



**Memorandum from the Office of the Inspector General**

November 10, 2010

Robert M. Deacy, Sr., LP 5D-C

**FINAL REPORT – INSPECTION 2010-13105 – STABILITY ASSESSMENT PROCESS REVIEW**

Attached is the subject final report for your review. This report does not include any recommendations and is to be used for informational purposes only. Accordingly, no response is necessary.

Information contained in this report may be subject to public disclosure. Please advise us of any sensitive information in this report that you recommend be withheld.

If you have any questions, please contact Greg R. Stinson, Acting Director, Inspections, at (865) 633-7367. We appreciate the courtesy and cooperation received from your staff during this review.

*Robert E. Martin*

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GRS:NLR

Attachment

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OIG File No. 2010-13105



Tennessee Valley Authority  
Office of the Inspector General

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# *Inspection Report*

## **STABILITY ASSESSMENT PROCESS REVIEW**

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Inspection 2010-13105  
November 10, 2010

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MEMORANDUM DATED SEPTEMBER 28, 2010, FROM ROBERT M. DEACY  
TO ROBERT E. MARTIN



# Inspection 2010-13105 – Stability Assessment Process Review

## EXECUTIVE SUMMARY

### Why the OIG Did This Review

The Office of the Inspector General (OIG) and a report prepared by McKenna Long and Aldridge, LLP identified weaknesses in Tennessee Valley Authority's (TVA) culture and the coal ash management program. This review was initiated to assess and report on (1) the appropriateness of TVA processes and (2) completed and planned actions, pertaining to culture change, stability assessments of TVA ash impoundments, and ash management.

The objectives of this review were to determine what processes TVA has followed since the Kingston Fossil Plant ash spill to address (1) deficiencies in ash management governance, (2) cultural issues identified, (3) stability of the other coal ash impoundments, and (4) deficiencies in the coal ash management program. The scope of this review included any and all information regarding coal ash management and risk.

### What the OIG Found

In summary, we found that since the Kingston Fossil Plant ash spill, TVA is taking appropriate actions to (1) improve ash management governance, (2) drive culture change, (3) evaluate the stability and corresponding safety factors pertaining to ash impoundments, (4) remediate risks, and (5) identify and address ash management deficiencies. Specifically, TVA has:

- Decided to include coal ash impoundments under the Dam Safety Program to increase governance and utilize the expertise of TVA's independent Hydro Review Board in assessing the safety and stability of coal ash impoundments.

- Taken action to drive organizational culture change including (1) hiring an independent cadre of professionals to assess the TVA culture, (2) instituting an organizational effectiveness initiative, and (3) reorganizing to improve accountability.
- Hired Stantec, Inc., to evaluate the stability of facility ash impoundments and has established an appropriate evaluation and remediation process.
- Taken immediate action to improve stability and remediate risks pertaining to many TVA coal ash impoundments.
- Compiled a gap analysis of all recommendations for TVA from all relevant review sources to ensure all ash management problem areas are addressed. The development and implementation of the quality assurance/quality control processes and the development of ash management policies and procedures are examples of key actions taken.

While TVA has made significant progress to date, it is important to note this is a long-term project that TVA must continue to make a priority.

### **Management's Comments on Draft Report**

TVA management concurred with the substance of the draft report and provided some administrative and clarifying comments for our consideration. These comments were reviewed and incorporated as appropriate. Management's complete comments are included in the Appendix to this report.

## **BACKGROUND**

On Monday, December 22, 2008, shortly after midnight, a retention wall for an ash containment area at the Kingston Fossil Plant failed. The failure resulted in approximately 5.4 million cubic yards of coal ash sludge to be released. The Emory River was impacted by the spill, along with approximately 300 acres of the Watts Bar Reservoir. In addition, a large number of homes and businesses were affected by the spill. Tennessee Valley Authority (TVA) is diligently working to clean up the spilled ash. To date, TVA has 75 contractors associated with the cleanup efforts. Ash is currently being dredged out of the river, dewatered on-site, and sent by rail to Arrowhead Landfill in Perry County, Alabama.

TVA's Board of Directors retained McKenna Long and Aldridge, LLP (McKenna) after the spill to advise the Board on legal issues pertaining to the spill. The Board also asked McKenna to prepare a factual report of the Kingston spill with regard to cultural issues that may have contributed to the spill. McKenna began their review in early January 2009 and on July 21, 2009, submitted "A Report to the Board of Directors of the TVA Regarding Kingston Factual Findings" that contained, among others, the following findings:

- A lack of clarity and accountability for ultimate responsibility
- A lack of standardization, training, and metrics
- Siloed responsibilities and poor communication
- A lack of checks and balances
- A lack of prevention priority and resources
- Reactive instead of proactive "fixes"

In a report issued by the Office of Inspector General (OIG) on July 23, 2009, titled "Review of the Kingston Fossil Plant Ash Spill Root Cause Study and Observations About Ash Management," we noted several important findings including:

- TVA failed to investigate and report management practices that contributed to the Kingston spill.
- TVA could have possibly prevented the Kingston spill if it had taken recommended corrective actions.
- AECOM overemphasized the "slimes" layer as a trigger for the Kingston spill, which could limit corrective actions.
- TVA's enterprise risk management program did not adequately address known risks associated with ash impoundments.
- The culture at TVA's fossil fuel plants impacted ash management.

McKenna's and the OIG's reports identified weaknesses in TVA's culture and the coal ash management program. This review was initiated to assess and report on the appropriateness of TVA processes and completed and planned actions, pertaining to culture change, stability assessments, and ash management.

Ash management is related to significant risks identified in TVA's enterprise risk management (ERM) system. An ERM system is designed to identify and mitigate risks that could adversely affect the organization's ability to achieve its mission and objectives. A strong and robust process for managing ash could help reduce the risk of 8 of the 19 enterprise risks including:

- Catastrophic Accident
- Coal Ash Management
- Unplanned Revenue Loss
- Major Business Disruption
- Environmental Contamination
- Litigation
- Major Construction Project
- Customer/Stakeholder Relations

## **OBJECTIVES, SCOPE, AND METHODOLOGY**

The objectives of this review were to determine what processes TVA has followed since the Kingston Fossil Plant ash spill to address (1) deficiencies in ash management governance, (2) cultural issues identified, (3) stability of the other coal ash impoundments, and (4) deficiencies in the coal ash management program. The scope of this review included information regarding TVA coal ash management and risk. In order to achieve our objectives, we:

- Interviewed key TVA officials and contractors to determine TVA's processes and actions taken to (1) identify TVA's cultural problems and affect culture change, (2) assess and remediate the stability of the other impoundments, (3) address immediate stability issues at TVA ash impoundments, and (4) correct ash management deficiencies.
- Reviewed documentation to identify, verify, and assess the process taken to evaluate ash impoundment stability and make determinations regarding immediate remediation needs.
- Reviewed documentation for actions taken by TVA regarding the stability of ash impoundments to verify work undertaken/completed.
- Reviewed documentation and conducted interviews regarding the deficiencies and corresponding actions taken or planned regarding the ash management program.

This review was conducted in accordance with the "Quality Standards for Inspections."



## **FINDINGS**

In summary, we found that since the Kingston Fossil Plant ash spill, TVA is taking appropriate actions to (1) improve ash management governance, (2) drive culture change, (3) evaluate the stability and corresponding safety factors pertaining to ash impoundments, (4) remediate risks, and (5) identify and address ash management deficiencies. Specifically, TVA has:

- Decided to include coal ash impoundments under the Dam Safety Program to increase governance and utilize the expertise of TVA's independent Hydro Review Board in assessing the safety and stability of coal ash impoundments.
- Taken action to drive organizational culture change including (1) hiring an independent cadre of professionals to assess the TVA culture, (2) instituting an organizational effectiveness initiative, and (3) reorganizing to improve accountability.
- Hired Stantec, Inc., to evaluate the stability of facility ash impoundments and has established an appropriate evaluation and remediation process.
- Taken immediate action to improve stability and remediate risks pertaining to many TVA coal ash impoundments.
- Compiled a gap analysis of recommendations for TVA from all relevant review sources to ensure all ash management problem areas are addressed. The development and implementation of the quality assurance/quality control processes and the development of ash management policies and procedures are examples of key actions taken.

While TVA has made significant progress to date, it is important to note this is a long-term project that TVA must continue to make a priority.

### **TVA IS TAKING STEPS TO IMPROVE ASH MANAGEMENT GOVERNANCE**

In our report titled "Review of the Kingston Fossil Plant Ash Spill Root Cause Study and Observations About Ash Management," we noted that "we found numerous memorandums dating from 1987 through 1996 where TVA internally discussed whether ash ponds should fall under the Dam Safety Program. TVA recognized that if dam safety guidelines were implemented, additional steps would need to be taken, such as closely reviewing the existing inspection procedures for compliance with dam safety requirements, performing additional stability analyses, adding monitoring instrumentation, and instigating a drilling and testing program. Some TVA managers and executives took the position that managing ash ponds under the Dam Safety Program was unnecessary for safety, and TVA was not technically required to do so. TVA ultimately did not place the ash ponds under the Dam Safety Program."

Also in the report, the OIG's consultant Marshall Miller and Associates, Inc., reported that had TVA included ash ponds in the Dam Safety Program, including performing customary geotechnical exploration, laboratory testing, and dike seepage and stability analyses, the probability of identifying some or all of the conditions that led to the Kingston failure would have increased significantly. Since the spill, TVA has taken steps to (1) increase the governance structure pertaining to ash management and (2) utilize the expertise of TVA's independent three-member Hydro Review Board.

### **Governance Structure**

Dam Safety, a group that previously was housed under River Scheduling, is being established as a separate independent governance group. Previously, this group had responsibility for all assets owned by the River Operations Group. Dam Safety's new responsibilities will include providing a governance role over coal ash impoundments in the TVA system.

The TVA Dam Safety Governance Group will be instituting guidance to delineate expectations for asset owners and define the requirements for compliance with Dam Safety guidelines. In summary, the Coal Combustion Products Projects and Engineering Group and the Coal Combustion Projects Group will be responsible for planning, operating, and maintaining the ash impoundments in accordance with the requirements defined by Dam Safety.

### **Hydro Review Board**

In compliance with the Federal Guidelines for Dam Safety, TVA Dam Safety personnel meet regularly with the Hydro Review Board. These meetings have typically occurred twice a year. The Hydro Review Board consists of three internationally recognized experts in dam engineering. The members were selected based on the depth and breadth of their academic and/or professional involvement in the field of dam engineering and their experience related to TVA dam safety projects and programs. They participate in periodic reviews of the analysis, design, inspection, instrumentation, construction, and rehabilitation of TVA dams and locks. The TVA Hydro Review Board's responsibilities include:

- Assuring consistency with industry practice and standards.
- Assuring structural, hydrologic, and seismic adequacy.
- Improving and integrating new developments/philosophies into TVA's Dam Safety Program.
- Finding practical and innovative solutions to dam engineering problems.

The Hydro Review Board has recently begun meeting regularly with the Coal Combustion Products Group. They have been providing guidance on topics such as seismic stability analysis and impoundment closure plans. TVA's plans call for continuing use of the Hydro Review Board to provide guidance and services to the Coal Combustion Product Group with regard to ash impoundments.

## **TVA HAS IMPLEMENTED ACTIONS TO AFFECT CULTURE CHANGE**

In our report titled "Review of the Kingston Fossil Plant Ash Spill Root Cause Study and Observations About Ash Management," we found that "ash management at TVA reflected a culture that ash was unimportant. This resulted in significant weaknesses in ash management practices across TVA including: (1) a failure to implement recommended corrective actions that could have possibly prevented the Kingston spill; (2) a lack of policies and procedures; (3) poor maintenance; (4) a lack of specialized training; (5) multiple organizational structure changes; (6) inadequate communication; and (7) a failure to follow engineering best practices."

Based on OIG reports and other external TVA reviews, it became evident that culture change was essential across TVA to improve accountability, communication, risk management, and operational effectiveness. While it is too early to fully assess the result of this culture change effort, TVA took immediate action to address the effectiveness and efficiency of operations.

Specifically, TVA implemented appropriate actions to assess the culture and drive change management. Actions included (1) hiring an independent cadre of professionals to assess the TVA culture (i.e., McKinsey and Company, Inc.), (2) instituting an organizational effectiveness initiative, and (3) reorganizing to improve accountability.

### **McKinsey and Company, Inc.**

TVA hired a third-party international management consulting firm, McKinsey and Company, Inc. (McKinsey), to complete a detailed review of TVA's systems, standards, controls, and culture. This addressed an OIG recommendation that TVA should dedicate a cadre of professionals to the task of remediating TVA's cultural issues.

McKinsey was retained by TVA as directed by the Board of Directors in the July 2009 Board meeting. The scope of McKinsey's assessment included determining how to transform the organization with regard to governance and accountability, organizational structure, operating policy and procedures, and institutional capabilities.

### **Organizational Effectiveness Initiative**

TVA has begun an Organizational Effectiveness Initiative (OEI) that is meant to create a unified structure throughout TVA. The OEI aims to strengthen TVA's organizational capabilities to deliver on its mission and strategy, as well as to improve organizational effectiveness, cooperation, and engagement within TVA.

The OEI has five main goals to perform in order to achieve its TVA mission. Those goals are to (1) set a clear strategic vision, (2) build talent and drive accountability, (3) run, maintain, and improve operational performance,

(4) provide robust financial stewardship, and (5) tackle significant multi-stakeholder strategy issues.

In order to achieve those goals, the OEI team has set up five different councils. Those councils are the (1) Executive Council, (2) People and Performance Council, (3) Finance Council, (4) Strategy and External Relations Council, and (5) Operating Council. Each of these councils have been tasked with achieving one of the goals, however, they must all work together in order to fulfill TVA's mission. The officers on these councils report directly to the Chief Executive Officer.

One of the OEI team's tasks was to restructure TVA to make the organizational structure more efficient and to increase communication lines. The specific mandate was to flatten the TVA organization by reducing levels and increasing spans of control that will improve communication and accountability. The new organizational structure is a tiered structure with uniform position titles across the entire organization so that each person's role in the company is clearly defined.

### **Organizational Accountability Pertaining to Ash Management**

In addition to the overall TVA Organizational Effectiveness Initiatives, TVA has taken several actions management believes are necessary to ensure the support for sound policies and procedures related to ash management. In essence, these actions are deemed significant by TVA management in not only correcting failures and deficiencies, but in addressing management improvement initiatives.

In summary, TVA management has made significant management and philosophical changes which are driving the development and implementation of (a) more detailed and rigorous policies and procedures for storing, handling, and maintaining ash and ash disposal facilities and (b) a comprehensive program for future coal combustion product remediation and conversion.

In fiscal year 2009, the Clean Strategies and Project Development organization<sup>1</sup> was established to help position TVA to meet the many challenges following the environmental event at Kingston. To strengthen the focus on TVA's coal combustion by-products and clearly establish accountability, the Coal Combustion Products Projects and Engineering Group and the Coal Combustion Management Group were created within Clean Strategies and Project Development.<sup>2</sup>

- Coal Combustion Products Projects and Engineering Group – Responsibilities include evaluating the physical integrity of all TVA ash and gypsum disposal

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<sup>1</sup> The Clean Strategies and Project Development organization has since changed to Fossil Generation, Development, and Construction.

<sup>2</sup> Further defining of organizational responsibilities now finds the Coal Combustion Products and Engineering Group and the Coal Combustion Management Group residing under Fossil Generation, Development, and Construction.

facilities, prioritizing projects across the system, and creating a rigorous routine inspection program.

- Coal Combustion Management Group – Responsibilities include the development and implementation of a consistent fleet strategy to address handling of all TVA coal combustion products.

While it is too early to determine whether the reorganizations will completely promote and drive culture change, it does dictate that all elements of ash management (environmental, engineering, and operations/maintenance) are now under the control of a single organization with its own stand-alone budget. This should provide a control mechanism to reduce the risk that funding needed for ash management is not redirected to address other capital or operating and maintenance needs. The capital program to convert TVA's 6 coal-burning plants currently using wet fly ash systems to dry fly ash systems and convert all 11 fossil plants to dry bottom ash systems resides in Fossil Generation, Development, and Construction. This program would close 18 existing ash and gypsum ponds. The projected cost of the plan is \$1.5 billion to \$2 billion over the next eight to ten years.

## **TVA HAS TAKEN STEPS TO EVALUATE THE STABILITY OF ASH IMPOUNDMENTS**

TVA commissioned the engineering firm Stantec, Inc., to inspect, evaluate, and make recommendations for the stability of all coal combustion by-product storage facilities at all of TVA's fossil plants. Stantec began this work in January 2009. One area of Stantec's global services includes geotechnical engineering. Stantec states:

*Stantec's geotechnical services are focused on solving our most pressing infrastructure construction and rehabilitation issues, including dams, and levee, transportation facilities, abandoned mine lands landfills, waterfront engineering and diving, byproduct engineering for electric utilities, and geotechnical program management or national and international clients. Stantec's comprehensive geotechnical services range from field explorations and laboratory testing to the design and construction management of complex geotechnical structures.*

Our (1) review of documentation, (2) peer reviews of Stantec construction and modification engineering design and laboratory work, and (3) TVA site walk-downs find Stantec engaging in such work for TVA. Specifically, Stantec's TVA work pertaining to impoundment stability analyses consists of a four-phase approach that is guiding immediate remediation activity, future planned actions, and changes to TVA coal combustion impoundment management. Stantec facilitates work management and tracking by providing TVA with a weekly update which addresses, among other things, progress on ongoing project work and activities to be performed in the future. In conjunction with TVA

impoundment facility assessments, remediation/construction work, and the closure process, Stantec has also developed an approach to evaluate TVA's coal combustion by-products storage facilities for seismic events.

### **Phase 1**

Stantec's Phase 1 reports were issued on June 24, 2009. Phase 1 geotechnical engineering work was broken into two parts—1a and 1b. Phase 1a consisted of on-site interviews and site walk-over. The objective of Phase 1a was to look for visible or obvious signs of distress or concerns that may require short-term corrective actions and to provide data for the prioritization of Phase 2 activities. The walk-overs were performed by teams of at least two engineers. The teams included at least one licensed engineer with experience in dam design, dam safety, and/or geotechnical engineering.

After reviewing documentation and becoming familiar with the facility and TVA practices, the teams returned to the sites to conduct Phase 1b. This phase consisted of:

- Additional interviews with plant personnel to learn more about the history, maintenance, operations, and issues at each facility.
- Completing field activities, including measurements of embankment slopes, crest widths, and freeboard. Stantec also further noted the extent of seepage, slope instability, erosion, sparse vegetation, trees, animal burrows, poor surface drainage, and other relevant features.

### **Phase 2**

Phase 2 consists of detailed engineering studies and analysis at each facility, including (a) geotechnical explorations, (b) stability, hydrologic, and hydraulic analysis, (c) remediation engineering and workplan development, and (d) conceptual designs. The order in which the evaluations were performed was based on Stantec's opinion of the risk associated with each facility. Phase 2 has been completed. For Phase 2, Stantec submitted to TVA all 16 final reports. The following chart shows when the final reports were submitted to TVA.



**FINAL GEOTECHNICAL STABILITY EVALUATION  
REPORTS FROM STANTEC**

<b>PLANT</b>	<b>AFFECTED AREA</b>	<b>FINAL REPORT DATE</b>	<b>STATUS</b>
ALF	East Ash Pond Geotech Stability Evaluation Report	03/25/10	Final Received
ALF	East Dike Stilling Pond Geotech Evaluation Report	02/04/10	Final Received
BRF	Ash Stack/Gyp Stack/Main Ash Pond Evaluation Report	04/12/10	Final Received
COF	Bottom Ash Pond 4 Geotech Evaluation Report	01/22/10	Final Received
COF	Area 5 Dry Stack Geotech Evaluation Report	03/26/10	Final Received
CUF	Gypsum Stack/Dry Ash Stack Geotech Evaluation Report	06/11/10	Final Received
CUF	Ash Pond Geotech Evaluation Report	03/29/10	Final Received
GAF	Fly Ash E/Bottom Ash A Geotech Evaluation Report	05/27/10	Final Received
JSF	Ash Disposal/Bottom Ash Geotech Evaluation Report	02/08/10	Final Received
JOF	Active Ash Pond Dike Geotech Evaluation Report	04/13/10	Final Received
PAF	Scrubber Sludge Complex Geotech Evaluation Report	06/14/10	Final Received
PAF	Peabody Ash Pond Geotech Evaluation Report	02/09/10	Final Received
SHF	Ash Pond and Dry Stack Geotech Evaluation Report	07/14/10	Final Received
SHF	Intake Dredge Cell Geotech Evaluation Report	03/09/10	Final Received
WCF	Ash Pond Complex Geotech Evaluation Report	02/04/10	Final Received
WCF	Gypsum Stack Complex	02/05/10	Final Received

**Phases 3 and 4**

Phases 3 and 4 have been initiated, Phase 3 consists of facility design and permitting, and Phase 4 consists of a detailed training program. Phase 3 has

evolved from the initial objective of developing engineering plans for recommendations developed in Phase 2 to something more comprehensive. Phase 3 now consists of development and approval of construction workplans and the capital project work necessary for (1) remediation of issues needing immediate attention, (2) improving stability and corresponding factors of safety, and (3) future impoundment projects, including impoundment closure plans.

With regard to training, the initial dam safety inspection training has been completed. TVA personnel who operate, inspect, and maintain the impoundments have completed a training program designed to increase awareness of dam failure modes, provide an understanding of what to look for in their daily work, and to recognize structural distress. The class also includes case histories, proper inspection procedures, and plant emergency procedures. The class teaches that during an inspection the dike crest, freeboard, dike slopes, dike toe areas, and outlet works should be evaluated. The training proposes an inspection schedule that includes an informal daily and weekly inspection by plant personnel, a formal monthly inspection by plant personnel, a quarterly inspection by a TVA team and an annual inspection by Stantec. This training module for about 300 employees was completed in September 2009. As public safety officers, the TVA Police also received this training. A comprehensive Coal Combustion Products training plan is scheduled to be developed before October 2010.

### **Stantec's TVA Facility Assessment Weekly Report**

To track progress of Stantec's approach to stability analysis and corrective action, Stantec submits a weekly report to TVA. The report contains a number of documents including (1) a *Facility Risk/Hazard Matrix*, which incorporates information from another contractor (URS) that is also performing impoundment enhancement and construction work, (2) the *Stantec Geotechnical Exploration Status at TVA Fossil Plants*, (3) the status of *TVA Facility Assessment Program*, *Stantec Construction Workplans*, and (4) the *TVA Facility Assessment Weekly Report*.

#### *Facility Risk/Hazard Matrix*

The facility matrix lists the impoundment facilities at each plant, the found factors of safety, the current factors of safety, and key actions to improve the current factors of safety and/or dam safety hazard classification. The factors of safety are color coded to easily show which facilities meet the minimum factor of safety of 1.5 and which ones need additional work.



### *Stantec Geotechnical Exploration Status at TVA Fossil Plants*

The geotechnical exploration status shows the drillings that have been completed and are planned for each facility, including completed boring footage. It also listed the planned and completed inclinometer and piezometer installations and number of cone penetrometer tests at each facility.

### *TVA Facility Assessment Program, Stantec Construction Workplans*

The weekly workplan update lists the workplans that have been completed, are in progress, and that are proposed for each TVA plant. The update also identifies what part of the facility will be modified. For example, the update notes that for Bull Run Fossil Plant Workplan No.1 (Workplan BRF-090414-WP1), the facilities to be modified are the gypsum and dry fly ash stacks. The repairs are to be made to the gypsum stack depression and fly ash dry stack wet area.

### *TVA Facility Assessment Weekly Report*

The facility assessment report is a very comprehensive report providing detailed information by TVA site. Information provided in the report may include services performed during the week pertaining to spillway replacement, geotechnical exploration and stability analysis, the instrumentation monitoring program, and other site repairs, observations, and discoveries. The report also identifies:

- Capital improvement projects services performed for the respective week.
- Anticipated tasks to be performed in upcoming weeks.
- Instrumentation Monitoring Program readings schedule and status.
- Current scope of work tasks and status.

### **Seismic Analysis**

TVA recognizes there is potential for strong earthquakes to occur within the region, and there is a tangible risk for seismic failure at each closed coal combustion by-products facility. These risks, including the likelihood and consequences of failure, must be understood to effectively manage TVA's portfolio of by-product storage sites.

Seismicity in the TVA service area is attributed to the New Madrid fault and smaller, less concentrated crustal faults. These two earthquake scenarios generate significantly different seismic hazards at each locality and will be considered independently within each facility risk assessment. At each closed by-product facility, TVA's plans call for:

- Potential seismic failure modes to be evaluated in sequence.
- Instability due to soil liquefaction, slope instability due to inertial loading, and other potential failure mechanisms to be addressed.
- Seismic performance to be evaluated for differing earthquake return periods until a limiting (lowest return period) event that would cause failure is obtained.

After the smallest earthquake that would cause failure at each site is determined, they will look at the likelihood of that earthquake occurring. The assessment of risk will also include estimates of potential consequences, as well as costs to mitigate the risks, that reflect the unique setting of the individual storage facility. At that point there will be an estimated probability of a seismic event occurring that would cause failure at each ash storage facility. These risks will be incorporated into the enterprise risk management process so management can choose to mitigate the risk or accept the risk based on the probability of occurrence and cost.

Following the same general methodology, seismic risks will be estimated in two phases. The near-term "Portfolio Seismic Assessment" will provide a rough estimate of seismic risks. The likely performance of each facility will be evaluated using simplified analyses, empirical methods, and the judgment of experienced engineers. The results will establish a ranking of the relative risks across the closure portfolio and also provide a preliminary picture of overall seismic risk. For the subsequent "Facility Seismic Assessments," seismic performance will be judged on the basis of site-specific data from the detailed engineering analyses, which will be completed during the closure design process for individual facilities.

## **TVA HAS TAKEN IMMEDIATE ACTIONS TO REMEDIATE RISKS RELATED TO ASH POND STABILITY**

TVA determined that it would be best to address stability concerns quickly rather than waiting until all the geotechnical exploration and detailed analyses were complete. Thus, they completed many initial remediation efforts at ash impoundment facilities based on Stantec's initial inspections.

While Stantec has completed all of its geotechnical exploration, other detailed analyses continue. Many critical remediation efforts have been completed or are ongoing and have increased the factor of safety at the respective ash impoundment. For example:

- Due to TVA's initial remediation efforts, the "as found" factors of safety for the various disposal facilities included ten impoundments with factors of safety at less than 1.3. To date, there are now only three impoundments with factors of safety less than 1.3.
- At Widows Creek Fossil Plant (WCF), because of a very low factor of safety and seepage, TVA took immediate actions rather than waiting on the more detailed analyses. Slopes have been flattened, and extensive stability actions have been completed. The pictures on the following page show the WCF gypsum stack prior to the initial remediation efforts and the WCF gypsum stack after the initial remediation efforts.

### WCF Gypsum Stack Prior to Initial Remediation Efforts



### WCF Gypsum Stack After Initial Remediation Efforts



- At Paradise Fossil Plant, because of the geotechnical and laboratory analysis, additional buttressing, armoring, and flattening were initiated for the Gypsum Complex. Work has been done to stabilize the Gypsum Complex dikes due to seepage, and work is ongoing.
- At Johnsonville Fossil Plant, the water level has been lowered, and a seepage collection system and new spillways have been installed.
- At Shawnee Fossil Plant, the exterior dike of the intake dredge cell has been stabilized and reconstructed.

During Phase 1 reviews, Stantec noted limited geotechnical instrumentation at a majority of the facilities, and the presence of a program to routinely obtain measurements was not found. Dam safety management of impoundments should include an instrumentation program to monitor performance and condition changes during operation of the facility. In general, instrumentation may consist of piezometers to measure water levels, inclinometers and monuments to monitor movement, and plates to monitor settlement. In response to the finding, as of May 28, 2010, Stantec has installed 61 slope inclinometers and 471 piezometers to monitor performance.

## **TVA HAS TAKEN ACTIONS TO ADDRESS ASH MANAGEMENT DEFICIENCIES**

After the Kingston spill, TVA received numerous recommendations from various groups, including the Office of the Inspector General, the TVA Board of Directors, and McKenna Long and Aldridge LLP. To ensure that no recommendation and concern went unaddressed, TVA created a gap analysis listing all recommendations and concerns from all sources and determined which recommendations overlapped. This gap analysis is a living document which is updated as work progresses.

We reviewed a gap analysis, which shows work that has been completed and work that is still ongoing. Some of the improvement areas pertain to:

- Programmatic documents.
- Standard processes/procedures.
- The environmental review process.
- The management of impoundments under Dam Safety.
- Documentation management.
- The quality assurance/quality control review process.
- Inspection reporting.
- Instrumentation monitoring.
- The Corrective Action Program.



- Security enhancement.
- The budget process.
- Training program development.
- Communication plans.
- Integration of ash management into Enterprise Risk Management.
- Utilization of industry benchmarking and leading practices.
- Coal Combustion Product industry leadership.
- The cultural change management program.
- Emergency action plans.

Based on our review of the gap analysis and previous findings in this report, TVA has made a good faith effort to track and address all recommendations received from various groups since the Kingston spill. TVA is making progress on addressing these recommendations and has plans in place to address the remaining recommendations.

The development and implementation of quality assurance/quality control processes and the development of ash management policies and procedures are examples of key actions taken.

### **TVA Has Implemented Peer Review and Quality Assurance/Quality Control Processes**

TVA has implemented a quality assurance/quality control (QA/QC) process for the analyses and remediation efforts at all TVA coal combustion by-product storage facilities, as well as Dike C at Kingston. After Stantec completes its stability analyses of each facility, a peer review will be conducted by one of three contractors. For selected plants, the peer review will be conducted with the assistance of Dr. Gonzalo Castro.<sup>3</sup> The peer reviewers offer changes to the analyses, planned actions, or other recommendations as needed. This process is intended to ensure that the most up-to-date and best engineering analyses have been performed on the remaining impoundments.

Both Stantec and URS will perform remediation activities at various sites, with another engineering firm peer reviewing their work. Management illustrated the QA/QC process as follows:

- Several key projects at various sites were initially selected to have a third-party review performed.
- Coal Combustion Products Projects and Engineering Group sent the necessary data, test analyses, documents, and other needed information to

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<sup>3</sup> Dr. Gonzalo Castro is a civil engineer with more than 35 years of experience in geotechnical engineering. He is a recognized expert in seismic analysis and earthquake engineering.

AECOM, URS, or Geosyntec as appropriate for the QA/QC analysis to be completed.

- Coal Combustion Products Projects and Engineering Group then coordinated the review comments with Stantec and the third-party review company. TVA management stated several good comments were received on the projects, and the resolution of those comments was driven to completion by an assigned engineer.

As an outgrowth of the peer review and QA/QC process and findings, TVA developed the *Facility Risk/Hazard Matrix* discussed above, which is updated weekly. Throughout the analysis and remediation efforts, the QA/QC process has caused some engineering assumptions and remediation actions to change. This has caused changes to TVA's requirements to get the facilities factors of safety to target. This matrix is a good example of TVA's process for peer QA/QC reviews, as the matrix tracks actions taken, action to be taken, and changes in factors of safety for each ash impoundment.

### **TVA Ash Management Policies and Procedures**

Prior to the Kingston spill, TVA had no policies or procedures regarding the handling and storage of coal combustion by-products. This resulted in the management at each fossil plant implementing their own strategies for handling and storing the coal combustion by-products created by their facility. In the aftermath of Kingston, TVA hired URS to develop extensive coal combustion by-product policies and procedures for TVA. URS has completed comprehensive policies and procedures.

The OIG reviewed the URS draft policies and procedures. The proposed policies and procedures cover such areas as:

- Descriptions of the TVA facilities.
- Description of Coal Combustion Product streams.
- Philosophy of operation.
- Ash management roles and responsibilities.
- Governing regulations and regulatory requirements.
- Environmental permits/permitting.
- Internal and external review protocols.
- Lessons learned.
- Coal Combustion Product management disposal capacity tracking and reporting.
- Safety program.
- Site security requirements.

- Training program.
- Data management.
- Design criteria-regulatory standards.
- Reporting.
- Procedural requirements for construction.
- Closure requirements.
- Post-closure requirements.
- Emergency operations and contingencies.
- General operation information and operational responsibilities.
- Inspections, monitoring, and reporting.

One example of these new procedures is the inspections program TVA has instituted to better monitor the condition of the facilities. The procedure requires a daily inspection by the Routine Handling Operation & Maintenance (RHO&M) foreman, weekly inspections by RHO&M supervisors, monthly inspections performed by RHO&M construction managers, and quarterly inspections by RHO&M program managers. Additionally, plans call for:

- Yearly inspections performed by a third-party engineering firm or the Dam Safety Group.
- A five-year inspection performed by a third-party engineering company.

Maximo<sup>4</sup> will automatically generate work packages prior to inspection due dates. The intent is for all work orders to be signed off, processed, and stored using TVA document storage. In addition, to prepare the inspectors, Stantec has completed an inspection training program at the various TVA facilities. Through this program, Stantec trained TVA personnel, including plant personnel and TVA Police, under dam safety guidelines. To date, 337 TVA personnel have received the training.

Also, to allow for visible inspections of the dikes/slopes, vegetation control is now required. Vegetation is scheduled to be cut frequently enough to limit the vegetation height to 6-10 inches and limit the growth of bushes, vines, etc. The plan is for vegetation growth on riprap slopes to be sprayed with herbicides on regular scheduled intervals.

Based on our review of these policies and procedures, there has clearly been significant improvement since the Kingston spill, when TVA had no policies and procedures for ash management.

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<sup>4</sup> Maximo is the IBM software TVA uses for work management, corrective action, and the supply chain.

## MANAGEMENT'S COMMENTS ON DRAFT REPORT

TVA management provided some administrative and clarifying comments for our consideration. These comments were incorporated; however, we modified the report to identify the number of facilities with a factor of safety of less than 1.3 based on supporting documentation. Specifically:

- Management stated that there are currently only two facilities with a factory of safety of less than 1.3, however, the latest information reviewed by the OIG shows there are three.

Management's complete comments are included in the Appendix of this report.



September 28, 2010

Robert E. Martin, ET 3C-K

COMMENTS - DRAFT INSPECTION 2010-13105 - STABILITY ASSESSMENT PROCESS  
REVIEW

FGD&C concurs with the substance of the draft report. Several minor editorial comments are provided for your consideration:

- Organizational name typo on page 5, 3rd paragraph; two places on page 7; two places on page 17, it is not "Coal Combustion Products and Engineering", rather "Coal Combustion Products Projects & Engineering.
- Time issue...on page 9, Phase 2 of the Stantec Assessment is actually complete.
- Another timing issue, on page 13, actual number of facilities that have a FoS < 1,3 is two, not five.

We have appreciated the opportunity to work closely with your staff and will continue to strive for a fully transparent interface between our organizations.



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Kingston Ash Recovery Project

Cc:

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OIG File No. 2010-13034