTION THRU TAILRACE CHANNEL  
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TYPICAL SECTIONS THRU INTAKE CHANNEL



TYPICAL SECTION FOR BOX CUTTING  
1" = 30'



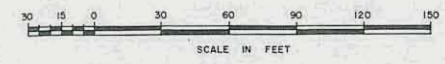
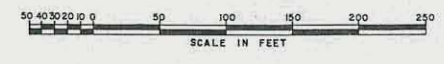
TYPICAL SECTION THRU DIKE  
SCALE: 1" = 20'

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ALABAMA POWER COMPANY  
BY *S. R. Hart, Jr.*  
VICE-PRESIDENT

EXHIBIT-L REVISION NO. TWO  
GENERAL DESIGN DRAWINGS  
(AS CONSTRUCTED)



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ALABAMA POWER COMPANY BIRMINGHAM, ALA.	
SUBJECT: COOSA RIVER DEVELOPMENT - F.P.C. PROJECT NO. 2146	
WALTER BOULDIN DAM	
DETAIL: TYPICAL SECTIONS THRU INTAKE, TAILRACE AND DIKE	
DRAWN BY: E.N.B.	TRACED BY: J.H.
DATE: 11-21-70	
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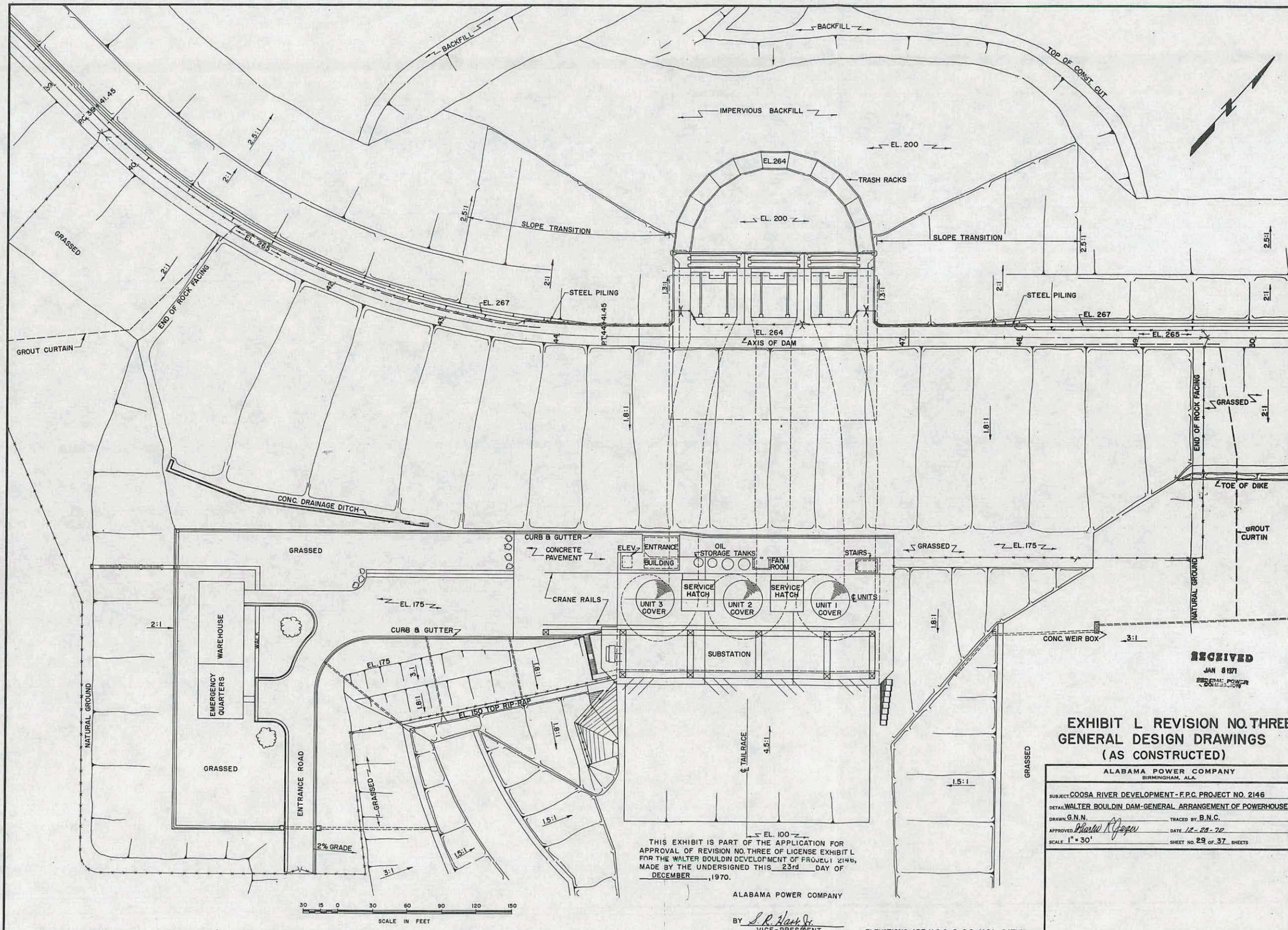
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reservoir slope was 1 on 2 from crest elevation 265 to elevation 245 and 1 on 2 1/2 below elevation 245 to the toe. The 1 on 2 slope was riprapped as protection against wave action. The grassed downstream slope was 1 on 2. Zoning included an upstream inclined, impervious diaphragm and a downstream horizontal drainage blanket. The reservoir area was blanketed, as required, for control of underseepage. As the earth dikes approached both sides of the concrete structure, steeper slopes were used to accommodate a more economical arrangement of the intake-powerhouse layout. The upstream slope transitioned to 1 on 1.3, relying on an outer rock-fill shell for stability. The downstream slope transitioned to 1 on 1.8 next to the powerhouse and was protected with rock facing. Plate 4 shows the general arrangement of the earth fill at the tie-in with the intake-powerhouse concrete structure.

The concrete gravity-type intake structure is 180 feet long and 164 feet high. It supports three intake gates (Tainter-type, 35.5 feet high and 40 feet wide) and three 30-foot-diameter steel penstocks which join the downstream powerhouse, as shown on Plate 4. The semioutdoor-type powerhouse, with circular hatch covers over the units and service bay, contains three vertical-type units each rated at 75,000 kilowatts, a total capacity of 225,000 kilowatts.

1-02 Failure of Earth Embankment. The Bouldin Dam earth embankment was breached at approximately 1:30 a.m. on February 10, 1975. The breach occurred adjacent to the intake on the east side. Plate 5 shows the location of the failure area with respect to project features. Before- and after-photographs of the failure area are shown on Plates 6 and 7. The breach in the earth embankment extended about 300 feet eastward of the east face of the intake structure. Erosion at the breach extended vertically downward to remove a significant volume of the foundation and the backfill at the east end of the concrete structure. A portion of the scoured area was backfilled with granular material, apparently from the action of gradually decreasing water velocities following the breach. Subsequent investigations indicated that the scour exceeded the depth of the original excavation for the construction. The maximum depth of scour was 165 feet below the top of the earth embankment and occurred near the east edge of the powerhouse. A cross section of the designed embankment section at the location of the breach east of the intake is shown on Plate 8.

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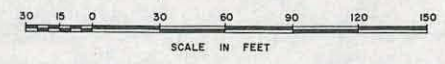


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ALABAMA POWER COMPANY

BY *S. R. Hart*  
VICE-PRESIDENT

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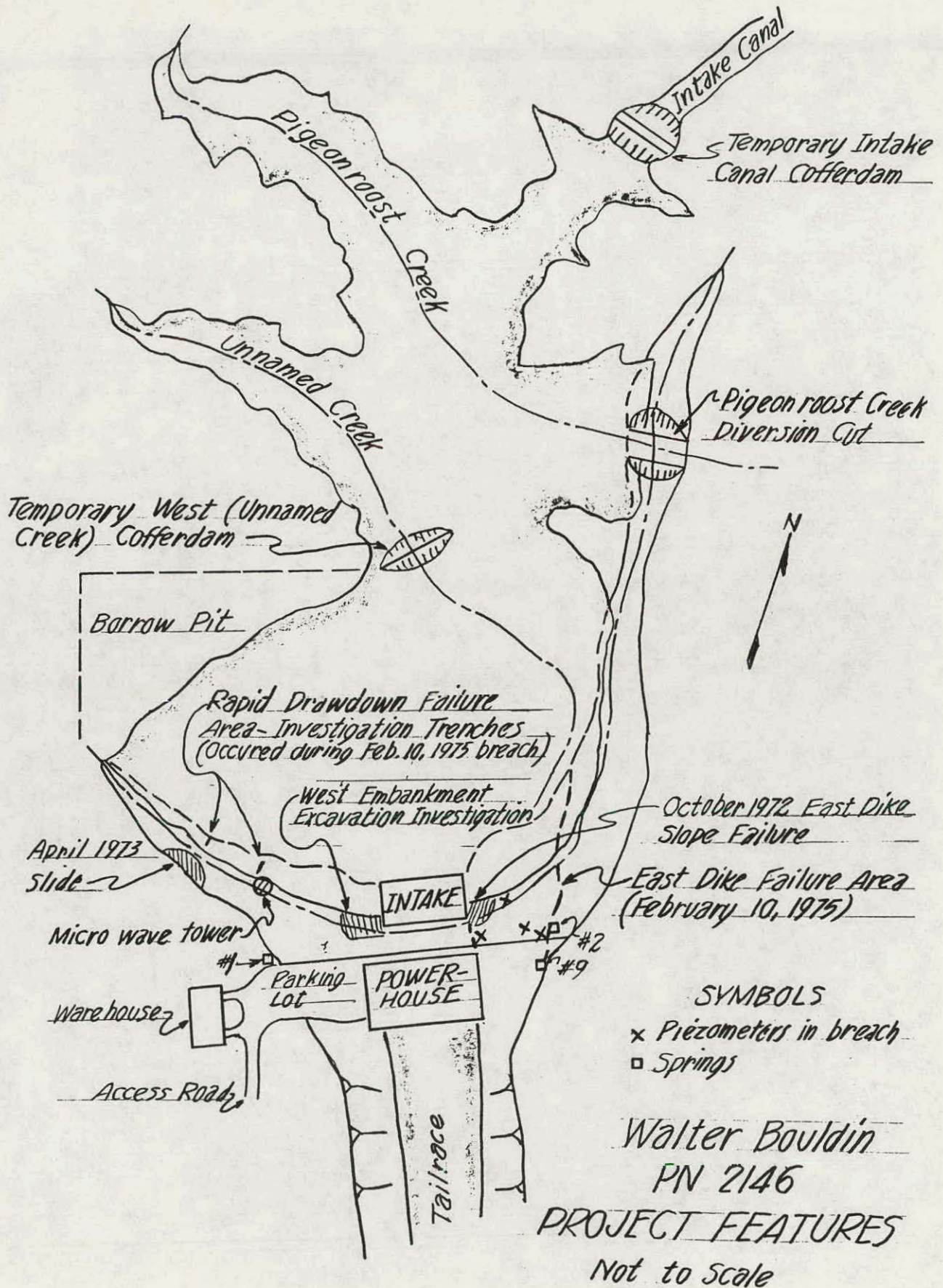
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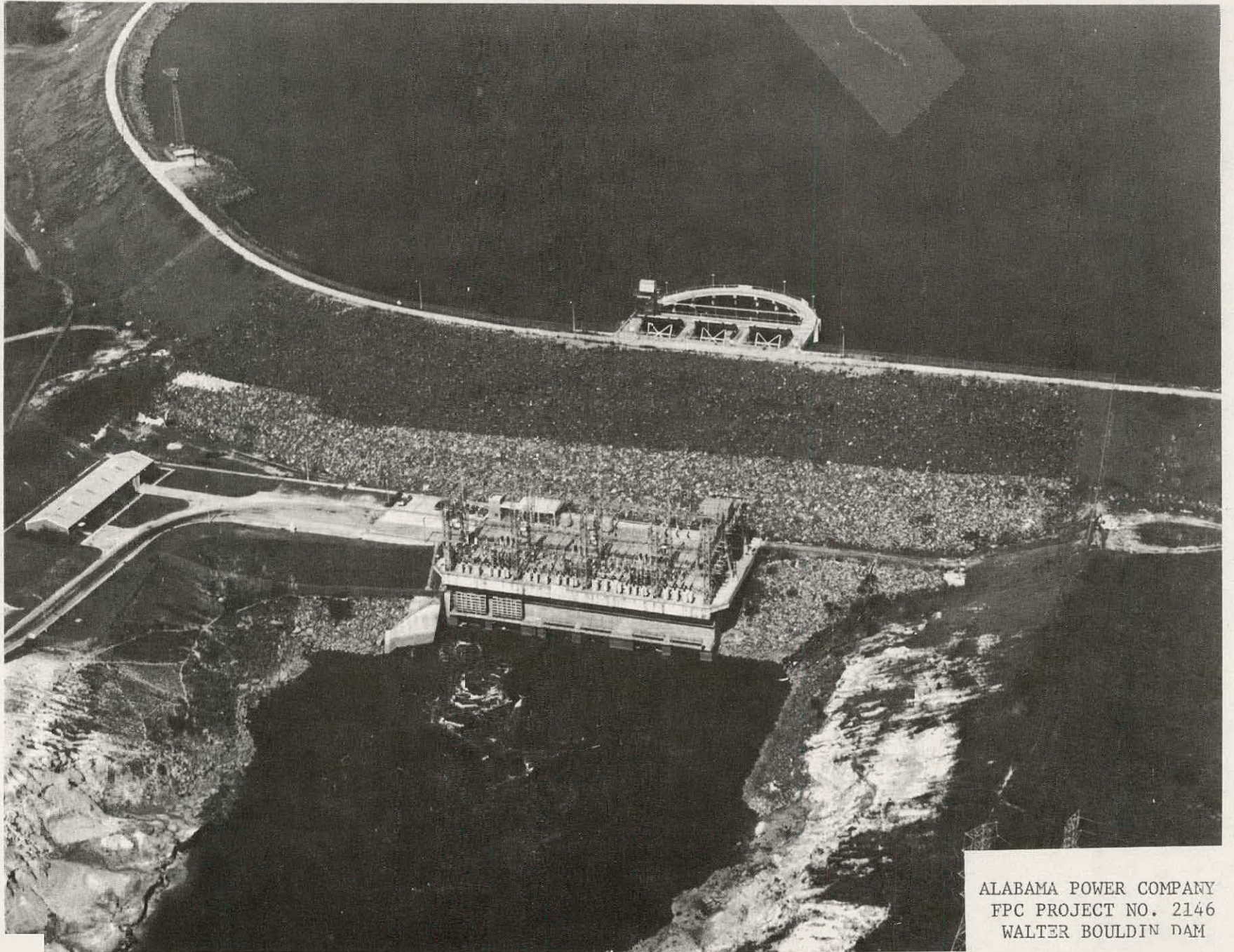
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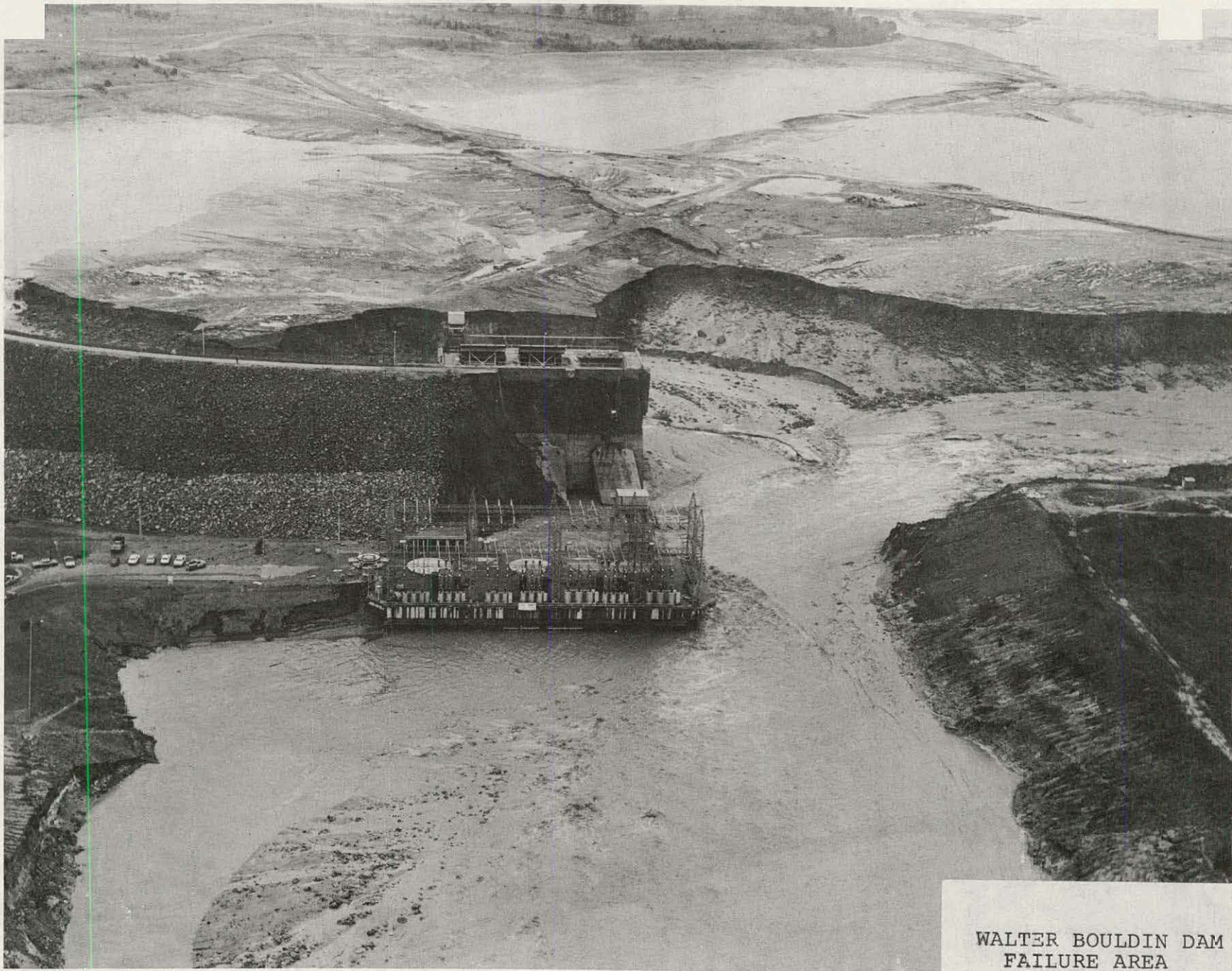
SUBJECT: COOSA RIVER DEVELOPMENT - F.P.C. PROJECT NO. 2146  
DETAIL: WALTER BOULDIN DAM - GENERAL ARRANGEMENT OF POWERHOUSE  
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APPROVED: *Charles R. Cooper* DATE: 12-28-70  
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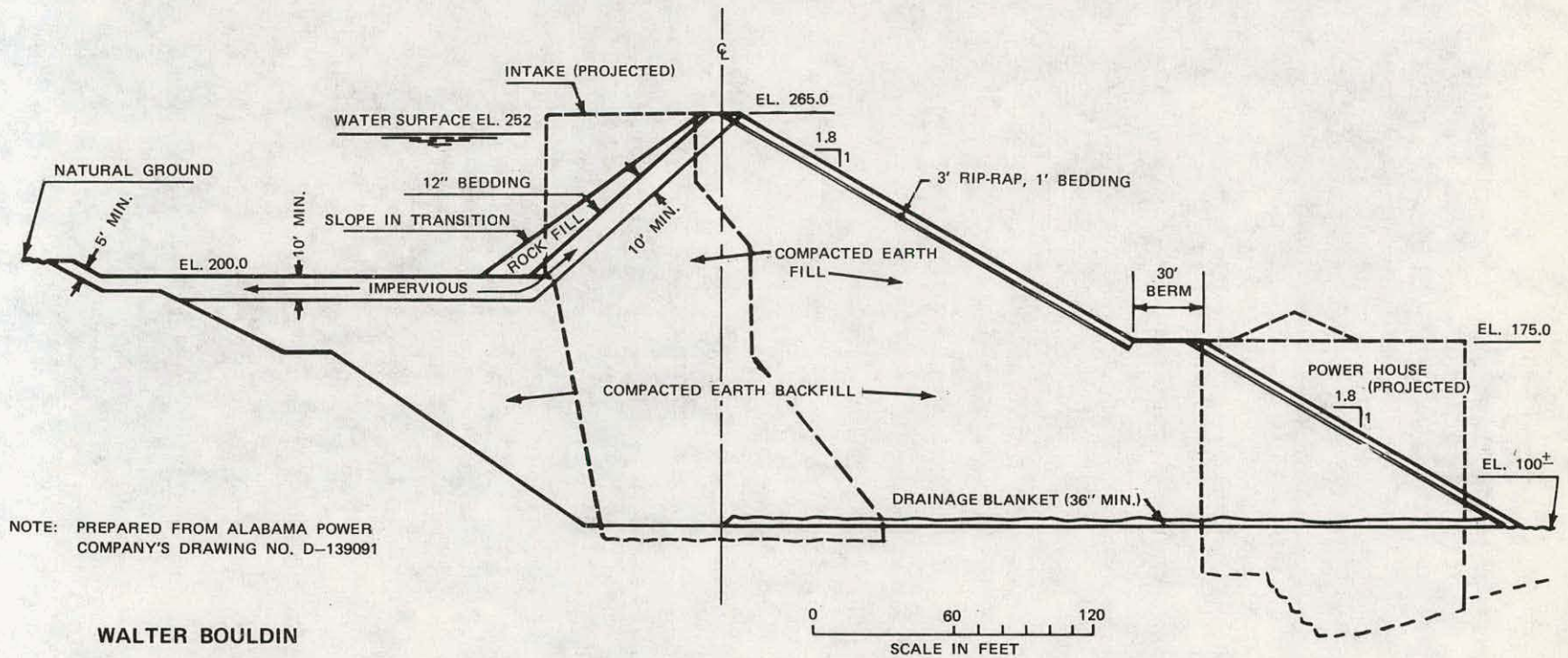


ALABAMA POWER COMPANY  
FPC PROJECT NO. 2146  
WALTER BOULDIN DAM



WALTER BOULDIN DAM  
FAILURE AREA

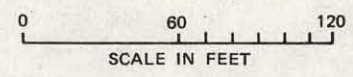




NOTE: PREPARED FROM ALABAMA POWER COMPANY'S DRAWING NO. D-139091

WALTER BOULDIN

at Station 46 + 88



Erosion to a depth of 50 feet below the original reservoir bottom continued along the upstream toe of the dike both east and west of the concrete structure. The semicircular trash rack structure, enclosing the entrance of the intake, was demolished and deposited in the foundation and tailrace area. The upstream slopes of both the east and west dikes were undercut extensively, creating numerous slides. Two of the more conspicuous failure zones included: (1) a 500-foot section of the east dike beyond the 300-foot breach which had its upper portion removed to about station 54 and (2) a drawdown slide, a secondary failure over 500 feet long, which occurred at the upstream slope of the west embankment near the location of the microwave tower.

Extensive deposits of washed sand and gravel were visible in scoured channels in the reservoir area. The tailrace immediately downstream of the powerhouse was filled with sand, gravel, riprap, and other debris to elevation 150, completely burying the draft tubes. Most of the embankment fill (riprap and granular material) immediately downstream of the intake was washed away. Large quantities of sand and gravel and some riprap were deposited on the powerhouse deck and switchyard, and on all three levels of the powerhouse. The generators were flooded by silt laden water that entered through the east stairwell and the ventilating shafts.

Observations of the initial action triggering the failure were hampered by darkness and the fact that the lights along the crest went out early during the beginning of the break. There was general agreement among early eyewitness accounts, however, that a shallow trough-like slump, possibly 25 feet deep, developed at the top of the embankment near the intake structure. Water was heard coming through the upper portion of the dike. The breach developed fairly rapidly, eroding from the top down.

Failure began about 1:30 a.m., Monday morning, February 10, 1975. By daybreak, erosion had progressed below the level of the powerhouse deck. Heavy flows continued through the breach for about 14 hours until the interconnected Jordan Reservoir was lowered to the elevation of a ledge of high ground at the entrance to Bouldin Reservoir. This natural weir gradually throttled the discharge and limited drawdown of Jordan Reservoir to elevation 239; otherwise damage to project works may have been more severe.

There were no personal injuries reported and no significant damage downstream. Reservoir water rushing through the break was confined by the banks of the 5-mile-long tailrace return channel leading to the Alabama River.

Principal damage from the failure was to the dam and associated power plant facilities. It is estimated that the power plant will be returned to operation in early 1979, or approximately 4 years following the failure. The loss of 225 megawatts of generating capacity and 460,000,000 kilowatt-hours of electric energy per year represents an estimated total cost of \$60 million to provide replacement power over the 4-year outage. In addition, the reconstruction has been estimated to cost about \$40 million, which includes capital expenditures, maintenance cost, and escalation during the reconstruction period.

## CHAPTER II

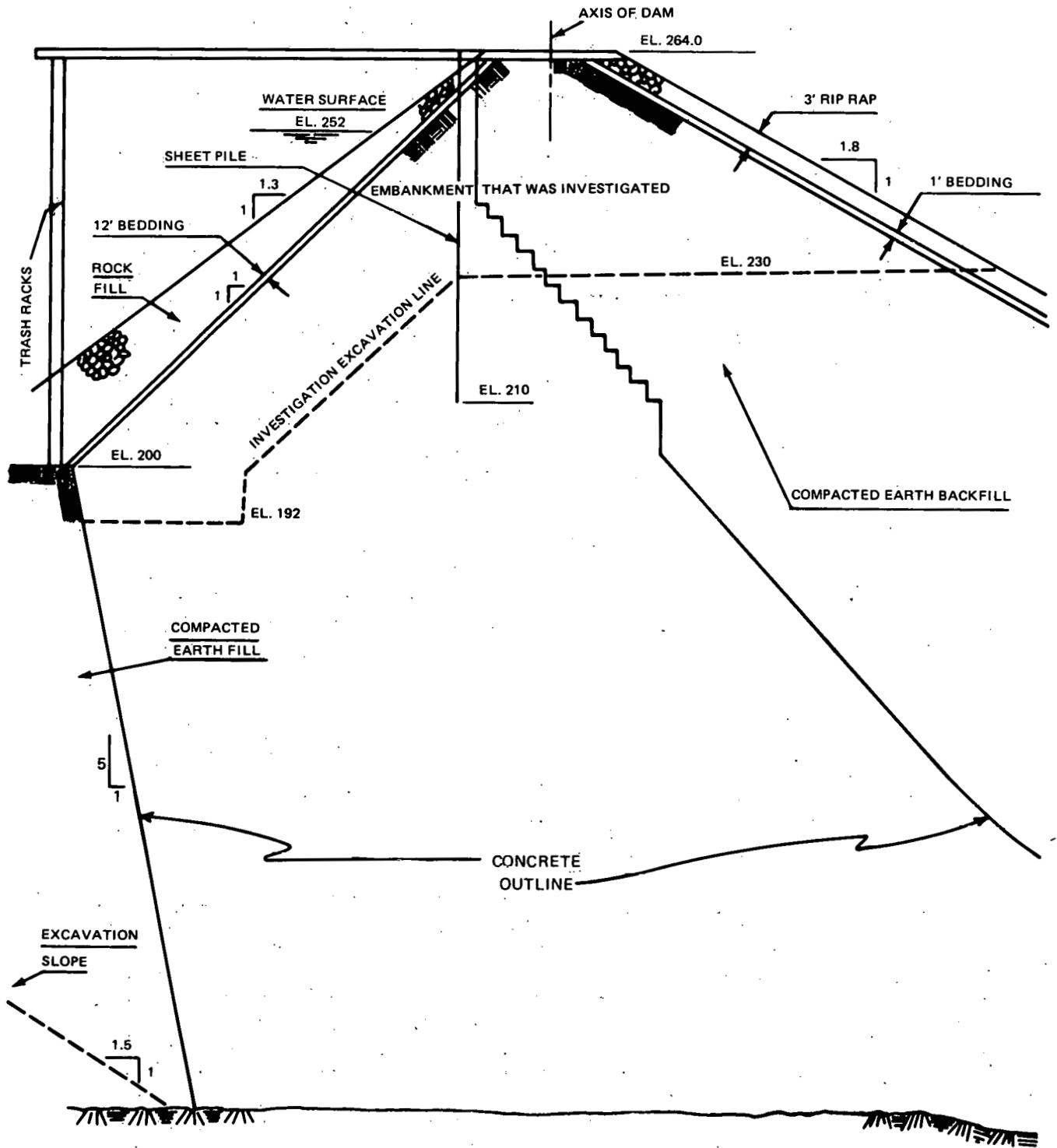
### INVESTIGATION OF FAILURE

#### 2-01 Field Investigation

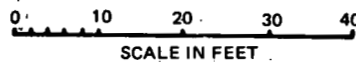
a. Exploratory Excavation. A major element in the investigation was the exploration of the embankment adjacent to and west of the intake structure. Since the embankment was designed to be symmetrical about the intake flow line, and the fill on both sides of the structure was placed at the same time, it was believed that an investigation of the west side might provide a representative indication as to the composition and construction of the failed portion east of the intake. Accordingly, the licensee arranged for a staged excavation of the west embankment. The zone excavated is illustrated by the section adjacent to the west face intake structure, shown on Plate 9. Excavation above elevation 230 included the full width of the embankment and extended from the west face of the intake to a point 300 feet west of it. Between elevations 192 and 230, only the upstream impervious blanket was investigated, from the intake for a distance of about 75 feet. Excavation was principally by a dozer, a gradall, and a small backhoe. Hand excavation was employed along the face of the intake and the curtain wall of sheetpiling which extended from the face of the intake. During the investigation, an engineer from the Commission's Atlanta Office was on the site to observe the excavation, make independent investigations, and direct sampling for independent testing.

The exploratory investigation of the as-built west side found the embankment zoning to be generally excellent from the standpoint of controlling possible through seepage. The upstream impervious diaphragm consisted of reddish brown, sandy, lean clays and clayey sands, while the downstream embankment zone was a well-graded granular material, an ideal material for resisting any tendency toward piping.

However, many instances of poor construction practice were noted. Sand and gravel lenses were found in the upstream impervious blanket. In some areas clay lenses were found in the upstream rock-fill zone. A lift of relatively impervious blanket material was found in the more



WALTER BOULDIN PROJECT NO. 2146  
 WEST FACE IN TAKE STRUCTURE



pervious downstream shell. Some lift thicknesses in excess of 12 inches were noted. Test results indicated that, at many locations, the moisture content of the material had been too high to achieve proper compaction. Also, it was apparent that the specified uncompacted lift thickness was too thick for the type of compaction equipment used.

b. 1972 Slide. On September 28, 1972, a rapid drawdown of the Bouldin forebay reservoir occurred due to an extended period of full load generation during which the units were discharging more water than the diversion canal from Jordan to Bouldin could supply. A drawdown from elevation 248 to 238 took place in 7 hours. On October 4, 1972, 6 days later, a slide was noticed at the crest of the upstream slope. It extended 30 to 40 feet on the east side of the intake. The location of the slide is shown on Plate 5. At the same time a surface crack was noted at the west side of the intake structure in earth material that had been spoiled on top of the riprap.

From a study of available color slides, photographs, and sounding profiles of the 1972 slide area, and judging by the dimensions of the vertical scarp at the top and the bulge at the toe, it appeared that the slide plane at the east dike may have extended well into the impervious embankment zone.

The east side was repaired by hand-tamping clay against the exposed sheetpiling and then dumping crushed stone (600 tons); over which a 2- to 3-foot-thick layer of riprap (950 tons) was placed. About 900 tons of riprap intermixed with rock fines were placed at the west embankment to improve stability.

c. Summary of Performance. There was no advance warning of the failure. It occurred suddenly and at night. The project was well instrumented and it was receiving periodic surveillance. The instrumentation data, including weirs, piezometers, and settlement, showed no adverse trends and gave no indication that failure was imminent. The project was inspected by the plant superintendent the day before the failure. Hydraulic and generation instrumentation data for the 24 hours preceding the onset of the failure indicated no abnormal conditions. The experience record of Walter Bouldin Dam indicated major problem areas which required special maintenance measures and careful

surveillance. The embankment slopes had experienced a number of slides which required immediate repair. The slides were an indication that the embankment slopes were generally too steep for the existing conditions. The initial reservoir filling resulted in several sources of uncontrolled seepage. The original design relied heavily on the existing natural impervious blanket inside the reservoir area for controlling underseepage. The natural blanket was not adequate, and it was necessary to add horizontal toe drains and vertical relief wells for improved underseepage control.

d. Cause of Failure. Observation of the failure was restricted due to darkness, and eyewitness accounts were limited and inconclusive in determining the actual cause of the failure. The investigation was devoted primarily to studies for determining the most likely cause of failure. From the study of all available evidence, it was concluded that the accident most likely occurred by a failure of the upstream slope near the east end of the intake structure. It is possible that the triggering action may have been a reactivation of the 1972 slide which occurred at the upstream slope east of the intake following a rapid drawdown of the reservoir. Subsequent slumping of the crest, or a retrograde slide, permitted reservoir water to flow through the formed depression at the upper portion of the dike and resulted in the developed breach by rapid erosion from the top down. The failure is described in more detail in a report dated February 1976 prepared by the Federal Power Commission's Bureau of Power entitled "Investigation of Failure of Walter Bouldin Dam, and Safety of Other Dams of the Alabama Power Company."

2-02 Deficiencies. The staff report on the investigation of the failure of Bouldin Dam discussed uncertainties associated with attempts to determine the exact cause of failure. For this reason a listing of deficiencies contributory to the failure must be somewhat broad to allow for the contingency that some undetected factor may have been instrumental in the failure of Bouldin Dam. Possible deficiencies leading to the failure were discussed in detail in the failure report and it was concluded that the most likely cause of failure was a combination of design and construction deficiencies, as noted below.

a. Steep Upstream Slope. A transition was used where the earth dam section abutted the intake structure. At this location, the dam was designed as a rock-fill section. It

had a steep 1 on 1.3 slope and was founded on a compacted clay blanket. The stability of this section was considered to be marginal.

b. Incomplete Specifications. The specifications used for the original construction of Bouldin Dam have been termed end-product specifications, wherein the contractor is responsible for attaining the desired end product. The Commission found that methods-type specifications are preferable, and noted that this is in accord with accepted practice by the Bureau of Reclamation and the Corps of Engineers who use methods-type specifications. Under such specifications, moisture control, layer thickness, type of compaction equipment, and number of passes of the equipment are specified, as necessary, to provide the desired degree of compaction. Methods specifications clearly delineate the owners' expected performance from contractors and places the primary responsibility on the owner for assuring that the construction will provide the results anticipated in the design.

c. Unacceptable Construction Practice. The incomplete specifications were a contributing factor to poor construction practice. Inspection during construction was inadequate. There was no moisture control, and lift thicknesses were too thick to obtain desired compaction. Zoning was not carefully executed. Pervious lenses of sand and rock fines were found in the impervious core. Lenses of impervious material were found in the rock-fill zone. There was some evidence, although inconclusive, to indicate that the as-built section did not conform to the design in that the rock zone east of the intake, at the location of the failure, was not constructed to the full design thickness.

d. Quality Control. A large percentage of density tests taken during the excavation of the embankment west of the intake indicated that specified compaction was not achieved. Field control measures were inadequate during construction. Moisture control was not specified, and the impervious material had too high a moisture content when placed. Also, it was placed in layers which were too thick to obtain the specified density and desired shear strength.

e. Repair of 1972 Slide. There was insufficient investigation of the upstream slide which occurred in October 1972 following a rapid drawdown of the forebay pool. Evidence was uncovered to indicate that the slide



was more deep seated than realized and the surficial repair was inadequate. It was concluded that progressive deterioration of this slide zone may have led to the 1975 failure.

2-03 Evidentiary Hearing. The Federal Power Commission in its Order Instituting Investigation and Providing for Hearing, issued February 20, 1975, (Appendix A) ordered a formal investigation of the causes of the failure of the Walter Bouldin Dam in order to determine the proper remedial actions which should be taken to assure that life, health, and property are adequately protected at this dam and other dams under the control of the licensee, the Alabama Power Company. The order further directed that the formal investigation should also determine whether the provisions of the Federal Power Act or any rule, regulation, or order of the Commission had been violated and, if so, which may have caused or contributed to the dam's failure.

Further, the Commission order provided that, upon completion of the investigation by the staff, an evidentiary hearing pursuant to Sections 10(c) and 308 of the Act shall be held to document and determine: (1) the cause or causes of the dam failure and (2) any remedial actions which may be warranted to correct any violations of the Act or any rule, regulation, or order thereunder or to assure that this dam failure or the potential for failure of any other related dams under the control of the licensee will not occur or reoccur.

The hearing which followed the investigation of the failure of the dam was commenced on April 22, 1976, and extended over 12 sessions, terminating on June 30, 1976. At this proceeding, witnesses of Alabama Power Company and the FPC staff presented testimony on their separate and independent investigations of the dam failure.

a. Administrative Law Judge's Decision. The Presiding Administrative Law Judge issued his initial decision on August 19, 1976 (Appendix B). On the basis of the evidence presented, he identified four serious weaknesses which contributed toward the failure:

- (1) Construction did not comply with design specifications in one or more critical areas of the earth-fill dikes;

- (2) Alabama Power Company's inspection procedures were not adequate to detect critical deficiencies between construction and specifications;
- (3) Review procedures utilized by staff with respect to this procedure were not sufficiently thorough to identify possible marginal design criteria prior to construction; and
- (4) Staff methods for review of dam construction procedures and maintenance practice with respect to Walter Bouldin were not sufficiently exacting to uncover construction deficiencies and possible areas of weakness.

2-04 Commission Order Adopting Decision. A Federal Power Commission order issued April 21, 1977, Opinion and Order Adopting Initial Decision with Modifications and Terminating Investigation of Walter Bouldin Dam, summarized the investigation and hearing (Appendix C). It emphasized the importance of deriving the maximum benefit from the investigation of the failure of Walter Bouldin Dam. The order directed the staff of the Bureau of Power ". . . to prepare for our future guidance a report on the deficiencies which were found in the respective areas of concern (staff, licensee, contractor, and others), together with its advice as to how such deficiencies have been and should be remedied over the short and long terms and at the respective levels of authority." Deficiencies and remedial measures are enumerated and discussed later in this report.

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## CHAPTER III

### ADMINISTRATIVE LAW JUDGE'S CONCLUSIONS AND RECOMMENDATIONS

The Presiding Administrative Law Judge, Samuel Kanell, found that the evidence did not provide a basis for conclusive determination of the precise cause of failure of Walter Bouldin Dam. As discussed in Section 2-03, he identified several serious weaknesses and deficiencies. In his conclusions and recommendations, he reported on deficiencies found in design, construction, inspection, maintenance, staff review, emergency procedures, and Order No. 315 reports. Judge Kanell's conclusions and recommendations read as follows:

#### "A. Dam Design

Earth fill dam design criteria must be reasonably conservative.

Dam design should provide increased margins of safety taking into account such factors as specific and exacting specifications of types and characteristics of materials and design strength. Flatter slopes will not prevent slides, but steeper slopes are more susceptible to slides. The steepness of an earth fill dike should not be influenced by the slope of an adjoining concrete structure to the extent that the stability of the earth fill slope could be considered to be only marginally safe.

It is arguable as to whether "end result" specifications or more detailed "methods type" specifications are preferable. Whichever procedure is used, it is essential that specifications be sufficiently clear to insure that designed strengths are achieved. An effective procedure for continuous testing of critical components of earth fill dams to insure compliance with specifications should be an integral part of the contractor's obligation subject to further regular check by company and Staff inspectors as outlined infra. While dam design should result in a reasonably economical structure, basic safety and dam stability can never be sacrificed in seeking to implement cost savings.

Earth fill dams must have sufficient strength to withstand unexpected water drawdowns, and sufficient stability to minimize the occurrence of surface slides.

On Brief, Staff contends that Alabama compromised the safety of the Walter Bouldin Dam to save money. It is undisputed that dam design should be reasonably conservative, and in light of the failure of this dam, it can be contended that design should have met higher standards of safety. However, this record does not support the contention that safety was compromised by Alabama in the interest of reducing construction costs. Nor does the record disclose that Staff suggested more conservative design features at the time of the initial review of the plans for this dam.

In response to the request of the Presiding Administrative Law Judge, on Brief, both Alabama and Staff submitted proposed findings and recommendations. Proposals of Staff include specific suggestions relating to redesign of the dam, but probative evidence was not submitted in support of these redesign concepts. Thus, the record of this proceeding does not permit evaluation of these design proposals.

It is expected that in accordance with its usual procedure, Staff will review with Alabama representatives the proposed reconstruction plans. Following such joint engineering evaluation of Staff suggestions, Staff is expected further to submit appropriate recommendations to the Commission concerning Alabama's proposed reconstruction plans to insure that the rebuilt dam incorporates reasonably conservative design concepts and is built in conformity with the findings and conclusions of this Initial Decision.

This investigation and related proceedings neither abrogate nor curtail Staff's continuing responsibility to monitor dam design and construction procedures and to advise the Commission with respect to necessary action to insure public safety.

"B. Construction Inspection

Adequate and proper inspection of the construction of an earth fill dam is not a matter to be treated casually. Inspectors must be fully trained, and have a

clear understanding of their functions. They should have all necessary authority to reject unsatisfactory work and to require necessary corrections. Inspection must be constant, consistent and thorough.

Testing equipment and procedures must insure that testing is complete; testing only the upper six inches of a 12-inch layer of soil is wholly unacceptable. The post-failure inspection disclosure of an unduly large proportion of substandard tests of the Walter Bouldin Dam makes it apparent that the testing conducted during construction of this dam did not meet this essential criterion. Testing cannot be sporadic. As noted supra, a large proportion of substandard compaction tests were uncovered in the soil layers of the west dike located between elevations 224 and 242. It would appear that testing was essentially nonexistent during the construction of this segment of the dike.

#### "C. Inspection Records

Inspection records should be detailed, comprehensive and consistent in form. It appears that during the construction of the Walter Bouldin Dam, each inspector kept records in his own manner and that review of these records could result in confusion rather than enlightenment. The misunderstanding as to whether rock zone construction conformed with specifications was the direct result of the inability of an Alabama draftsman to understand the nature of the inspector's field notes. It would also appear that Alabama supervision of the work of these individuals was ineffective.

Construction inspection records should show as-built sections of construction with reasonable clarity. To determine as-built sections of the Walter Bouldin, Alabama was compelled to make reference to the original design drawings, but documentary evidence to show that actual construction complied with design drawings was not available, except for reference to a small scale drawing on one page of a field notebook. This does not constitute record keeping for a project of this magnitude.

#### "D. Dam Maintenance

Slides, springs, foundation problems and other matters occur at earth fill dams. Some of these problems are minor and some may have significance. Each of these

occurrences requires adequate and thorough investigation because a basic weakness in a segment of the dam may be indicated. Each such occurrence should be reported promptly to the Commission. The potential gravity of such matters precludes a field determination that a slide or a spring is too insignificant to warrant a written report to the Commission regional office. Prompt reports of all such matters must be required with Staff follow-up as necessary.

Further, a uniform method of maintenance record keeping must be required. The initial record of the 1972 slide repair at the Walter Bouldin Dam was filed as part of a generator and turbine maintenance record and a more complete record of this slide was not prepared until over 3 years after the slide occurred. This should not recur.

Commission directive reaffirming and clarifying the nature of maintenance record keeping for licensed projects should be issued.

#### "E. Commission Staff Review

Commission Staff has performed a commendable job in the thorough review of the Walter Bouldin Dam failure and the stability of other dams controlled by Alabama.

Prior to this failure, it would have been most desirable if Staff had exercised more effective review over, (1) the initial design criteria of this dam, (2) construction and inspection procedures during construction, and (3) the 1972 slide when this matter was verbally reported by an Alabama representative.

It would appear to be impractical for Staff to conduct the extensive type of examination of all dams licensed by the Commission as Staff has conducted of the dams controlled by Alabama. However, Staff review procedures must be strengthened and there should be no reluctance or hesitancy to conduct critical and constructive reviews of proposed dam designs to achieve a higher degree of safety and dam stability. While the licensee has the responsibility to build and maintain a structure that will pose no threat or danger to life or property, the nature of the work conducted by Staff to insure that the licensee meets this responsibility should be more clearly and definitively delineated.

For example, Staff could arrange for sample tests to be taken at critical areas during construction to insure compliance with design standards. Staff should review licensee inspection records and monitor work of inspectors to insure adequate inspection procedures. Dam maintenance records and daily log books should be a matter of regular Staff review and inspection. (During the course of this hearing, it became apparent that Staff were not familiar with the records maintained by Alabama.)

Staff should be encouraged to exercise initiative and imagination during dam inspection visits and to follow through on any matter indicating problem areas or unusual events that may be indicative of safety problems or lack of dam stability.

"F. Emergency Procedures

Procedures should be established for necessary action in the event of emergencies such as the weakening of a dam, a breach or other unusual hazard. Such procedures should provide for prompt warning to and possible evacuation of those affected, methods of diverting water to minimize pressure on the weakened facility, and, as necessary, standby arrangements for emergency repairs.

"G. Order No. 315 Reports

The Commission issued Order No. 315 on December 27, 1965 (34FPC1551) for the purpose of providing for adequate inspection of licensed facilities and to insure their safety. It is apparent that the Order No. 315 report of the Walter Bouldin Dam did not identify the areas of possible weakness which subsequently resulted in the failure of this dam. Reports submitted to the Commission pursuant to this order should be more thorough and include sufficient independent testing and other appropriate procedures to provide meaningful information relating to the stability and safety of licensed projects."



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## CHAPTER IV

### RECONSTRUCTION OF BOULDIN DAM

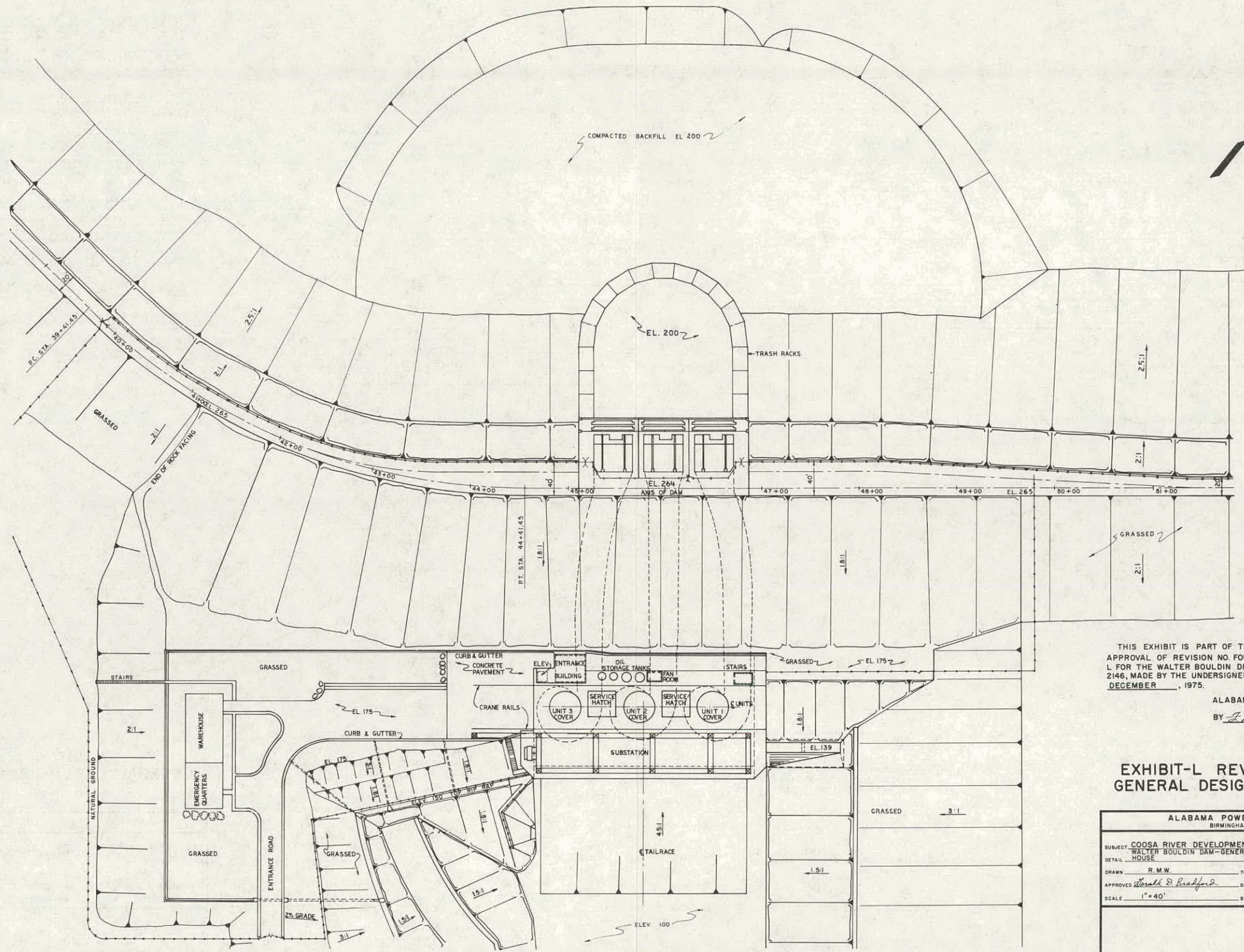
4-01 General. On December 16, 1975, the licensee filed an application requesting the Commission to authorize it to rehabilitate and rebuild those facilities that were damaged by the breach of Walter Bouldin Dam. Licensee proposed to reconstruct the dam using an earth-fill section along the same alignment as the original construction. The design contemplated the removal of all material which had been weakened or distressed at the time of failure. Since it had been recognized that there were uncertainties in the efforts made to pinpoint the cause of failure, a principal criterion of the design was that it should be sufficiently conservative to allow for the contingency that some undetected factor may have had a bearing on the Bouldin Dam failure. The redesign provided for an earth dam using flatter slopes, and it included a positive cutoff to intercept the existing previous aquifers in the foundation. Rigid specifications were proposed to insure that construction would meet the strict requirements imposed by the design.

All of the remaining original embankment required some modification. Representative cross sections of the repair or remedial measures, as shown on Plate 11, include an inclined core and a conventional open cutoff trench concept throughout. Required excavation of existing foundation and embankment material was conservatively estimated to provide for the removal of all questionable material.

The most critical embankments extend for approximately 500 feet on each side of the concrete intake structure. These areas were to be completely excavated to remove all of the initial construction, including the original powerhouse backfill. The new embankments at the east and west faces of the intake were designed to have upstream slopes varying from 1 on 2 1/2 adjacent to the intake structure to 1 on 2, with these slopes being faced with riprap to resist wave action (Plates 10 and 11). The downstream slope, 1 on 1.8, was to be protected by a 3-foot outer layer of rockfill. Elaborate zoning was included in the design to control any possible through seepage. The design provided

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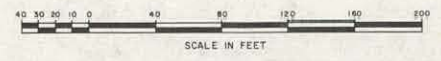


THIS EXHIBIT IS PART OF THE APPLICATION FOR APPROVAL OF REVISION NO. FOUR OF LICENSE EXHIBIT L FOR THE WALTER BOULDIN DEVELOPMENT OF PROJECT 2146, MADE BY THE UNDERSIGNED THIS 15<sup>th</sup> DAY OF DECEMBER, 1975.

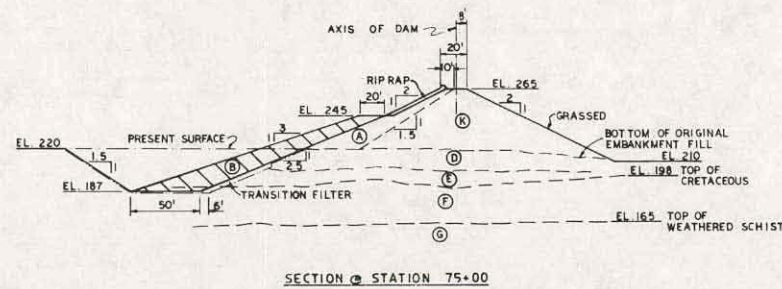
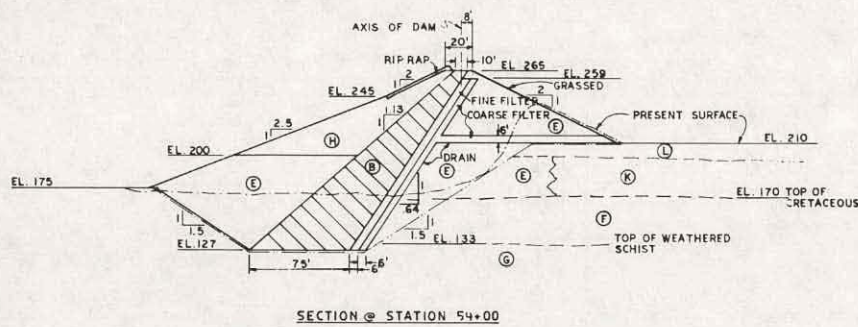
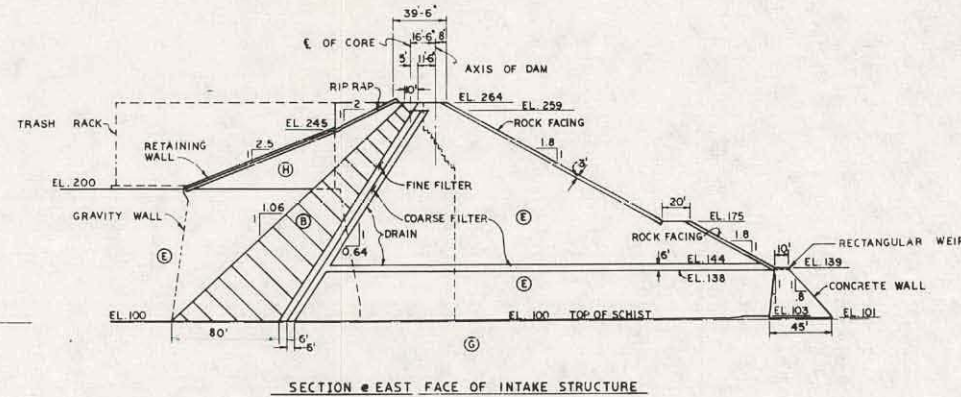
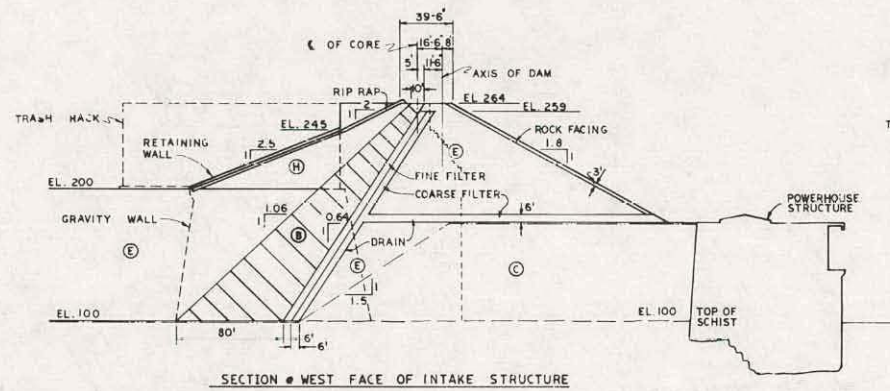
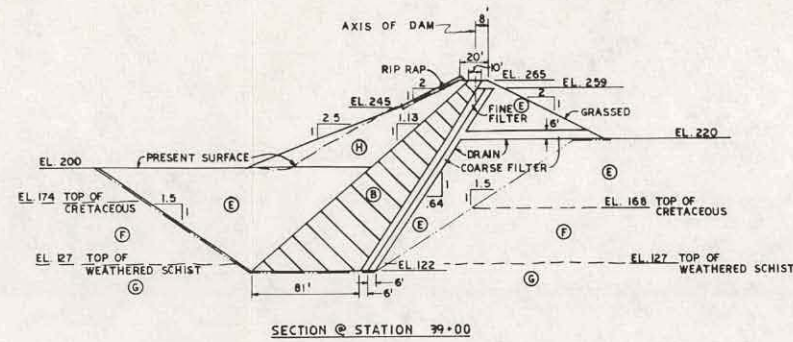
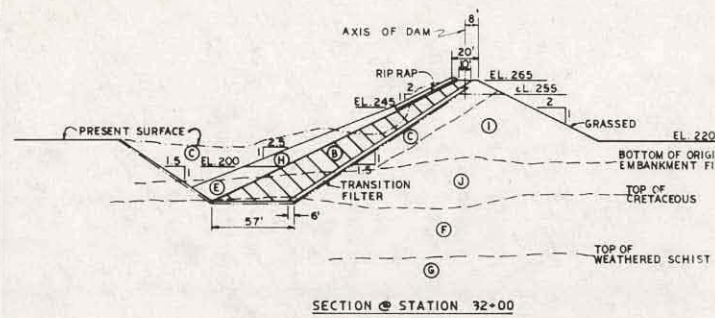
ALABAMA POWER COMPANY  
 BY *H. P. Clanton, Jr.*  
 VICE-PRESIDENT

**EXHIBIT-L REV. NO. FOUR  
 GENERAL DESIGN DRAWINGS**

ALABAMA POWER COMPANY BIRMINGHAM, ALA.	
SUBJECT COOSA RIVER DEVELOPMENT-FPC PROJECT NO. 2146 WALTER BOULDIN DAM-GENERAL ARRANGEMENT OF POWER-HOUSE	
DETAIL	
DRAWN R. M. W.	TRACED BY
APPROVED <i>Donald D. Bradford</i>	DATE 12-15-75
SCALE 1" = 40'	SHEET NO. 29 OF 37 SHEETS



ELEVATIONS ARE U.S.C. & G.S. M.S.L. DATUM

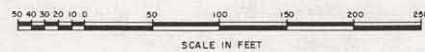


**SOIL TYPES**

- (A) EXISTING CLAY CORE
- (B) CLAY CORE
- (C) RED SANDY CLAY
- (D) CLAY AND CLAYSTONE
- (E) SAND AND GRAVEL
- (F) MICACEOUS CLAYEY SAND
- (G) MICA SCHIST
- (H) PROCESSED SAND AND GRAVEL
- (I) CLAYEY SANDS AND GRAVEL
- (J) SAND AND GRAVEL WITH CLAY LENSES
- (K) CLAYEY FINE SAND WITH SILT LENSES
- (L) CLAY AND SILT

**LINE TYPES**

- PRESENT SURFACE
- - - EXCAVATION SURFACE FOR RECONSTRUCTION
- REDESIGNED DAM SECTION SHOWING NEWLY PLACED ZONES
- - - LINES SEPARATING ZONES



THIS EXHIBIT IS PART OF THE APPLICATION FOR APPROVAL OF LICENSE EXHIBIT L FOR THE WALTER BOULDIN DEVELOPMENT OF PROJECT 2146, MADE BY THE UNDERSIGNED THIS 15th DAY OF DECEMBER, 1975.

ALABAMA POWER COMPANY

By *J. L. Clayton Jr.*  
VICE-PRESIDENT

**NOTES:**

- 1) THE INNER SLOPE OF THE CLAY CORE IS 0.64:1 FROM THE INTAKE STRUCTURE TO STATION 37+50 (WEST) AND 35+00 (EAST). BEYOND THOSE TWO STATIONS ON EITHER SIDE THE INNER SLOPE STARTS FLATTENING AND BECOMES 2.5:1 AT THE UNDESIGNED SECTIONS OF THE DAM. THE OUTER SLOPE OF THE CLAY CORE IS 1.00:1 AT THE INTAKE STRUCTURE. THIS SLOPE REMAINS CONSTANT UP TO STATION 44+00 (WEST) AND 47+00 (EAST). FROM THESE TWO STATIONS THE OUTER SLOPE FLATTENS GRADUALLY AND BECOMES 1.13:1 AT STATION 45+00 (WEST) AND 48+00 (EAST). THE OUTER SLOPE REMAINS CONSTANT AT 1.13:1 UP TO STATION 37+50 (WEST) AND 35+00 (EAST) AFTER WHICH IT IS FLATTENED GRADUALLY TO 3:1 AT THE UNDESIGNED SECTIONS OF THE DAM.
- 2) FROM THE INTAKE STRUCTURE TO STATION 39+00 AND STATION 54+00, THE CLAY CORE IS FOUND ON COMPETENT WEATHERED SCHIST (I.E. SARROLITE) EXCEPT FOR THE PORTION CLOSE TO THE INTAKE STRUCTURE WHERE IT IS FOUND ON SOUND ROCK.
- 3) FROM STATION 55+00 TO STATION 66+00 THE CLAY CORE MOVES OUT OF THE EMBANKMENT AND BECOMES THE UPSTREAM IMPERVIOUS SHELL OF THE DAM, STARTING AT ABOUT STATION 62+00. A TWENTY FOOT BEAM IS PROVIDED AT ELEVATION 255 AND IS CONTINUED TO ABOUT STATION 58+00 WITH THE OUTSIDE SURFACE HAVING A 3:1 SLOPE. FROM STATION 57+50 TO STATION 20+00 THE CLAY CORE MOVES OUT OF THE EMBANKMENT AND BECOMES THE UPSTREAM IMPERVIOUS SHELL OF THE DAM, STARTING AT ABOUT STATION 20+00. A TWENTY FOOT BEAM IS PROVIDED AT ELEVATION 245 AND IS CONTINUED TO ABOUT STATION 22+50 WITH THE OUTSIDE SURFACE HAVING A 3:1 SLOPE.
- 4) THE POSITIVE CUT-OFF SYSTEM IS PROVIDED FROM STATION 24+00 TO STATION 30+00 BASED ON THE SITE GEOLOGY AND PAST PERFORMANCE OF THE DAM.
- 5) NEAR THE INTAKE STRUCTURE THE CLAY CORE IS FOUND ON SOUND ROCK FOR A LENGTH OF ABOUT 30'. THEN THE FOUNDATION BASE OF THE CLAY CORE IS BROUGHT ON EITHER SIDE UP WITH A 4:1 SLOPE TO EL. 127 AND IS CONTINUED UP TO STATIONS 39+00 AND 54+00 (SEE DRG. NO. D-PS-4154).
- 6) GOING FROM STATION 39+00 AND 54+00 ON EITHER SIDE, THE FOUNDATION BASE OF THE CLAY CORE IS BROUGHT UP WITH A 4:1 SLOPE TO THE TOP OF THE COMPETENT CRETACEOUS FORMATION AND CONTINUED ALONG THE REST OF THE NEWLY PLACED CUT-OFF SYSTEM. (SEE DRG. NOS. DRG. 4150, 4152 - 4154).
- 7) THE CHIMNEY DRAIN CONSISTS OF A FINE FILTER AND A COARSE FILTER BOTH HAVING A HORIZONTAL DIMENSION OF SIX FEET. THE HORIZONTAL DRAIN IS PROVIDED WITH A VERTICAL DIMENSION OF SIX FEET AND CONSISTS OF A COARSE FILTER.
- 8) THE CONCRETE RETAINING WALL IS PROVIDED AT THE DOWNSTREAM TOE NEAR THE POWERHOUSE STRUCTURE IN ORDER TO ELIMINATE THE POSSIBILITY OF SEEPAGE BELOW THE TAILWATER LEVEL.
- 9) THE CONCRETE RETAINING WALL NEAR THE POWERHOUSE STRUCTURE IS PROVIDED WITH A RECTANGULAR WEIR IN A SHALLOW TRENCH TO MEASURE SEEPAGE WATER.

**EXHIBIT-L  
GENERAL DESIGN DRAWINGS**

ALABAMA POWER COMPANY BIRMINGHAM, ALA.	
SUBJECT: GOOSA RIVER DEVELOPMENT - F.P.C. PROJECT NO 2146 WALTER BOULDIN DAM - TYPICAL DAM SECTIONS AT KEY LOCATIONS	
DETAIL:	
DRAWN: R.M.W.	TRACED BY:
APPROVED: <i>Harold Bradford</i>	DATE: 12-15-75
SCALE: 1" = 50'	SHEET NO 27th OF 37 SHEETS

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for an inclined impervious diaphragm-type section, supported upstream and downstream by generous outer shells of high strength compacted sand and gravel material. The upstream zone was to be free-draining to satisfy emergency drawdown requirements. The inclined core would be protected by a two-layer inclined filter and horizontal drain as shown on Plate 11.

A major change from the original design was the elimination of the steep embankment slope adjacent to the intake structure. To accomplish this, massive concrete gravity upstream walls were to be constructed at the left and right of the existing intake structure which is founded on rock. As shown on Plate 12, the walls would provide a continuous plane surface against which to abut the east and west embankments. Safety against piping was to be provided by use of adequate filters and drains.

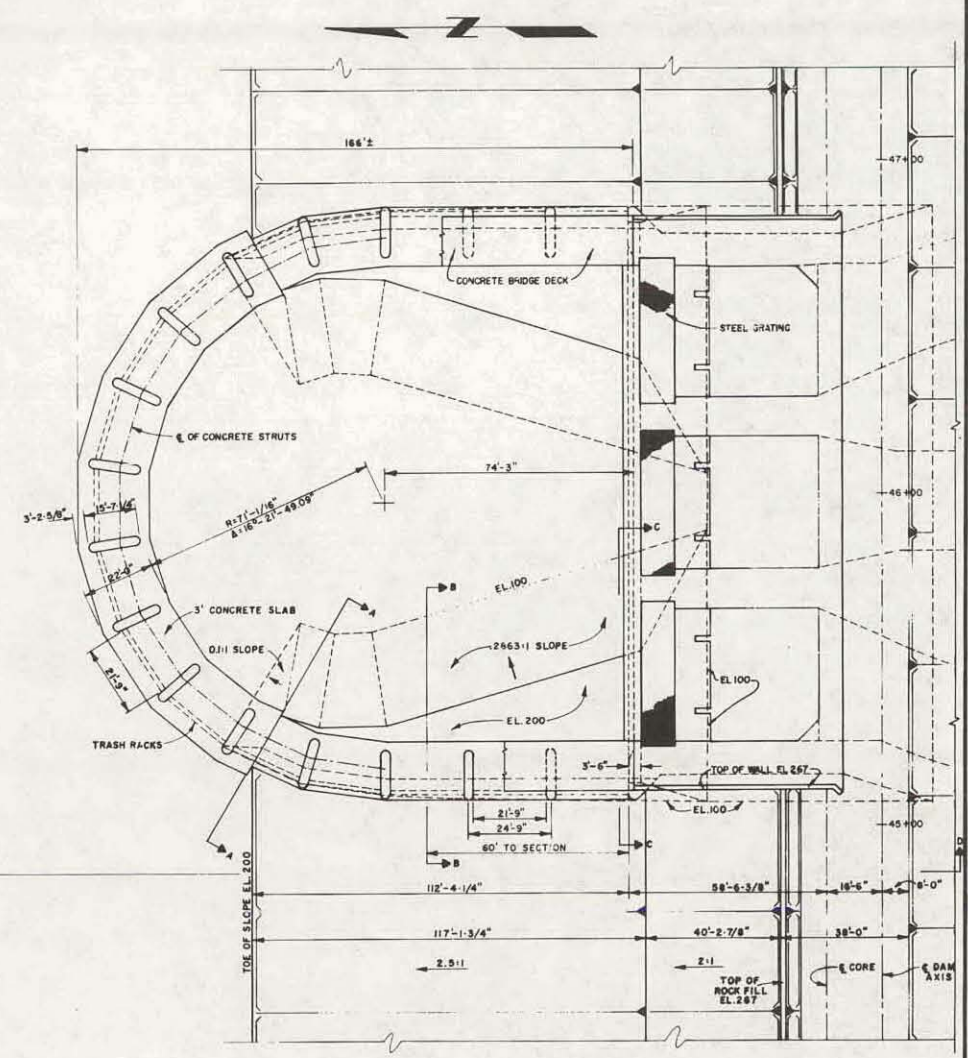
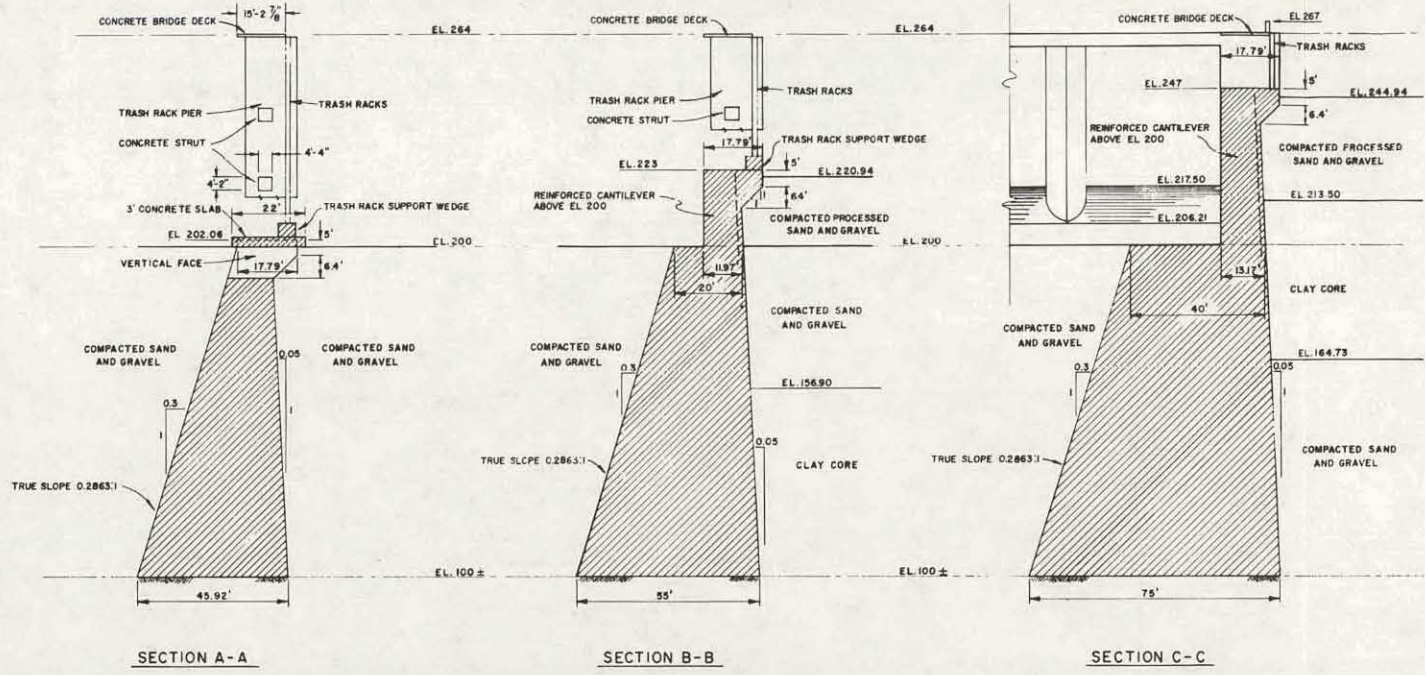
4-02 Order Amending License. The Commission, by order issued April 29, 1977, (Appendix D) authorized the licensee to proceed with the reconstruction of Bouldin Dam, generally in accordance with plans submitted for approval by the licensee. Reconstruction is to be prosecuted with due diligence and completed not later than November 1979.

The Commission's authorization to proceed with reconstruction requires the licensee to comply with a number of special conditions. These are set forth in additional license articles included in the license for Project No. 2146. The plans and specifications and licensee's quality assurance plan must be approved by the Director, Office of Electric Power Regulation prior to start of reconstruction. The licensee is required to retain a board of three or more qualified independent consultants to review the design, specifications, and construction of the project for safety and adequacy. Adequate instrumentation must be installed to monitor the performance of the project structures, and licensee is required to obtain Commission approval prior to initial filling of the reservoir. Licensee is also required to file with the Commission an emergency action plan designed to provide an early warning to upstream and downstream inhabitants and property owners if there should be an impending or actual sudden release of water caused by an accident to, or failure of, project structures.

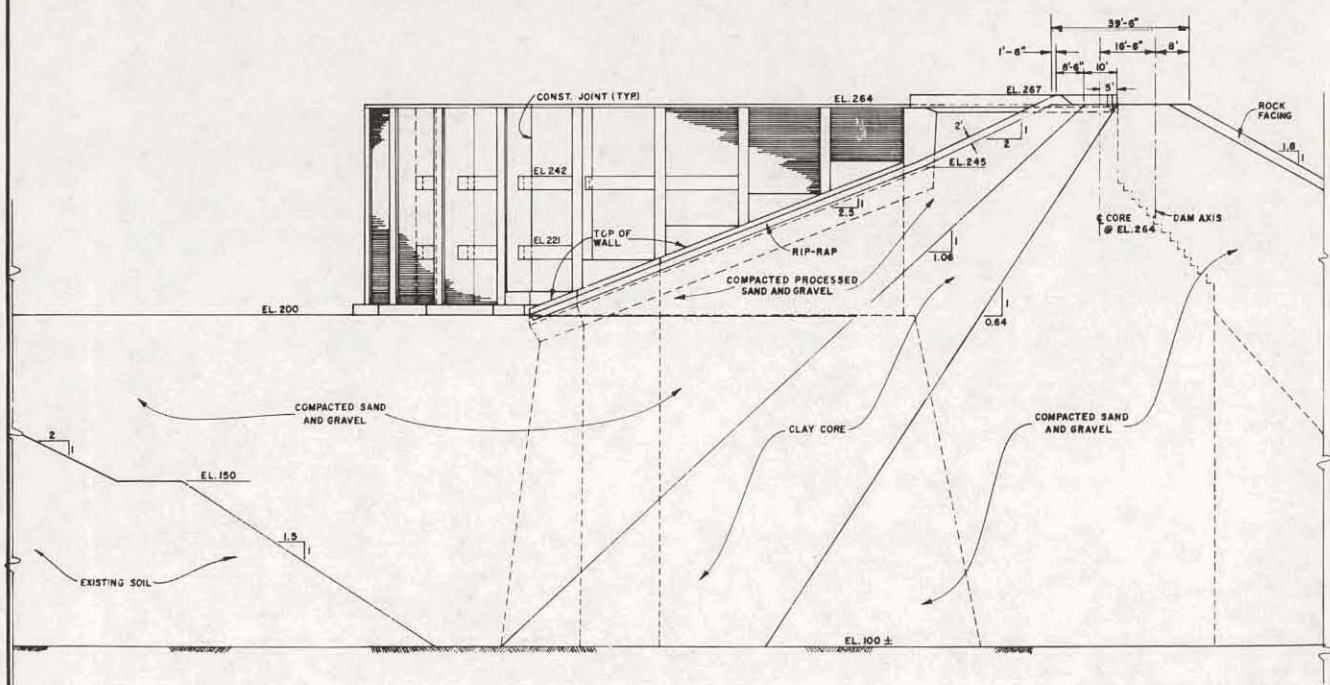
4-03 Quality Assurance. The licensee has instituted a strong and thorough quality assurance and control program for the reconstruction of the Walter Bouldin Dam. The



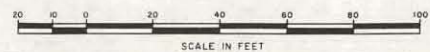
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PLAN VIEW OF INTAKE, RETAINING WALL, & TRASH RACKS



SECTION D-D



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THIS EXHIBIT IS PART OF THE APPLICATION FOR APPROVAL OF LICENSE EXHIBIT L FOR THE WALTER BOULDIN DEVELOPMENT OF PROJECT 2146, MADE BY THE UNDERSIGNED THIS 15th DAY OF DECEMBER, 1975.

ALABAMA POWER COMPANY  
 BY *F. L. Clayton Jr.*  
 VICE-PRESIDENT

**EXHIBIT-L  
 GENERAL DESIGN DRAWINGS**

ALABAMA POWER COMPANY BIRMINGHAM, ALA.	
SUBJECT: COOSA RIVER DEVELOPMENT-FPC PROJECT NO. 2146	
DETAIL: WALTER BOULDIN DAM - CROSS SECTION AT INTAKE - HEADWORKS WING WALLS	
DRAWN: R.M.W.	TRACED BY:
APPROVED: <i>Donald D. Crawford</i>	DATE: 12-15-75
SCALE: 1" = 20'	SHEET NO. 273 OF 37 SHEETS

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program is designed to assure that construction is rigidly controlled to meet all applicable specifications, design drawings, codes, and standards. The program specifies frequency of control tests, methods of testing, recording of results, and review of results. The program also establishes procedures for administering quality control and fixes responsibility for review and analysis of data to assure a well-constructed job.

The licensee has inaugurated a program for training and qualifying its inspectors in the performance of the various quality control tests required for the reconstruction of the project. A test fill program has been scheduled, which will provide guidance in determining the most effective types of compaction, optimum moisture content, and lift thickness of the various materials. The test fill program, as proposed, should provide valuable information for construction procedures of the several portions of the embankments. It should also serve to train inspectors by familiarization with materials, equipment, and testing techniques during the early construction phase of the work.

Frequent inspections of the construction will be made by Southern Services, Inc., design engineer for the reconstruction to augment the full-time inspection of the licensee's construction staff and to insure that basic design concepts are being carefully executed. The design engineer would be available also for making timely decisions on design problems encountered due to changed conditions during construction. The designated board of consultants will schedule periodic inspections to review construction progress and to provide technical counsel and expertise, where required. The consultants also serve to monitor licensee's construction inspection program.

4-04 Commission Staff Review. A special license article provides for review and approval of the detailed construction drawings and specifications prior to construction. This requirement is a direct result of the Bouldin failure and will result in increased responsibility by the Commission staff for the safety of newly constructed dams. Staff has reviewed the safety and adequacy of the proposed reconstruction. The new design is appreciably more conservative than the original construction. Two of the more significant changes are (a) a positive cutoff trench and (b) flatter slopes. The designed embankment sections have been analyzed and found to have adequate stability against maximum possible

ranges of pool levels, including earthquake and sudden drawdown loading conditions. Adequate instrumentation will be installed to monitor the performance of the completed embankment. It will include movement points along the crest, piezometers in the fill and foundations, slope indicators, and weirs.

Frequent in-depth inspections by staff have been scheduled during the reconstruction to permit a thorough review of construction practice, compliance with approved plans and specifications, and effectiveness of licensee's quality assurance program. Among the lessons learned during the investigation of the Bouldin Dam failure is the importance of comprehensive records of the construction and field control testing. The FERC inspecting engineer must consider that the project may in the future develop serious safety problems requiring a careful examination of as-built records.

## CHAPTER V

### EVOLUTION OF FERC DAM SAFETY PROGRAM

5-01 General Inspection Procedures. Section 10(c) of the Federal Power Act requires that "the licensee shall maintain the project works in a condition of repair adequate for the purposes of navigation and for the efficient operation of said works in the development and transmission of power, . . . ." It also empowers the Federal Energy Regulatory Commission to prescribe rules and regulations for the protection of life, health, and property.

In an application for license, the applicant is required to submit general design drawings and supporting information, analyses or data regarding explorations, material usage, and stress analyses of the major structures. These data are reviewed by the Commission's technical staff, primarily for safety and adequacy of the proposals. After the license is issued and the project is under construction, staff engineers visit the project once a month, or more often as necessary, to review construction and testing procedures, to note progress and quality of construction, and to determine whether the project is being constructed in accordance with the general design drawings approved by the Commission. After completion of construction and the project is placed in operation, inspection by the Commission's staff are less frequent, normally once a year. During these annual inspections, staff engineers review the overall development from a safety standpoint and also determine if the owners are operating the facilities in accordance with the license provisions.

5-02 Prior to 1963. Prior to 1963 when construction of Walter Bouldin Dam was initiated, relatively little emphasis was placed on the development of an effective dam safety program as a part of the Commission's supervisory and regulatory functions in the licensing of non-Federal hydroelectric projects. Usually staff members assigned to this function were engineers with broad general experience whose duties also included other licensing functions. There were few specialists; for example, prior to 1963, there were no staff specialists in the field of engineering geology or

soil mechanics. Since that time the practices of the Commission as they affect dam safety have been essentially under continuous review, with modifications and improvements.

5-03 1963 to 1975. During 1963 there were two significant dam failures, the Baldwin Hills Dam in California, not subject to FERC jurisdiction, and the Vaiont Dam in Italy, which led to a reassessment by the Bureau of Power of its policy on dam safety. It was concluded that there should be increased emphasis on inspecting licensed projects. To accomplish this, a Section of Inspections, now Inspections Branch, was established in the Division of Licensed Projects. This section was to include personnel having expertise in the fields of geology, soil mechanics, foundations, and heavy construction. These experts assist the Project Analysis Branch in the review of proposed designs and make joint inspections with the Regional Office staff of the more significant projects and those which encounter problems.

The Inspections Branch coordinates the work of the Regional Offices in matters dealing with inspections. Functions of the Inspections Branch include: (a) preparation of guidelines for the inspection of projects, (b) training of field inspection engineers, and (c) review of construction and operation reports for completeness of coverage and identification of potential problems.

a. Inspections by Independent Consultants. The concern for safety of licensed dams prompted the Commission to issue Order No. 315 in December 1965. This order established a new Part 12 of the Commission's Regulations on the subject of inspection of project works with respect to safety of structures. The order provides for a program of periodic safety inspections by consultants at regular 5-year intervals to supplement the inspections of the Commission's staff. This requirement applies to those hydroelectric projects having a dam exceeding 35 feet in height above streambed or a gross storage capacity in excess of 2,000 acre-feet. The inspections are performed by, or under the responsibility and direction of, qualified independent consultants employed by the licensees. The basic purpose of the consultant's inspection is to determine whether there are deficiencies or potential deficiencies in the design, quality and adequacy of maintenance, or methods of operation of the project structures, which might endanger public safety. The design review includes an estimate of

the Probable Maximum Flood for use in evaluating adequacy of the spillway and analyses of seismic stability, where appropriate. The physical inspection includes an examination of seepage, movement, cracking of concrete structures, reservoir shoreline, and performance observation records, including instrumentation.

b. Guidelines. The following pertinent instructions or guidelines have been issued to the Regional Offices since 1967:

- (1) June 18, 1969. Memorandum requires the Regional Engineer to obtain from the licensee a copy of the plans and specifications for review by personnel assigned to making the monthly construction inspections.
- (2) December 9, 1969. Memorandum furnishes guidelines on the scope of Part 12 consultants' safety inspection reports with reference to spillway adequacy and stability of structures, including dams.
- (3) January 27, 1970. Memorandum outlines a training program to be provided for Regional Office inspectors.
- (4) May 13, 1971. Memorandum requests that all licensees be notified of a requirement to report all drownings and fatal or serious accidents to the FPC Regional Engineer for evaluating the need for safety requirements and preventative measures.
- (5) June 20, 1972. Memorandum furnishes guidelines for the inspection of upstream slope protection for earth dams.
- (6) January 2, 1973. Memorandum requires that a review of performance observation data be summarized and reported in annual operation inspection reports.
- (7) January 5, 1973. Memorandum furnishes additional guidelines on Part 12 safety inspection reports with reference to a



determination of the Probable Maximum Flood in evaluating spillway adequacy.

- (8) October 18, 1974. Memorandum requires staff inspectors to ensure that an annual test operation has been made of all spillway gates.

c. License Conditions. Additions or changes in license requirements since the construction of Bouldin Dam include the following:

- (1) Standard Article 4 for unconstructed major projects has been revised and now requires that the licensee furnish to the Regional Engineer for his approval a detailed program of inspection for the project.
- (2) Licensee is required to install appropriate instrumentation to monitor seepage, uplift, and performance of the project structures and reservoir slopes.
- (3) Licensee is required to retain a board of qualified independent consultants to review the design, specifications, and construction of each major project for safety and adequacy. The board is expected to assess the construction inspection program, construction procedures and progress, planned instrumentation, the filling schedule for the reservoir, and plans for surveillance during the initial filling.

## CHAPTER VI

### STATUS OF DAM SAFETY PROGRAM

6-01 Deficiencies Remedied. The failure of Walter Bouldin Dam in February 1975 resulted in a further reevaluation of the Commission's dam safety program. Recent improvements or additions since the failure are discussed below.

a. Inspection Guidelines. On August 6, 1975, a memorandum from the Chief, Bureau of Power to all Regional Engineers provided additional guidelines for the inspection of licensed projects under construction and quality control of earth embankments. Inspectors have been instructed to review and report critical construction features, quality control, results of field control tests, and as-built and other construction records of the licensee. Additional inspection guidance to Regional Office staff is being given through joint inspection trips and meetings with technical experts from the Washington Office staff. It is the policy of staff to inspect regularly the construction of all major project structures. If for any reason there is an impediment to staff's inspection, the impediment must be removed immediately, or staff is to recommend that construction be stopped.

b. Emergency Action Plan. The Commission's dam safety program recognizes that accidents may occur even when careful preventative measures have been taken. Therefore, licensees and applicants to license constructed projects are required to file with the Commission an emergency action plan designed to provide an early warning to downstream inhabitants and property owners if there should be an impending or actual sudden release of water caused by an accident to, or failure of, project structures. The plan must include instructions to be provided on a continuing basis to operators and attendants for actions they are to take in the event of an emergency, measures to be taken to minimize the effects of any accident on downstream life and property, and detailed and documented plans for notifying law enforcement agents, downstream residents, and others that could be endangered.

c. Attendance at Board Meetings. Attendance of FERC representatives at the periodic meetings of the licensee's board of consultants is an excellent opportunity to review

safety features of unusual design problems and problems arising during construction. Since the Bouldin failure, it is the general practice of FERC staff to attend these meetings on a regular basis.

d. Review of Plans and Specifications. Early review practices of the staff were generally limited to approval of general design drawings for safety and adequacy. Reviews of the more detailed construction plans and specifications generally were not made by staff, although the plans and specifications were available to Regional Office inspectors for their reporting on construction progress. As a direct result of the Bouldin failure, all licenses authorizing construction of major dams now require that the detailed plans and specifications be submitted for review by FERC staff prior to construction. The Director, Office of Electric Power Regulation is also authorized to require changes in plans and specifications. This requirement will result in an increased responsibility by the Commission staff for the safety of newly constructed dams.

#### 6-02 Deficiencies Pending

a. Proposed New Regulations. Staff is considering revisions to the Commission's Part 12 Regulations to include the following requirements, most of which are already contained in miscellaneous directives or letters to licensees.

- (1) Licensee is responsible for informing the Commission through it's Regional Engineer of any accident or observed condition which may have bearing on the overall safety or operational capability of the project.
- (2) Provide for periodic testing of spillway gates.
- (3) Clarify and/or modify height of dam and reservoir capacity requirements for a consultant's safety inspection report.
- (4) Guidelines to include specific analyses for spillway adequacy and stability in consultant's safety inspection reports.
- (5) Guidelines for preparing and keeping inspection records during project construction.
- (6) Guidelines for preparing and keeping records of maintenance of project structures.

- (7) Clarification of the authority of the Commission's Regional Engineer, as the Commission's authorized representative, in matters involving the safety of project structures.
- (8) Requirement to file with the Commission, an emergency action plan designed to provide early warning in event of an impending sudden release of reservoir water caused by an accident or failure of project structures.

b. Improved Staff Capability. The ultimate success of any dam safety program depends to a large extent on the number and quality of those assigned to this program. Arrangements have been made for all FERC staff members involved in dam inspections to attend Corps of Engineers training courses on earth and rock-fill construction held periodically at Vicksburg, Mississippi. Also, there will be increased staff participation in technical seminars relating to dam safety, generally sponsored by the American Society of Civil Engineers, the Corps of Engineers, and universities. A total of 25 FERC professional staff members from our five Regional Offices and the Washington Office are assigned full time to dam safety inspection. Other staff members devote a portion of their time to dam safety inspection and design review work. Recently, an additional 14 positions were authorized for dam safety work. These positions will be filled as soon as qualified personnel can be recruited. A further review is being made of the personnel requirements needed to ensure a fully adequate dam safety effort.

6-03 FCCSET Activities. In April 1977, President Carter directed each Federal agency responsible for, or involved with site selection, design, construction, certification or regulation, inspection, maintenance and operation, repairs, and ultimate disposition of dams to undertake a thorough review of practices which could affect the safety of these structures. President Carter also asked the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) to review the practices and procedures of the agencies and to develop criteria for Federal dam safety. The Commission staff is currently participating in this cooperative study and is represented on a number of task force committees for the preparation of proposed Federal dam safety guidelines for management procedures to ensure dam safety. A review of Federal Power Commission

(now FERC) practices which could affect safety and integrity of dams was submitted to FCCSET in September 1977, and a copy of the text of the report and Appendix B thereof is attached as Appendix E.

6-04 Conclusions. The Bouldin failure and other recent failures, such as the Bureau of Reclamation's Teton Dam, suggest that it is appropriate for all charged with responsibility of dam design, construction, operation, or regulation to reevaluate criteria, procedures, and requirements relating to dam safety.

Those deficiencies noted as being the most probable reasons for the failure of Bouldin Dam have been corrected by the current in-depth dam inspection and supervision program of the FERC. Since the time of the initial construction of Bouldin Dam, many improvements have been made in the Commission's program relating to dam safety: the requirement for a board of consultants to review design and construction; periodic training of staff engaged in inspection of projects during construction and operation; recruitment of staff members with extensive active experience in design and construction of dams; instituting the periodic Part 12 safety inspections by a qualified consultant; review or approval of detailed plans and specifications prior to construction; review and approval of licensee quality assurance and inspection programs; specific attention to construction details or methods of construction; thorough and timely investigations of remedial repairs following accidents; and requirement for an emergency action plan in event of a serious accident to project structures.

The Commission's program for dam safety is an evolving effort. For example, the staff is participating in an overall assessment of the Government's dam safety efforts in cooperation with the Federal Coordinating Council for Science, Engineering, and Technology at President Carter's direction. The Commission's entire dam safety program will be reviewed following completion of that assessment, and modifications will be made as necessary. Changes already made as a result of the investigation of the Bouldin Dam failure have added significantly to an improved program. With the added staffing planned, the dam safety program should attain a degree of effectiveness commensurate with its importance. Even so, the staff must be continuously alert to make further improvements in this program.

APPENDIX A

UNITED STATES OF AMERICA  
FEDERAL POWER COMMISSION

Before Commissioners: John N. Nassikas, Chairman;  
Albert B. Brooke, Jr., Rush Moody, Jr.  
William L. Springer, and Don S. Smith.  
Alabama Power Company ) Project No. 2146

ORDER INSTITUTING INVESTIGATION  
AND PROVIDING FOR HEARING



(Issued February 20, 1975)

On February 10, 1975, the 64-foot high earthfill dam at the Bouldin Dam of the Coosa River Project No. 2146 failed. This failure occurred in the earth dike east of the power plant and resulted in a flow through the dike which was estimated at approximately 50,000 cfs.

The Bouldin Dam obtains its water from a reservoir of the Jordan Project No. 618. Because flows from this reservoir to the Bouldin Dam are not regulated, the failure of the dam resulted in a substantial decrease in the level of the reservoir at the Jordan Project No. 618, adding flows in the river downstream from the dam.

The dam failure occurred at 1:30 a.m. on February 10, 1975. During the morning of February 10, 1975 the Atlanta Regional Engineer and an assistant visited the site. The Head of the Section on Inspections of the Bureau of Power and an assistant plus two engineers from the Atlanta Regional Office visited the dam site last week and met with a Board of Consultants retained by the licensee in connection with the dam failure.

We believe the failure of this dam raises questions about the safety and adequacy of project works subject to our jurisdiction under the terms and conditions of the Federal Power

Act (Act) and the conditions of the license for this project, particularly Articles 2, 3, and 4 <sup>1/</sup>. Section 10(c). <sup>2/</sup> of the Act expressly provides:

That the licensee shall maintain the project works in a condition of repair adequate for the purposes of navigation and for the efficient operation of said works in the development and transmission of power ... and shall conform to such rules and regulations as the Commission may from time to time prescribe for the protection of life, health, and property.

We are therefore ordering a further formal investigation pursuant to the Act into the causes of this dam failure in order to determine the proper remedial actions which should be taken to assure that life, health, and property are adequately protected at this dam and other dams under the control of the licensee. The formal investigation should also determine whether the provisions of this Act or any rule, regulation, or order of the Commission have been violated and, if so, which may have caused or contributed to the dam's failure.

Following the completion of the present Staff field investigation and the formal investigation, an evidentiary hearing pursuant to Section 10(c) and 308 <sup>3/</sup> of the Act shall be held to document and determine the cause of this dam failure and any remedial actions which may be warranted to correct any violations of the Act or any rule, regulation, or order thereunder or to assure that this dam failure or the potential for failure of any other related dams under the control of the licensee will not occur or reoccur.

The Commission further finds:

It is appropriate and in the public interest for the purposes of administration of the Federal Power Act that a

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<sup>1/</sup> Alabama Power Company, Project No. 2146, 18 F.P.C. 265, 270 (1957).

<sup>2/</sup> 16 U.S.C. §803(c).

<sup>3/</sup> 16 U.S.C. §825g(a).



formal investigation and hearing be ordered concerning the failure of the Bouldin Dam of the Coosa River Project No. 2146, any matters related thereto, and the potential for failure of any other related dams under the control of the licensee.

The Commission orders:

(A) Pursuant to the authority contained in and subject to the jurisdiction conferred upon the Federal Power Commission by the Federal Power Act, particularly Section 10, 307, 308, and 309, an investigation and hearing shall be instituted into matters involved and issues presented in this proceeding.

(B) As a part of the investigation, the Commission Staff is hereby directed to conduct an examination into the Bouldin Dam failure and the potential for failure of any other related dams under the licensee's control; to obtain such facts and information from the books, records, facilities, and properties of the Alabama Power Company, its parents, affiliates, or subsidiaries as may be necessary or appropriate to conduct this investigation; and to furnish such recommendations as may be necessary or appropriate in light of the investigation.

(C) Alabama Power Company, its parents, affiliates, or subsidiaries, shall cooperate and assist Commission Staff in its investigation.

(D) The Commission's Secretary shall issue notice of the time and place of the hearing. The procedure for the hearing shall be prescribed by the Presiding Administrative Law Judge in conformance with the Commission's Rules of Practice and Procedure.

(E) The Commission's Secretary is hereby directed to issue a notice of this investigation and hearing with provision for the filing of protests or petitions to intervene.

By the Commission.

( S E A L )

Kenneth F. Plumb,  
Secretary.

APPENDIX B

UNITED STATES OF AMERICA  
FEDERAL POWER COMMISSION



Alabama Power Company

) Project No. 2146

INITIAL DECISION ON INVESTIGATION OF EARTH  
FILL WALTER BOULDIN DAM FAILURE

(August 19, 1976)

APPEARANCES

Robert McD. Smith, Esq., Lewis W. Page, Jr., Esq., and George F. Bruder, Esq. for Alabama Power Company

Richard A. Azzaro, Esq. for the Staff of the Federal Power Commission

KANELL, Presiding Administrative Law Judge

I. NATURE OF PROCEEDING

On February 10, 1975, the earth fill Walter Bouldin Dam failed and this hydroelectric project became inoperative. By order issued February 20, 1975, the Commission directed that an investigation and hearing be held to determine appropriate remedial action to be taken to assure that life, health and property are adequately protected at this dam and other dams under the control of the licensee, Alabama Power Company (Alabama). The Commission stated that the failure of the Walter Bouldin Dam raised issues concerning the safety and adequacy of projects under the jurisdiction of the Commission and the compliance by the licensee with conditions prescribed by the Commission in authorizing construction and maintenance of this dam.

The failed dam was licensed by the Commission as part of Project No. 2146 (18 FPC 265 /1957/), pursuant to authority vested in the Commission under Section 4(e) of the Federal Power Act. This project license pertains to a series of dams which comprise the Coosa River Project, undertaken by the Alabama Power Company to provide hydroelectric power for its customers.

Pursuant to the directive of the Commission, prior to the hearing held on this matter, a comprehensive investigation of this dam's failure was conducted by Commission Staff. Hearing in this matter initiated on April 22, 1976, and extended over 12 sessions, terminating on June 30, 1976.

By order issued June 17, 1976, the Commission authorized Alabama to undertake limited work on the Walter Bouldin Dam in preparation for possible reconstruction, subject to the condition that such work would be done only in the presence of and with the specific written approval of a Commission representative. The Commission stipulated that its representative would have the authority and the responsibility to stop the limited work authorized if such action became necessary to preserve evidence regarding the cause of the failure of the dam. If the work is stopped the Commission required that appropriate investigation by the Commission Staff representatives would be made prior to resumption of the work.

Following the hearing, briefs were filed by Alabama and Staff. Final briefs were received on July 30, 1976.

## II. WALTER BOULDIN DAM

This dam is located near the mouth of the Coosa River at the town of Wekumpka in Elmore County, Alabama. Construction of the dam was started in August 1963 and it was completed on September 30, 1967.

Walter Bouldin Dam consisted of two dikes about 164 feet high extending from each side of a 164 foot high and 180 foot long concrete water intake structure.

The western earth fill embankment was about 2,320 feet long and the east earth fill embankment was about 5,120 feet in length. The embankments were extended to the high ground at each side of the reservoir area.

The dam retained water of the Coosa River forming an impounded water area covering about 920 acres. This impounded area is connected to the Jordan River reservoir by a 7,000 foot long intake canal.

The concrete water intake structure served three 30 foot diameter steel penstocks which were designed to feed water under gravity pressure to the power house located downstream and at an elevation of about 100 feet below the water line of the Walter Bouldin Dam reservoir. The power house contains three hydroelectric generating units each rated at 75,000 kilowatts for a total capacity of this facility of 225,000 kilowatts. This electric generating capacity has provided about four percent of Alabama's total electric power requirements. Electric interchange arrangements with other electric generating subsidiary companies which comprise the Southern Company system have made it possible for Alabama to continue to serve its customers despite the loss of the Walter Bouldin electric generating capacity.

The Walter Bouldin Dam was constructed by contractors engaged by Alabama. All earth and embankment work was performed by Harbert Construction, either as a primary contractor or as a subcontractor to the Blount Construction Company. All earth materials for the dam were obtained on site, generally in the area of excavation for the power house and environs.

Plans and specifications for this project were prepared by Southern Services, Inc.,<sup>1/</sup> an engineering subsidiary of the Southern Company, which is the parent of Alabama. These plans provided for an earth fill dam consisting of a clay core with an upstream facing of rock fill and riprap and a downstream facing of sandy gravel material. The dam design utilized the natural clay of the river bottom as a foundation for the earth fill dikes.

Proposed plans and specifications for the reconstruction of the Walter Bouldin Dam have also been prepared by the same engineering subsidiary of Southern Company, with assistance of independent consultants.

### III. DAM FAILURE

The failure of the Walter Bouldin Dam occurred at 1:30 A.M. on February 10, 1975, and reportedly without advance warning. Visual inspection of the dam had been performed by the plant superintendant on the day prior to the failure. No unusual

<sup>1/</sup> Now designated as Southern Company Services, Inc.

occurrences were noted by the normal inspection procedure which consisted of driving a vehicle along the top of the embankments and making observations.

The failure occurred in the eastern dike just east of the concrete intake structure. It appears from all available evidence that the failure was initiated by an upstream slide near the crest of the dam in the area of the failure. Alabama personnel reported that a slump or depressed area developed at the top of the embankment in the area of the breach and water was heard coming over or through the upper portion of the eastern dike. This breach was deepened and widened by onrushing water resulting in a 300 foot wide breach in the eastern dike, extending eastward from the concrete intake structure. The dike foundation was scoured to a depth of 50 feet below the original reservoir bottom and over 1.25 million cubic yards of materials were washed downstream by the release of the impounded water. The power house was inundated, and rendered inoperative. The force of the onrushing water is indicated by a generating unit component weighing about six tons which was washed about 550 feet downstream from the power house.

No personal injuries resulted from this dam failure. Except for minor damage to one parcel of downstream property all damage from the dam failure was limited to the dam and associated power plant facilities. Repair of the dam and the power house have been held in abeyance pending this investigation and Commission approval of the proposed plans for reconstruction.

#### IV. ALABAMA INVESTIGATION

On February 11, 1975, the day following the dam failure, Alabama appointed a four-member board of inquiry to investigate this failure. The board consisted of Alabama's Vice President for Engineering, a representative of Southern Services, a representative of Alabama's Power Supply Department and a representative of Alabama's Construction Department. The board engaged the services of three experienced consultants to assist in this investigation.

The essential findings of this board were that the failure was not caused by (1) earthquake or seismic disturbance, (2) known ground water seepage, (3) dispersive clays, (4) burrowing

by animals or ants, (5) sabotage or (6) overtopping of the embankment by overflowing the reservoir.

The Board's investigation included an exploratory excavation and detailed examination of the earth embankment west of the intake structure, namely that portion of the dike which did not fail. This examination disclosed that (1) soil compaction was less than specified, (2) some compacted lifts were thicker than specified, (3) damp zones existed, (4) sand pockets consisting of rock or filter fines were located in clay areas, and (5) clay was found in the rock riprap areas.

The Board found no evidence of piping, water seepage or any single cause or series of events to which it could conclusively ascribe the reason for the breach of the dam, other than weaknesses arising from inadequate construction.

The Alabama Board of Inquiry concluded, in effect, that the plans and specifications for this dam were adequate and that the dam failure and washout probably resulted from the failure of the construction contractor to comply strictly with such plans and specifications for the construction of the dam.

In this proceeding, Alabama took a position consistent with the findings of the Board, namely, that the construction contractor failed to comply fully with the earth fill specifications, resulting in inadequate embankment strength. The specifications for the east and west embankments were identical and the two dikes were constructed at about the same time with comparable equipment and materials.

The Board of Inquiry assumed that construction inadequacies discovered by the detailed inspections that were made of the western embankment after the dam failed were also present in the failed portion of the eastern embankment.

Thus, the Alabama Board of Inquiry concluded that deviation by the construction contractor from the design specifications constituted the reason for the failure of the Walter Bouldin Dam and that one or more slides on the upstream face of the dam just east of the intake structure triggered this failure.

It is Alabama's position that since the western dike withstood the sudden water drawdown after the breach of the dam,

the deficiencies uncovered by the post-failure investigation of the western dike must have been present to a greater extent in the failed eastern dike.

#### V. COMMISSION STAFF INVESTIGATIONS

Pursuant to Commission directive, a lengthy and detailed investigation of this matter was conducted by Commission Staff. On September 15, 1975, a detailed report was submitted by the Commission's Atlanta Regional Office to the Chief, Bureau of Power. Based on this report and additional investigations, the Bureau of Power prepared a comprehensive report, dated February 1976, on the failure of the Walter Bouldin Dam and its investigation of the other dams under the control or ownership of the Alabama Power Company.

The Atlanta report states that the cause of the failure of this dam cannot be conclusively determined, but that failure may have occurred immediately following one or more successive upstream slides along the dike just east of the intake structure. Four main factors leading to the failure of the dam are deemed to include the following: (1) weakened foundation (of embankment), (2) weakened embankment caused by an October 1972 slide on the upstream face of the eastern embankment in the area of the dam breach (3) steep design slopes of the embankments, particularly in the area near the intake structure and (4) poorly consolidated fill.

The Bureau of Power report found deficiencies in both design and construction of the dam. The embankment design was considered to be marginal, due to steep slopes, especially in the area near the intake structure. This report concluded that rigid adherence to specific field control measures to insure an adequate and safe structure was required, and that such high degree of field control necessary to insure safety was not attained.

The foregoing conclusion is supported by the observation that zoning of the layers of materials comprising the dam was not carefully executed. Examination of the western dike disclosed pervious lenses of sand and rock fines in the impervious clay core. Lenses of clay were found in the rock fill zone. Further, this report concluded that specifications for earth fill compaction were incomplete and moisture content of materials was not specified.



The Bureau of Power report also noted that the rock fill zone was thinner than specified, but Alabama, as outlined, infra, asserts that this observation was based upon incorrect interpretation of construction field notes by an Alabama draftsman. Alabama submitted a substitute drawing for the drawing relied on by Staff to support this assertion. This substitute drawing shows no material deviation between construction and design of the rock fill zone in the area of the dam failure.

Prior to the hearing, Staff Counsel took a number of depositions from Alabama employees, officials, and retired employees, in an effort to obtain information from all possible sources concerning the construction and maintenance of the Walter Bouldin Dam.

Commission Staff members were present during the exploratory excavation of the western dike that was made by the Alabama Board of Inquiry following the washout of the eastern dike. (The same contractor that constructed the dikes was engaged by Alabama to make this exploratory excavation. It would appear that Alabama was not aware at this time that it would pursue a legal claim against this contractor, inter alia, arising from the dam failure.) Staff personnel arranged for field and laboratory tests of samples of materials that were taken during the course of this excavation.

The Bureau of Power report also summarizes detailed investigations made by Commission Staff of 13 other dam projects under Alabama's control. These investigations disclose some minor deficiencies not deemed critical from the standpoint of safety, but no unusual problems were uncovered at any of the other dams except for the Logan Martin Dam, located on the Coosa River about 100 miles north of Montgomery, in St. Clair and Talladega Counties, Alabama. It was noted that leakage at this dam requires careful surveillance and appropriate action to reduce this leakage. (See Commission order issued July 7, 1976, in this Project.)

## VI. SUMMARY OF EVIDENCE PRESENTED AT HEARING ON DAM FAILURE

Witnesses were presented by Alabama and Staff to outline and explain their investigation of the causes of the failure of this dam. Counsel for Alabama called attention to the presence at the

hearing of representatives of the construction firms involved in the construction of the Walter Bouldin Dam and representatives of an indemnity insurance company. No appearance was entered by any representative of these interests. It appears that civil actions have been initiated by Alabama against two contracting firms as the result of the failure of this dam, based on Alabama's claim that the dam was not built in accordance with the specifications. Further, Alabama has filed claims with its insurance carrier for the damage it sustained as the result of this dam failure.

It was emphasized by the Presiding Administrative Law Judge at the hearing, that this proceeding would not be used as a forum to try any of the claims involving these parties, but that this proceeding would be restricted to the issues prescribed by the Commission in assigning this matter for hearing, namely, the causes for the failure of the Walter Bouldin Dam and recommendations for appropriate remedial action to prevent any future dam failure and to insure adequate protection from hazards to life, health and property resulting from dam failure.

Alabama witnesses reviewed the findings of its Board of Inquiry and outlined measures that Alabama is now undertaking to improve quality control procedures in the supervision of construction projects.

As noted, supra, Alabama asserts that the design and construction specifications for the Walter Bouldin Dam were adequate and consistent with accepted engineering practice. The specifications for this dam are characterized by Alabama as the "end result" type in contrast to more detailed "methods" type of specifications. Thus, the specifications for the Walter Bouldin Dam did not require the contractor to use designated types of equipment. Specific construction methods were not required, but it was deemed to be the contractor's responsibility to achieve the designated results such as the prescribed degree of compaction of materials, and to place specified materials in the amounts and at the locations required by the design specifications and associated drawings.

Thus, Alabama takes the position that the failure of the dam did not result from any inadequacies in the design or specifications, but is the result of construction inadequacies and the consequent weaknesses in the structure, as outlined in its Board of Inquiry report.

Witnesses called by Staff explained the nature of Staff participation in the exploratory excavation of the western embankment and other facets of Staff investigation of the failure of this dam. Two theories were initially submitted by Staff witnesses. The basic Staff position as set forth, supra, is that while no one reason can be ascribed to the dam failure, contributing factors include deficiencies in both design and construction, and one or more upstream slides triggered the subsequent failure of the dam.

The upstream slide theory is supported by the limited visual observance by Alabama employees of the dam failure. These observers referred to a notch or depression in the crest of the dam, with water washing over or through the upper portions of the dam. It is assumed that mud found in the power plant generator cooling coils after the dam failure originated in the upstream embankment. This further indicates the occurrence of a slide which would result in muddy water washing downstream.

A second theory presented by a witness for Staff is that there may have been an insufficient bond between the impervious clay material in the eastern embankment and the concrete intake structure resulting in "piping" (creation of a passageway for water seepage). Dark stains on the concrete which were exposed following the washout of the eastern dike were analyzed to determine whether this was the residue of algae growth which is dependent on the presence of water. If such growth existed, it would support the theory that water seepage occurring in this area resulted in weakening this portion of the dam and was a factor in its subsequent failure. However, laboratory tests disclosed that these stains were not the result of algae. Therefore, this theory of water seepage is not supported by objective evidentiary data pertaining to possible algae growth.

Staff contention that piping is a possible cause of failure is supported by the dark, possibly water stains on the concrete intake structure and the relatively poorer soil compaction attained in the area near this structure. The evidence supporting the piping theory was limited in contrast to the more detailed evidence supporting the weak dike-upstream slide theory.

## VII. EVALUATION OF DAM FAILURE EVIDENCE

There are no basic differences among the three investigatory reports submitted in this proceeding. All three reports concur with respect to the basic findings that weaknesses existed in the dikes because construction standards did not comply with specified design and construction requirements. All reports refer to the findings of the exploratory excavation work which disclosed inadequate compaction of materials at many critical areas, particularly at points near the intake structure. The discovery of sand lenses and excessively thick lifts of material are cited as factors indicating poor construction standards and contributing to the weakening of the dam below the designed levels of strength.

Staff also contends that design criteria were marginal. The longitudinal segments of the earth fill embankments on each side of the concrete structure were designed to have vertical inclines of one foot for each 1.3 feet of horizontal distance, beginning at the intake structure and flattening to a vertical incline of one foot vertical to each two feet horizontal at distances of about 150 feet from this concrete structure. Beyond the 150 feet points the lower portions of the dikes had a one foot vertical incline for each two and one-half feet horizontal distance. Further, as noted, supra, Staff points out the failure of the dam specifications to provide complete details on (1) how prescribed degrees of compaction were to be obtained and (2) how moisture content would be controlled.

Staff sought to review all available records relating to the construction and maintenance of this dam. Detailed search was made of Alabama's files to obtain such information.

It appears that field notebooks maintained by Alabama's construction supervisory personnel contained data relating to the quantity of material deposited during the construction of the earth fill dikes, but such data were not designed to reflect whether the construction met design standards. These field data were compiled to determine the amount of payment due the contractor. Thus, it was necessary to look to small scale sketches in the field notebooks to endeavor to compare actual construction with design. No other Alabama records were submitted in this proceeding to demonstrate that construction of the dam conformed with design specifications.

There is no disagreement among the reports that the dam failure did not result from overtopping of the dikes by

overflowing the reservoir, from earthquake, sabotage, animal burrowing, or other foundation disturbance.

No information was available at the hearing to indicate that Alabama construction supervisory personnel encountered any unusual problems during construction.

Alabama's chief supervisor of earth fill construction during the period of construction is now retired. This witness testified at the hearing that in some limited instances minor changes in the contractor's work were required. This included scraping off a portion of a layer of material deemed to be too thick, or recompaction of soil layers to achieve the prescribed degree of compaction. If excessive moisture was noted, a layer of material might have been removed or it might have been permitted to dry in the sun until it appeared to be sufficiently dry. While Alabama usually had one or two construction inspection personnel on the job at most times, the testimony of Alabama's witness is that it was not possible for an Alabama inspector to examine or observe each lift or layer of material that was placed in the dike during the course of construction. Thus, Alabama depended to a large extent on the contractor's foremen to lay and compact the dike material as required by the specifications.

While some tests of thickness and compaction were taken by instruments, it appears that the eye of the Alabama inspector was the main instrument used by Alabama to insure that layers of material complied with the specified 12-inch thickness required for most of the dike, and the 4-inch thickness required in the areas adjacent to the intake structure.

Equipment used by Alabama personnel to test compaction and moisture content provided for taking a 6-inch deep sample of soil for testing purposes. Thus, only the upper portion of the 12-inch lifts could be tested for compaction and moisture content.

Records maintained by Alabama of the construction of this dam did not disclose any deviation of construction from specifications in the matters of compaction or lift thickness. This was explained by pointing out that such matters were immediately corrected upon detection.

However, as noted supra, the post-failure exploratory investigation of the west dike disclosed a number of compaction and lift thickness deviations from specifications. It is particularly disturbing to note that in the segment of west dike, generally between elevations 224 and 242, tests taken

during this investigation disclosed that 7 of 15 in place dry densities were below the required 92% compaction standard, and 3 out of 4 samples did not meet the required 95% compaction tests. One in-place test disclosed a 77.5% compaction in lieu of the specified 95% compaction.

Higher compaction was required in the area near the intake structure because of the critical importance of this area to the stability of the dam, and the indepth examination of the west dike uncovered an unduly large proportion of substandard compaction tests in this vital area of the dam. It was the corresponding area of the east dike that washed out, resulting in failure of the dam.

An additional matter that may have been a factor pertaining to the failure of this dam is a slide that was initially observed on October 4, 1972. This slide on the upstream side of the eastern embankment of the dam near the intake structure, apparently occurred after a substantial drawdown of the water level. This slide was the subject of detailed testimony and evidence at the hearing. Alabama employees did not consider this slide to be of sufficient importance to warrant a special report to the Commission at the time that it occurred. Alabama arranged for prompt repair of this slide, and such work was completed within a period of about two weeks after the slide was discovered. It appears that oral reference was made to the slide at the time of the next FPC Staff inspection of the dam in early 1973 and that no further inquiry was made by the FPC representative at that time. Thus, the matter was apparently dismissed as a minor incident which had been rectified.

The 1975 dam failure took place in the area of this 1972 slide. Only a portion of the impervious clay that was washed out by the slide was replaced during the course of the repair work. Alabama characterized this slide as merely superficial, and emphasized that only a small, almost insignificant portion of the impervious clay was affected, and that measured laterally, no more than one or two feet of the clay core were washed out. Said core was about 50 feet thick at the water line level of the dike.

The repair work consisted of replacing and tamping by hand clay above the water line of the dam which had been washed out. Washed out clay below the water line was not replaced. Riprap rock cover was replaced by dumping stone off the crest of the dam onto the damaged area, covering the clay core that had been exposed by slide.

A detailed report of this 1972 slide and the resultant correction work was not prepared until April 3, 1975, after the

dam failed.

All three reports of the dam failure concluded that this slide may have been a significant factor bearing on the weakening of the eastern dike. Further, the occurrence of the slide may have been a warning of a basic area of weakness in this portion of the dam. It appears that neither Alabama nor FPC field personnel gave consideration to this possibility at the time that this slide occurred or when it was later reported to the FPC Staff. It appears further that a Commission directive calling for immediate reporting of matters of this nature that could bear upon the stability of dams licensed by the Commission has not been enforced or fully implemented by Commission Staff, since there was no apparent follow up to the oral report of this slide made by Alabama to the FPC field engineer. Nor was any investigation made of the reason for a toe bulge in the base of the dike extending about 40 feet beyond the toe as originally designed, in the area of this slide. This bulge may have been indicative of a significant area of weakness in this portion of the dam.

An issue in contention between Staff and Alabama is whether the dam failure resulted from inadequate design and specifications for the dam, or whether the failure was due to deviation between design and construction resulting in structure weakness below designed strength. Stated more simply, was the failure of the dam the fault of the designer, or of the builder, or both?

Alabama asserts that design was adequate but that construction standards did not comply with design criteria. Staff contends that design was marginal in some respects. Both Staff and Alabama agree that construction inadequacies were uncovered in the post-failure inspection of the dam.

In its proposed reconstruction of the dam, Alabama's designers, Southern Company Services, have chosen not to use the original design. However, Alabama's witnesses continue to assert that the original design provided an adequate margin of safety and that failure of the dam was not a result of design but was due to lack of compliance by the construction contractor with design criteria in a critical area.

Further, Alabama points out that a new design for replacement of the washed out dam is required because basic conditions have changed. The original clay foundation was scoured by the dam washout to a depth of 50 feet below the floor of the former reservoir. The remaining dikes were weakened by the sudden drawdown of the reservoir following the dam failure, and several slides have occurred along the face of the dikes.

Therefore, extensive reconstruction of the dikes is required. A slope incline consisting of  $2\frac{1}{2}$  feet of horizontal distance for each foot of vertical incline is planned in lieu of the former ratio of 1.3 to 1 in the immediate area of the intake structure. More conservative features of the planned new structure include a cut-off trench, additional drainage and a slanted clay core that will be extended to bed rock in the vicinity of the intake structure. This structure will be supplemented by supporting concrete walls that will extend upstream. The rebuilt dikes will utilize rock riprap as slope protection but rock will not be used as fill as was done in the original design. In lieu of rockfill, a sandy gravel material will be used as a shell over the clay core. Further, more conservative estimates of material strengths will be used in determining safety factors for the new design. It appears that all of the foregoing proposed design changes are intended to provide a more stable structure than the original dam.

The fact that a more conservative design is planned for the new dam does not conclusively demonstrate that the former design was substandard or marginal. However, it is apparent that the original design and specifications could have been more detailed, more exacting, and many of the more conservative features incorporated in the new design would have provided a higher degree of safety than the design of the original structure.

It should be noted that the preliminary design proposal for the original dam included the construction of concrete wing walls on each side of the concrete intake structure. This concept was abandoned in favor of installation of steel sheet piling within the clay core of the embankments in the area immediately adjoining the intake structure. It was determined at the time that this decision was made that a \$2 million construction cost saving would be attained and the sheet piling would assist in supporting the steeper 1.3 to 1 slope used in the dikes in this area. This sheet piling also served the purpose of dispersing any water seepage in this area of the dike.

It is of interest to note that the proposed new structure will have concrete wing walls extending upstream in contrast to the originally contemplated concrete walls extending laterally from the intake structure. These new wing walls will facilitate the use of a flatter slope in the rebuilt dikes adjoining the intake structure. In part, the steeper slopes of the original dikes were required because of need to form an effective bond with the original concrete intake structure which had a slight negative slope.



It could be contended that Alabama was negligent in not designing the original dam with sufficient stability to withstand unexpected water drawdowns, and to take into account the possibility that some components of construction might be below designed strength, that could become areas of weakness when subject to unusual stress.

However, a far more serious area of apparent negligence is Alabama's failure to take adequate measures during construction of the dam to insure compliance with specified design and construction standards. Evidence including (1) Alabama's inspection procedures, (2) substandard construction disclosed by post-failure examination, and (3) review of available records of construction inspection, support the conclusion that inspection was often marginal, casual and conducted on a spot-check rather than on a continuing basis. Inspection records were confusing or non-existent and on-the-job corrective measures were insufficiently exacting for a construction project of this magnitude and significance. Tests were inadequate both in number and in scope.

As noted supra, when excessively thick layers of material were observed by Alabama personnel during the course of construction, such layers were not removed, but were "bladed off", namely scraped off by the contractor's construction equipment to each side of the clay material. If soil appeared to be damp, it would be windrowed, left to dry, scarified to loosen, allowed to dry again and then releveled and recompacted.

The post-failure examination of the west dike, which uncovered a sand layer of up to one foot thick within the supposedly impervious clay core of the dam, with some sand lenses extending for the full width of the clay core leads to the conclusion that inspection was inoperative or wholly ineffective during some periods of construction. It is wholly unacceptable to take compaction tests that analyze only the top six inches of a 12-inch layer of material. It cannot be understood whether any inspection took place in those areas where post-failure examination disclosed layers of material of up to 14 inches in thickness, when such layers were to have been no more than 12 inches in thickness when placed into position and 8 inches in thickness or less when compacted.

Alabama has recognized this problem by its establishment of improved inspection procedures, including the establishment of a new quality control unit which will be independent of construction staff. In addition to internal organizational changes, there must be assurance this new "independent" inspection will be more effective and the individual inspectors on the job will

not repeat mistakes of the past.

As noted Alabama did not prepare a report of the 1972 slide until after the dam failed, about 3 years later. But even after the report was prepared, the extent of the review of this report by Alabama officials is questionable, in light of the fact that no Alabama official noted the deviation set forth in this report between the design and the construction of the earth fill dike until after this was emphasized in the Bureau of Power report.

Reports should not be made merely for the record. They should be carefully reviewed and acted upon as necessary.

Pursuant to Commission Order No. 315, issued December 27, 1965 34FPC1551, Alabama filed a report with the Commission in July 1972 on the inspection of the Walter Bouldin Dam.

This report, prepared by a consultant engaged by Alabama, recited that examination of the records of the construction of this dam showed that the structure "...was of a satisfactory consistent strength...." This report recommended continued surveillance of two springs. (Neither of these springs was deemed to have been a factor in the subsequent failure of the dam.) This report also noted that all 1262 compaction tests taken during the course of construction were satisfactory. (In contrast, note the number of substandard test results detected in the post-failure analysis, as outlined supra.)

It must be concluded that this Order No. 315 report provided minimal useful information to Alabama or the Commission. Such reports should include adequate testing and other examination as appropriate to insure dam safety.

Pursuant to Commission procedures in licensing projects of this nature, Commission Bureau of Power personnel reviewed the plans for the construction of Walter Bouldin Dam prior to its construction. While it appears that Staff made some suggestions for design changes at that time, it does not appear that the design criteria now considered to be marginal were considered to be of sufficient importance at the time of this initial review to recommend that the Commission reject the proposed dam design plans.

Effective Staff review of construction plans and design specifications for hydroelectric dams must consist of detailed analysis of such plans to determine whether critical areas could become points of weakness. If such areas are identified, Staff must recommend corrective action and ask that Commission approval be withheld until appropriate action is taken by the proposed

licensee. Staff review of construction plans should be more aggressive and Staff should not hesitate to question design concepts when construction cost savings may result in less effective standards of safety.

Commission Staff cannot assume the responsibilities of management in the formulation of design plans, but Staff must be able to assure the Commission prior to construction that the proposed plans provide an acceptable degree of safety. Further, while Staff cannot assume the construction supervision responsibility of management, a Staff visit to a construction site should consist of more than a casual overview of the activities in progress. Spot checks of specific critical areas of construction to insure compliance with construction plans would be in order and review of inspection procedures to monitor their effectiveness is most desirable. Examination of construction supervision records is another useful tool.

Alabama's witness stated that if another slide similar to the 1972 slide occurred on an Alabama dam, it is possible that no report would be submitted to the Commission and similar corrective action would be taken in the same manner that any minor maintenance matter is handled. This testimony clearly indicates a lack of understanding of the function of the Commission in matters of this nature. Definitive Commission directives outlining the circumstances under which written reports are required with respect to projects licensed by the Commission must insure that matters bearing upon safety of licensed projects are reported promptly. Regional offices of the Commission should receive immediate reports of any occurrences that could affect safety. If an oral report is received, as in the case of the 1972 slide, a written report should be required from the licensee and Staff should require immediate investigation and evaluation by the licensee or qualified consultants. There should be no recurrence of the failure of a Staff representative to ask appropriate questions and to obtain additional information about such matters. A thorough investigation of the 1972 slide might have disclosed an area of basic weakness in the Walter Bouldin Dam.

Alabama and Staff investigatory reports agree that the cause for the failure of this dam cannot be definitely determined. These reports concur that the 1972 slide could have caused a weakening of the eastern dike or the slide, and may have been an unrecognized warning of a basic weakness in this segment of the dike. Thus, it is disturbing that the repair of this slide and the subsequent report of this matter to a Commission Staff member were treated in a casual manner. Such report consisted of only oral reference to this matter at the time of the visit

of the FPC representative some months after the slide occurred. The record of this proceeding discloses no written report on the slide by staff or any staff effort to investigate this matter any further at the time it was initially reported.

Repair of the slide consisted of replacing and hand tamping only the above water portion of the washout of the clay core in the area of the steel sheet piling near the intake structure, and clay below the water line was not replaced. As described by Alabama's witness, the prime concern was to replace the clay against this sheet piling. It could be theorized that the presence of the piling precluded a possible observation that the damage to the clay core of the dike was more extensive than a mere surficial slide, as this was characterized by Alabama. No compaction test was taken of the replaced clay to determine whether construction specification standards were maintained. This 1972 slide was treated as a minor maintenance matter and no claim was made at that time against the construction contractor for any breach of his contractual obligations.

Alabama is now confronted with a Walter Bouldin Dam reconstruction program estimated to cost \$35,580,200 at 1975 prices. With expected 12% escalation by the end of 1977, the total escalated cost is estimated at \$39,849,900. In addition, Alabama has been deprived of the 225 KW generating capacity of this facility following the failure of this dam.

#### VIII. ADDITIONAL ALABAMA DAMS

Staff Bureau of Power report (Ex. 2) referred to supra, provides extensive information outlining Staff's investigation of the other 13 dams in the Alabama system in addition to the Walter Bouldin Dam. A team of Staff specialists reviewed the geology, foundation treatment, plans, specifications, construction reports, photographs, seepage, settlement, piezometer observations and other material pertaining to these dams. This inspection was conducted in cooperation with Alabama representatives.

As set forth in this report, the potential failure of these dams is considered to be negligible except for the Logan Martin Dam which is the subject of continuing review. Minor deficiencies were observed which require corrective action but no significant area involving any hazards were noted.

This report concluded as follows:

"Many of the older concrete structures exhibit some deterioration and cracking, not unexpected considering

their age. The recommendations for these structures were primarily for tests of an exploratory nature to confirm the integrity of the structures.

Significant deficiencies were noted at some of the earth embankments. At Weiss Dam, two slide areas are in need of repair. At Henry Dam, improved control of underseepage is recommended in a localized area. Measures for correcting these deficiencies have been scheduled.

Many of the earth embankments have tall vegetative growth on the slopes which hinders effective inspection. It is recommended that the licensee institute an experimental program to develop a turf growth which will improve visibility of the slopes. Currently, the licensee is experimenting with new equipment for mowing the steep 1 on 2 embankment slopes. Future embankment designs should give serious consideration to the use of flatter slopes to accommodate mowing equipment.

At Logan Martin Dam there is a serious leakage problem and the potential for failure is relatively high when compared to other dams. Due to the great thickness of the cavernous limestone/dolomite foundation, it appears impractical to eliminate all of the leakage. Some reductions in leakage have been achieved by reinforcing the original grout curtain. It is recommended that experimental measures be undertaken to reduce the leakage by widespread blanketing of the reservoir bottom, with quarry run rockfill followed by smaller rock and finer materials.

Problems may continue to occur at Logan Martin Dam, similar in nature to the sink hole which developed at the downstream slope of the embankment in 1968. It is concluded that the safety of Logan Martin Dam is dependent on continued surveillance, as presently practiced, combined with timely action to make remedial repairs when required."

By order issued July 7, 1976, in Project No. 2146, the Commission prescribed interim emergency procedures recommended by the Bureau of Power to be implemented by Alabama at the Logan Martin Dam.

Such procedures include continuous surveillance, nighttime illumination of critical areas, and expedition of exploratory and grouting work. Further, detailed monitoring of leakage

and other critical areas is required with periodic reports to the Commission of this ongoing work and other significant new developments or findings.

It is concluded that the Bureau of Power report substantially sets forth all relevant information pertaining to the stability and safety of these dams and that the foregoing procedures prescribed by the Commission will insure adequate corrective actions and continued monitoring of the condition of the Logan Martin Dam.

## IX. CONCLUSIONS AND RECOMMENDATIONS

The evidence of this proceeding does not provide a basis for conclusive determination of the precise cause of failure of the Walter Bouldin Dam. However, this proceeding has disclosed serious weaknesses and deficiencies as follows: (1) construction did not comply with design specifications in one or more critical areas of the earth fill dikes, (2) Alabama inspection procedures were not adequate to detect critical deficiencies between construction and specifications, (3) review procedures utilized by Commission Staff with respect to this project were not sufficiently thorough to identify possible marginal design criteria prior to construction and (4) Staff methods for review of dam construction procedures and maintenance practices with respect to the Walter Bouldin were not sufficiently exacting to uncover construction deficiencies and possible areas of weakness.

Dam design should incorporate reasonably conservative design criteria. Construction methods and procedures should assure that designated degrees of soil compaction and moisture content are attained to insure the safety of earth fill dams.

The following conclusions and recommendations are submitted:

### A. Dam Design

Earth fill dam design criteria must be reasonably conservative.

Dam design should provide increased margins of safety taking into account such factors as specific and exacting specifications of types and characteristics of materials and design strength. Flatter slopes will not prevent slides, but steeper slopes are more susceptible to slides. The steepness of an earth fill dike should not be influenced by the slope of an adjoining concrete structure to the extent that the stability of the earth fill slope could be considered to be only marginally safe.

It is arguable as to whether "end result" specifications or more detailed "methods type" specifications are preferable. Whichever procedure is used, it is essential that specifications be sufficiently clear to insure that designed strengths are achieved. An effective procedure for continuous testing of critical components of earth fill dams to insure compliance with specifications should be an integral part of the contractor's obligation subject to further regular check by company and Staff inspectors as outlined infra. While dam design should result in a reasonably economical structure, basic safety and dam stability can never be sacrificed in seeking to implement cost savings.

Earth fill dams must have sufficient strength to withstand unexpected water drawdowns, and sufficient stability to minimize the occurrence of surface slides.

On Brief, Staff contends that Alabama compromised the safety of the Walter Bouldin Dam to save money. It is undisputed that dam design should be reasonably conservative, and in light of the failure of this dam, it can be contended that design should have met higher standards of safety. However, this record does not support the contention that safety was compromised by Alabama in the interest of reducing construction costs. Nor does the record disclose that Staff suggested more conservative design features at the time of the initial review of the plans for this dam.

In response to the request of the Presiding Administrative Law Judge, on Brief, both Alabama and Staff submitted proposed findings and recommendations. Proposals of Staff include specific suggestions relating to redesign of the dam, but probative evidence was not submitted in support of these redesign concepts. Thus, the record of this proceeding does not permit evaluation of these design proposals.

It is expected that in accordance with its usual procedure, Staff will review with Alabama representatives the proposed reconstruction plans. Following such joint engineering evaluation of Staff suggestions, Staff is expected further to submit appropriate recommendations to the Commission concerning Alabama's proposed reconstruction plans to insure that the rebuilt dam incorporates reasonably conservative design concepts and is built in conformity with the findings and conclusions of this Initial Decision.

This investigation and related proceedings neither abrogate nor curtail Staff's continuing responsibility to monitor dam design and construction procedures and to advise the Commission with respect to necessary action to insure public safety.

## B. Construction Inspection

Adequate and proper inspection of the construction of an earth fill dam is not a matter to be treated casually. Inspectors must be fully trained, and have a clear understanding of their functions. They should have all necessary authority to reject unsatisfactory work and to require necessary corrections. Inspection must be constant, consistent and thorough.

Testing equipment and procedures must insure that testing is complete; testing only the upper six inches of a 12-inch layer of soil is wholly unacceptable. The post-failure inspection disclosure of an unduly large proportion of substandard tests of the Walter Bouldin Dam makes it apparent that the testing conducted during construction of this dam did not meet this essential criterion. Testing cannot be sporadic. As noted supra, a large proportion of substandard compaction tests were uncovered in the soil layers of the west dike located between elevations 224 and 242. It would appear that testing was essentially non-existent during the construction of this segment of the dike.

## C. Inspection Records

Inspection records should be detailed, comprehensive and consistent in form. It appears that during the construction of the Walter Bouldin Dam, each inspector kept records in his own manner and that review of these records could result in confusion rather than enlightenment. The misunderstanding as to whether rock zone construction conformed with specifications was the direct result of the inability of an Alabama draftsman to understand the nature of the inspector's field notes. It would also appear that Alabama supervision of the work of these individuals was ineffective.

Construction inspection records should show as-built sections of construction with reasonable clarity. To determine as-built sections of the Walter Bouldin, Alabama was compelled to make reference to the original design drawings, but documentary evidence to show that actual construction complied with design drawings was not available, except for reference to a small scale drawing on one page of a field notebook. This does not constitute adequate record keeping for a project of this magnitude.

## D. Dam Maintenance

Slides, springs, foundation problems and other matters occur at earth fill dams. Some of these problems are minor and some may have significance. Each of these occurrences requires adequate and thorough investigation because a basic



weakness in a segment of the dam may be indicated. Each such occurrence should be reported promptly to the Commission. The potential gravity of such matters precludes a field determination that a slide or a spring is too insignificant to warrant a written report to the Commission regional office. Prompt reports of all such matters must be required with Staff follow-up as necessary.

Further, a uniform method of maintenance record keeping must be required. The initial record of the 1972 slide repair at the Walter Bouldin Dam was filed as part of a generator and turbine maintenance record and a more complete record of this slide was not prepared until over 3 years after the slide occurred. This should not recur.

Commission directive reaffirming and clarifying the nature of maintenance record keeping for licensed projects should be issued.

#### E. Commission Staff Review

Commission Staff has performed a commendable job in the thorough review of the Walter Bouldin Dam failure and the stability of the other dams controlled by Alabama.

Prior to this failure, it would have been most desirable if Staff had exercised more effective review over, (1) the initial design criteria of this dam, (2) construction and inspection procedures during construction, and (3) the 1972 slide when this matter was verbally reported by an Alabama representative.

It would appear to be impractical for Staff to conduct the extensive type of examination of all dams licensed by the Commission as Staff has conducted of the dams controlled by Alabama. However, Staff review procedures must be strengthened and there should be no reluctance or hesitancy to conduct critical and constructive reviews of proposed dam designs to achieve a higher degree of safety and dam stability. While the licensee has the responsibility to build and maintain a structure that will pose no threat or danger to life or property, the nature of the work conducted by Staff to insure that the licensee meets this responsibility should be more clearly and definitively delineated. For example, Staff could arrange for sample tests to be taken at critical areas during construction to insure compliance with design standards. Staff should review licensee inspection records and monitor work of inspectors to insure adequate inspection procedures. Dam maintenance records and daily log books should be a matter of regular Staff review and inspec-

tion. (During the course of this hearing, it became apparent that Staff were not familiar with the records maintained by Alabama.)

Staff should be encouraged to exercise initiative and imagination during dam inspection visits and to follow through on any matter indicating problem areas or unusual events that may be indicative of safety problems or lack of dam stability.

#### F. Emergency Procedures

Procedures should be established for necessary action in the event of emergencies such as the weakening of a dam, a breach or other unusual hazard. Such procedures should provide for prompt warning to and possible evacuation of those affected, methods of diverting water to minimize pressure on the weakened facility, and, as necessary, standby arrangements for emergency repairs.

#### G. Order No. 315 Reports

The Commission issued Order No. 315 on December 27, 1965 (34FPC1551) for the purpose of providing for adequate inspection of licensed facilities and to insure their safety. It is apparent that the Order No. 315 report of the Walter Bouldin Dam did not identify the areas of possible weakness which subsequently resulted in the failure of this dam. Reports submitted to the Commission pursuant to this order should be more thorough and include sufficient independent testing and other appropriate procedures to provide meaningful information relating to the stability and safety of licensed projects.

#### H. Proposed Forfeiture

Staff recommends that Section 315(a) of the Federal Power Act be invoked and that Alabama be required to make forfeiture to the United States in the maximum amount provided by statute of \$1,000 for the alleged violation of Article No. 3 and \$1,000 for alleged violation of Article No. 4 of Form L-6, Terms and Conditions for Unconstructed Major Projects Affecting Navigable Water and Lands of The United States 16FPC 1121, arising from Alabama's alleged failure to promptly report to the Commission the 1972 slide that occurred on the upstream side of the east dike of the Walter Bouldin Dam and the resultant corrective work. In making this recommendation, Staff points out that this slide may have been a factor in the subsequent failure of this dam.

In light of hindsight and the facts uncovered by this investigation, it is clear that this slide should have been reported promptly. However, it must be noted that after a verbal

report was made to a Commission representative, there is no evidence in this record that any action was taken at that time on behalf of the Commission, or that notation of this matter was made as part of any written report in the Commission files.

Alabama personnel made a field decision that this slide was of insufficient importance to warrant a special report, but the matter was reported at the next inspection visit by a Commission representative.

The foregoing review of the factual background of this matter does not support the conclusion that Alabama has violated Articles 3 and 4 of Form L-6.

Article 3 requires that a licensed project be constructed in substantial conformity with the plans approved by the Commission. Alabama's failure to promptly report to the Commission that this slide occurred and was repaired within a few days does not constitute a willful failure to construct a facility in accordance with approved plans.

Article 4 of Form L-6 provides for inspection and supervision by the Commission Regional Engineer of the construction, operation and maintenance of a licensed project, and the licensee is directed to furnish to the Regional Engineer all requested information and to allow unrestricted access to the licensed projects. Staff argues that repair of the 1972 slide constituted an alteration of the licensed project. Whether or not this repair was an alteration is not determinative of the issue as to whether Alabama violated Article 4. This Article requires licensee cooperation to facilitate the inspection and supervision functions of the Regional Engineer, and Article 4 sets forth no specific requirement for immediate report of a slide or similar occurrence.

It is an established principle that statutes or regulations that are punitive in nature must be strictly construed.

Based on the foregoing review of the facts of this matter, the requirements of Articles 3 and 4 of Form L-6 and the provisions of Section 315(a) of the Federal Power Act, it is concluded that Staff has not demonstrated a willful failure of Alabama to comply with a Commission order within the purport of Section 315(a) of the Federal Power Act.

Therefore, Staff's recommendation for forfeiture is not approved.

As outlined supra, it is recommended that Staff prepare for Commission review and adoption, a draft rulemaking order definitively outlining the responsibility of a project licensee to report promptly to the Commission all matters or occurrences that could bear upon the safety or stability of a licensed project.

On Brief, Staff also contends that Alabama did not provide results of soil tests as promptly as possible. However, Staff recommends no remedial action with respect to this contention and this issue is considered to be moot. The record reflects no instance in which Alabama was not reasonably responsive to a Staff request for information.

I. Possible Violation of Commission Regulations or Order

It is concluded that the licensee Alabama has not violated any Commission regulation or order. However, it is recommended that Commission licenses for erection of an earth fill dam more clearly delineate the responsibility of the licensee to insure the construction and maintenance of a safe and stable structure by adoption of the additional safeguards set forth in this Initial Decision.

X. ORDER

WHEREFORE IT IS ORDERED, subject to review by the Commission, that this investigation is terminated. The foregoing recommendations are herewith submitted to the Commission for appropriate remedial action.



Samuel Kanell

Presiding Administrative Law Judge

APPENDIX C

UNITED STATES OF AMERICA  
FEDERAL POWER COMMISSION

OPINION NO. 795

Alabama Power Company

)

Project No. 2146

OPINION AND ORDER ADOPTING INITIAL DECISION  
WITH MODIFICATIONS AND TERMINATING  
INVESTIGATION OF FAILURE OF WALTER BOULDIN DAM

Issued: April 21, 1977

DC-A-6

UNITED STATES OF AMERICA  
FEDERAL POWER COMMISSION

Alabama Power Company

)

Project No. 2146

OPINION NO. 795

APPEARANCES

Robert McD. Smith, Esq., Lewis W. Page, Jr., Esq., and George F. Bruder, Esq. for Alabama Power Company

Richard A. Azzaro, Esq. for the Staff of the Federal Power Commission

HYDRO-ELECTRIC DAMS  
(Staff review of design)  
(Inspection of construction)  
(Off-specification construction)  
MAINTENANCE OF DAMS  
(Reports of occurrences)  
BREACH OF DAM  
SECTION 315(a) FORFEITURE

UNITED STATES OF AMERICA  
FEDERAL POWER COMMISSION

Before Commissioners: Richard L. Dunham, Chairman;  
Don S. Smith, John H. Holloman III,  
and James G. Watt.

Alabama Power Company ) Project No. 2146

OPINION NO. 795

OPINION AND ORDER ADOPTING INITIAL DECISION  
WITH MODIFICATIONS AND TERMINATING  
INVESTIGATION OF FAILURE OF WALTER BOULDIN DAM

(Issued April 21, 1977)

1. On February 10, 1975, a breach occurred in the eastern 8,457-foot long earthfill embankment of the Walter Bouldin Dam, one of the five hydro-electric dams included in Alabama Power Company's (Alabama Power's) license for Project No. 2146. The onrushing waters quickly emptied the impounded reservoir, and fortunately there was no loss of life and little property damage other than to the dam itself. Nonetheless, Alabama Power thereby lost 225,000 kilowatts of generating capacity representing about four per cent of its total capacity.

2. On the same day the Commission's Regional Engineer in charge of its Atlanta Regional Office visited the site, and on the following day Alabama Power commenced a formal investigation into the failure. And the Commission, by order issued February 20, 1975, initiated a formal investigation and hearing thereinto stating,



"We are... ordering a ... formal investigation pursuant to the Federal Power Act into the causes of this dam failure in order to determine the proper remedial actions which should be taken to assure that life, health, and property are adequately protected at this dam and other dams under the control of the licensee. The formal investigation should also determine whether the provisions of this Act or any rule, regulation or order of the Commission have been violated and, if so, which may have caused or contributed to the dam's failure."

3. The Commission staff thereafter conducted a comprehensive investigation into the failure of the dam. And the hearing which followed was commenced on April 22, 1976, and extended over twelve sessions terminating on June 30, 1976. 1/ After briefing, presiding Administrative Law Judge Samuel Kanell, on August 19, 1976, issued his Initial Decision in which he discussed the events surrounding the failure of the dam, including the investigations and the evidence before him, evaluated the evidence in the light of the contentions of the parties, and concluded that while the evidence "does not provide a basis for conclusive determination of the precise cause of failure of the Walter Bouldin Dam", it does disclose (1) that the construction of the earthfill dikes did not comply with the design specifications in one or more critical areas, (2) that Alabama Power's inspection procedures during the construction of the dam were not adequate to detect those deficiencies, (3) that the Commission staff's review procedures were not sufficiently thorough to identify possible marginal design criteria prior to construction of the dam and (4) and that the staff's review of the construction procedures and maintenance practices pertaining to the dam were not sufficiently exacting to uncover construction deficiencies and possible areas of structural weakness.

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1/ On December 16, 1975, Alabama Power filed an application for amendment of its license to authorize reconstruction of the Walter Bouldin Dam, and by order issued June 17, 1976, during the course of the hearing, the Commission issued a conditional limited work authorization.

4. On the basis of those conclusions, Judge Kanell submitted certain recommendations to the Commission pertaining to increased margins of safety in the design of dams, improved inspection of construction and records thereof, prompt reporting and investigation of occurrences at dams, more effective Commission staff review of the foregoing, and the establishment of emergency procedures. Additionally, he concluded that the staff did not demonstrate that Alabama Power willfully failed to comply with a Commission order so as to require a forfeiture under Section 315(a) of the Federal Power Act 2/, and that Alabama Power did not violate any Commission regulation or order. And, subject to Commission review, Judge Kanell ordered that the investigation be terminated.

5. Both the Commission staff and Alabama Power filed briefs on and opposing exceptions. And while both agree that the investigation should be terminated, the staff contends that the presiding judge erred in rejecting its "specific suggestions" on redesign, in failing to find that Alabama Power compromised the safety of the dam to reduce its construction costs and in concluding that Alabama Power was not shown to have committed violations requiring a forfeiture under Section 315(a) of the Federal Power Act. Alabama Power, on the other hand, generally supports the Initial Decision but excepts to certain findings and inferences.

#### REDESIGN SUGGESTIONS

6. The Commission staff excepts to Judge Kanell's failure to adopt twelve "specific suggestions" pertaining to the redesign and reconstruction of Walter Bouldin Dam and to its operation and maintenance after reconstruction, which the staff had proposed in its initial brief to the judge. In view of their length, such "specific suggestions" are set out in Appendix A to this opinion and order. Citing record evidence allegedly supporting each of the twelve "specific suggestions", the staff excepts particularly to Judge Kanell's statement that

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2/ "Any licensee or public utility which willfully fails, within the time prescribed by the Commission, to comply with any order of the Commission, to file any report required under this Act or any rule or regulation of the Commission thereunder, to submit any information or document required by the Commission in the course of an investigation conducted under this Act, or to appear by an officer or agent at any hearing or investigation in response to a subpoena issued under this Act, shall forfeit to the United States an amount not exceeding \$1,000 to be fixed by the Commission after notice and opportunity for hearing."

"Proposals of Staff include specific suggestions relating to redesign of the dam, but probative evidence was not submitted in support of these redesign concepts. Thus, the record of this proceeding does not permit evaluation of these design proposals."

7. Alabama Power asserts, in reply, that the staff's citations are to portions of the record at which witnesses perceived certain problems but did not propose solutions to them and, as a result, the staff's "specific suggestions" are not sponsored by any of its fourteen witnesses nor supported by probative evidence. At the time of the pre-hearing conference, Alabama Power asserts, and at other times during the course of the hearing, Alabama Power made it known to the presiding judge that it wanted an opportunity to evaluate and test any recommendations the staff might make and to offer evidence in response to those recommendations, and the judge proceeded on the premise that Alabama Power would be accorded such an opportunity. And finally, Alabama Power continues, the staff placed in evidence a statement of its position, Alabama Power waived its opportunity to present further evidence on the staff's position, and the record was closed without any evidentiary consideration of the staff's "specific suggestions".

8. Under these circumstances, and particularly since the staff unveiled its "specific suggestions" in its initial brief to the presiding judge, and notwithstanding that the record as a whole may contain some evidence to support at least some of the staff's "specific suggestions", we agree with Judge Kanell that this proceeding does not permit evaluation of the staff's proposals 3/ and will deny the staff's exception. We will do so, however, without expressing any views on the merits of the staff's "specific recommendations" and without prejudice to their consideration as part of Alabama Power's license amendment proceeding which was publicly noticed on May 24, 1976, for we agree with Alabama Power that now they are more properly considered in that proceeding.

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3/ We will note in passing that Alabama Power addresses each of the staff's "specific suggestions" in its brief opposing exceptions, indicating that some of them are included at least in part in its license amendment application, that others are moot in view of changes proposed therein, and that still others are vague and/or not supported by evidence.

## SAFETY AND COSTS

9. The staff excepts to Judge Kanell's conclusion that

"this record does not support the [staff's] contention that safety was compromised by Alabama [Power] in the interest of reducing construction costs. Nor does the record disclose that Staff suggested more conservative design features at the time of the initial review of the plans for this dam."

While the staff concedes that Alabama Power did not intentionally compromise the safety and adequacy of Walter Bouldin Dam, it argues that there is "substantial evidence" to show that Alabama Power's "continuous efforts to save construction costs resulted in deficiencies" which were underlying causes of the dam's failure. With respect to design, the staff asserts that the eastern embankment was shaped to fit an economical arrangement of concrete headworks resulting in a steep 1 on 1.3 <sup>4/</sup> upstream slope adjacent to the intake (and near the point of failure) which, in turn, resulted in marginal stability of the slope. And with respect to construction, the staff claims that the upstream outer rockfill zone was thinner than was required by the design drawings, that the specifications for compaction of the earth fill did not address moisture control or types of compaction equipment, and that field inspections were inadequate and therefore failed to detect pervious lenses of sand and rock fines in the impervious core, as well as lenses of impervious material in the rockfill zone, and the failure to achieve the specified degree of compaction.

10. The staff contends that the marginal embankment design and the insufficiently compacted earthfill are the product of Alabama Power's "apparent overriding concern for short run economics." As originally proposed and approved by the Commission, concrete wing walls both upstream and downstream would have allowed 1 on 2.5 upstream slopes and 1 on 2 downstream slopes adjacent to the intake instead of 1 on 1.3 and 1 on 1.8 slopes, as finally constructed at an estimated saving of \$2,000,000, the staff asserts. And because the embankment design was marginal, it continues, rigid adherence to specific field control measures

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<sup>4/</sup> One-foot rise for each 1.3 feet horizontally.

were essential to building a sound structure. But Alabama Power utilized "end result" instead of "method" specifications, the staff asserts, thereby leaving the method of spreading and compacting the fill and the selection of compacting equipment to the contractor at a potential saving to Alabama Power, and thereby failed to receive a sound structure. And finally, the staff urges that the actions of the staff at the time of reviewing the plans for the dam is not relevant to the question of whether Alabama Power compromised the safety and adequacy of the dam to save construction costs.

11. Alabama Power responds unequivocally that any cost saving by it was compatible with the integrity of the project and that it did not knowingly or carelessly take any action which impaired that integrity. Thus, its design witness testified, at Tr. 1552-3:

PRESIDING JUDGE: Do I understand correctly since you had a ratio on that slope near the intake structure of 1.3 to 1 ... meant in effect you had to have the 1.3 to 1 to conform with the concrete structure? Is that what that amounts to?

THE WITNESS: If you permit, I would put it the other way around. We did not put the structure there and then fit the slope. We examined what slope we could get the stability factors on and then made the placement. 5/

And Alabama Power contends that the stability of the embankment slopes is confirmed by the fact that the west dike, which was designed identical to the east dike and suffered certain construction deficiencies, as a later inspection showed, continued to stand after the catastrophic drawdown caused by the failure of the east dike - which suggests that the deficiency was in the construction of the east dike rather than its design.

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5/ Alabama Power calls attention, in this connection, to the presiding judge's statement, "The steepness of an earth fill dike should not be influenced by the slope of an adjoining concrete structure to the extent that the stability of the earth fill slope could be considered to be only marginally safe." Alabama Power apparently agrees with the statement, as we do, but it excepts to any implication which might be drawn from the statement that the safety of the embankments of the Walter Bouldin Dam was compromised to fit them with the intake structure. We grant the exception in the light of the testimony of its design witness that the intake structure was designed to fit a slope which it considered stable.

12. Furthermore, Alabama Power asserts, the staff's contention that the embankment design was marginal is inconsistent with the staff's and the Commission's prior actions. An earlier version of the Walter Bouldin Dam proposed rockfill embankments of 1.3 to 1 adjacent to the intake structure on both the upstream and downstream slopes, Alabama Power notes, and

"By letter of March 2, 1964, the Bureau of Power requested stability computations supporting the 1.3:1 downstream slope and said that if there were any difficulty with stability, it could be corrected, not by flattening the slope, but by decreasing the earthfill and increasing the rockfill.... In the course of the letter the Bureau of Power acknowledged 'the slope of 1.3 to 1 for the rockfill is generally adequate....'"

Thereafter, Alabama Power provided a stability analysis showing a minimum safety factor of 1.72, and the Commission approved its application at 32 FPC 229. Later, however, Alabama Power continues, it proposed to change the site to the one at which it finally constructed the Walter Bouldin Dam; it filed a design drawing showing a 1.3 to 1 slope, no further justification was requested and the Commission approved the final design at 35 FPC 15 stating, among other matters, "The structures...as proposed to be changed and modified, are considered stable and adequate under both normal and flood water conditions of loading." And Alabama Power concludes that the facts suggest that the staff's reviewing engineers "proceeded diligently to inform themselves of the facts and independently verify the safety and adequacy of the proposed structures."

13. "End result" specifications, which state the degree of compaction to be attained, are widely recognized and accepted; Alabama Power argues, because they result in the best product for the best price; and it is not necessary to specify any moisture limits when such specifications are utilized since there are implicit moisture levels for each soil density which cannot be exceeded if the specified density is to be achieved. And Alabama Power points out that the staff's assertion that the upstream outer rockfill zone east of the intake structure was thinner than was required by the design drawings is based upon an erroneous drawing in the record which was explained to be such and was replaced by a corrected drawing during the course of the hearing, and that the corrected drawing shows that the rockfill was placed substantially as required by the design drawing.

14. Alabama Power excepts to substantially all of the following paragraphs of the Initial Decision:

"It should be noted that the preliminary design proposal for the original dam included the construction of concrete wing walls on each side of the concrete intake structure. This concept was abandoned in favor of installation of sheet steel piling within the clay core of the embankments in the area immediately adjoining the intake structure. It was determined at the time that this decision was made that a \$2 million construction cost saving would be attained and the sheet piling would assist in supporting the steeper 1.3 to 1 slope used in the dikes in this area. This sheet piling also served the purpose of dispersing any water seepage in this area of the dike.

"It is of interest to note that the proposed new structure will have concrete wing walls extending upstream in contrast to the originally contemplated concrete walls extending laterally from the intake structure. These new wing walls will facilitate the use of a flatter slope in the rebuilt dikes adjoining the intake structure. In part, the steeper slopes of the original dikes were required because of need to form an effective bond with the original concrete intake structure which has a slight negative slope."

15. Alabama Power contends, in this connection, that at the first of three proposed sites for the Walter Bouldin Dam it proposed to construct thin reinforced concrete counterfort walls resting on compacted earthfill and extending upstream and downstream from the intake structure, the function of which was to contain the ends of the embankments at the powerhouse intake structure. It contends, further, that such concept was abandoned because the proposed foundation was not deemed suitable and because the steel reinforcement was subject to corrosion. Alabama Power also contends that the sheet steel piling was driven into the embankments laterally away from the powerhouse intake structure, not to support the embankments or the ends of the embankments, but for the sole purpose of lengthening the path of possible seepage. And the \$2 million saving, Alabama Power asserts, was based on using sheet piling instead of thin concrete core walls laterally in the same configuration. Thus, Alabama Power argues, it never proposed

"concrete walls extending laterally from the intake structure" at any of the three proposed sites nor wing walls (up and downstream) at the final site. Furthermore, it argues, the proposed wing walls for the reconstructed Walter Bouldin Dam would be heavy gravity concrete structures which would rest on a rock foundation and contain the ends of 2.5 on 1 embankments which, in turn, would be flatter than previously to accommodate different construction materials. And finally, Alabama Power asserts, the negative slope of the intake structure was on its upstream face and not on its side faces where the embankments are bonded to the concrete and, in any event, the upstream slopes of the embankments do not affect the quality of the bond.

16. The staff asserts, in reply, that Alabama Power's supervising design engineer for the Walter Bouldin Dam said during the course of an interview by its Board of Inquiry on April 22, 1975, that the sheet piling was extended a greater distance from the intake structure than was the general practice so that it would reach the point where the 1.3 on 1 slope flattens into a 2.5 on 1 slope, that the sheet piling design was considered perfectly safe and that it would save an estimated \$2,000,000 over the concrete wing wall designs.

17. As noted earlier, Judge Kanell found that the evidence "does not provide a basis for conclusive determination of the precise cause of failure of the Walter Bouldin Dam". No exceptions to that conclusion have been filed and, as a result, any objections thereto are deemed waived under § 1.31(c) of the Commission's Rules of Practice and Procedure. Consistent with Judge Kanell's finding, with which we concur, we find that the question of whether Alabama Power intentionally or negligently jeopardized the safety of the Walter Bouldin Dam is as insusceptible of definitive resolution as is the question of pinpointing the causes of its failure, for the onrushing waters obviously destroyed some of the critical evidence.

18. The staff concedes that Alabama Power did not intentionally compromise its safety, but argues that there is "substantial evidence" to show that Alabama Power's "continuous efforts to save construction costs resulted in deficiencies" which were underlying causes of the dam's failure. Assuming arguendo



that there is such "substantial evidence", we are unable to assign fault any more than we are able to select which of the deficiencies caused the dam to fail. And we would note, in this connection, that the purpose of this investigation was not to assess fault with a view toward awarding or denying an award of money damages, as in the case of civil litigation. The investigation was to focus upon fault with a view toward forestalling breaches of Alabama Power's other dams and avoiding the same mistake/s<sup>7</sup> in connection with an assumed reconstruction of the Walter Bouldin Dam and the construction of other hydro-electric dams. 6/

19. Apparently both Alabama Power and the Commission staff were satisfied prior to the construction of the Walter Bouldin Dam that its design provided an acceptable degree of safety in the light of its potentiality for destroying lives and property. The concept of an "acceptable degree of safety" is essentially a value judgement, for the risks caused by most structures can ordinarily be eliminated or at least reduced by spending additional funds for their construction. And the record does not inform us to what extent the safety of the dam could have been increased by specified additional expenditures, so that one might try to determine not only the point of diminishing returns, but the point at which reasonable persons would agree that further expenditures would be too marginally productive of additional safety.

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6/ As is explained in Footnote 10, *infra*, fault with respect to a particular deficiency can be assessed against different persons for different reasons at different levels of authority and responsibility. But for the purpose of this investigation it is sufficient to identify the deficiencies together with the responsible parties in their respective areas of concern and take corrective action.

20. In this context, any saving in construction costs by Alabama Power might be viewed as having increased the risks of the dam. Certainly it does not take in-depth knowledge of the laws of physics to understand that relatively steep embankments are more susceptible to slides--and weakening--than relatively flat embankments. And certainly it does not take more than slight knowledge of human behavior to understand that an acceptable degree of safety cannot be made to depend upon 100 per cent adherence to specifications. The question, then, is whether Alabama Power exceeded the bounds of propriety in the light of the potential danger of the dam.

21. The staff argues, in this connection, that Alabama Power exceeded those bounds by replacing a design calling for a 2.5 on 1 upstream embankment with the one which eventually failed and called for a 1.3 on 1 upstream embankment, at a savings of about \$2,000,000. In reporting to the staff upon the results of Alabama Power's stability analysis in his letter of March 20, 1964, Mr. Walter Bouldin, then President of Alabama Power, said,

"The soil characteristics were based on the average values from laboratory tests for remolding samples at 95% compactions. The samples were obtained from borrow areas where we expect to obtain the embankment fill."

While Alabama Power thereby satisfied itself and the staff of the stability of 1.3 on 1 embankments on the basis of 95% compactions of the materials which it proposed to utilize, its construction contract specified 92% compactions, except adjacent to the intake structure where they would be 95%. And while Alabama Power's designed 1.3 on 1 slope is shown as such on its Exhibit L drawings which were approved by the Commission, the compaction specifications upon which the stability of that slope depends are not shown on those drawings. 7/

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7/ If such specifications had been shown on those drawings we would not hesitate to find from the record that Alabama Power violated Article 3 of its license, requiring forfeiture under Section 315(a) of the Federal Power Act, by failing to construct a project work in substantial conformity with an approved exhibit. Judge Kanell said, in this connection, that "it is apparent that the original design and specifications could have been more detailed, more exacting, and many of the more conservative features incorporated in the new design would have provided a higher degree of safety than the design of the original structure.'

22. It appears, therefore, that the construction contract permitted compaction which was somewhat looser than 95% at points which were sufficiently close to the intake structure that the embankments had not yet flattened from 1.3:1 to 2.5:1, resulting in embankments which were somewhat less stable than Alabama Power had contemplated. And it appears that there was nothing to tie the construction contract specifications into the Exhibit L drawings. While Alabama Power, as the licensee, was primarily responsible for the design and construction of the dam, the staff could have been more circumspect with respect to its review of the design and its inspection of the construction. 8/ Other factors also appear to have contributed to the ultimate breach of the dam and, therefore, we are not persuaded that special culpability should attach to Alabama Power for attempting to save construction costs.

23. The staff fails in other ways to convince us that Alabama Power's economy measures were inconsistent with the integrity of the dam. Contrary to the staff's position, the evidence indicates that Alabama Power designed the concrete headworks to fit an embankment which was considered stable both by Alabama Power and the staff. The staff's claim that the upstream outer rockfill zone was too thin is not borne out by the record. And although there are advantages and disadvantages to both "method" and "end result" specifications, we are persuaded that "method" specifications would result more consistently in superior construction. The record shows, in this connection, that the utilization of "method" specifications is the accepted practice of the two largest builders of dams in the United States, the Corps of Engineers and the Bureau of Reclamation.

24. We are most impressed by Alabama Power's apparent inertia to assure itself that it would receive the stable structure which it thought it was purchasing when it contracted for the construction of the dam. As Judge Kanell found, Alabama Power had only one or two construction personnel on the job at most times, and

"It appears that field notebooks maintained by Alabama's construction supervisory personnel contained data relating to the quantity of material deposited during the construction of the earth fill dikes, but such data were not designed to reflect whether construction met design standards. These field data were compiled to determine the amount of payment due the contractor."

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8/ Judge Kanell is commended for his candor with respect to the shortcomings of the Commission staff which may have contributed to the failure of the dam. Hopefully, the wisdom of retrospect gained in this instance will help prevent other failures in the future.

We are not surprised, therefore, that those records did not disclose any deviations from the specifications with respect to compaction or lift thickness in the light of the numerous such deviations which were found in the western embankment following the failure. And we seriously question whether those personnel were imbued with any substantial authority and responsibilities pertaining to inspection of the construction or whether they were present to perform ministerial duties.

25. We find, therefore, that Alabama Power's obvious failures to establish and carry out an effective inspection program while the dam was under construction, and to prepare and maintain clear records thereof, are inexcusable in the light of its multi-faceted responsibilities to the public. Certainly the additional cost, consisting principally of salaries, would have been miniscule in comparison to the cost of reconstructing the dam. And certainly the additional cost would have been insignificant in the light of the risks to lives and property. But Alabama Power claims on exception that in line with industry practice it relied primarily on the responsibility of its contractors. In view of such industry practice, which the staff does not refute, we are not prepared to conclude that Alabama Power compromised the safety of the dam to save the costs of establishing and carrying out an effective inspection program. 9/

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9/ We find the industry practice to be inadequate and caution all present and future hydro-electric licensees to establish and carry out effective inspection programs, and to prepare and maintain clear records thereof, both during and following their construction of hydro-electric dams.

Alabama Power excepts to the presiding judge's characterization of its testing procedure as being "wholly unacceptable", asserting that the specified 12 inch lifts would be reduced to 8 inches when compacted and that its testing procedure would penetrate 6 inches thereinto. We find no fault in the testing procedure as such employed by Alabama Power, but it appears that the effectiveness of that procedure was diminished by the laxity of its effort to determine the thickness of the lifts which it tested or the presence of misplaced materials. In this context we agree with the presiding judge and deny Alabama Power's exception.

26. The principal purpose of this proceeding, as expressed in the order of February 20, 1975, is to determine the "causes of this dam failure in order to determine the proper remedial actions which should be taken to assure that life, health, and property are adequately protected...." Upon review of the record in the light of the exceptions, we share Judge Kanell's inability to pinpoint the cause or causes of the failure. And we find, as he does, that certain factors, such as off-specification construction of the dam (i.e., construction which was not in accordance with the specifications), contributed to its failure. We find, also, that these factors have been isolated, that the responsible parties have been identified and that corrective action has been or will be taken. The principal purpose of this proceeding has, therefore, been substantially accomplished. In this context, we believe that the staff's exception that Alabama Power compromised safety for economy cuts across the contributing factors and seeks to assign the ultimate fault to Alabama Power. And while we have no doubt that Alabama Power must bear the ultimate blame in view of its control over the dam from its design and location to its completion, and beyond, there appears little to be gained from the additional assignment of fault which the staff now seeks. 10/ More is to be gained if those who contributed to the failure of the dam face and remedy their shortcomings in their respective areas of concern. And, therefore, we will deny the staff's exception.

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10/ Assuming arguendo that the sole cause of the breach of the dam was the construction contractor's failure to achieve the specified compaction percentages and to apply lifts in the specified thicknesses and free from foreign materials--in short, shoddy construction--we might assign fault (1) to the construction contractor for failing to comply with the specifications, (2) to Alabama Power for failing to oversee that the construction contractor complied with the specifications, (3) to our staff for failing to require Alabama Power to oversee the construction contractor effectively and (4) to ourselves for failing to adopt regulations under which Alabama Power would have routinely overseen the construction contractor effectively. For the purpose of this proceeding it is sufficient to isolate the contributing factors, identify the responsible parties in their respective areas of concern and take corrective action; and conversely, it is not necessary to make an ultimate assignment of fault as in civil litigation for damages and as the staff seeks in the exception under consideration.

## FORFEITURE

27. The staff excepts to Judge Kanell's rejection of its recommendation that Alabama Power be subjected to a forfeiture under Section 315(a) of the Federal Power Act, 11/ asserting that Alabama Power's failure to report to the Commission the upstream slide which was noted in the eastern embankment on October 4, 1972, violated Articles 3 and 4 of its license, Subsection (a) of Section 9 and Subsections (a), (b) and (c) of Section 10 of that Act. In view of their length, such provisions are set out in Appendix B to this opinion and order.

28. As the staff indicates, a rapid drawdown of the reservoir impounded by the Walter Bouldin Dam occurred on September 28, 1972, thereby eliminating temporarily the pressure of the reservoir against the earthen embankments. On October 4, 1972, a slide was observed at the crest of the upstream slope of the eastern embankment extending 30 to 40 feet from the intake structure. 12/ And a 12 to 15 foot surface crack was observed in the western embankment near the intake structure. Within the next several days the slide and crack were inspected visually. While it was estimated that the slide penetrated some 3 to 4 feet into the 10-foot impervious layer, and while soundings and other observations of a diver indicated that the slide material extended 30 to 40 feet into the reservoir, no physical tests, such as compaction tests, were made in the slide area. Alabama Power thereby judged that the slide was

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11/ See Footnote 2, supra.

12/ Alabama Power faults Judge Kanell's statement, "The 1975 dam failure took place in the area of this 1972 slide," arguing that while the 1972 slide occurred next to the intake structure and was centered about 15 feet east of it, the 1975 failure was centered about 50 feet east of that structure. While we agree with Alabama Power that the available evidence suggests that the two occurrences were not centered at precisely the same place, Judge Kanell's statement is correct and not misleading in the context of an 8,457-foot long embankment and, therefore, we will deny Alabama Power's exception.

not serious and almost immediately filled the area with rockfines and riprap to protect it against erosion through wave-action of the reservoir. Alabama Power finally reported the slide to the Commission orally during the course of a field inspection of the dam on April 17, 1973, but did not prepare a detailed written report until April 3, 1975, some two months after the failure of the dam.

29. The staff contends that the nature and extent of Alabama Power's duty to make prompt reports to the Commission pursuant to Articles 3 and 4 of its license were communicated to Alabama Power in a letter dated April 17, 1964, as follows:

"The spacing of our inspections does not permit as close a surveillance of licensed projects as we would like. It therefore becomes necessary for us to rely on the licensees to keep us informed on all project developments in which the Commission would have an interest."

"Interests of the Commission would include but would not be limited to such items as important shutdowns and suspensions of operations due to failure of equipment or structures; unusual movement or settlement of structures, any unusual increase in observation well levels, relief well flows, uplift pressures or seepage, the development of new leakage or cracks, or any other signs of instability of the project structures. Also included would be such items as obstructions to or inoperation of fish passage facilities, conflicts between reservoir development for recreational use and operation of the reservoir for power purposes, and any deviation from the terms of the license. The above list is not intended to be all-inclusive and should only be used as a general guide as to the type of information to which the Commission has an interest."

"In accordance with the above, it is requested that this office be kept informed either by telephone, telegram, or letter, as appropriate, on all matters of concern pertaining to the construction, operation, and maintenance of the projects. Immediate notification is requested on any development which could have an effect on the safety of project structures, and on any other matter of concern which requires prompt remedial measures." (Emphasis added by the staff.)

And it contends, further, that Alabama Power acknowledged receipt of that letter stating, on April 30, 1964:

"We will comply with the request to notify your Office of any unusual or abnormal developments or major equipment failures pertaining to the safety of our hydro plants at licensed Projects Nos. 82, 618, 2146, and 349." (Emphasis added by the staff.)

And the staff also contends that the repair of the 1972 slide violated Section 9(a) of the Federal Power Act in that it constituted a substantial alteration and addition not in conformity with the plans previously approved, and further, that Alabama Power violated Section 10 of that Act and Articles 3 and 4 of its license by failing to seek prior Commission approval of the required repairs, and by failing to notify the Commission of the occurrence of the slide and the subsequent repairs.

30. Alabama Power responds, on the other hand, that it did not deliberately ignore any statutory or regulatory provision or any article of its license:

"It inspected the 1972 slide, concluded that it was superficial and repairable without material modification of the project works, and proceeded to the repairs. It informed the Commission's inspector of the repairs at the next regular inspection. There was no requirement that [Alabama Power] Company report immediately a slide which it believed did not threaten the integrity of the dam or that it obtain permission to repair such a slide."



Noting that the project cost \$41,000,000 and that the repair cost only \$13,000, Alabama Power contends that the repair qualifies as a "minor change in project works" within the meaning of Article 3 which provides, among other matters,

"Minor changes in the project works or divergence from such approved exhibits may be made if such changes will not result in decrease in efficiency, in material increase in cost, or in impairment of the general scheme of development; but any of such minor changes made without the prior approval of the Commission, which in its judgment have produced or will produce any such results, shall be subject to such alteration as the Commission may direct."

31. Alabama Power excepts to Judge Kanell's statement, "A detailed report of this 1972 slide and the resultant correction work was not prepared until April 3, 1975, after the dam failed," asserting that the 1972 slide was investigated when it occurred and that the report dated April 3, 1975, "merely pulled together the results of earlier investigations and studies made immediately after the 1972 slide." Furthermore, Alabama Power asserts, "There is no evidence of record establishing a direct causal connection between the" 1972 slide and the 1975 failure.

32. In reply, the staff cites certain evidence to the effect that there is such a causal connection, including the following statement of Alabama's Power consultants:

"We believe that the triggering mechanism responsible for this slide in spite of the stabilizing influence of [sic] the full reservoir, could have been one of the following (or both in combination):

1. Abrupt Failure of Sheet Pile Wall:  
The sheet piling is a unique feature in such a dam. It undoubtedly had a large influence on the distribution of stresses within the dam. Tied to the concrete intake structure and driven to refusal in the gravelly sand shell, it must have helped resist upstream movement of the upstream slope. Following the 1972 slide, considerable longitudinal tension developed in the wall, preventing collapse of the adjacent dam crest. Assuming that the slope was creeping toward the reservoir, the sheet piling wall would be gradually subjected to increasingly higher stresses after the 1972 slide, contributing a large part of the total force resisting upstream slope movement.

If the piling failed suddenly due to overstressing (such as tensile failure of an interlock), the load being carried by the piling would then abruptly add to the shear stresses in the soil"

33. We agree with the presiding judge that it is clear in the light of the facts uncovered by this investigation that the 1972 slide should have been reported to the Commission promptly. <sup>13/</sup> Alabama Power to the contrary notwithstanding, we find that the record does contain evidence, which is substantial in the legal sense, to the effect that the 1972 slide was a cause of the 1975 failure of the dam. And we find, in these connections, that the 1972 slide penetrated into the impervious layer and either weakened the eastern embankment, requiring more than superficial repair, or was symptomatic of the structural weakness of that embankment, requiring further investigation into its cause, or both.

34. Alabama Power's contention that its report dated April 3, 1975, "merely pulled together the results of earlier investigations and studies made after the 1972 slide" is not well-taken and its exception is denied. The fact that Alabama Power permitted the facets of its investigation to remain some two and one-half years in disjoined form until after the occurrence of the greater catastrophe is clear evidence that it took neither the 1972 slide nor its investigation seriously, for the disjoined facets and unreported investigation were about as useful as no inquiry whatsoever. And although there is evidence in the record that the slide was reported as such

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13/ 18 CFR § 12.3 provides, in this connection:

"When an inspection by the licensee or the Commission's staff reveals conditions of concern regarding the safety of any project structure or the operation of the project works, the licensee shall cause such additional inspection and investigation to be made as may be found by the Commission to be warranted under the circumstance."

18 CFR § 12.4 specifies that such inspections shall be made by qualified independent consultants, and 18 CFR § 12.5 provides for reports of such inspections and recommendations without specifying when such reports should be submitted to the Commission, except:

"If, during the course of an inspection, conditions are disclosed which indicate the need for emergency corrective measures, the situation shall be reported to the Commission at once."

to the Commission's Regional Engineer in April 1973, it appears that such oral report downplayed the slide as essentially a minor slippage of riprap, <sup>14/</sup> an occurrence which is not unusual at earthen dams. The long delay and the eventual appearance of the report after the 1975 failure certainly leave Alabama Power vulnerable to the belief, whether or not true, that its report of April 3, 1975, was prepared with a view toward justifying Alabama Power's treatment of the slide as having been surficial only.

35. If the facets of Alabama Power's investigation had been drawn together promptly after the 1972 slide, and if such report had been filed with the Commission, some other individual reviewing that report - an Alabama Power employee not too intimately involved with the slide, or the Commission's Regional Engineer - may have drawn the conclusion which the staff now does from the photographic prints of the slide, its penetration into the impervious layer and the under-water soundings, that it was far more extensive than simply a surficial slide. Or such other individual reviewing that report might have caused the initiation of a further inquiry into the cause of that slide, thereby uncovering the shoddy construction of the dam, or revealing a pressure build-up along the sheet metal piling or other condition affecting the stability of the eastern embankment close to the intake structure.

36. Although we find that Alabama Power was not justified in treating the 1972 slide as surficial in view of the fact that the slide did penetrate into the impervious layer, we are not prepared to conclude, for the purpose of invoking a forfeiture under Section 315(a) of the Federal Power Act for wilfully or intentionally failing to comply with a Commission order or a statutory provision of that Act or a regulatory provision thereunder, that the particular repairs in this instance constituted a "change" in approved "maps, plans or specifications" within the meaning of Section 9(a), or that they constituted a "substantial alteration or addition not in conformity with the approved plans" within the meaning of Section 10(b) and Article 3. Nor do we believe that Alabama Power's failure to report the 1972 slide promptly violated those parts of Section 10(c) and Article 3 as require it to "conform to such rules and regulations as the Commission may from time to time prescribe for the protection of life, health and property".

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<sup>14/</sup> We fault Alabama Power for having failed to provide the Regional Engineer with the data which eventually found its way into Alabama Power's report dated April 3, 1975.

37. On the other hand, and assuming arguendo that the particular repairs constituted a "substantial alteration or addition not in conformity with the approved plans", we would agree with the staff that Section 10(b) and Article 3 would impose a duty on Alabama Power to report the repairs, and implicitly the occurrence of the slide, to the Commission. Any such alterations or additions which are made under emergency conditions are subject to such modifications and changes as the Commission may direct - which implicitly requires a report to enable the Commission to determine whether or not to direct the making of any modifications and changes and, if so, the nature and extent thereof. Otherwise, such additions and modifications require the prior approval of the Commission - which also implicitly requires a report to explain the reasons why approval of such alterations and additions is sought. And even the provision in Article 3 pertaining to "minor changes in the project works", on which Alabama Power relies, implicitly requires a report to enable the Commission to determine whether the minor changes have produced or will produce any of the changes specified therein.

38. Alabama Power treated the 1972 slide as a slippage of riprap and covered the exposed impervious layer with rockfines and riprap to prevent its erosion and thereby maintain the integrity of the Walter Bouldin Dam.<sup>15/</sup> Whether or not such repairs were "minor changes in the project works" within the meaning of Article 3 of the license, as Alabama Power contends, we find that they were no less than "maintenance" work within the meaning of Article 4, which work is expressly subject to the inspection and supervision of the Commission's Regional Engineer, and which work is also subject to the requirement that Alabama Power "shall notify ~~the~~ Regional Engineer of the date upon which work will begin." And, as a result, we also find that Alabama Power violated Article 4 of its license by failing to so notify the Regional Engineer before the work began. Although Alabama Power notified the Regional Engineer of the slide

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<sup>15/</sup> Proper maintenance of the dam would appear to have required a draw down of the reservoir and a temporary loss of generation to permit the replacement and compaction of that part of the impervious layer which slid into the reservoir, as well as replacement of the riprap.

during the annual inspection some seven months later, and did not attempt to conceal its occurrence, we find that Alabama Power proceeded with the repair or maintenance work without first notifying the Regional Engineer, and that it thereby violated Article 4, requiring forfeiture under Section 315(a) of the Federal Power Act. 16/

39. Alabama Power raises several procedural objections to the imposition of a forfeiture. Alabama Power cites a commitment of staff counsel at a conference on July 17, 1975, to notify Alabama Power of any asserted violations, and it claims that staff counsel promised that it would be so notified in the so-called Washington Report of the failure of the dam. But we do not read the commitment as being so specific. Alabama Power concedes that the staff expressed its intent to seek a forfeiture in the staff's Statement of Position admitted into evidence just prior to the close of the hearing, and we are unable to find any basis in the record for concluding that the staff did not notify Alabama Power of any asserted violations promptly after the staff concluded that violations had occurred. The Commission's order of February 20, 1975, instituting

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16/ In this connection, we accept the staff's position that we need find only an intentional act in order to find a "willful" failure within the meaning of Section 315(a) imposing civil sanctions. Screws v. United States, 325 U.S. 91, 101 (1945). And while we believe that Alabama Power's conduct was lethargic in the light of the high degree of danger which might result from an incorrect field judgement, we are unable to conclude that its culpability rose to the point that it "willfully and knowingly" violated Article 4 within the meaning of Section 316 of the Federal Power Act imposing criminal sanctions.

We are satisfied, additionally, that the requirement in Article 4 that the Regional Engineer be notified of the date upon which maintenance work "will" begin is a sufficient prescription by the Commission of the time within which the failure must occur, if at all, within the meaning of Section 315(a).

this proceeding, clearly states that one of the purposes of this evidentiary hearing is to document and determine "any remedial actions which may be warranted to correct any violations of the Act or any rule, regulation, or order thereunder or to assure that this dam failure or the potential for failure of any other related dams under the control of the licensee will not occur or reoccur." Certainly that language is broad enough to place Alabama Power on notice that it might be subjected to forfeiture pursuant to Section 315(a) as a deterrent to its repetition of any conduct which might be found to have violated Article 4 of its license. As is required by 18 CFR § 3.141 17/, we will by separate order initiate a proceeding to fix the amount of the forfeiture.

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17/ "On the basis of staff studies and recommendations, proceedings to fix the amount of forfeitures under section 315(a) of the act are initiated by Commission order served on the parties and interested state agencies and published in the the FEDERAL REGISTER. A hearing may be held."

## MISCELLANEOUS

40. Alabama Power takes exception to the accuracy of seven statements in the Initial Decision, all of which are hereby granted as follows:

(1) If the embankments at the intake structure rose 64 feet above the reservoir bottom, and if the reservoir bottom at that point consisted of some 100 feet of compacted fill on a rock foundation, as appears to be the case, we agree with Alabama Power that it would be more accurate to describe the embankments as being 64 feet high at the intake structure, rather than 164 feet, as stated. 18/

(2) The eastern embankment was 8,457 feet long, rather than 5,120 feet, as stated.

(3) The Walter Bouldin Dam generating facilities provided about 4% of Alabama Power's capacity, rather than 4% of its requirements, as stated.

(4) The project works of the Walter Bouldin Dam are off-river and, therefore, its design did not utilize a river bottom, as stated. Furthermore, its design utilized an in situ natural clay blanket on which its clay core rested in some areas, rather than all areas, as implied.

(5) Parts of the forebay area, rather than parts of the dike foundation, as stated, were scoured to a depth of 50 feet.

(6) During the construction of the Walter Bouldin Dam Alabama Power's supervisory personnel encountered a ground water seepage problem which required remedial action, but it has not been suggested that that problem was related to the 1975 failure of the dam.

(7) The core of the embankments was 35 feet thick, rather than 50 feet thick, as stated, at the water line level.

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18/ Alabama Power's statement in connection with the fourth asserted inaccurate statement in the Initial Decision that the embankments were built on rock in the area of the powerhouse is contradictory and appears to be inaccurate.



41. By order issued June 17, 1976, the Commission authorized Alabama Power to remove and store riprap, remove portions of the damaged dikes and divert water from areas of the dikes planned for reconstruction of the Walter Bouldin Dam, subject however to the condition that the work would be performed only in the presence, or with the specific written approval, of a Commission representative who would have authority to stop the work to preserve any additional evidence which might be uncovered as to the cause of the failure of the dam. The staff asks that the relevant conditions (Nos. 2 and 3 of the said order) remain in effect notwithstanding the termination of the investigation, and Alabama Power does not oppose the staff's request.

42. And finally, we would observe that if the public is to derive the maximum benefit from Alabama Power's and our investigations into the failure of the Walter Bouldin Dam we should observe the same standard as we would establish herein for Alabama Power and other licensees with respect to compiling the pieces of an inquiry into a single document in which the overall picture can be seen more clearly. Judge Kanell made certain general recommendations which we believe should be addressed specifically by the staff of the Bureau of Power. And the staff of that Bureau has undertaken certain measures with a view toward remedying some of the deficiencies which were found to exist. While some of those deficiencies obviously are remedied by new and/or improved procedures at the staff level, others would apparently require new and/or revised standard license articles and/or regulations. And others may be beyond our authority and would require statutory changes. We are therefore directing the staff of the Bureau of Power to prepare for our future guidance a report on the deficiencies which were found in the respective areas of concern (staff, licensee, contractor and others) together with its advice as to how such deficiencies have been and should be remedied over the short and long terms and at the respective levels of authority.

The Commission orders:

(A) The Initial Decision of presiding Administrative Law Judge Samuel Kanell issued herein on August 19, 1976, is adopted as the decision of the Commission as modified in this opinion and order.

(B) The investigation of the failure of the Walter Bouldin Dam which was initiated by the Commission's order issued herein on February 20, 1975, is hereby terminated.

(C) Notwithstanding the termination of the investigation as set forth in Ordering Paragraph (B), the second and third conditions of the Commission's Order Granting Motion of Alabama Power Company for Issuance of a Limited Work Authorization for Walter Bouldin Dam With Conditions, issued June 17, 1976, shall remain in force pending the Commission's action on Alabama Power Company's application for amendment of its license to authorize reconstruction of Walter Bouldin Dam.

(D) All exceptions are denied to the extent that they are not expressly granted in the body of this opinion and order.

(E) Promptly after the issuance of this opinion and order the Bureau of Power shall prepare and issue a report as described in the last paragraph of the body of this opinion and order.

(F) Alabama Power Company shall forfeit to the United States an amount not exceeding \$1,000 to be fixed by the Commission in a proceeding to be initiated pursuant to §3.141 of the Commission's Rules and Regulations under the Federal Power Act, for willfully failing in October 1972 to notify the Commission's Regional Engineer, in compliance with Article 4 of its license for Project No. 2146 and the Commission order issuing its license, of the date upon which maintenance work upon the Walter Bouldin Dam would begin.

By the Commission.

( S E A L )

Kenneth F. Plumb,  
Secretary.

III. The following procedures should be used in the design, construction, operation and maintenance of the reconstructed Walter Bouldin Dam.

- a. No attempt should be made to tie in the embankment to the east and west faces of the intake structure; instead, concrete wing walls (non-overflow gravity monoliths) should be constructed out from the east and west faces a sufficient distance so that the approach fills can be wrapped around the wing walls. The wing walls should be founded on bedrock to provide a cutoff and should have side and end slopes of 2 vertical on 1 horizontal or flatter so that hand compaction will not be required. A gravity concrete monolith should be provided along the north (upstream) face of the concrete intake so as to provide a buttress for the east and west wing walls.
- b. As much of the impervious cover has been removed by the scour during the failure, a positive cutoff to an impervious member should be provided for the entire length of the east and west dikes. The base of the cutoff trench should be treated to prevent piping of the embankment into bedrock openings. Appropriate explorations and grouting should be accomplished during construction with control on grouting pressures to prevent lifting (jacking) of the rock.
- c. Positive control of through seepage should be provided through inclined and horizontal drains constructed from plant-processed materials.
- d. The outer slopes should be designed for an unquestionable margin of safety against failure for end of construction, rapid drawdown, and through seepage conditions.
- e. Instrumentation should be provided to monitor pore pressures and movements during constructions, and to monitor piezometric levels, seepage discharges, and movement after construction. Schedules for instrumentation readings should be developed for the construction and operational stages. Detailed instructions should be provided on plotting the data; and forms for plotting the data should be furnished field personnel.

- f. A written report presenting the basis for design should be submitted to the Federal Power Commission for approval prior to completion of the plans and specifications. The basis for design, the final design, and the plans and specifications should be reviewed and approved by the Federal Power Commission. Special emphasis should be given in the review to the constructibility of the design.
- g. The qualifications and bids of the contractors should be carefully scrutinized prior to awarding the contract.
- h. A qualified inspection staff should be provided. It should include a geologist to supervise the grouting program, map the foundation, and to prepare a foundation report. It should also include a soils mechanics engineer to supervise the embankment, construction, supervise installation of the instruments, evaluate instrumentation data, and prepare the embankment construction report. Sufficient inspectors and materials technicians should be provided to provide inspection and testing on all shifts. Orientation programs should be held for the inspection staff to emphasize the importance of their work in achieving a safe structure.
- i. Site inspections should be scheduled for the designers, Federal Power Commission engineers, and boards of consultants at appropriate times during the foundation excavation and during the construction of the embankment. Slides, excessive pore pressures, or other construction problems should be promptly brought to the attention of the designers and the FPC.
- j. An inspection of the dam should be scheduled during the initial filling by the designers and the FPC. The foundation and embankment reports accompanied by instrumentation plots should be available for review by the inspecting parties. Continuous monitoring of the instrumentation data by a soils mechanics engineer should be required. The damtenders should be instructed as to essential items such as seepage, slides, dampspots, etc.; to be noted in their daily inspection. Annual inspections should be required for the reconstructed

dam, and the reports should include updated plots of all the instrumentation data with analysis thereof. The reports should all include detailed descriptions of all problems related to the stability and safety of the structure. The reports should describe the required remedial work for the problems and include a schedule for accomplishment thereof. The FPC should be promptly notified of any problems relative to the safety of the structure that develop between the annual inspections. Annual instead of biennial inspection should be held at this project for an indefinite period due to the difficult geotechnical site conditions.

- k. The licensee should provide complete specifications for compaction of earthfill. These compaction specifications should provide specifically for moisture control and the type of compaction equipment.
- l. Testimony indicates that the entire length of forebay embankment was constructed with limited embankment testing and inspection. For these reasons it must be assumed that the integrity of these embankments as constructed, is subject to question and will be presumed as unsuitable for reservoir containment until investigated and demonstrated acceptable.

Section 9 of the Federal Power Act provides in pertinent part:

"That each applicant for a license hereunder shall submit to the Commission -

"(a) Such maps, plans, specifications, and estimates of cost as may be required for a full understanding of the proposed project. Such maps, plans, and specifications when approved by the Commission shall be made a part of the license; and thereafter no change shall be made in said maps, plans, or specifications until such changes shall have been approved and made a part of such license by the Commission."

Section 10 of the Federal Power Act provides in pertinent part:

"All licenses issued under this Part shall be on the following conditions:

"(a) That the project adopted, including the maps, plans, and specifications, shall be such as in the judgment of the Commission will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for the use or benefit of interstate or foreign commerce, for the improvement and utilization of water power development, and for other beneficial public uses, including recreational purposes; and if necessary in order to secure such plan the Commission shall have authority to require the modification of any project and of the plans and specifications of the project works before approval.

"(b) That except when emergency shall require for the protection of navigation, life, health, or property, no substantial alteration or addition not in conformity with the approved plans shall be made to any dam or other project works constructed hereunder or of an installed capacity in excess of two thousand horsepower without the prior approval of the Commission; and any emergency alteration or addition so made shall thereafter be subject to such modification and change as the Commission may direct.

"(c) That the licensee shall maintain the project works in a condition of repair adequate for the purposes of navigation and for the efficient operation of said works in the development and transmission of power, shall make all necessary renewals and replacements, shall establish and maintain adequate depreciation reserves for such purposes, shall so maintain and operate said works as not to impair navigation, and shall conform to such rules and regulations as the Commission may from time to time prescribe for the protection of life, health, and property. Each licensee hereunder, shall be liable for all damages occasioned to the property of others by the construction, maintenance, or operation of the project works or of the works appurtenant of accessory thereto, constructed under the license, and in no event shall the United States be liable therefor."

Article 3 of the license provides:

"Said project works shall be constructed in substantial conformity with the approved exhibits referred to in article 2 herein or as changed in accordance with the provisions of said article. Except when emergency shall require for the protection of navigation, life, health, or property, no substantial alteration or addition not in conformity with the approved plans shall be made to any dam or other project works under the license without the prior approval of the Commission; and any emergency alteration or addition so made shall thereafter be subject to such modification and change as the Commission may direct. Minor changes in the project works or divergence from such approved exhibits may be made if such changes will not result in decrease in efficiency, in material increase in cost, or in impairment of the general scheme of development; but any of such minor changes made without the prior approval of the Commission, which in its judgment have produced or will produce any of such results, shall be subject to such alteration as the Commission may direct. The licensee shall comply with such rules and regulations of general or special applicability as the Commission may from time to time prescribe for the protection of life, health, or property."

Article 4 of the license provides:

The construction, operation, and maintenance of the project and any work incident to additions or alterations, whether or not conducted upon lands of the United States, shall be subject to the inspection and supervision of the Regional Engineer, Federal Power Commission, in the region wherein the project is located, or of such other officer or agent as the Commission may designate, who shall be the authorized representative of the Commission for such purposes. The licensee shall furnish to said representative such information as he may require concerning the construction, operation, and maintenance of the project and of any alteration thereof, and shall notify him of the date upon which work will begin, and as far in advance thereof as said representative may reasonably specify, and shall notify him promptly in writing of any suspension of work for a period of more than one week, and of its resumption and completion. The licensee shall allow him and other officers or employees of the United States, showing proper credentials, free and unrestricted access to, through, and across the project lands and project works in the performance of their official duties.



APPENDIX D

UNITED STATES OF AMERICA  
FEDERAL POWER COMMISSION

Before Commissioners: Richard L. Dunham, Chairman;  
Don S. Smith, John H. Holloman III,  
and James G. Watt.

Alabama Power Company ) Project No. 2146

ORDER AMENDING LICENSE (MAJOR)

(Issued April 29, 1977)

On December 16, 1975, Alabama Power Company (Licensee) filed an application under the Federal Power Act (16 U.S.C. §791a-825r) for amendment of license for the Walter Bouldin development, one of several developments licensed under FPC Project No. 2146, on the Coosa River, a navigable water of the United States.

Public notice of the application was given on March 31, 1976, with May 24, 1976, as the last day for responses thereto. No protests or petitions to intervene were received.

The amendment of license would authorize the rehabilitation and rebuilding of those facilities and structures that were damaged by the breach of Walter Bouldin Dam on February 10, 1975. Licensee proposes to rebuild the dam at the same location, again using an earth embankment. The tailrace would be dredged to remove the material eroded from the dam embankment and the reservoir area during the failure. The intake and powerhouse facilities would be repaired and restored to operating condition.

The original Walter Bouldin development was completed in 1967. It consisted of a 7000-foot intake canal that drew water from the reservoir of the Jordan Project No. 618, a 920-acre forebay pond, an earth dam (maximum height--about 164 feet), a powerhouse containing three 75,000 kW units and a 5-mile long tailrace channel.

On February 10, 1975, the east embankment of Walter Bouldin Dam failed within a matter of hours without warning.

DC-A-15

This and other factors<sup>1/</sup> raised questions about the safety and adequacy of projects subject to our jurisdiction under terms of the Federal Power Act (Act) and the conditions of the license for this project. Consequently, we ordered a formal investigation<sup>2/</sup> pursuant to the Act into the causes of the failure and provided for an evidentiary hearing; our purposes were several:

We are therefore ordering a further formal investigation pursuant to the Act into the causes of this dam failure in order to determine the proper remedial actions which should be taken to assure that life, health, and property are adequately protected at this dam and other dams under the control of the licensee. The formal investigation should also determine whether the provisions of this Act or any rule, regulation, or order of the Commission have been violated and, if so, which may have caused or contributed to the dam's failure.

Following the completion of the present Staff field investigation and the formal investigation an evidentiary hearing pursuant to Section 10(c) [15 U.S.C. §803(c)] and 308 [15 U.S.C. §825g(a)] of the Act shall be held to document and determine the cause of this dam failure and any remedial actions which may be warranted to correct any violations of the Act or any rule, regulation, or order thereunder or to assure that this dam failure or the potential for failure of any other related dams under the control of the licensee will not occur or reoccur. <sup>3/</sup>

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<sup>1/</sup> While there was no loss of human life, the loss of this energy source placed hardship upon the ratepayers.

<sup>2/</sup> FPC Staff had upon notification of the failure commenced a field investigation.

<sup>3/</sup> Alabama Power Company, Project No. 2146, Order Instituting Investigation And Providing For Hearing (issued February 20, 1975).

Mindful of the hardship caused by the failure and the attendant delay, we are nevertheless satisfied that the public has been well served by this extensive investigation. The evidence produced thereby has demonstrated the need for additional protective measures and increased Commission surveillance over various stages of hydroelectric development, including design, construction, and maintenance. Increased surveillance by the Commission, however, would not relieve licensees of the primary responsibility for the safety of their hydroelectric developments.

Our amendment of the Project No. 2146 license in the manner hereinafter provided implements those measures deemed necessary and appropriate to ensure the safety and adequacy of the rehabilitated project works, and a reliable source of power.

#### Financial Considerations

Licensee estimates that the total capital cost of reconstructing the Bouldin development would be \$24,412,250.<sup>4/</sup> The total estimated annual cost of producing power by the proposed reconstructed project is \$7,209,000. The annual cost of producing equivalent power from the most reasonable alternative, a combined cycle generating station, would be \$24,083,000. Thus, the estimated net annual benefit of reconstructing the Bouldin development is \$17,074,000.

With regard to its ability to finance the reconstruction of the development, Licensee states that it has an established, ready market for its securities and the sale of these will assist it in financing the proposed work.

#### Agency Comments

By letter dated February 24, 1976, the Secretary of the Commission requested appropriate State and Federal agencies to review and comment upon the subject application for amendment of license. Comments on the application were received from the following State and Federal agencies:

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<sup>4/</sup> All cost figures are based on 1975 prices.

Department of Transportation,  
U.S. Coast Guard, dated April 19, 1976

Department of the Army,  
U.S. Army Corps of Engineers, dated April 21, 1976

Department of the Interior, dated April 21, 1976

U.S. Energy Research and Development Administration,  
dated May 6, 1976

Department of Health, Education and Welfare,  
dated May 6, 1976

U.S. Environmental Protection Agency, dated  
May 13, 1976

State of Alabama, Department of Conservation and  
Natural Resources, dated April 23, 1976

Relevant substantive comments and Licensee's response thereto are discussed hereinafter.

#### Navigation

The Corps of Engineers recommended that additional conditions be made part of the license to provide for water releases for navigation purposes and for coordination with downstream Corps projects. Regarding water releases for navigation purposes, the Corps recommended that such releases be specified by its District Engineer for navigation below the Corps' existing Claiborne Lock and Dam. Licensee opposes this as an open-ended requirement. With respect to a requirement for coordination with the Corps' downstream projects, Licensee states that a coordination procedure has been worked out with the Corps.

We have determined that current terms of the Project No. 2146 license adequately cover the concerns raised by the Corps. Article 18 provides that the Secretary of the Army may require the release of project water and control operation of the project for navigation purposes. Additionally, Article 39 provides for coordination of operation of the Bouldin development with the Corps' existing Jones Bluff project. Should the Licensee fail to cooperate with the Corps on the basis of these articles, we will entertain an appropriate complaint from the Corps at that time.

Subject to the above discussed recommendations, the Corps approved the plans of project structures insofar as the interests of navigation are concerned.<sup>5/</sup>

#### Historical and Archeological Resources

No sites within the area of proposed reconstruction are included in the current National Register of Historic Places. The Alabama Historical Commission has reported that there are no known historical or archeological sites in the construction area. The Historical Commission requested that if borrow material is to be taken from new borrow areas outside the project boundary, assurance be made that no historical or archeological sites are disturbed. We have made provision in Article 58 for Licensee's consultation with the Alabama State Historic Preservation Officer prior to the use of new borrow or spoil areas.

#### Recreation

In commenting on the subject application, Interior expressed its concern that the potential of the Bouldin development to meet identified recreation needs has not yet been fully explored. Interior stated that a more comprehensive review will be carried out when it reviews Licensee's revised Exhibit R for Project No. 2146 which was filed with the Commission on October 6, 1975. Licensee states that it has assessed the recreational potential of the Bouldin development and established that the planned reconstruction is consistent with the project's potential for recreation.

We are not inclined at this time to pursue any discussion of recreation related issues. Our consideration of such issues should be deferred until all relevant comments on Licensee's revised Exhibit R have been received and analyzed by the Commission staff. Accordingly, any decisions we reach regarding recreational development at the Bouldin development will derive from a separate proceeding in the future.

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<sup>5/</sup> By letter dated September 4, 1975, Licensee was advised by the District Engineer of the Mobile District of the Corps of Engineers that a permit pursuant to Section 404 of the Federal Water Pollution Control Act of 1972 (Publ. L. No. 92-500) would not be necessary for the rehabilitation work.

### Fishery Resources

Both Interior and the Alabama Department of Conservation and Natural Resources (DCNR) have commented that the Bouldin development can affect fishery resources below Bouldin and Jordan Dams and recommended modified releases at Bouldin to enhance the tailwater fishery. Licensee responds that fishing in the tailwater would be unsafe because the tailrace below Bouldin powerhouse would be extremely turbulent and the water could rise 10 to 13 feet almost immediately. The intake and tailrace canals were constructed to provide for a possible future navigation lock. Access to the tailrace would be difficult as steep, unstable banks go down 75 feet to the water, and the proposed Corps of Engineers lock would cut off access to the tailrace from the east. Steep sides below the waterline and wash from movement of commercial navigation on the tailrace channel would prevent development of safe shoreline areas for boat launching facilities. Furthermore, Licensee estimates that the releases requested for fishery improvement would reduce generation by 59,000,000 kWh at an annual replacement value \$619,500.

The divergent comments of the interested parties preclude any Commission judgment on the feasibility or potential of a tailrace fishery at this time. Inasmuch as agency comments regarding this fishery at Bouldin are recreation oriented, we deem it more appropriate to consider this matter at a later date in conjunction with Licensee's revised Exhibit R for Project No. 2146.

### Environmental Considerations

The Environmental Protection Agency reported that the proposed reconstruction would result in only slight impacts on water quality and the area ecosystem provided measures to protect the environment and to mitigate adverse effects are followed.

Runoff occurring during reconstruction in the forebay area would be directed to a holding pond and then pumped into the tailrace canal approximately 2,000 yards below the powerhouse. This runoff is not expected to cause any significant increase in sedimentation or turbidity in Pigeon Roost Creek or the Coosa River downstream from the powerhouse. Discharges from the tailrace canal are to meet applicable State and Federal water quality standards.

During construction, dirt roads would be watered to prevent excessive dust; and waste materials would be burned in accordance with State regulations. Noise levels would be controlled by mufflers in accordance with State and Federal regulations. Operations that might involve sanitary waste disposal, oil spillage, dredging, spoil pile runoff, or the use of insecticides would meet Environmental Protection Agency and Alabama Water Improvement Commission guidelines.

DCNR expressed its concern about erosion at the spoil areas and recommended that spoil be treated in accordance with EPA guidelines and that it be revegetated as soon as practicable. Additionally, DCNR recommended methods such as riprapping to remedy continuing erosion along the tailrace canal.

Borrow areas associated with dam reconstruction would be primarily confined to the forebay. If additional borrow material is needed, it would be obtained from a site outside the project boundary now being used for pasture and row crops. Licensee states that if borrow material is required from a site outside of the project, topsoil would be returned to the land as stipulated by the owner. Borrow for the temporary dikes and diversions would be taken from existing spoil areas and returned to these same areas after construction. Licensee has advised us that it intends to revegetate spoil and borrow areas at the earliest practical time. We have provided for the earliest possible revegetation of borrow and spoil areas in Article 57 set forth hereinafter.

In response to DCNR's recommendation of the use of riprap along the tailrace canal, Licensee stated that erosion of the tailrace canal has not caused nor is anticipated to cause any significant environmental problems. Consequently, Licensee asserts the use of riprap would be economically unjustified. Inasmuch as the severity of the erosion situation has not been established, we shall direct the Licensee to conduct a study thereof in cooperation with DCNR and submit a report for Commission consideration. This study is provided for in Article 59, set forth hereinafter, requiring Licensee to take reasonable measures to prevent soil erosion, stream sedimentation, and water or air pollution.

Water quality monitoring in the Coosa River near the Walter Bouldin site has been carried out by Licensee for



several years. Results of this monitoring program indicate that the waters of the project area are of good quality. In addition, Licensee has entered into a cooperative agreement with the United States Geological Survey to establish continuous water quality monitoring upstream from the Walter Bouldin site. This monitoring provides continuous data for five parameters: dissolved oxygen, temperature, pH, turbidity and conductivity.<sup>6/</sup>

The proposed action would rebuild a formerly operating facility. There would be no change in operating procedures previously followed. No additional construction, transmission lines or land would be required. Measures to control runoff during construction have been included in the proposal and Licensee has a water quality monitoring system in operation. Accordingly, our approval of this application for amendment of license to reconstruct the Walter Bouldin development would not be a major Federal action significantly affecting the quality of the human environment. The preparation of an environmental impact statement pursuant to the requirements of the National Environmental Policy Act of 1969 and Commission Order No. 415-C is therefore not required.

#### Conservation

The reconstruction of the Bouldin development would provide for the restoration of a renewable source of energy equivalent to that provided by 200,000 tons of coal or 725,000 barrels of oil per annum.

#### Safety and Adequacy

We turn now to consideration of the safety and adequacy of the Bouldin development as reflected in the plans filed as part of this application for reconstruction. In light of our extensive investigation of the failure of Walter Bouldin Dam and the conclusions reached in our order and opinion terminating that investigation, reviewing the

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<sup>6/</sup> Pursuant to Section 401(a) of the Federal Water Pollution Control Act Amendments of 1972, the Alabama Water Improvement Commission issued a certification to Alabama Power Company of Birmingham, Alabama; for the reconstruction of Walter Bouldin Dam.

proposed plans and assuring appropriate construction procedures have been the subject of our special attention.

In his initial brief to the Presiding Administrative Law Judge (ALJ) in the proceeding investigating the failure of Walter Bouldin Dam, Staff Counsel offered twelve specific suggestions relating to the redesign of the dam. We agreed with the ALJ's determination that the scope of the investigatory proceeding did not permit evaluation of Staff Counsel's proposals. We agreed to that conclusion "without expressing any views on the merits of the Staff's 'specific recommendations' and without prejudice to their consideration as part of Alabama Power's License amendment proceeding..."<sup>7/</sup> Without discussing each of Staff Counsel's specific suggestions, we wish to note that our review of Licensee's plans for reconstruction revealed that to a great extent Staff Counsel's concerns have been adequately provided for. Those plans have been carefully reviewed by the technical staff in our Bureau of Power, and we are confident that the plans in conjunction with the procedures set forth in the license conditions we shall now discuss should assure that the rehabilitated project works are safe and adequate.

In the Initial Decision on Investigation of Earth Fill Walter Bouldin Dam Failure, issued August 19, 1976, the ALJ set forth recommendations for remedial action to assure the protection of life, health, and property at Bouldin and other projects under the control of the Licensee. For the purposes of this order, we have consolidated those recommendations into the following three categories and provided for special license requirements appropriate to each.

(1) Dam Design

The ALJ cautioned that design criteria for earth fill dams must be reasonably conservative.

The plans for repairing and modifying the earth embankments show that about 5000 feet of the east-north embankment, including the breached section and all of the west embankment

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<sup>7/</sup> Alabama Power Company, Project No. 2146, Opinion and Order Terminating Investigation of Failure of Walter Bouldin Dam (issued April \_\_, 1977).

(about 2100 feet) will be reconstructed or modified to have an upstream slope of 2.5 horizontal to 1.0 vertical, a downstream slope of 2.0 horizontal to 1.0 vertical and a sloping impervious core founded in a cutoff trench.

Licensee's stability analysis of the proposed design, using soil characteristics determined by laboratory analysis, shows that the dam will have satisfactory factors of safety against sliding under normal reservoir levels and earthquake and sudden drawdown conditions, if constructed properly and according to the specifications.

The proposed design of the junction between the earth embankments and the existing intake structure has been examined and is considered adequate to minimize the possibility of leakage at that point.

The design of the existing intake structure and powerhouse was analyzed for stability prior to their construction and was found to be safe. A visual inspection of the structures subsequent to the dam's failure indicates that they did not develop cracks or settle as a result of the unusual loading, an observation that leads us to conclude that the structures are safe for continued use.

In order to assure appropriate monitoring of dam design, we have included in Article 54 a requirement that final contract bid specifications and drawings be submitted to the Chief, Bureau of Power for approval prior to commencement of reconstruction. Furthermore, the Bureau of Power staff has reviewed the preliminary drawings and specifications for reconstruction submitted by the Licensee, and by letter to the Licensee dated January 24, 1977 recommended certain changes in those drawings and specifications. By letter dated March 25, 1977, Licensee indicated that the recommended changes will be reflected in the final drawings and specifications that are to be submitted for approval by the Chief, Bureau of Power pursuant to Article 54.

## (2) Construction Inspection

The ALJ was critical of the inspection during construction of the earth fill dam by the Licensee and recommended thorough inspection by well trained inspectors who keep detailed records.

Although adequate inspection procedures are an inherent responsibility of any licensee undertaking construction of project works, we have specifically provided for the filing of a quality assurance plan in conjunction with the final contract bid specifications and drawings. That plan should set forth in detail the procedures to be utilized to assure that actual construction conforms to the approved specifications. Additionally, monitoring Licensee's construction inspection program is included as a responsibility of the Board of Independent Consultants that the Licensee is required to retain pursuant to Article 55. The qualifications of the proposed Board members shall be submitted to the Chief, Bureau of Power for approval.

### (3) Project Maintenance and Commission Notification

Acknowledging the possibility of slides, springs, foundation problems, and other matters that may occur at earth fill dams, the ALJ recommended thorough investigation and prompt reporting of any such occurrence that might indicate a basic weakness in a segment of the dam.

In light of the handling of the 1972 slide at the Bouldin development, we deem it appropriate to refer Licensee to our discussion thereof in our opinion and order terminating investigation of failure of Walter Bouldin Dam, specifically finding paragraphs 33-38. Licensee has the responsibility, under its license, to immediately notify the Commission's Regional Engineer in the event of any development that could have an effect on the safety of any project structure. Such notification should be followed by a detailed written report on the occurrence, including, inter alia, any remedial measures planned or undertaken.

### Exhibit L

The Exhibit L drawings submitted by the Licensee have been examined and found to conform generally to the Commission's Rules and Regulations. Subject to the further conditions imposed by Article 54, we shall approve these drawings for inclusion in the Project No. 2146 license, superseding the Exhibit L drawings noted. Furthermore, pursuant to Article 5 of the license, Licensee will be required to submit revised "as-built" Exhibit L drawings upon completion of the reconstruction.

Comprehensive Development

In its Order Amending License (Major) for Project No. 2146, issued August 4, 1960, the Commission authorized the construction of the Walter Bouldin development<sup>8/</sup> and found that the inclusion of that development within Project No. 2146 would create a project best adapted to a comprehensive plan for the improvement and development of the Coosa River for the use or benefit of interstate or foreign commerce, for the improvement and utilization of water-power development and for other beneficial public uses, including recreational purposes. There have been no developments on the Coosa River since that time that would cause us to modify that assessment.

The Commission finds:

- (1) It is appropriate and consistent with the public interest that the license for Project No. 2146 be amended to provide for the reconstruction of Walter Bouldin Dam as hereinafter provided.
- (2) Public notice of the filing of the application for amendment of license was given March 31, 1976. No protests or petitions to intervene were filed.
- (3) Subject to the terms and conditions hereinafter imposed, the cost of reconstructing the Walter Bouldin Dam is reasonable compared to the cost of developing suitable alternative sources of power.
- (4) No new license conditions are necessary in the interests of navigation or coordination with downstream projects of the U.S. Army Corps of Engineers.
- (5) No known historical or archeological sites are within the area of proposed reconstruction.
- (6) Our consideration of the revised Exhibit R for Project No. 2146 should be deferred until all comments thereon have been received and analyzed by the Commission staff.

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<sup>8/</sup> Walter Bouldin development is referred to in that order as "Jordan No. 2."

(7) Commission consideration of issues related to the feasibility and potential of a tailrace fishery below Bouldin Dam should be undertaken at a later date in conjunction with the revised Exhibit R for Project No. 2146.

(8) Our action in approving this application would not constitute an action that would require preparation of a detailed environmental impact statement pursuant to the requirements of the National Environmental Policy Act of 1969 and Commission Order No. 415-C.

(9) The evidence compiled during the investigation of the 1975 failure of Walter Bouldin Dam demonstrates a need for the requirements imposed herein regarding design, reconstruction, and maintenance of this development of Project No. 2146.

(10) Subject to the terms and conditions hereinafter imposed, the reconstruction authorized should result in safe and adequate project works.

(11) The amended Exhibit L drawings described in ordering paragraph (B) below generally conform to the Commission's Rules and Regulations and should be approved as part of the Project No. 2146 license subject to the conditions of Article 54.

(12) Subject to the terms and conditions hereinafter imposed, the project as modified will be best adapted to a comprehensive plan for the improvement and utilization of water power development and for others beneficial public uses, including recreational purposes.

The Commission orders:

(A) The application of Alabama Power Company for amendment of license for Coosa River Project No. 2146 to authorize reconstruction of Walter Bouldin Dam is hereby approved subject to such further approval and requirements as are set forth in the license articles in ordering paragraph (C) below.

(B) The following Exhibit L drawings are hereby approved and made a part of the license for Project No. 2146 subject to the provisions of Article 54, superseding the Exhibit L drawings so designated below:

<u>Exhibit L</u>	<u>FPC No.</u> <u>2146-</u>	<u>Showing</u>	<u>Superseding</u> <u>FPC No. 2146-</u>
Sheet No. 27A of 37	350	Plan of Dike Sta. 23 + 00 - Sta. 37 + 00	
Sheet No. 27B of 37	351	Plan of Dike Sta. 37 + 00 - Sta. 55 + 00	
Sheet No. 27C of 37	352	Plan of Dike Sta. 55 + 00 - Sta. 68 + 00	
Sheet No. 27D of 37	353	Plan of Dike Sta. 68 + 00 - Sta. 82 + 00	
Sheet No. 27E of 37	354	Plan of Dike Sta. 82 + 00 - Sta. 98 + 00	
Sheet No. 27F of 37	355	Plan of Dike Sta. 98 + 00 - Sta. 114 + 00	
Sheet No. 27G of 37	356	Plan of Dike Sta. 114 + 00 - Sta. 131 + 27	
Sheet No. 27H of 37	357	Typical Sections at Key Locations	
Sheet No. 27I of 37	358	Cross section at intake headworks wing walls	
Sheet No. 28 of 37	359	Typical section thru intake and tailrace	339
Sheet No. 29 of 37	360	General Arrangement of Powerhouse	340

(C) The license for Coosa River Project No. 2146 is amended by adding thereto the following license articles:

Article 53. The Licensee shall commence reconstruction of project works within 6 months from the issuance date of this amendment and shall thereafter in good faith and with due diligence prosecute and complete such reconstruction within two and one-half years after the effective date of this amendment.

Article 54. Before commencement of reconstruction the Licensee shall submit for approval by the Chief, Bureau of Power one copy each of the final contract bid specifications and drawings and a quality assurance plan for the reconstruction work.

Article 55. The Licensee shall retain a board of three or more qualified independent consultants to review the design, specifications, and construction of the project for safety and adequacy. The names and qualifications of the proposed board members shall be submitted to the Chief, Bureau of Power for approval. Among other things, the Board shall assess the geology of the project site and surroundings; the proposed design, specifications, and construction of the dam, powerhouse, electrical and mechanical equipment involved in water control, and emergency power supply; the construction inspection program; construction procedures and progress, instrumentation, and plans for surveillance during initial filling of the reservoir. The Licensee shall submit copies of the board's report on each meeting. The Licensee shall also submit a final report of the board upon completion of the project. The final report shall be filed with the Commission within 60 days after initial reservoir filling and shall include, inter alia, a statement indicating the Board's satisfaction with the construction, safety, and adequacy of the project structures.

Article 56. The Licensee shall install appropriate instrumentation and other devices to monitor seepage, uplift, and performance of the project structures and reservoir slopes. A plan for initial filling of the reservoir, a plan of instrumentation, and a schedule of recording instrument readings shall



be furnished to the Commission prior to initial filling of the reservoir. The Licensee shall furnish periodically to the Commission, as may be requested by the Commission or its Atlanta Regional Engineer, a report and analysis of the instrument readings.

Article 57. The Licensee shall, in the reconstruction of the Walter Bouldin development, revegetate borrow and spoil areas in the earliest practical time after the completion of work at each area.

Article 58. The Licensee shall, in the reconstruction of the Walter Bouldin development, consult with the Alabama State Historic Preservation Officer prior to the use of new borrow or spoil areas, including any outside the project boundary, to determine the extent of any archeological survey and salvage excavations that may be necessary, and provide funds in a reasonable amount for any needed surveys or salvage excavations to be conducted and completed prior to the commencement of such work.

Article 59. In the construction, maintenance, or operation of the project, the Licensee shall be responsible for, and shall take reasonable measures to prevent, soil erosion on lands adjacent to streams and other waters, stream sedimentation, and any other form of water or air pollution. The Commission, upon request or upon its own motion, may order the Licensee to take such measures as the Commission finds necessary for these purposes, after notice and opportunity for hearing; provided that the Licensee shall conduct, in cooperation with the Alabama Department of Natural Resources and Conservation, a study of erosion along the tailrace canal of the Walter Bouldin development to determine: 1) the causes thereof; 2) the specific effects of this erosion on water quality and fishery resources; 3) what measures could be taken to eliminate or reduce this erosion or mitigate the effects thereof; and 4) the benefits of erosion control weighed against the costs thereof. The study shall begin concurrently with operation of the Bouldin development and end three years thereafter. The results of the study shall be submitted to the Commission for its information within 6 months of its completion.

Article 60. The Licensee shall file with the Commission and shall implement, and modify when appropriate, an emergency action plan designed to provide an early warning to upstream and/or downstream inhabitants and property owners if there should be an impending or actual sudden release of water caused by an accident to, or failure of, project structures. Such plan, to be submitted within one year of the date of issuance of this order, shall include, but not be limited to, instructions to be provided on a continuing basis to operators and attendants for actions they are to take in the event of an emergency; detailed and documented plans for notifying law enforcement agents, appropriate Federal, State and local agencies, operators of water-related facilities, and those residents and owners of properties that could be endangered; actions that would be taken to reduce the inflow to the reservoir, if such is possible, by limiting the outflow from upstream dams or control structures; and actions to reduce downstream flows by controlling the outflow from dams located on tributaries to the stream on which the project is located. The Licensee shall also submit a summary of the study used as a basis for determining the areas that may be affected by such emergency occurrence, including criteria and assumptions used. Licensee shall monitor any changes in upstream or downstream conditions which may influence possible flows or affect areas susceptible to damage, and shall promptly make and file with the Commission appropriate changes in such emergency action plan.

(D) This order shall become final 30 days from the date of its issuance unless an application for rehearing shall be filed as provided in Section 313(a) of the Act, and failure to file such an application shall constitute acceptance of this order. In acknowledgment of the acceptance of this order amending license it shall be signed for the Licensee and returned to the Commission within 60 days from the date of issuance of this order.

By the Commission.

( S E A L )

Kenneth F. Plumb,  
Secretary.

Project No. 2146

IN TESTIMONY of its acknowledgment of acceptance of all of the provisions, terms and conditions of this order amending license, Alabama Power Company, this \_\_\_\_\_ day of \_\_\_\_\_, 1977, has caused its corporate name to be signed hereto by \_\_\_\_\_, its \_\_\_\_\_ President, and its corporate seal to be affixed hereto and attested by \_\_\_\_\_, its \_\_\_\_\_ Secretary, pursuant to a resolution of its Board of Directors duly adopted on the \_\_\_\_\_ day of \_\_\_\_\_, 1977, a certified copy of the record of which is attached hereto.

By \_\_\_\_\_  
President

Attest:

\_\_\_\_\_  
Secretary

(Executed in quadruplicate)

APPENDIX E

FEDERAL POWER COMMISSION

BUREAU OF POWER

REVIEW OF

PRACTICES WHICH COULD AFFECT SAFETY

AND

INTEGRITY OF DAMS

September 1, 1977

APPENDICES A, C, AND D OMITTED

## INTRODUCTION

The Federal Power Commission is a regulatory agency and is authorized to issue licenses to private individuals, corporations, states, and municipalities for the construction and operation of hydroelectric projects. The Commission has not been authorized to construct or operate hydroelectric projects.

Engineering functions related to the Federal Power Commission's hydroelectric project licensing program are carried out by the Bureau of Power. Responsibilities related to the adequacy of site investigation, project design, construction, and inspection fall within the purview of the Project Analysis and Inspection Branches of the Bureau of Power's Licensed Projects Division and the Commission's five regional offices.

An applicant's proposed design of a project is reviewed for safety and adequacy. The review includes on-site inspections; analyses of geologic investigations and reports thereon; analysis of the proposed foundation treatment; independent stability analyses; hydrology and hydraulic studies; an assessment of materials testing programs; and the suitability of proposed materials for construction.

With the acceptance of a license for a hydroelectric project issued by the Federal Power Commission, a licensee is bound by the Commission's Rules and Regulations and by terms and conditions of the license. The license contains standard and special articles, or conditions, to assure that the project will be constructed properly and maintained in a safe and operable condition. An important requirement is that the licensee engage an independent board of consultants to review the design, specifications, and construction of the project for safety and adequacy.

The Federal Power Commission's inspection program provides for prelicense, construction, operation, and special inspections by staff personnel, usually from the regional office. Projects under construction are inspected monthly, or more often, as appropriate, and operating projects are inspected annually unless conditions warrant more frequent inspection. In addition, the licensee is required by Part 12 of the Commission's regulations to have its larger sized projects inspected every five years by an independent engineering consultant.

The practices of the Commission as they affect dam safety have been essentially under continuous review, modification, and improvement since the early 1960's. Budgetary restraints, however, have seriously hampered efforts to maintain an adequate number of qualified technical staff personnel.

## DISCUSSION

### Authority

This review of Federal Power Commission practices which would affect the safety and integrity of dams is submitted to the Federal Coordinating Council for Science, Engineering and Technology in accordance with President Carter's directive of April 23, 1977.

### Licensing Authority

The Federal Power Commission's authority to license non-federal waterpower projects dates back to June 10, 1920 when Congress enacted the Federal Water Power Act. The Federal Water Power Act was amended on March 3, 1921, to exclude therefrom any authority to license water power projects in national parks or national monuments. The Commission was reorganized as an independent Commission (previously it was composed of the Secretaries of Agriculture, Interior, and War) under the Act approved June 23, 1930. By Title II of the Public Utility Act of 1935, approved August 26, 1935, the original Federal Water Power Act was made Part I of the Federal Power Act and Parts II and III were added to that act.

Section 4(e) of Part I of the Federal Power Act authorizes the Commission, "To issue licenses to citizens of the United States or to any association of such citizens, or to any corporation organized under the laws of the United States or any State thereof, or to any State or municipality for the purpose of constructing, operating and maintaining dams, water conduits, reservoirs, power houses, transmission lines or other project works...". Section 4(f) of Part I of the Act authorizes the Commission "To issue preliminary permits for the purpose of enabling applicants for a license hereunder to secure the data and to perform the acts required by Section 9 hereof:...". Section 9 sets forth the general filing requirements for a license application. Section 15 of the Act authorizes the Commission to issue a new license to the licensee or to a new licensee if the United States does not, at the expiration date of the license, exercise its right to takeover.

### Authority Regarding Safety and Adequacy of Licensed Projects

Section 10(a) of the Act requires that projects licensed by the Commission "be best adapted to a comprehensive plan for improving or developing a waterway or waterways...". Section 10(c) of the Act provides "That the Licensee shall maintain



the project works in a condition of repair adequate for the purpose of navigation and for the efficient operation of said works in the development and transmission of power, shall make all necessary renewals and replacements, shall establish and maintain adequate depreciation reserves for such purposes, shall so maintain and operate said works as not to impair navigation, and shall conform to such rules and regulations as the Commission may from time to time prescribe for the protection of life, health, and property..."

### Licensed Projects

Currently there are 403 licenses outstanding for major projects, i.e. installed capacity in excess of 2,000 horsepower, 91 licenses for minor projects, 2,000 horsepower or less; and 16 outstanding preliminary permits. These licensed projects include over 850 dams of various types and size. In addition, there are existing and proposed projects for which license or preliminary permit applications are pending and at least 260 existing projects for which license applications are expected. Therefore, it is projected that over 1,100 dams will be under license sometime in the near future.

The number of Commission professional staff members directly involved in matters which would affect the safety and integrity of dams totals 36, 19 in the Washington Office and 17 in the regional offices. In addition, 7 staff members inspect project structures relative to public safety in the recreational use of project facilities including such safety features as fences, booms, warning signs, signals, etc.

### Activities Pertaining to Preliminary Permits

Preliminary permits are issued to potential license applicants to allow them to conduct feasibility studies needed to complete a license application while maintaining priority to file such license application. A preliminary permit is not a necessary prerequisite to a license application, and construction work is not authorized by such permit.

#### Permittee

A brief summary of the work generally performed by a permittee under a preliminary permit consists of the following:

- (1) Gathering field data.
- (2) Testing public reaction and/or initiating programs to inform the public about the project.

- (3) Conferring with government officials regarding necessary permits and certifications.
- (4) Coordinating studies with state and federal fish and game and recreation departments.
- (5) Conducting preliminary studies and investigations to determine the competency of the site(s).
- (6) Determining the type and size of structures based on site investigations and the availability of suitable construction materials.
- (7) Determining the amount of power to be developed.
- (8) Making cost estimates.
- (9) Conducting power market studies.
- (10) Making financial and/or economic feasibility studies.

For details related to the requirements of a preliminary permit, see Appendix A which is a copy of a preliminary permit recently issued by the Commission.

#### Washington Office

Prior to applying for a preliminary permit, a potential applicant may meet with FPC staff personnel to discuss the type of work to be accomplished under the authority of a preliminary permit and how to prepare an application for preliminary permit. Upon the filing of an application for preliminary permit, the application is reviewed for compliance with the Commission's Rules and Regulations. Once an acceptable application is filed with the Commission, it is sent to federal, state, and local agencies and interested parties for review and comments. A notice of the application, giving general details of the proposal and inviting comments, is published in the local newspaper(s) having a circulation in the general area of the proposed project site. A notice of the application is also published in the Federal Register. Upon termination of the review and comment period, usually sixty days, the comments are considered by the Commission in its deliberations on issuing the permit.

During the effective period of the permit, normally three years, staff reviews the quarterly progress reports prepared by or for the permittee and the comments thereon prepared by staff of the FPC's Regional Office. Based on its review of the progress reports and Regional Office comments, staff may call to a permittee's attention additional matters which should be investigated either initially or in more detail. For proposed projects involving large and complex structures, the project site(s)

is usually inspected by a staff geologist, a soils engineer, and a civil engineer, accompanied by the Regional Office inspector. The scope of completed and planned investigations is reviewed in light of the inspection and any area of investigation not being adequately carried forth is brought to the permittee's attention.

#### Regional Office Activities

The Regional Office notifies the permittee of requirements under the preliminary permit and supervises compliance with the terms thereof. Staff members attend meetings between representatives of permittee and government agencies regarding the proposed design, construction, and operation of the project. These meetings involve consideration of factors related to securing the required state, local, and federal permits; compliance with special acts such as NEPA and the Fish and Wildlife Coordination Act; and special studies.

Monitors work schedules and progress reports to see that investigations and coordination effects are proceeding in a timely and complete manner, and provides comments thereon to the Washington Office. Makes site inspection(s) to observe geologic test procedures and results, and prepares commentary reports for the Washington Office.

Provides advice to the permittee in its preparation of a license application.

#### Activities Pertaining to License Applications

##### Washington Office

Staff usually meets with a prospective applicant prior to the filing of an application to explain licensing procedures. Upon receipt of an acceptable license application, public notice of the application is given in local newspapers and federal register. Pursuant to Section 4(e) of the Federal Power Act, other laws, and Commission policy the complete application is sent to appropriate federal, state, and local government agencies and organizations, including River Basin Commissions, for review and comments.

Staff makes independent engineering studies of matters related to the project design, including hydrology, hydraulics, structural stability, construction quantities and costs, power production, adaptability to comprehensive development, and economic feasibility. Special reports supporting the project design on matters such as geology, laboratory soil analyses, spillway design flood, surge phenomena, production costs for pumped storage projects, and stability analyses are critically reviewed and assessed for completeness and adequacy. If any aspect of the design or supportive reports is found to be deficient or inadequate, the applicant will be required to correct the deficiencies or make additional studies.

Staff in its independent evaluation of hydrology, hydraulics, and structural design generally relies on design criteria established by the Corps of Engineers and/or the Bureau of Reclamation. In addition, staff refers to such other generally accepted engineering design and construction criteria as are available. To the extent that an applicant or its engineer can reasonably support any variation from accepted criteria without creating a hazard to human life, staff will accept the engineer's judgment as an economic risk to the applicant. Furthermore, it is recognized that subsequently a Board of Consultants would also have to approve the design.

In making independent stability analyses of dams other than those in the low hazard class, staff utilizes various computer programs. When available, programs prepared by the Corps of Engineers are adapted to the Commission's in-house computer and used to check applicant's design. Staff engineers are required to be thoroughly familiar with the assumptions inherent in a program, and its limitations, before using it. Staff also utilizes the Portland Cement Association Crown Cantilever computer program, prepared by Alfred Parme, for checking the stresses in arch dams.

When the application is for a constructed project, considerable weight is attached to the physical condition of the project works. The project is inspected by Regional Office personnel and may also be inspected by Washington staff accompanied by the Regional Office inspector, depending on the condition of the project. When the application is for a license for a constructed project not previously licensed, design criteria are somewhat more flexible than that

used for an unconstructed project; however, the structures must be stable under probable maximum flood and earthquake loading, or the consequences of structural failure under the assumed loading conditions must be in the low risk category. When a project structure is not considered safe, the applicant will be asked to correct the situation or, alternatively, the license when issued will contain special articles requiring the licensee to modify the structure, as necessary, to make it safe.

Environmental impact statements contain information relative to dam safety, since the project is described, construction and operation methods are defined, and the effects of catastrophic events on the project are discussed. The impact statement is made available to Federal, state, and local governments, and interested private concerns. Comments received on the impact statements are sometimes addressed to these items.

The Licensed Projects Division staff prepares an environmental impact statement for all major unconstructed projects and some constructed projects. The applicant's environmental report, Exhibit W of the license application, and the comments received thereon from federal, state, and local agencies and authorities are used to supplement staff's own studies in preparing the environmental impact statement. For most major constructed projects and minor projects, staff prepares only an environmental evaluation report. This report is used internally and is not distributed for comments. However, the environmental evaluation report may be made available to any party upon specific request.

When all comments have been received on the application and staff's environmental impact statement, an engineering report is prepared for the Commission. The report includes a discussion of the issues identified during the review process and includes staff's recommendations for standard and special articles to be included in the license, if issued. Special articles relating to dam safety are included for the purpose of assuring that the

project will be properly designed, constructed, and operated to best serve the public interest. Typical safety related articles included in licenses for major unconstructed projects are listed in Appendix B.

### Regional Office

The Regional Office reviews the application and prepares a report thereon, including recommendations for special articles to be included in the license.

When the application is for a constructed project, the project is inspected for safety and adequacy and field checks are made to assure the accuracy of the project description, including the Exhibit L (design drawings included in the application for license). Any discrepancies between the existing project works and those described in the application are brought to the applicant's attention and reported to the Washington Office. The Regional Office also reports on the extent to which the flood plain is developed below the dam.

When the application is for an unconstructed project, Regional Office staff members inspect the proposed site, and observe site investigations, testing programs, and model studies. A report thereon is prepared for the Washington Office. If an independent board of consultants has been retained by the applicant, board meetings are attended and reports thereon are submitted to the Washington Office. This is an important function in that any contemplated design changes or additional site investigations will be brought to staff's attention at a early date for consideration. There appears to be a trend developing for applicants to retain a board of consultants before the license is issued in order to have the benefit of the board's early review of the proposed design.

### Applicant

While the license application is being processed, the investigation of the site for final design, including testing of materials, is continued. Investigations at this stage include

additional core borings with water loss tests, exploration tunnels and test pits, verification of borrow areas, and installation of instruments to measure in situ rock stresses. Also, streamflow measurements and water quality monitoring, including temperature, are continued.

Furnishes the Commission staff with all supplemental information and studies needed for a full understanding of the project. This includes all geotechnical reports, laboratory test results, boring logs, computer programs, detailed cost estimates with breakdown of quantities and costs, environmental data and studies, and mathematical and physical model studies as they become available.

Reviews and comments on the comments and recommendations made by federal, state, and local agencies and authorities on the license application. Also furnishes comments on staff's environmental impact statement.

#### Activities after the License is Issued for Construction

##### Licensee

Prepares contract drawings and specifications, issues bid invitations, prepares and submits for Commission approval Exhibit L drawings showing the final conceptual design of the project works, reviews and awards contracts, and upon approval of the Exhibit L drawings, commences construction. Submits qualifications of proposed members for the independent board of consultants, to the Chief, Bureau of Power for approval.

##### Washington Office

Contract drawings, specifications, and the quality control plan are reviewed for adequacy. This review is made by an engineering geologist and civil engineers experienced in design and soil mechanics. Review efforts are coordinated with the regional office staff.

The qualifications of the members of the board of consultants are reviewed and, if satisfactory, the board is approved by the Chief,

Bureau of Power. The Exhibit L drawings are reviewed and stability analyses are made to verify the adequacy of the proposed design. If the analyses show that the proposed design will produce safe structures when constructed in accordance with the contract drawings and specifications, the exhibits are approved for construction.

Attend board of consultant meetings as observers. Review Regional Office construction inspection reports. At critical phases of construction, visit the site in company with the Regional Office inspector to observe such items as foundation preparation, grouting procedures, underground excavations and rock support systems, and material selection and testing.

If field conditions would require a substantial change in the approved design, revised Exhibit L drawings are filed showing the proposed redesign. The proposed design is analyzed and, if satisfactory, the revised Exhibit L drawings are approved by the Commission.

#### Regional Office

Construction plans, specifications and quality control programs are reviewed by personnel experienced in construction and inspections. The Regional Engineer approves Licensee's construction inspection program and makes periodic checks to observe if Licensee is adhering to the approved program and using qualified inspection personnel.

Notifies licensee of regional office requirements regarding advance and continuing information to be furnished by licensee to assure adequate supervisory control of construction. Inspects project, usually once a month, but more often if critical foundation areas are being exposed and treated. Observes whether construction is proceeding in accordance with approved plans and acceptable procedures as to methods, quality control, safety, materials testing and placement, records-keeping, etc., and notifies licensees of any deficiencies noted. Checks to see if licensee is complying



with the terms of the license. Prepares and submits a report on the construction inspections to the Washington Office.

### Board of Consultants

The Board of Consultants makes independent reviews of all major engineering and geotechnical aspects of the project. The Board is required to approve the Exhibit L drawings which are subsequently approved by the Commission for construction. The Board reviews and comments on licensee's construction plans, specifications, and the quality control plan. For other aspects of the Board's responsibilities, see the special articles in Appendix B.

The Board schedules inspections of the project during critical phases of construction to assure that the foundations are properly prepared and treated, grouting procedures are being properly carried forth, borrow materials are being properly processed and placed to assure proper moisture content, gradations and zoning, and construction work is progressing satisfactorily, and is properly supervised.

The Board is required to approve the instrumentation plans and the reservoir(s) filling program. Normally the Board will schedule a meeting to observe the reservoir filling. In the event that field conditions require a design change, the Board will review, and, if satisfactory, approve the proposed change.

## Activities Pertaining to Operating Licensed Projects

### Regional Office

A Regional Office inspector inspects operating projects annually and makes special inspections as required. The annual operation inspections address the following.

- (1) Is the project being adequately maintained?
- (2) Do any adverse conditions exist which would affect public safety?
- (3) Is licensee complying with the terms of the license?

- (4) Is instrumentation being monitored and are instruments being properly maintained?
- (5) Do spillway gates operate satisfactorily?
- (6) Is emergency power available and reliable?
- (7) As applicable, is licensee complying with the recommendations made by its independent engineering consultant in conformance with Part 12 of the Commission's regulations and,
- (8) Are licensee's operating personnel familiar with implementation of the emergency operation readiness program?

Any deficiencies noted during the inspection are called to licensee's attention for correction and are described in the inspection report submitted to the Washington Office.

Inspections made under Part 12 of the Commission's regulations are reviewed with respect to the safety of the structures. A letter approving the Part 12 inspection or requesting that further studies be included in the report is sent to the licensee with Washington Office concurrence.

Notifies licensees approximately one year before the Part 12 inspection reports are due. Advises licensee of any special engineering studies that need to be covered in the Part 12 inspection report.

Reviews and analyzes licensee's monthly operation and periodic instrumentation reports. Receives licensee's reports on accidents and drownings and recommends corrective actions to be taken, if project related. Maintains liaison with state, local, and federal agencies regarding licensee's compliance with special operating requirements.

#### Washington Office

Reviews Regional Office inspection reports. When the inspection report discloses a problem area or a potential problem area, Washington Office staff may inspect the project in company with the regional office inspector to evaluate the seriousness of the situation and make recommendations to the licensee for corrective measures. In an emergency situation where a dam's safety is jeopardized, and to the extent that time would permit, Washington

Office and Regional Office staff members would inspect the project and make recommendations for emergency action to be taken to improve the dam safety. Recommendations for emergency action could include such items as lowering the reservoir, drilling pressure relief wells, grouting, etc.

Reviews inspection reports of private consulting engineers made in compliance with Part 12 of the Commission's rules and regulations and approves or modifies the Regional Office recommendations as to needed modifications to, or approval of, Part 12 inspection reports.

### Special Procedures to Assure Dam Safety

#### Inspection by Independent Consultants

The concern for safety of dams prompted the Commission to issue Order No. 315 in December 1965. This order established a new Part 12 of the Commission's Regulations on the subject of inspection of project works with respect to safety of structures. See Appendix C. The order provides for a program of periodic safety inspections by consultants at regular 5-year intervals to supplement the inspections of the Commission's staff. This requirement applies to those hydroelectric projects having a dam exceeding 35 feet in height above streambed or a gross storage capacity in excess of 2,000 acre-feet. The inspections are performed by or under the responsibility and direction of qualified independent consultants employed by the licensees. The basic purpose of the consultant's inspection is to determine whether there are any deficiencies or potential deficiencies in the design, quality and adequacy of maintenance, or methods of operation of the project structures which might endanger public safety. The design review includes an estimate of the Probable Maximum Flood in evaluating spillway adequacy, and seismic stability analyses, as appropriate. The physical inspection includes an examination to detect seepage, movement, cracking of concrete structures, reservoir shoreline instability, and performance observations records, including instrumentation.

Staff is considering a proposal to expand Part 12 of the Commission's Regulations to include the following additional requirements, some of which have already been imposed on Licensees by miscellaneous directives or letters.

- (1) The Licensee will be responsible for informing the Commission through its Regional Engineer of any accident or observed condition which may have bearing on the overall safety or operational capability of the project.
- (2) The Licensee will be required to report all drownings and fatal or serious accidents occurring on project lands or waters.
- (3) The Licensee will make periodic tests of spillway gate operation.
- (4) The requirements for height of dam and reservoir capacity for a consultant's safety inspection report will be clarified.
- (5) Guidelines will be provided to include specific analyses for spillway adequacy and stability in consultant's safety inspection reports.
- (6) Licensee will be required to file an emergency action plan designed to provide early warning in event of an impending sudden release of reservoir water caused by an accident or failure of project structures.

#### Internal Improvement of Inspection Program

Prior to 1963, very little emphasis was placed on developing an effective dam safety program as a part of the supervisory and regulatory functions of the Federal Power Commission. This situation changed during 1963, however, and an Inspections Branch (then designated as a section) was established in the Licensed Projects Division. The Inspections Branch is staffed with personnel experienced in geology, soil mechanics, foundations and heavy construction. Its functions include establishment of inspection programs and guidelines, developing training programs for inspectors, assisting Regional Office personnel with engineering matters requiring a high degree of expertise, and reviewing construction and operation inspection reports of the Regional

Offices for completeness and identification of potential problems. Inspections Branch personnel also review the Part 12 inspection reports and recommendations thereon from the Regional Offices. The Inspections Branch cooperates and works closely with the Project Analysis Branch in reviewing the design of proposed projects and modifications to existing structures.

The following pertinent instructions or guidelines have been issued to the Regional Offices since 1967:

- (1) June 18, 1969. Memorandum provides for obtaining construction drawings and specifications for new construction to be reviewed by personnel responsible for making the monthly construction inspections.
- (2) December 9, 1969. Notification of licensee to include specific reviews of stability of structures and spillway adequacy as a part of the Part 12 inspection.
- (3) January 27, 1970. Memorandum provides for training program for Regional Office inspectors.
- (4) May 13, 1971. Requirement to request all licensees to report all drownings and fatal or serious accidents to the FPC Regional Engineer.
- (5) June 20, 1972. Memorandum pertains to inspection of upstream slope protection for earth dams.
- (6) January 2, 1973. Memorandum requests a review of performance observation data to be summarized and reported in annual operation inspection reports.
- (7) October 18, 1974. Requirement for annual test operation of spillway gates.
- (8) November 5, 1975. Regional Office responsibility to review and clarify Licensee's plans for emergency action in the event of dam failure.

Copies of the above memoranda are included as Appendix D.

### Emergency Action Plan

Alabama Power Company's Walter Bouldin Dam, FPC Project No. 2146, failed in February 1975. Although there was no loss of life and only minor downstream property damage resulting from the failure, it was apparent to staff that an emergency warning plan should be developed for each dam wherein its failure would have a significant, adverse impact on downstream property and public safety. Therefore, on August 15, 1975, a letter by direction of the Commission was signed by the Chief, Bureau of Power, and sent to each Licensee. The letter requested that a study be made of the effect of dam failure on downstream areas and that measures for minimizing the effects of dam failure be identified. The letter also required the Licensees to submit a plan of emergency action to be taken, including notification of law enforcement and other local agencies, in case of either an impending or an actual accident or dam failure which may cause a sudden release of water.

### Special License Conditions

When a licensee accepts a license issued by the Commission it is bound by the terms and conditions (including articles) of the license. In addition to the standard articles included in all project licenses, special articles peculiar to each project are included to assure that the project will be constructed, operated and maintained in a safe manner.

Special articles related to dam safety for constructed projects may require modifications of the structures. The modifications could include such items as providing additional spillway capacity, providing additional freeboard to permit passage of the spillway design flood, opening or providing foundation drains to relieve uplift forces, repairing deteriorated concrete to restore structural integrity, post tensioning of structures, special analyses and studies to verify structural integrity, etc. Although the Commission has not required a board of consultants to review work being required by a special article (s), it is conceivable that it may do so in the future.

Special articles related to dam safety for unconstructed projects are generally directed to design and construction. Special articles are included which require the licensee to submit contract drawings and specifications for review by the Chief, Bureau of Power (with authority to require changes);

to retain a board of independent consultants to review all significant engineering aspects of design, construction and initial operation; to file final design exhibit L drawings for Commission approval; to make model studies to verify design; to provide emergency spillways; to file an emergency action plan; and etc.

### Aspects of the Dam Safety Problem Requiring Special Attention

The President's memorandum on page 2 indicated that the following items should be investigated.

1. "...means of inclusion of new technological methods into existing structures and procedures;..."

The Commission's dam safety program has evolved over a number of years and is structured to have the flexibility to incorporate new technological methods, as available. To the extent that is possible, within our manpower and budgetary constraints, new methodologies are integrated into the staff procedures and Commission Regulations. At the staff level, the utilization and familiarity of new methodologies are incorporated through personnel training, technical seminars, employing staff with special expertise, and reviewing the technical literature. New methodologies are also available through the use of independent boards of consultants required as a condition of new licenses and pursuant to Part 12 of the Commission's Regulations. Where special problems arise, the Commission staff can complement its studies and review through special requirements being imposed upon a licensee's board of consultants. For example, a new hydrometeorological Report No. 51, prepared by the National Oceanic and Atmospheric Administration, is being finalized and is expected to be published within a year. The use of this report when published, will affect some of the previously used estimates of probable maximum precipitation (PMP) and spillway design flood estimates. For those dams affected by a significant increase in the estimated PMP, staff will examine their hazard potential and those dams classified other than low hazard will be re-evaluated for stability.

The FPC has a number of hydraulic fill dams under license. As part of the Part 12 inspection, staff is requiring licensee to have its consultant determine whether the dam would be subject to liquefaction during a design earthquake. For dams located near recently active faults where the intensity and duration of earthquakes would be high, the licensee will be required to utilize new methodologies to study the dynamic

response of the structure. Within the next five years, all hydraulic fill dams under FPC jurisdiction will have been evaluated for seismic stability.

For a number of years, the FPC staff has been using high speed digital computer programs for making stability analyses. Use will be made of new and better programs, and/or additional computer capacity and perepheral equipment as they become available.

2. "...the degree to which probabilities or risk-based analysis is incorporated into the process of site selection, design, construction, and operation;..."

The FPC staff does not use "probabilistic or risk-based analysis" to evaluate human life. In cases where loss of human life may be involved, the FPC staff would not project the loss of life and assign a cost to it for use in a cost-benefit analysis. The project design must be adequate to ensure that no loss of life would be anticipated. If it is not possible to design a proposed project with such assurance, the proposed project would be rejected and alternatives would be considered.

3. "...the degree of reliance on in-house, interagency, and outside expert interpretation of geologic data in site selection and design development..."

The geologic data are gathered, the site is selected, and the project is designed by the licensee's engineers, either in-house or consulting firm. The FPC staff independently evaluates the geologic data, site selection, and design (see pps. 5 and 6 in discussion above). An independent board of consultants reviews the geologic data and approves the site and project design (see page 10 and the board of consultants special article in Appendix A). The Commission staff relies equally on in-house and outside expertise. Where there is disagreement as to the interpretation of geologic data, staff attempts to resolve such matters in meeting with licensees and their consultants.

4. "...the effect on dam safety of earthquake or other earth movement hazards;..."

The possibility of liquefaction of loose saturated sands and silts when subjected to earthquake shocks has been a concern to engineers for years. Since the massive slide and near collapse of the lower San Fernando hydraulic fill earth



dam during the February 9, 1971, California earthquake, particular attention has been paid to hydraulic fill dams in seismically active areas. As previously discussed (item (1) above) the Commission has been requiring licensees with hydraulic fill dams in potential major earthquake areas to assess the stability of the structure under earthquake conditions as part of the Part 12 inspection program. Reservoir rim stability is also considered in the Part 12 inspection program. In areas where potential reservoir rim slides could produce a wave that would overtop and endanger the dam, reservoir levels have been lowered until a better understanding of the rim stability is obtained.

5. "...the effects of cost-saving incentives on decisions both prior to and during construction;..."

The FPC staff encourages cost saving incentives when the cost savings result in hydroelectric power being furnished to the public at the lowest possible cost, provided that safety of the project works is not compromised. The staff must advise the Commission that a project is economically feasible, therefore, it is necessary that a project be designed at the least possible cost commensurate with safe design.

6. "...the procedures by which dam safety problems are identified, analyzed and solved;..."

Dam safety under the FPC program is approached at three stages: (1) preconstruction, (2) during construction, and (3) post-construction. Preconstruction activities consist of staff review of designs, verification of foundation adequacy, recommendations for special studies, etc. Licensee's board of consultants also review and approve designs, foundation adequacy and such other critical design parameters as may affect the project's safety. During the construction phase, special attention is directed to the adequacy of plans and specifications, quality control, adequacy of licensee's inspection program and other related factors so that the staff is assured that construction will meet the design criteria. Staff inspections are made periodically to assure safe structures and reports are made to the Washington Office on the progress and quality of construction. Licensees and its board of consultants also review the same general parameters in parallel with staff. Any problems identified during the reviews or inspections are dealt with through meetings or in the field during inspection, as necessary. After construction is completed, staff makes annual inspections to assure that the performance of the project is consistent with the license terms and criteria for safe project operation. Licensees are required to have an independent consultant's review of the project every 5 years pursuant to Part 12 of the Commission's Regulations to assure dam safety.

7. "...the involvement of local communities in identifying, analyzing and solving dam safety questions;..."

As discussed previously in this report, public notice of applications for preliminary permits, licenses, and amendments thereto are published in local newspapers and the federal register. Private citizens or citizen organizations and local communities may comment on the proposal, or may petition to intervene in the licensing procedure. The Commission's staff responds, as appropriate, to inquiries and protests.

The FPC staff can best serve the public by maintaining a competent and adequately trained staff of experts to critically review proposed unconstructed projects for safety, adequacy, economy, and comprehensive development of the resource. Depending upon the degree of public interest, the staff may sponsor informal, informative type public meetings in the proposed project area. Similar meetings may be conducted by the applicant to further the public's understanding of the action being proposed. The FPC regional offices due to their geographical location are usually more accessible to the public than the Washington office and are available to answer questions from the public concerning a proposed project.

8. "...the major outstanding dam safety problems of the agency."

Major dam safety problems are related principally to the catastrophic phenomena of floods and earthquake and to the more "normal" problems, such as excessive seepage, leakage, and the deterioration of materials of which the dam is constructed. The following dams are being closely observed for any developing trends which would require immediate emergency action such as lowering the reservoirs and making repairs. Some of the dams are operating with normal reservoir elevations and some are operating with reservoirs drawn down below normal elevations. Under the category of major dam problems associated with floods and earthquake, are the following.

- (1) Santee-Cooper River dams of South Carolina Public Service Authority, FPC No. 199. The 1977 Part 12 inspection report concluded that the hydraulic fill in the north embankment of the Santee River dam would liquefy during a strong earthquake. The Santee River dam impounds about 1,500,000 acre-feet of water. The Part 12 report concluded, also, that the sand layer under the rolled earth west embankment of the Cooper River dam would liquefy under the design earthquake. The Cooper River dam impounds approximately 1,200,000 acre-

feet of water. In addition, the spillway capacity of the Santee River dam is insufficient to pass a probable maximum flood. These matters are currently being assessed to determine what remedial actions may be required. However, preliminary studies indicate that even though the reservoir impounded by the Santee River dam is large, the downstream flood plain is uninhabited and failure of the dam structures by overtopping during a PMF or failure of the hydraulic fill embankment by liquefaction during a strong earthquake would not create a major hazard to downstream life and property. The analysis of the foundation under the Cooper River dam west embankment is not complete and will require additional studies.

(2) Bagnell Dam (FPC No. 459) located on the Osage River Missouri, and owned by Union Electric Company is a concrete gravity dam impounding 1,246,000 acre-feet of usable storage. The dam would be overtopped by a PMF. Modifications to the structure to enable it to safely pass a PMF will depend on the strength of the dam concrete. Core borings of the concrete are currently being taken and analyzed.

(3) Hauser Lake Dam (FPC No. 2188) located on the Missouri River, Montana, and owned by The Montana Power Company is a concrete gravity dam that might fail if it were subjected to a severe earthquake. Stability analyses of the dam are being finalized, and recommendations for any remedial work, that may be required will be made following completion of the stability analyses.

(4) Upper Baker development (FPC No. 2150) located on the Baker River, Washington, and owned by Puget Sound Power and Light Company is a concrete gravity rock embankment dam that has a usable storage capacity of 221,000 acre-feet. During March of 1975, Upper Baker reservoir was drawn down 30 feet due to the danger of a potential large land slide being triggered by volcanic activity of Sherman Crater of Mt. Baker. In April of 1976, the U.G.S.G. studies indicated that the chance of eruption and major mud flow was less likely than in mid-1975. Thus the restrictions on the reservoir were removed, and the reservoir commenced filling to normal level in April 1976. Sherman Crater is being closely monitored for any indication of a renewal of volcanic activity.

(5) Licensed projects having earthen dams constructed by the hydraulic fill method and located in geographic areas subject to high intensity earthquakes will be analyzed for dynamic response to earthquakes. Although not all such dams have been studied, they will be in the near future.

Under the category of major dam problems associated with excessive seepage, leakage, and deterioration of materials are the following.

(1) Logan Martin Dam (FPC No. 2146) located on the Coosa River, Alabama, owned by Alabama Power Company. The dam consists of a concrete gravity spillway, intake and powerhouse section flanked by earth embankments. Maximum height of the earth embankments is 97 feet. Bedrock is the Cooper Ridge or lower Knox dolomite with isolated beds of limestone and scattered masses of chert. The rock is highly jointed, faulted, and cavernous. Even though the bedrock was extensively grouted during construction, underseepage developed soon after the dam was completed and the reservoir was impounded in 1964. Upstream sinkholes and downstream boils have developed and persisted through periods of remedial grouting beginning in 1968 and the filling of sinkholes in 1968 and 1969. The rate of underseepage has increased through the years. Recently the licensee has intensified subsurface investigations and enlarged its special Board of Consultants in an effort to gain a better understanding of the foundation conditions. Remedial measures ongoing or just completed consist of multiple row grouting, construction of a rock bolster on the downstream face of the left embankment, and improved downstream drainage. Consideration is being given to additional upstream blanketing and continued grouting. This project is being closely monitored with piezometers, movements markers, and reservoir floor soundings.

(2) Terminal dam (FPC No. 400) located on the Animas River, Colorado, owned by the Colorado-Ute Electric Association. The dam is a 55-foot high timber crib structure impounding, when full, 23,000 acre feet of usable storage. During June, 1976, leakage through the dam increased from a normal 10-12 cfs to 40 cfs. Divers sent down to investigate found that an approximately 3-foot diameter hole had formed below the sheet piling. This was corrected by dumping about 55 cubic yards of gravel in the vicinity of the hole and leakage returned to normal. A subsequent inspection disclosed a large void under the concrete cap between the sheet piling and the dam face. Remedial action is under study, however, the reservoir is drawn down 10 feet to protect the dam. Licensee intends to replace the dam as soon as a new license is issued, i.e. the original license has expired and the project is operating under an annual license.

(3) Elwha Dam (FPC No. 2683) located on the Elwha River, Washington, owned by the Crown Zellerbach Corporation. The dam is a concrete gravity structure impounding a small, silted reservoir. The dam is questionably stable under a flood which could be expected once in one hundred years. The Commission's Secretary requested the Corporation to undertake

remedial measures to improve the safety of the dam. However, the project has not been determined to be subject to FPC jurisdiction (the proceedings are in progress), and the Corporation is not willing to act until the jurisdictional issue is resolved.

(4) There are numerous other dams under FPC jurisdiction where seepage or leakage is high and which are being closely monitored for trends. At present, these situations appear to have stabilized and the dams represent only a potential problem.

### Conclusion

The FPC staff's independent review of proposed hydro-electric projects, including site investigations, design, and construction, together with the review function provided by an independent board of technical consultants, provides a reasonable assurance that new projects will be safely designed, constructed, and monitored. The FPC's inspection program in conjunction with its requirement for inspection of major dams every five years by an independent engineering consultant gives a reasonable assurance that any developing situation which could endanger the safety of a dam would be recognized early enough so that only appropriate remedial measures would be required. Experience has shown that most Licensees maintain close surveillance of their dams by operating and maintenance personnel.

The degree to which the FPC's dam safety procedures can be maintained and/or improved depends upon its ability to maintain a highly qualified and trained technical staff. The Bureau of Power must be authorized and budgeted to hire and train competent personnel. Staff personnel must be permitted to take work-related specialized courses, regularly attend meetings of boards of consultants, keep up-to-date on technological advances by attending professional seminars, and be authorized sufficient travel funds to give office-type personnel field experience.

The FPC dam safety program as presently planned is considered adequate, but additional staffing is urgently needed. The dam safety program could be made outstanding, if adequate resources are provided.

APPENDIX B

Special Articles Related  
to  
Dam Safety

Article . No substantial change shall be made in the maps, plans, specifications, and statements described and designated as exhibits and approved by the Commission in its order as a part of the license until such change shall have been approved by the Commission: Provided, however, That if the Licensee or the Commission deems it necessary or desirable that said approved exhibits, or any of them, be changed, there shall be submitted to the Commission for approval a revised, or additional exhibit or exhibits covering the proposed changes which, upon approval by the Commission, shall become a part of the license and shall supersede, in whole or in part, such exhibit or exhibits theretofore made a part of the license as may be specified by the Commission.

Article . The project area and project works will be in substantial conformity with the approved exhibits referred to in Article      herein or as changed in accordance with the provisions of said article. Except when emergency shall require the protection of navigation, life, health, or property, there shall not be made without prior approval of the Commission any substantial alteration or addition not in conformity with the approved plans to any dam or other project works under the license or any substantial use of project lands and waters not authorized herein; and any emergency alteration, addition, or use so made shall thereafter be subject to such modification and change as the Commission may direct. Minor changes in project works, or in uses of project lands and waters, or divergence from such approved exhibits may be made if such changes will not result in a decrease in efficiency, in a material increase in cost, in an adverse environmental impact; or in impairment of the general scheme of development; but any of such minor changes made without the prior approval of the Commission, which in its judgment have produced or will produce any of such results, shall be subject to such alteration as the Commission may direct.

Article . The project, including its operation and maintenance and any work incidental to additions or alterations authorized by the Commission, whether or not conducted upon lands of the United States, shall be subject to the inspection and supervision of the Regional Engineer, Federal Power Commission, in the region wherein the project is located, or of such other officer or agent as the Commission may designate,

who shall be the authorized representative of the Commission for such purposes. The Licensee shall cooperate fully with said representative and shall furnish him such information as he may require concerning the operation and maintenance of the project, and any such alterations thereto, and shall notify him of the date upon which work with respect to any alteration will begin, as far in advance thereof as said representative may reasonably specify, and shall notify him promptly in writing of any suspension of work for a period of more than one week, and of its resumption and completion. The Licensee shall submit to said representative a detailed program of inspection by the licensee that will provide for an adequate and qualified inspection force for construction of any such alterations to the project. Construction of said alterations or any feature thereof shall not be initiated until the program of inspection for the alterations or any feature thereof has been approved by said representative. The Licensee shall allow said representative and other officers or employees of the United States, showing proper credentials, free and unrestricted access to, through, and across the project lands and project works in the performance of their official duties. The Licensee shall comply with such rules and regulations of general or special applicability as the Commission may prescribe from time to time for the protection of life, health, or property.

Article . The operations of the Licensee, so far as they affect the use, storage and discharge from storage of waters affected by the license, shall at all times be controlled by such reasonable rules and regulations as the Commission may prescribe for the protection of life, health, and property, and in the interest of the fullest practicable conservation and utilization of such waters for power purposes and for other beneficial public uses, including recreational purposes, and the Licensee shall release water from the project reservoir at such rate in cubic feet per second, or such volume in acre-feet per specified period of time, as the Commission may prescribe for the purposes hereinbefore mentioned.

Article . The Licensee shall retain a Board of three or more qualified, independent, engineering consultants to review the design, specifications, and construction of the project for safety and adequacy. The names and qualifications of the Board members shall be submitted to the Chief, Bureau of Power, for approval. Among other things, the Board shall assess the geology of the project site and surroundings; the design, specifications, and construction of the dikes, dams, spillways, powerhouse, electrical and mechanical equipment



involved in water control, and emergency power supply; instrumentation; the filling schedule for the upper and lower reservoirs and plans for surveillance during the initial filling; the construction inspection program; and construction procedures and progress. The Licensee shall submit to the Commission copies of the Board's report on each meeting. Reports reviewing each portion of the project shall be submitted prior to or simultaneously with the submission of the corresponding Exhibit L final design drawings. The Licensee shall also submit a final report of the Board upon completion of the project. The final report shall contain a statement indicating the Board's satisfaction with the construction, safety, and adequacy of the project structures.

Article \_\_\_\_\_. Within six months of the effective date of this order, the Licensees shall submit, in accordance with the provisions of the Commission's applicable orders, rules and regulations, all necessary revised plans, designs, specifications, exhibits, reports and forms, reflecting the approved proposed project, as modified herein, in conformity with the views, findings and conclusions set forth in the initial decision issued herewith. The Licensees shall not begin construction of any project works until the Commission has approved the submitted revised Exhibit L drawings and Exhibit M showing final designs of project works.

Article \_\_\_\_\_. The Licensees shall submit in accordance with the Commission's Rules and Regulations revised Exhibit L drawings showing final designs of any major project works, and the Licensees shall not begin construction of any major project structure until the Commission has approved the Exhibit L drawing therefore.

Article \_\_\_\_\_. The Licensee shall file with the Commission's Regional Engineer and Chief, Bureau of Power, one copy each of the contract drawing and specifications as soon as they become available; and shall submit for Commission approval prior to the start of construction revised Exhibit L drawings showing the final design of the project works.

Article \_\_\_\_\_. The Licensees shall file with the Commission's Regional Engineer and Chief, Bureau of Power, one copy each of the contract plans and specifications prior to the start of construction. The Chief, Bureau of Power, may require appropriate changes to the plans and specifications as to assure a safe and adequate project.

Article \_\_\_\_\_. Prior to the submission of revised Exhibit L drawings as herein provided, the licensee shall submit for approval by the Commission's Chief, Bureau of Power, computations to verify the final design of the surge chamber and penstocks. The licensee shall submit revised Exhibit L drawings, in accordance with the Commission's rules and regulations, showing the final designs and locations of the major project works; and final designs and locations of the major project works; and the licensee shall not begin to construct any project structure until the Commission has approved the drawings therefor.

Article \_\_\_\_\_. The Licensee shall, after obtaining written approval from the Chief of Engineers of the plans of any project structures affecting navigation, submit, in accordance with the Commission's Rules and Regulations, revised Exhibit L drawings and an Exhibit M showing final designs of the project works, and a revised Exhibit showing, inter alia, the location and orientation of the project works with respect of the Government dam. The Licensee shall not begin construction of any such dam. The Licensee shall not begin construction of any such project structures until the Commission has approved such exhibits.

Article \_\_\_\_\_. The Licensees shall provide primary and backup systems to stop the pumping cycle automatically when the water surface in the upper reservoir reaches a level of 4,042 feet (msl). In the event the Commission, upon the Licensees' filing of their final Exhibit L drawings for approval, shall find such systems inadequate reasonably to prevent overpumpage and consequent damages, the Licensees shall construct a spillway and take such other measures as the Commission shall order to prevent damages from overpumpage.

Article \_\_\_\_\_. The Licensee shall file for Commission approval detailed plans to assure the safety of the upper reservoir dam from inadvertent overpumping and shall not commence construction of the upper reservoir dam until such plans are approved.

Article \_\_\_\_\_. The Licensee shall conduct a mathematical model study and/or a hydraulic model study to verify the adequacy of the design of the surge chambers and shall submit the results of such studies to the Commission and shall not commence construction of such facilities prior to Commission approval of the design of the surge chambers.

Article \_\_\_\_\_. The Licensees shall take appropriate measures to minimize leakage from the project reservoirs through karstic or solution cavities.

Article \_\_\_\_\_. The design and construction of all facilities that will be an integral part of the dam or that could affect the integrity of the navigation system, including construction procedure and sequence, shall be subject to the review and approval of the District Engineer, Corps of Engineers, Louisville, Kentucky.

Article \_\_\_\_\_. The Licensee shall install appropriate instrumentation and other devices to monitor seepage, uplift, and performance of the project structures and reservoir slopes. A plan of instrumentation and a schedule for recording instrument readings shall be filed with the Commission prior to the initial filling of the upper reservoir. The Licensee shall furnish periodically to the Commission, as may be requested by the Commission or its authorized representative, a report and analysis of the instrument readings.

Article \_\_\_\_\_. Licensee shall operate the project during flood periods in a manner such that the peak stream flow below the lower reservoir will be no greater than would have occurred in the absence of the project.

Article \_\_\_\_\_. Prior to initiation of the filling of the lower reservoir, the Licensees shall enter into an agreement with the Corps of Engineers, District Engineer, Pittsburgh, Pennsylvania, specifying a plan of operation which would take into account changes in the flow regime and total runoff of the Cheat River which will result from project reservoir operation in normal, dry and flood periods due to such items as reservoir operation, minimum flow releases and minimum withdrawals of water from Blackwater River and withdrawals during initial project reservoir filling. A copy of the agreement shall be filed with the Commission prior to commencement of operation.

Article \_\_\_\_\_. The Licensees shall submit a schedule and plans for surveillance of initial filling of the project reservoirs and install appropriate instrumentation and other devices to monitor seepage, uplift, and performance of the project structures and reservoir slopes. Plans for reservoir filling and instrumentation, and a schedule of recording instrument readings, shall be furnished to the Commission prior to initial filling of the reservoirs. The Licensees shall furnish periodically to the Commission, as may be requested by the Commission or its authorized representative, a report and analysis of the instrument readings.

Article \_\_\_\_\_. Licensee shall file with the Commission an emergency action plan designed to provide an early warning to downstream inhabitants and property owners if there

should be an impending or actual sudden release of water caused by an accident to or failure of, project structures. Such plan, to be submitted prior to initial filling of the project reservoirs shall include, but not be limited to, instructions to be provided on a continuing basis to operators and attendants for actions they are to take in the event of an emergency; detailed and documented plans for notifying law enforcements agents, appropriate Federal, State, and local agencies, operators of downstream water-related facilities, and those residents and owners of properties that could be endangered; actions that would be taken to reduce the inflow to the reservoir, if such is possible, by limiting the outflow from upstream dams or control structures; and actions to reduce downstream flows by controlling the outflow from dams located on tributaries to the stream on which the project is located. Licensee shall also submit a summary of the study used as a basis for determining the areas that may be affected by such emergency occurrence, including criteria and assumptions used.