

TECHNICAL EVALUATION REPORT

HYDROLOGICAL CONSIDERATIONS (SEP III-C)

INSERVICE INSPECTION OF WATER CONTROL STRUCTURES

YANKEE ATOMIC ELECTRIC COMPANY

YANKEE ROWE NUCLEAR POWER STATION

NRC DOCKET NO. 50-029

FRC PROJECT C5257

NRC TAC NO. 41549

FRC ASSIGNMENT 16

NRC CONTRACT NO. NRC-03-79-118

FRC TASK 544

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July 15, 1982

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FOREWORD

This Technical Evaluation Report was prepared by Franklin Research Center under a contract with the U.S. Nuclear Regulatory Commission (Office of Nuclear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor licensing actions. The technical evaluation was conducted in accordance with criteria established by the NRC.

Mr. J. Scherrer and Ms. S. Roberts contributed to the technical preparation of this report through a subcontract with WESTEC Services, Inc.

1. INTRODUCTION

1.1 PURPOSE OF REVIEW

The purpose of this review is to evaluate the assumptions, conclusions, and completeness of documentation in responses by the Yankee Atomic Electric Company (YAEC) for Systematic Evaluation Program (SEP) Topic III-3.C (Inservice Inspection of Water Control Structures) for the Yankee Rowe Nuclear Power Station. The Nuclear Regulatory Commission (NRC) is reviewing this and other safety topics within the SEP and intends to coordinate an integrated assessment of plant safety after completion of the review of all applicable safety topics and design basis events (DBEs).

1.2 GENERIC BACKGROUND

The SEP was established to evaluate the safety of 11 of the older nuclear power plants. An important element of the evaluation is to judge the plants by current licensing criteria with respect to 137 selected topics, several of which relate to hydrologic assessments of the site.

In a letter dated January 14, 1981 [1], the NRC agreed to the SEP Owners Group's proposed redirection of the SEP whereby each licensee would select any 60% of the SEP topics and submit evaluations of these in time for a review by the NRC staff to be completed by June 1981. Evaluations of topics not selected by a licensee were the NRC's responsibility. The Licensee (YAEC) chose to submit an evaluation for Topic III-3.C in accordance with the SEP guidelines.

1.3 PLANT-SPECIFIC BACKGROUND

In a letter received by the NRC on February 2, 1982 [2], YAEC submitted an evaluation of Topic III-3.C, comparing the water control structure inspection program for the Yankee Rowe Nuclear Power Station with criteria currently used by the NRC staff for licensing new facilities. Further information for this evaluation was obtained during a site visit [3]. A Licensee response to

an NRC request for additional information [4] presented further information for review. The submitted documentation is reviewed in this technical evaluation report, and the adequacy of the Licensee's submittal is assessed.

2. REVIEW CRITERIA

The reference criteria used for this topic were based on the Code of Federal Regulations, Title 10, Part 50 (10CFR50), Section 50.36 and Appendix A (General Design Criteria 1, 2, and 44), and 10CFR100, including Appendix A. Pertinent regulatory positions are identified in the following Regulatory Guides:

- 1.127 Inspection of Water-Control Structures Associated with Nuclear Power Plants [5]
- 1.27 Ultimate Heat Sink for Nuclear Power Plants [6]
- 1.28 Quality Assurance Program Requirements (Design & Construction) [7]
- 1.132 Site Investigations for Foundations of Nuclear Power Plants [8]
- 1.59 Design Basis Floods for Nuclear Power Plants [9].

The specific criteria against which the Licensee's submittal was evaluated are given in Regulatory Guide 1.127.

3. TECHNICAL EVALUATION

In the following evaluation, the inservice inspection program for water control structures at the Yankee Rowe Nuclear Power Station is evaluated by the provisions of Regulatory Guide 1.127. For reference, Figure 1 depicts a general site feature map.

3.1 SAFETY-RELATED WATER CONTROL STRUCTURES

Licensee Identification

The following water control structures and components associated with the Yankee Rowe site are identified by the Licensee [2] and require surveillance in accordance with applicable NRC rules and Regulatory Guide 1.127.

A. Cooling Water System Structures

The identified cooling water system structures are those relating to the availability and protection of the ultimate heat sink (UHS). They include the intake and discharge structures and other associated features, and Sherman Dam.

B. Flood Control Structures

The identified flood control structure is the flood protection dike.

Evaluation

The Sherman Dam is identified by the Licensee as a water control structure at the Yankee Rowe plant. Its function is to impound the ultimate heat sink (UHS). The Licensee did not identify Harriman Dam as a flood control structure, even though its failure would cause flooding of the site [10]. The Licensee states that Sherman Dam is licensed and regulated by the Federal Energy Regulatory Commission (FERC) and that FERC maintains a formal inspection program which includes inspection reports [2]. The Licensee concludes that FERC's inspection program precludes the necessity of including Sherman Dam in this inspection program for the Yankee Rowe plant.

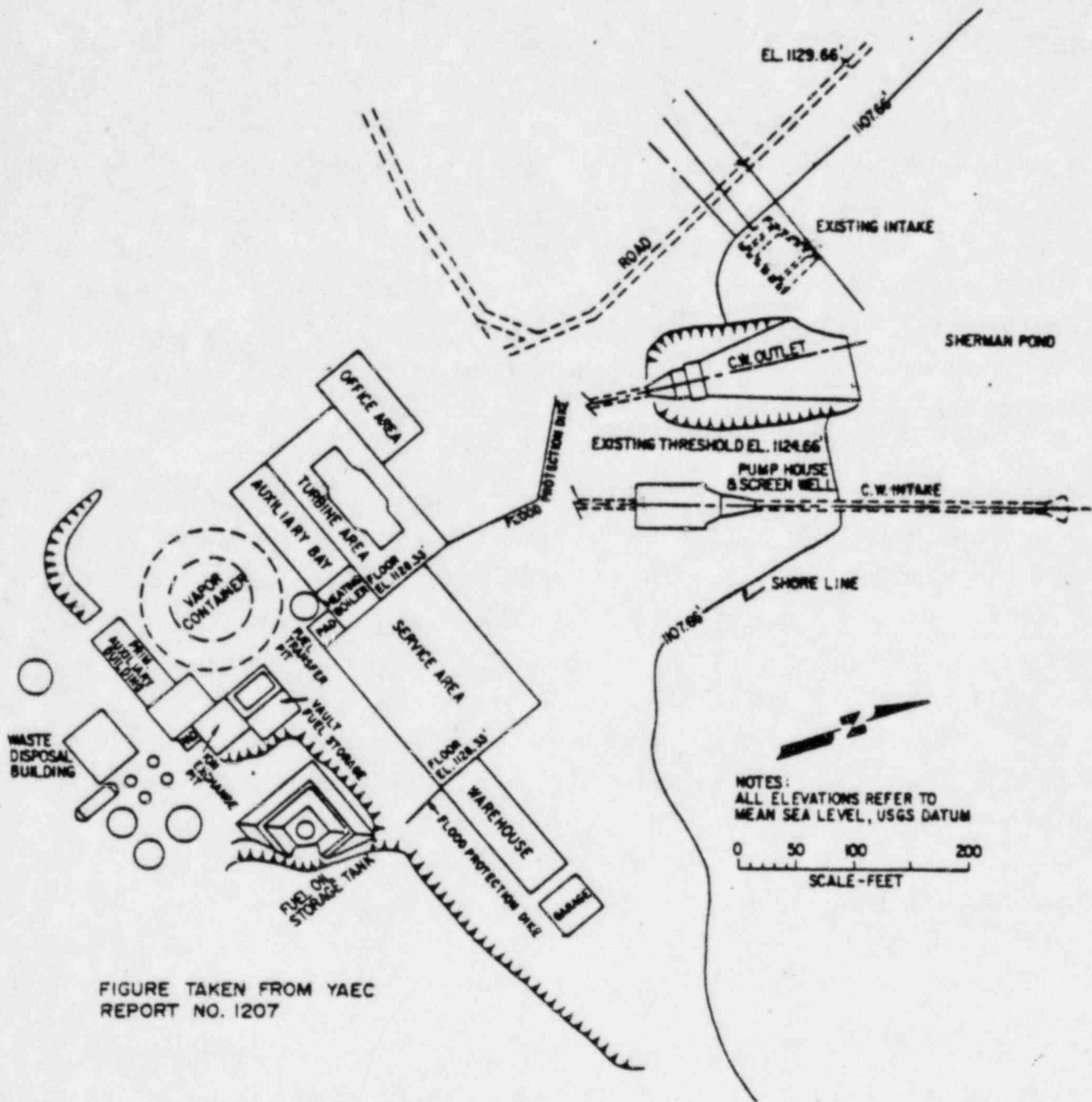


FIGURE TAKEN FROM YAEC REPORT NO. 1207

Figure 1. General Site Feature Map

Both Harriman and Sherman Dams are safety-related water control structures, albeit for different reasons. Harriman Dam protects the site from the hazards of flooding caused by intense precipitation (probable maximum precipitation [PMP]) in the Deerfield River Basin (see SEP Topic II-3.B) and rapid discharge of Harriman Reservoir, while Sherman Dam impounds the ultimate heat sink (see SEP Topic II-3.C). Neither of these dams, however, falls under the strict interpretation of Regulatory Guide 1.127, Section C, which states "this guide applies only to water-control structures specifically built [underline added] for use in conjunction with a nuclear power plant and whose failure could cause radiological consequences adversely affecting the public health and safety." However, it is apparent that the intent of Regulatory Guide 1.127 is to include both of these dams since failure of either dam will result in unacceptable consequences to the site. In the case of Harriman Dam, a failure during full pool conditions would cause significant flooding of the site (see SEP Topic II-4.E, Dam Integrity), or a failure of the dam during intense precipitation in the basin (PMP) would result in flooding of the site (see SEP Topic II-3.B). In the case of Sherman Dam, failure would result in a loss of ultimate heat sink (see SEP Topic II-3.C). It is this reviewer's understanding that the nature and source of the ultimate heat sink at the site will be changed in the near future to a source independent of Sherman Reservoir. However, at present, according to the Licensee's submittal of SEP Topic III-3.C, Sherman Dam is a water control structure which falls under the requirements of Regulatory Guide 1.127. Therefore, the inspection programs conducted at both Sherman Dam and Harriman Dam should be included as components of the formal inservice inspection program at the Yankee Rowe plant.

Conclusion

A. Cooling Water System Structures

Independent review confirms the Licensee's selection of the intake and discharge structures and their associated features, and Sherman Dam as appropriate cooling water system structures requiring surveillance in accordance with applicable NRC rules and Regulatory Guide 1.127.

Should the Licensee develop other means of providing cooling water for the ultimate heat sink, those structures should be included in the future inservice inspection program for safety-related water control structures.

B. Flood Control Structures

Independent review confirms the Licensee's selection of the flood protection dike as an appropriate flood protection structure requiring surveillance under Regulatory Guide 1.127.

Should the Licensee develop other means of protection against local flooding, these structures should be included in this inservice inspection program.

The Licensee did not identify Harriman Dam as an essential flood protection structure. Harriman Dam is an essential flood protection structure and should be a component of the Licensee's future formalized inspection program.

3.2 DETAILS TO BE INSPECTED

Licensee Identification

The following specific details of the previously identified structures and components are identified by the Licensee [2] as appropriate to inspection:

A. Cooling Water System Structures

<u>Details</u>	<u>Observation</u>	<u>Frequency</u>
Intake structure concrete surfaces	Deterioration, structural cracking, horizontal or vertical movement including abnormal settlements, heaving, deflections or lateral movement, and seepage	None identified
Discharge structure concrete surfaces	Same as above	None identified
Intake conduits interior surfaces	Erosion, corrosion, cavitation, cracks, joint separation, and leakage at cracks or joints	None identified

A. Cooling Water System Structures (Cont.)

<u>Details</u>	<u>Observation</u>	<u>Frequency</u>
All features including trash racks and areas surrounding the front of intake crib	Silt or debris accumulation	None identified

B. Flood Protection Structures

<u>Details</u>	<u>Observation</u>	<u>Frequency</u>
Flood protection dike	Damage, exposure of less wave-resistant materials	None identified
Stop logs	Operational adequacy	No specific frequency identified

Conclusion

A. Cooling Water System Structures and Components

The Licensee's identification of details to be inspected is appropriate. However, the Licensee did not indicate these details are, in fact, components of their present program. The details mentioned should be incorporated in their formal future inspection program.

B. Flood Protection Structures and Components

The Licensee's identification of details to be inspected is incomplete. The following additions are recommended:

More observations should be performed for the flood protection dike, including inspections for slumping, erosion, and settlement of foundation.

Additional flood protection details should be added as identified in Reference 11, as follows:

<u>Details</u>	<u>Observation</u>	<u>Frequency</u>
Screenhouse flood control panels inside door casings	Ease of installation and proper functioning	Annually

3.3 INSPECTION PROGRAM

A formal inspection program for inservice water control structures employing the methodology set forth in Regulatory Guide 1.127 has not been established to date. An inspection program does exist, however, for some of the structures and includes investigations of some of the pertinent details. The Licensee has made no mention of detailed checklists which are used to guide inspections in identifying details to be inspected. Further, the Licensee has not stated that the inspection program is conducted or overseen by qualified engineering personnel.

Inspection Report

Regulatory Guide 1.127 identifies the need to prepare inspection reports following the inspection of safety-related water control structures. These documents should be maintained on site for reference purposes. The Licensee made no mention in their submittal [2] of the existence of reports for formal and routine inspections resulting from the inspection program now underway at the Yankee Rowe facility. However, the Licensee stated during a recent site visit [3] that formal reports are kept on file, and that construction documents are available on site.

Frequency of Inspection

No routine frequencies of inspection were identified by the Licensee as required by Regulatory Guide 1.127. In addition, special inspections should follow extreme events that challenge both the UHS supply and flood protection structures. For the UHS, this implies that an inspection is necessary following a significant buildup of ice or other debris, or the occurrence of an earthquake. For flood protection structures, this implies that inspection is necessary following a large storm or heavy local precipitation.

Adequacy of Other Inspection Programs

The Licensee has stated that the FERC inspection suffices as an adequate inspection program fulfilling the requirements of Regulatory Guide 1.127. In this respect, the NRC has stated that the Licensee may meet criteria if the structure in question is regulated by another agency (e.g., FERC) enforcing a comparable inspection program. In order to respond to a specific NRC staff request, this TER presents a comparison of the requirements of Regulatory Guide 1.127 and FERC inspection requirements, and presents a conclusion as to the degree of interchangeability. The NRC staff will subsequently assess the appropriateness of FERC's requirements to meet NRC requirements for inspection programs.

A comparison of Regulatory Guide 1.127 inspection program requirements and FERC inspection program requirements is presented in tabular form. The Regulatory Guide 1.127 requirements are presented on the left in the sequence presented in the Regulatory Guide and are matched in the opposite column with applicable elements of the FERC program, where available. Elements of Regulatory Guide 1.127 that apply to inspection of features other than dams (i.e., canals, etc.) are considered not applicable to the focus of this review of Harriman and Sherman Dams and so have been omitted from the excerpted text of Regulatory Guide 1.127.

In conclusion, it is apparent that the FERC dam inspection requirements are comprehensive and detailed. Further, in comparison with the inspection program requirements of Regulatory Guide 1.127, the FERC (18CFR12) requirements are, in some cases, more detailed. For those facilities which strictly enforce the inspection program outlined in 18CFR12, Safety of Water Power Projects and Projects Works, the intent of Regulatory Guide 1.127 will be met.

Conclusion

1. The Licensee should develop a formal inspection program which incorporates all aspects of Regulatory Guide 1.127.
2. The Licensee should develop inspector checklists which contain details to be inspected for use in future inspections.

Regulatory Guide 1.127 Requirements

C. Regulatory Position

1. Engineering Data Compilation

Engineering data related to the design, construction, and operation of the water control structures should be collected, and to the extent practical, included in the initial inspection report.

These data should include the following items:

a. General Project Data

1. General vicinity data
2. As-built drawings
3. Construction and as-built photos

b. Hydrologic and Hydraulic Data

1. Drainage area, basin characteristics
2. Storage capacity
3. Elevation of max design pool
4. Spillway characteristics
5. Emergency spillways

c. Foundation Data/Geologic Features

d. Properties of Embankment/Test Reports

e. Concrete Properties

f. Electrical and Mechanical Equipment

g. Modification Records

h. Water Control Plan

i. Earthquake History

j. Design Assumptions

FERC 18CFR12 Requirements

Section 12.12

Maintenance of Records

a. Kinds of Records

The licensee must maintain as permanent project records ... the following:

- (i) Engineering and geological data relating to design, construction, maintenance, repair, or modification of the project, including design memoranda and drawings, laboratory and testing reports, geologic data (such as maps, sections, or logs of exploratory borings or trenches, foundation treatment, and excavation), plans and specifications, inspection and quality control reports, "as-built" construction drawings, designer operating criteria, photographs, and any other data necessary to demonstrate that construction, maintenance, repair, or modification of the project has been performed in accordance with plans and specifications

(ii) Instrumentation observations

(iii) Operational and Maintenance history

b. Location of records

1. Original records in central location
2. Copies on site or in central location

c. Transfer of Records

Transfer to new owner

Regulatory Guide 1.127 Requirements

2. Onsite Inspection Program

Detailed checklists should be developed and followed for the project structures to document the observations of each significant structural and hydrologic feature. Particular attention should be given to detecting evidence of:

- leakage
- erosion
- seepage
- slope stability
- settlement
- displacement
- tilting
- cracking
- deterioration
- drain function
- relief well function

Verify adequacy of maintenance and operating procedures

Observe post-construction changes

The inspections should include appropriate features and items, including but not limited to the following:

- a. Concrete structures in general
- b. Embankment structures
- c. Spillway structures
- d. Reservoirs
- e. Not Applicable
- f. Safety and Performance Instrumentation
- g. Operational and Maintenance Features
- h. Post-Construction Changes

FERC 18CFR12 Requirements

Subpart D - Inspection by Independent Consultant

Section 12.30. Applicability
Harriman dam would be included as applicable

Section 12.31

Definition

Qualifications of Inspector [applies to Reg. Guide 1.127]; see Section 5, inspection reports]

Section 12.32

General Inspection Requirements

All aspects (excluding electrical transmission and generating aspects) must be inspected

Section 12.35

Specific Inspection Requirements.

a. Scope of inspection

The inspection by the independent consultant shall include:

1. Due consideration of all relevant reports on the safety of the development made by or written under the direction of Federal or state agencies, submitted under Commission regulations, or made by other consultants
2. Physical field inspection of the project works and review and assessment of all relevant data concerning:
 - (i) Settlement
 - (ii) Movement

Regulatory Guide 1.127 Requirements

FERC 18CFR12 Requirements

Section 12.35 (Cont.)

- (iii) Erosion
- (iv) Seepage
- (v) Leakage
- (vi) Cracking
- (vii) Deterioration
- (viii) Seismicity
- (xi) Internal stress and hydrostatic pressures in project structures or their foundations or abutments
- (x) The functioning of foundation drains and relief wells
- (xi) The stability of critical slopes adjacent to a reservoir or project works
- (xii) Regional and site geological conditions, and

3. Specific evaluation of:

- (i) The adequacy of spillways
- (ii) The effects of overtopping of nonoverflow structures
- (iif) The structural adequacy and stability of structures under all credible loading conditions
- (iv) The relevant hydrological data accumulated since the project was constructed or last inspected under this subpart
- (v) The history of the performance of the project works through analysis of data from monitoring instruments, and

Regulatory Guide 1.127 Requirements

FERC 18CFR12 Requirement:

Section 12.35 (Cont.)

(vi) The quality and adequacy of maintenance, surveillance, and methods of project operations for the protection of public safety.

b. Evaluation of spillway adequacy.

The adequacy of any spillway must be evaluated by considering hazard potential which would result from failure of the project works during flood flows.

Regulatory Guide 1.127 Requirements

3. TECHNICAL EVALUATION

When... significant changes have occurred, an evaluation of the existing conditions of the water control structures should be made.

- a. Hydraulic and Hydrologic Design Capacities
- b. Stability Assessments

FERC 18CFR12 Requirements

Section 12.36

Emergency Corrective Measures

If, in the course of an inspection, an independent consultant discovers any condition for which emergency corrective measures are advisable, the independent consultant must immediately notify the licensee and the licensee must report that condition to the Regional Engineer pursuant to 12.10(a) of this part.

Section 12.37(c) (2)

Report of the Independent Consultant

- (i) Analyze the safety of the project works and the maintenance and methods of operation of the development fully in light of the independent consultant's reviews, field inspections, assessments, and evaluations described in 12.35;
- (ii) Identify any changes in the information and analyses required by paragraph (b) of this section that have occurred since the last report by an independent consultant under this subpart and analyze the implications of those changes; and
- (iii) Analyze the adequacy of existing monitoring instruments, periodic observation programs, and other methods of monitoring project works and conditions affecting the safety of the project or project works with respect to the development.

Regulatory Guide 1.127 Requirements

4. Frequency of Inspections (Not to exceed each 5 years)

a. Initial Inspection

Inspection immediately after topping out for earth filled dams and prior to impoundment of water for concrete dams.

b. Subsequent Inspections

1 year interval for 4 years
2 year interval for 4 years
5 year interval thereafter

c. Special Inspections

Following large floods, earthquakes, hurricanes, tornadoes, etc.

FERC 18CFR12 Requirements

Time for Inspections and Reports

Section 12.38

a. General rule

After the initial inspection and report under this subpart for a project development, a new inspection under this subpart must be completed and the report on it filed not later than five years from the date the last report on an inspection was to be filed under this subpart.

b. Initial inspection and report

1. For any development that has a dam that is more than 32.8 feet (10 meters) in height above stream bed or impounds an impoundment with a gross storage capacity of more than 2,000 acre feet (2.5 million cubic meters), which development was constructed before the date of issuance of the order licensing or amending a license to include that development, the initial inspection under this subpart must be completed and the report on it filed not later than two years after the date of issuance of the order licensing the development or amending the license to include the development.

Regulatory Guide 1.127 Requirements5. Inspection Reports

Technical reports should be prepared for each general inspection. These documents should be maintained on site. Report abnormal hazardous conditions to NRC staff.

Report Contents:

a. Initial Report

1. Results of visual inspection
2. Results of instrumented observations
3. Evaluation of operational adequacy of reservoir regulation plan and maintenance of the dam and operating facilities
4. Technical assessment of the cause of distress or abnormal conditions
5. Conclusions and recommendations

b. Subsequent reports

All of above elements, plus any extreme events which occurred since last report.

FERC 18CFR12 RequirementsReport of the Independent Consultant

Section 12.37

a. General requirement

Following inspection of a project development as required under this subpart, the independent consultant must prepare a report and the licensee must file three copies of that report with the Regional Engineer. The report must conform to the provisions of this section and be satisfactory to the authorized Commission representative.

b. General information in the initial report

1. The initial report filed under this subpart for any project development must contain:

- (i) A description of the project development
- (ii) A map ... indicating the location of the project development
- (iii) Plans, elevations, and sections of the principal project works
- (iv) A summary of the design assumptions, design analyses, spillway design flood, and the factors of safety used to evaluate the structural adequacy and stability of the project works and
- (v) A summary of the geological conditions.

Regulatory Guide 1.127 Requirements

FERC 18CFR12 Requirements

Section 12.37 (Cont.)

2. To the extent that the information and analyses required in paragraph (b) (1) of this section, are contained in a report of an independent consultant ..., information and analyses may be incorporated by specific reference into the first report prepared and filed under this subpart.

c. Information required for all reports

Any report of an independent consultant filed under this subpart must contain the information specified in this paragraph.

1. Monitoring information

The report must contain monitoring information ... that measures the behavior, movement, deflection, or loading of project works or from which the stability, performance, or functioning of the structures may be determined.

- (i) Any monitoring data plotted on graphs must be presented in a manner that will facilitate identification and analysis of trends.
- (ii) Plan and sectional drawings of project structures sufficient to show the location of all critical or representative existing monitoring instruments.

Section 12.37 (Cont.)

2. Analyses

The report must:

- (i) Analyze the safety of the project works and the maintenance and methods of operation of the development fully
- (ii) Identify any changes in the information and analyses ... and analyze the implications of those changes and
- (iii) Analyze the adequacy of existing monitoring instruments, periodic observation programs, and other methods of monitoring project works and conditions.

3. Incorporation by reference

To the extent that conditions, assumptions, and available information have not changed since the last previous report by an independent consultant under this subpart, the analyses required under paragraphs (c)(2)(i) and (ii) of this section may be incorporated by specific reference to the last previous report.

4. Recommendations

Based on the independent consultant's field observations and evaluations of the project works and the maintenance, surveillance, and methods of operation of the development, the report must contain the independent consultant's recommendations on:

Regulatory Guide 1.127 Requirements

FERC 18CFR12 Requirements

Section 12.37 (Cont.)

- (i) Any corrective measures necessary
- (ii) A reasonable time to carry out each corrective measure, and
- (iii) Any new or additional monitoring instruments, periodic observations, or other methods of monitoring ... that may be required.

5. Dissenting views

If the inspection and report were conducted and prepared by more than one independent consultant, the report must clearly indicate any dissenting views.

6. List of participants

The report must identify all professional personnel who have participated in the inspection.

7. Statement of independence

The independent consultant must declare that all conclusions and recommendations in the report are made independently.

8. Signature

The report must be signed by ... consultant responsible for the report.

Regulatory Guide 1.127 Requirements

Qualifications of Inspector

The inspection should be conducted under the direction of qualified engineers experienced in the investigation, design, construction, and operation of these types of facilities. The field inspection team should include engineers, engineering geologists, or other specialists.

FERC 18CFR12 Requirements

Section 12.31

Definitions (Including Qualifications of Inspector)

For purposes of this subpart:

- a. "Inspection consultant" means any person who:
 1. Is a licensed professional engineer
 2. Has at least 10 years' experience and expertise in dam design and construction and in the investigation of the safety of existing dams, and
 3. Is not, and has not been within two years before being retained to perform an inspection under this subpart, an employee of the licensee or its affiliates or an agent acting on behalf of the licensee or its affiliates.

3. The program should be conducted and overseen by qualified engineering personnel.
4. The Licensee must define inspection frequencies for all items included in the future formal program using guidance from Regulatory Guide 1.127.
5. The Licensee should identify in the formal inspection program the potential need for special inspections following the occurrence of events (e.g., earthquake or intense precipitation) which might jeopardize the integrity of safety-related water control structures. Further, the Licensee should develop initiation criteria for these special inspections (e.g., 6 inches of rain in 24 hours).
6. The inspection program requirements of 18CFR12, (FERC program on "Safety of Water Power Projects and Public Works") are comparable to those identified in Regulatory Guide 1.127.

4. CONCLUSIONS

The inservice inspection program for water control structures at the Yankee Rowe plant does not conform in all respects to Regulatory Guide 1.127 and requires modification. Recommendations are as follows:

4.1 SAFETY-RELATED WATER CONTROL STRUCTURES

The Licensee did not identify Harriman Dam as an essential flood protection structure. Harriman Dam is an essential flood protection structure and should be incorporated as a component of the Licensee's future formalized inspection program.

4.2 DETAILS TO BE INSPECTED

The Licensee's listing of details to be inspected is incomplete. Elaboration is provided in Section 3.2. Further, the Licensee should formalize their inspection program to incorporate the details which were identified in their submittal [2] and those identified in this TER.

4.3 INSPECTION PROGRAM

1. The Licensee should develop a formal inspection program which incorporates all aspects of Regulatory Guide 1.127.
2. The Licensee should develop inspector checklists which contain details to be inspected for use in future inspections.
3. The future program should be conducted and overseen by qualified engineering personnel.
4. The Licensee must define inspection frequencies in accordance with Regulatory Guide 1.127, for all features and details.
5. The Licensee should develop initiation criteria for special inspections which will subsequently prompt these special inspections.
6. The inspection program requirements of 18CFR12 (FERC program on "Safety of Water Power Projects and Public Works") are comparable to those identified in Regulatory Guide 1.127.

Upon initiation of these additions and modifications, the inservice inspection program for water control structures at the Yankee Rowe plant will satisfy the intent of Regulatory Guide 1.127.

5. REFERENCES

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