

Appendix H

Part 12D Safety Inspection Report Outline

Table of Contents

The Table of Contents must show the inclusive page numbers for each section and subsection. If any subsection is not applicable, include the subsection with a statement of “Not Applicable” and an explanation of the reason(s) why.

For licensed projects that include multiple independent dam and powerhouse developments, separate Part 12D reports should be published for each development.

- 1. Executive Summary**
- 2. Project Description**
- 3. Discussion of Potential Failure Mode Analysis Report**
- 4. Performance Monitoring and Visual Surveillance with Respect to Potential Failure Modes**
- 5. Field Inspection**
- 6. Operations and Maintenance Programs Relative to Potential Failure Modes**
- 7. Assessment of Supporting Technical Information Document**
- 8. Recommendations**

List of Tables (with location)

List of Figures (with location)

List of References

Appendices for Part 12D Inspection Report

- A. FERC Letter Requiring Part 12D Inspection**
- B. FERC Letter Approving Part 12D Consultant** - Include date of current report outline provided by FERC
- C. Project Figures**

Only provide general overview drawings necessary to understand the project and items discussed in the report. If figures are placed in Section 2, provide a statement that figures may be found in Section 2. Optionally, if the STI is bound with the Part 12D report provide a statement that figures may be found in the STI document; duplicate drawings from the STI do not need to be included in the Part 12D report proper.

Additional detailed drawings will be included in the Supporting Technical Information document.

D. Instrumentation Monitoring Data Plots

List each figure and drawing included in the report. Optionally, instrumentation plots may be placed in Section 4 of the report and a statement included in Appendix D that the plots may be found in Section 4.

E. Inspection Photographs

Optionally, some or all of the photographs may be included in the appropriate sections of the report. If photographs are included within the report, provide a list of the photographs and the corresponding page number in Appendix E.

F. Inspection Checklists (Optional)**G. Operation and Maintenance Documentation (If required)**

1.0 Executive Summary

The executive summary is intended to be a concise summary of the Part 12D Independent Consultant's findings, assessments, conclusions and recommendations. The information can be provided in narrative and/or bulleted format.

1.1 General (include *brief* project description)

1.2 Summary Assessment of the FMA report

1.3 Summary of Field Inspection Findings

1.4 Summary of O&M status

1.5 Summary Assessment of "Supporting Technical Information" document

Note: Specifically identify any new calculations conducted by the Part 12D Independent Consultant for this report.

1.6 Conclusions

Provide a summary of conclusions from each section of the report listed by section.

1.7 Summary of Recommendations

Provide a summary of conclusions from section 8 of this report.

1.8 Certification

Note: By signing this document, the Part 12D Independent Consultant is stating that the entire report has been developed by and under the direction of the undersigned. The Part 12D Independent Consultant shall make a clear statement that he/she generally concurs with the assumptions, methods of analyses, and results of all studies documented in the report. The Part 12D Independent Consultant is thus taking responsibility for the Part 12D report contents as a Professional Engineer. It is not required to repeat this statement in each section or sub-section of the report.

1.8.1 List of all field inspection participants

1.8.2 Reference to FERC Order 122 dated March 1, 1981 and paragraph 12.37 (c) (7).

1.8.3 Signature(s) of Part 12D Independent Consultant(s)

1.8.4 PE Stamp

See Appendix A: **FERC Letter Requiring Part 12D Inspection**

See Appendix B: **FERC Letter Approving Part 12D Consultant** - (Include date of current report outline provided by FERC)

2.0 Project Description

2.1 Brief Project Description

For each major element and ancillary structure, provide a brief description of the type of structure, general dimensions, etc. The detailed project description will be in the “Supporting Technical Information” document.

For multi-project or development licenses, include a brief outline of how this site fits with the other projects.

2.2 Hazard Potential Classification.

Based on views from the dam, other project works inspected and discussion with the licensee, document any changes in upstream or downstream conditions that might affect the Hazard Potential Classification. Review with the licensee the methods and assumptions used to develop the IDF. If the IDF is less than the PMF, the IC should confirm that the IDF is still valid based on an assessment of the downstream conditions as noted above.

2.3 Summary of Standard Operating Procedures

2.3.1 Purpose of Project (Run of river, storage, flow augmentation, flood surcharge storage, control reserve, pumped storage, etc.)

2.3.2 Reservoir rule curves by season (include operating restrictions if any)

2.3.4 Standard gate operation procedures (lead and following gates, emergency power systems, etc.)

2.4 Modifications Conducted for Project Safety

Document any modifications to project works since the last Part 12D inspection that have been done to improve project safety. (i.e.: spillway gates reinforced, seepage drain, berm added, crest raised, post-tensioned anchors installed, foundation drains or relief wells cleaned, etc.). In the next Part 12D Safety Inspection Report, these items will become part of Section 2.1. This information should be fully described in the updated “Supporting Technical Information” document submitted with the Part 12D report.

Do not include routine maintenance such as unit overhaul, gate painting, etc. Note, that generators, transformers, and transmission facilities are excluded from the Part 12D program under 18CFR subsection 12.35.

2.5 Flood History

2.5.1 Flood of Record, PMF, IDF

2.5.2 Zero freeboard spillway capacity

2.5.3 Peak spillway discharge during last five year period

2.5.4 Peak reservoir elevation during last five year period

2.6 Conclusions (If any)

See Appendix C: **Project Figures** (Note: If the STI is bound with this report, do not duplicate figures)

3.0 Discussion of Potential Failure Mode Analysis Report

Do not include security issues in the Part 12D report. For licensed projects that include multiple independent dam and powerhouse developments, separate PFMA studies and reports should be made each development.

3.1 General

Identify the team members, and their affiliations, who developed the comprehensive Potential Failure Modes Analysis (PFMA) or its update. Note that the process was in accordance with FERC Engineering Guideline Chapter 14.

3.2 Assessment of Potential Failure Mode Analysis Report

3.2.1 General

List the viable potential failure modes identified in the PFMA report. These would generally be Category 1 through Category 3 events. Provide an assessment of the reasonableness and completeness of the failure mode scenario and whether the PFMs identified have a real possibility of occurrence. Potential Failure modes should be listed in order of importance.

3.2.2 Potential Failure Mode Scenarios

Each realistic potential failure mode description should include the sequence of conditions and events that would lead to the failure mode.

- PFM 1. (i.e. Internal erosion, piping)
- PFM 2. (i.e. Seismic induced deformation)
- Etc.

3.2.3 Assessment of Mitigation Actions for Each Potential Failure Mode

For each potential failure mode, assess the actions that can be taken to mitigate the developing potential failure. (This would come from the PFMA report).

- PFM 1
- PFM 2
- Etc

3.2.4 Assessment of Monitoring Program for Each Potential Failure Mode
For each potential failure mode, assess the monitoring (visual and instrumentation) that exists or is recommended in the PFMA report that will warn of development of the potential failure mode, of adverse performance, or of an impending failure condition.

- PFM 1
- PFM 2
- Etc

3.2.5 Are there other potential failure modes that have been identified and addressed in this report or that should be assessed?

3.3 Supporting Documentation

Has the Licensee archived all materials and documents that were utilized in the PFMA session?

3.4 Conclusions

See “Supporting Technical Information” document: **Potential Failure Mode Analysis Study Report** (Update as appropriate)

4.0 Performance Monitoring and Visual Surveillance with Respect to Potential Failure Modes

Note: Review and Assessment of performance monitoring programs must always be done from the point of view of potential failure modes. Although the primary assessment is with respect to the potential failure modes identified in the PFMA study, the Independent Consultant must determine if there are potential failure modes not previously addressed or not adequately considered.

For the purposes of this section, a Threshold value is the value used in the analysis or design, or is established from the historic record. An Action Level is the instrument reading that triggers increased surveillance or an emergency action.

4.1 Operator's Surveillance Program

Daily/weekly operator's inspections and reports.

4.2 Active Instrumentation

This will vary by project. Discuss only the instruments actually at the project. Is instrumentation in accordance with Chapter 9 of the Engineering Guidelines?

4.2.1 Piezometers

4.2.2 Weirs

4.2.3 Settlement/alignment monuments

4.2.4 Crack gages

4.2.5 Upstream river and/or rain gage stations

4.2.6 Headwater/tailwater (alarm systems)

4.2.7 etc.

4.3 Threshold and Action levels

For each instrument, or group of instruments as appropriate, provide a table of Threshold and Action levels as defined above. If the information is included in the STI provide an assessment of the information.

4.4 Reading procedures/frequency

4.4.1 Data acquisition and evaluation (manual/automated)

4.4.2 Data evaluated in a timely manner by a qualified engineer

4.4.3 Spurious readings (are spurious readings confirmed or explanations provided)

4.4.4 Readings compared to Threshold and Action levels defined for each instrument

4.5 Assessment of Instrumentation Data and Performance Monitoring Programs Relative to Potential Failure Modes

Include newly identified potential failure modes

4.6 Conclusions

Instrumentation plots may be presented in either Appendix D or Section 4 of the Part 12D report. If the plots are included in Section 4, include a statement in Appendix D that the instrumentation plots may be found in Section 4.

5.0 Field Inspection

5.1 Field Inspection Observations

For each element of the project (i.e.: spillway, earthfill embankment, gravity section, intake, powerhouse, conveyance system, etc.), observe and report visual observations of the following issues as appropriate. Include photographs of significant project features and observations. If an inspection checklist is used, include a copy of the checklist in this section. A site specific inspection checklist should be formatted to include specific visual surveillance items identified in the PFMA.

The intent of this section is to highlight changed conditions for the report reviewer, not to document unimportant or minor details.

The report should be in text format by structure or element addressed individually. For each structure or element of the project, The Part 12D Independent Consultant should consider the following items:

- Settlement
- Movement – including abutments (cracks or other signs of distress or change)
- Erosion
- Seepage/Leakage
- Cracking
- Deterioration
- Spillway gate Operation/Standby Power (At a minimum, the Part 12D Independent Consultant needs to review the licensee’s annual certificates of spillway gate operation and interview project operating staff to assure that emergency backup systems work and that operating personnel know how to use them.)
- Outlet/Sluice Gate Operation
- Water conveyance systems (canals / flumes / penstocks / tunnels / surge chambers, emergency bypass or closure systems, etc.)
- Foundation Drain/Relief Well Operation
- Evidence of high artesian or uplift pressures (structures / foundations / abutments)
- Observations of sediment transport (piping evidence)
- Observations of seeps, wet areas, springs, green grass
- Other Pertinent Observations

5.2 Status of Response(s) to Recommendation(s) in Last Part 12D Report.

5.3 Field Observations with Respect to Potential Failure Modes

Document field observations pertinent to each potential failure mode noted in Section 3

5.4 Adequacy/Operation of Public Alert Systems

Note: Are upstream spillway warning buoys, and downstream sirens and lights operable?

5.5 Conclusions

See Appendix E: **Inspection Photographs** (Optionally, some or all of the photographs may be included in the appropriate sections of the report. If photographs are included within the report, provide in Appendix E a list of the photographs and the corresponding page number)

See Appendix F: **Inspection Check List** (optional)

6.0 Operation and Maintenance Programs Relative to Potential Failure Modes

Do not include security issues in the Part 12D inspection report. If observations of significant O&M issues are made, include in report for possible new potential failure mode analysis.

6.1 Summary PFMA identified O&M issues (from PFMA report)

6.2 Operation and Maintenance Procedures

6.2.1 Communication/Response

Address adequacy and reliability of remote monitoring, communication and control systems (Operations / Instrumentation / Telemetry – Do the systems provide adequate reliability and redundancy? Can a specific gate, valve or other project component be operated remotely on demand?)

6.2.2 Electrical/Mechanical Systems

- Spillway Gate Motors (line/line voltage, amperage draw)
- Standby and Redundant Power Sources
- Manual/Remote/Automatic Operation of Gates and Valves
- Gate Operation Sequence
- Icing protection (heaters/bubblers/reservoir level restriction)

6.2.3 Human Factors

- Adequate Staff for Emergency Response (Multiple Sites)
- Reliable Access Routes (winter/storm conditions)
- Training
- Electricians/Mechanics/Laborers
- Adequate Time to Respond
- Call Out Systems (time for crew to reach site after call out)

6.3 Assessment of O&M Procedures Relative to Potential Failure Modes

6.4 Conclusions

See Appendix G: **Operation and Maintenance Documentation**

7.0 Assessment of Supporting Technical Information Document

The purpose of this section is for the Part 12D Independent Consultant to assess the contents of the “Supporting Technical Information” document compiled by the licensee.

- 7.1 Potential Failure Mode Analysis Study Report (Include a statement referring to Section 3 for a discussion of the Potential Failure Mode Analysis)
- 7.2 Project Description and Drawings
- 7.3 Construction History
- 7.4 Standard Operating Procedures
- 7.5 Assessment of Geology and Seismicity
- 7.6 Assessment of Hydrology and Hydraulics
- 7.7 Assessment of Instrumentation
- 7.8 Assessment of Stability and Stress Analyses of Project Structures
- 7.9 Assessment of Spillway Gates
- 7.10 Pertinent Correspondence Related to Safety of Project Works
- 7.11 Status of Studies in Process and Outstanding Issues
- 7.12 References
- 7.13 Conclusions

The Licensee is responsible for compiling the “Supporting Technical Information” (STI) document.

The initial STI should be provided to the Independent Consultant and three hard copies and two digital copies shall be submitted to the FERC. As new information is obtained, or modifications are made to the project, the licensee will update this document as required. Updates to this document shall be provided to the current FERC Part 12D Independent Consultant for review, to the FERC and to other document holders. Document holders should be requested to insert the updated pages in the STI, and add the revision to the revision notice log in the front of the STI.

Except for the initial submittal of an STI document, if no significant changes have been made to the STI since the prior Part 12D Inspection report, either a digital copy of the most current STI in *.pdf, *.jpg, *.tif, or other acceptable formats (check with the FERC for acceptability of alternative formats prior to submittal) or a hard copy of the STI shall be included with the Part 12D report. For small projects, the STI document may be bound with the Part 12D report.

8.0 Recommendations

Each Recommendation should be identified as a maintenance or dam safety item and include a schedule for completion/implementation.

Each section of the report should be included for completeness. If there are no recommendations pertinent to a given section of the report include that section with a “None” comment.

- 8.1 Project Description
- 8.2 Potential Failure Mode Analysis Report
- 8.3 Performance Monitoring and Visual Assessment with Respect to Potential Failure Modes
- 8.4 Field Inspection
- 8.5 Operations and Maintenance Programs Relative to Potential Failure Modes
- 8.6 Assessment of Supporting Technical Information Document

APPENDICES

List of Tables (with location)

List of Figures (with location)

List of References

A. FERC Letter Requiring Part 12D Inspection

Note: May include specific FERC concerns to be addressed by Part 12D Independent Consultant.

B. FERC Letter Approving Consultant

Note: Include date of report outline provided by FERC.

C. Project Figures

This Appendix should include the following figures as appropriate. All Figures should be consecutively numbered. Figures should be general without excessive detail so as to be clearly legible. Figures should include documentation of significant changes since last Part 12D report. If STI document to be directly bound in this report, do not duplicate the figures. FERC Exhibit and relicensing drawings can be used.

- Location map with project facilities located including conveyance systems and access routes from main roads and nearest town
- Plans of project facilities
- Typical sections and profiles of key project features (dams, spillways, powerhouses, intakes, emergency/fuse plug spillways, chute profiles, etc.)
- Profiles and typical sections of water conveyance systems (canals, tunnels, penstocks, flumes, surge chambers, etc)
- Satellite or aerial photo of project and downstream area
- Spillway and tailwater rating curves

D. Instrumentation Monitoring Data Plots

Note: Plans and cross-sections with locations of each instrument, including design phreatic surface or uplift pressure profile, and tabulated data for each instrument are included in the “Supporting Technical Information” document only. See Chapter 9, Instrumentation and Monitoring, of the Engineering Guidelines for additional information. Only time versus reading graphs are included here as NEW information.

If data plots are included in Section 4 of the Part 12D report, a statement should be provided here directing the reader to Section 4 for the information.

- Time versus Reading data plots

- Plot all data to date, not just last five years (alternative is to plot last 15 years and note historic range for each unit)
- Do not put too many instruments on one plot
- Try to put all instruments from one section or profile on the same plot
- Mark tip elevation, unscreened length, ground elevation and top of piezometer elevation for each unit on the data plot
- Use symbols for each unit, not just colors (colors do not reproduce in black and white and some people are color blind)
- Include headwater and tailwater levels on each plot
- Force all time scales to show full year cycles from January through December
- For multiple plots for the same project, force vertical and horizontal scales on all plots of the same type to have the same scale or total range so plots can be directly overlaid
- Mark threshold values
- Show monthly precipitation on one sheet
- Mark action levels requiring emergency response

E. Inspection Photographs

F. Inspection Checklist (optional)

G. Operation and Maintenance Documentation (if required)

Appendix I

Guidelines for Supporting Technical Information

Purpose:

The purpose of the Supporting Technical Information document (STI) is to summarize those project elements and details that do not change significantly between quinquennial FERC Part 12D Independent Consultant Safety Inspection Reports. The licensee will create and maintain this document for use by themselves, the Part 12D Consultant and the FERC.

The STI should include sufficient information to understand the design and engineering analyses for the project such as:

- A complete copy of the Potential Failure Mode Analysis report
- A detailed description of the project and project works
- A summary of the construction history of the project
- Summaries of Standard Operating Procedures
- A summary of geologic conditions affecting the project works
- A summary of hydrologic and hydraulic information
- Summaries of instrumentation and surveillance for the project and collected data
- Summaries of stability and stress analyses for the project works
- Pertinent correspondence from the FERC and state dam safety organizations related to dam safety

The STI should use tables, figures, and drawings in preference to text and should not include complete copies of the original documents except for the “Potential Failure Mode Analysis” study report. Only key paragraphs of the original reports should be included in this document for clarity.

The STI is a “living” document, in that as new data or analyses become available they are appended to the initial STI and outdated material is removed. The document should be bound in a three ring binder to facilitate updating the STI as necessary.

The Licensee should coordinate this document with the Part 12D inspection report outline to be sure the Independent Consultant will have all the information necessary for review of the project. The initial STI should be provided to the Independent Consultant and three hard copies and two digital copies shall be submitted to the FERC. Updates to this document shall be provided to the current FERC Part 12D Independent Consultant for review, to the FERC and to other document holders. Document holders should be requested to insert the updated pages in the STI, and add the revision to the revision notice log in the front of the STI.

Except for the initial submittal of an STI document, if no significant changes have been made to the STI since the prior Part 12D Inspection report, either a digital copy of the most current STI in *.pdf, *.jpg, *.tif, or other acceptable formats (check with the FERC for acceptability of

alternative formats prior to submittal) or a hard copy of the STI shall be included with the Part 12D report. For small projects, the STI document may be bound with the Part 12D report.

The complete STI should be reviewed and reprinted at least every 15 years and hard copies submitted with the Part 12D report.

The “Supporting Technical Information” document must include a revision sheet and contain the following sections:

Section	Title
	Table of Contents
1.	Failure Mode Analysis Study Report
2.	Description of Project Structures
3.	Construction History
4.	Standard Operation Procedures
5.	Geology
6.	Hydrology / Hydraulics
7.	Instrumentation
8.	Stability / Stress Analysis of Project Structures
9.	Spillway Radial Gates
10.	Pertinent Correspondence Related to Safety of Project Works
11.	References

The information to be included in each section is described below.

SUPPORTING TECHNICAL INFORMATION**Revision Log
Table of Contents****1.0 Potential Failure Mode Analysis Study Report**

Include a complete copy of the latest “Failure Modes Analysis” study report with all attachments. All updates shall be included in this Section of the STI.

2.0 Description of Project Works and Project Drawings

This is a detailed description of the project and project works that is part of the Part 12D Independent Consultant review. In general, this information will come directly from existing sources such as prior Part 12D Inspection Reports, licensing or relicensing documents or company brochures. The detailed descriptions would include the following elements as appropriate:

- 2.1 General project description including project name and owner
- 2.2 Project location including nearest town(s), river system, etc.
- 2.3 Purpose of Project
- 2.4 Main dam and any auxiliary dams
- 2.5 Spillway(s) including stilling basins
- 2.6 Non-overflow water retaining structures such as powerhouses
- 2.7 Intakes
- 2.8 Conveyance systems (penstocks, tunnels, surge chambers, flumes, canals, inverted siphons, including control, regulating, and pressure relief devices, etc.)
- 2.9 Powerhouse(s)
- 2.10 Low level outlets including minimum flow devices

The following drawings shall be included

- 2.11 USGS Quad map or other location map with project facilities located including conveyance system alignment
- 2.12 Plan of licensed project facilities and project boundaries
- 2.13 Typical sections and profiles of key project works (dams, spillways, powerhouses, intakes, canals, tunnels, penstocks, flumes, surge chambers, inverted siphons, etc.)
- 2.14 Satellite or aerial photo of project and downstream area if available

3.0 Construction History

In general, this information will be copied directly from existing sources such as prior Part 12D reports, construction reports or company brochures. Include a summary of the project construction history based on the following sources of information:

- 3.1 Design reports and pertinent memoranda from licensing and permitting documents
- 3.2 Laboratory investigations and construction testing reports
- 3.3 Field and lab geotechnical investigations
- 3.4 Construction reports and photographs
- 3.5 Specification documents
- 3.6 Reports of major modifications conducted for dam safety since last Part 12D inspection
- 3.7 Construction chronology that includes all a summary of original construction and all significant work completed related to project safety. Do not include routine maintenance items such as gate painting, unit overhauls, etc.

4.0 Standard Operation Procedures

Include a statement summarizing the standard operating procedures for the project. This section should include seasonal minimum flow requirements, lead and follow gate sequence, reservoir level restrictions by season, etc.

5.0 Geology and Seismicity

In general, this section should be copied from existing reports and company brochures. Include summaries of applicable information in the following sections:

- 5.1 Geology
 - 5.1.1 Regional geology
 - 5.1.2 Site geology and local foundation conditions including geologic maps, cross-sections and profiles under the dam(s) and pertinent project works.
 - 5.1.3 Potential landslides, loose rock formations or adverse bedding orientations that could affect project works
 - 5.1.4 Potential sinkhole, karst, solutioning, basalt flow issues, etc. that could impact project works
 - 5.1.5 Potential weak seams such as bentonite or soluble gypsum layers
 - 5.1.6 Geologic artesian sources (geothermal, high abutments, etc.). Do not include artesian pressures due to normal dam seepage.

5.2 Seismicity

- 5.2.1 Map of fault traces that effect project
- 5.2.2 Table of fault, distances, depths, magnitude at fault, PGA at site, etc.
- 5.2.3 Site MCE and DBE development
- 5.2.4 Time history of adopted earthquakes
- 5.2.5 Floating earthquake magnitude, PGA, and distance
- 5.2.6 Historic earthquake centers map

The USGS website (<http://neic.usgs.gov>) includes information on seismicity and may be a useful reference.

6.0 Hydrology and Hydraulics

Provide supporting information to document the development of the Probable Maximum Flood (PMF) and the routing of the PMF through the reservoir and project spillways. In general, this information will come directly from existing sources such as prior Part 12D inspection reports or company reports. The following information that should be included as applicable:

6.1 Hydrology

- 6.1.1 Hydrometeorology report used
- 6.1.2 Probable Maximum Precipitation for general and local storms
- 6.1.3 Drainage basin description including drainage area
- 6.1.4 Antecedent conditions
- 6.1.5 Loss rates
- 6.1.6 Basin and sub-basin precipitation/runoff models
- 6.1.7 Unit Hydrograph
- 6.1.8 Reservoir inflow and outflow hydrographs for the PMF event
- 6.1.9 Floods of record including highest flood flows and reservoir elevations

6.2 Hydraulics – Dams

- 6.2.1 Project discharge-rating curves (For multiple gate spillways, outlet structures, powerhouse units, and emergency/fuse plug spillways, include the contribution of each component as well as the total capacity. Include the equations used to develop the curves including overtopping and orifice flow where appropriate).
- 6.2.2 Tailwater rating curve (Compare to dam break studies)
- 6.2.3 Normal and flood freeboard without wave action
- 6.2.4 Zero freeboard flood capacity (without wave allowance)
- 6.2.5 Inflow Design Flood (based on dam break)
- 6.2.6 Reservoir Probable Maximum and Inflow Design Flood outflow hydrographs and corresponding reservoir levels
- 6.2.7 Freeboard for general and thunderstorm events

- 6.2.8 Stilling basin or plunge pool design flood flow
- 6.2.9 Operating rule curve (if storage reservoir)
- 6.3 Hydraulics – Water Conveyance Systems
 - 6.3.1 Hydraulic capacity of water conveyance system(s)
 - 6.3.2 Normal operating freeboard
 - 6.3.3 Spillway discharge rating curve(s)
 - 6.3.4 Summary of transient analysis

7.0 Instrumentation

This section is to include drawings and/or sketches showing the location of each active instrument. Include cross-sections of project structures showing instrument tip elevation, ground elevation and readout point location. See Chapter 9, Instrumentation and Monitoring, of the engineering guidelines for additional discussion.

Note: time versus reading graphs for each instrument will be included only in the Part 12D inspection report.

- 7.1 Plans, sections, and details of active or useful reference instrumentation
 - If a unit has been abandoned or replaced, but the historic data is still being used for safety evaluations, include the appropriate information for the record
- 7.2 Reading frequency for each instrument (reading procedures should not be included in this document)
- 7.3 Procedures for resolving spurious readings
- 7.4 Tabulated Data for each instrument
- 7.5 Type of instrument (pneumatic/vibrating wire piezometer, Parshall flume, gape gage, inclinometer, etc)
- 7.6 Predicted value for each instrument (threshold values are values used in design or analysis of project structures)
- 7.7 Historic range of readings for each instrument
- 7.8 Threshold and Action level for each instrument

8.0 Stability and Stress Analyses of Project Structures

Because every dam and hydroelectric project is unique, it is not possible to list here all the various items that are required to adequately detail stability or stress assessments of the project water retaining structures. It will be the responsibility of the Licensee to include all information necessary for the reader to understand the assumptions, methods of analysis, and load cases assessed for each project structure. Stability and stress analyses for each structure shall be summarized graphically for ease of understanding and communication and to create a permanent record storage.

The following types of information should be provided:

- 8.1 General
 - 8.1.1 Listing of credible load cases analyzed (including water levels for dam, canal and flume analyses or pressure for penstock and flowline analyses)

- 8.1.2 Statement of the method of analysis used and the computer program adopted.
- 8.1.3 Properties of materials based on site specific tests or assumptions (state which). Include representative test data and summary sheets.
- 8.2 For each gravity structure and load case:
 - 8.2.1 Graphic free body diagram (cross-section) of each structure showing:
 - the assumed self weight of the cross section
 - all applicable loads including, as appropriate:
 - assumed uplift pressure distribution
 - silt loads
 - headwater and tailwater loads
 - point loads
 - ice load
 - 8.2.2 Key elevations
 - 8.2.3 Key lateral dimensions
 - 8.2.4 Piezometer and drain locations
 - 8.2.5 Foundation shear strength parameters
 - 8.2.6 Minimum cohesion to meet stability criteria
 - 8.2.7 Negative crest pressures
 - 8.2.8 Concrete unconfined and splitting tensile strength test results
 - 8.2.9 AAR potential or evidence, failure planes investigated, etc.
- 8.3 For each embankment structure and load case:
 - 8.3.1 Graphic cross-section showing
 - embankment zoning
 - phreatic surface
 - critical failure surfaces
 - key elevations
 - key lateral dimensions
 - slopes
 - headwater and tailwater elevations
 - 8.3.2 Potential for uncontrolled seepage at toe
 - 8.3.3 Summary of liquefaction analyses
 - 8.3.4 Summary of deformation analyses

- 8.3.5 Procedures used to determine soil properties, etc.
 - Soil Classification
 - Atterberg limits
 - etc.

- 8.3.6 Procedures used to determine soil strengths
 - Triaxial Tests (type and loadings)
 - Standard Penetration Tests
 - Cone Penetration Tests
 - Becker Hammer Tests
 - etc.

- 8.4 For each arch dam load case:
 - 8.4.1 Finite element mesh
 - 8.4.2 Stress contours
 - 8.4.3 Vector diagrams
 - 8.4.4 Thrust block stability and joint sterionets
 - 8.4.5 Pulsating load potential, etc.

- 8.5 For each water conveyance system that has a highlighted PFM
 - 8.5.1 Stress and stability analyses

- 8.6 Summary table of factors of safety for each structure and load case, with required value.

For embankment structures and overburden foundations, the material strengths used in the stability analyses should be properly identified i.e. effective stress or total stress. The methods used to determine pore pressures should also be described.

For gravity structures, it is useful to provide a spreadsheet of the key numbers from the analysis.

9.0 Spillway Gates

For each spillway gate type, include the following information:

- 9.1 Table of material properties (steel type, trunnion bearing type and friction properties, etc).
- 9.2 A summary of the stress analysis computations
 - 9.2.1 Graphic of gate model used for stress analysis
 - 9.2.2 Table of critical stresses in each member for each load condition.
- 9.3 Trunnion, wheel, or other lubrication procedures, schedule, etc.
- 9.4 Summary of gate hoist motor load tests to date (line-line voltage, amperage draw, reservoir level, and initial draw if available)
- 9.5 Spillway gate detailed inspection report

10.0 Pertinent Correspondence Related to Safety of Project Works

Include FERC annual operation inspection reports for the five years preceding the current Part 12D inspection report. Include any major correspondence from FERC or State Dam Safety Agencies related to outstanding dam safety issues for the project.

11.0 References

List of references available for review of dam safety issues and that were used to assemble this document.