Memorandum from the Office of the Inspector General

July 28, 2016

James R. Dalrymple, LP 3K-C
John J. McCormick, Jr., BR 4D-C

REQUEST FOR MANAGEMENT DECISION – EVALUATION 2016-15359 – ACTIONS TAKEN TO ADDRESS RISKS RELATED TO COAL PLANT DUCTWORK

Attached is the subject final evaluation report for your review and management decision. Your written comments, which addressed your management decision and planned actions for three of the recommendations, have been incorporated into the report. For those three recommendations, please notify us when final actions are complete. Please advise us of your planned actions in response to the remaining recommendations within 60 days from the date of this report.

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 or wish to discuss our findings, please contact Meghan H. Petty, Senior Auditor, at (423) 785-4812 or E. David Willis, Director, Evaluations at (865) 633-7376. We appreciate the courtesy and cooperation received from your staff during the evaluation.

David P. Wheeler
Assistant Inspector General
(Audits and Evaluations)
ET 3C-K

LWC:FAJ
Attachment
cc (Attachment):

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OIG File No. 2016-15359

Office of the Inspector General

Evaluation Report

To the Senior Vice President, Power Operations and the Vice President Safety, River Management and Environment

ACTIONS TAKEN TO ADDRESS RISKS RELATED TO COAL PLANT DUCTWORK

Evaluations Team
Meghan H. Petty
Lucas W. Cotter

Evaluation 2016-15359
July 28, 2016

ABBREVIATIONS

ADEM	Alabama Department of Environmental Management
Bull Run	Bull Run Fossil Plant
CR	Condition Report
Cumberland	Cumberland Fossil Plant
ECP	Employee Concerns Program
EPA	Environmental Protection Agency
EP&C	Environmental Permitting and Compliance
FY	Fiscal Year
Guidance	Flue Gas Leak Reporting Guidance
H&SC	Health and Safety Committee
Kingston	Kingston Fossil Plant
Medgate	Medgate Reporting System
NO_x	Nitrogen Oxides
NOV	Notice of Violation
OGC	Office of the General Counsel
OIG	Office of the Inspector General
OSHA	Occupational Safety and Health Administration
Paradise	Paradise Fossil Plant
SCFM	Standard Cubic Feet per Minute
SCR	Selective Catalytic Reduction
SO_2	Sulfur Dioxide
SPP	Standard Processes and Procedures
TVA	Tennessee Valley Authority

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APPENDIX

Evaluation 2016-15359 – Actions Taken to Address Risks Related to Coal Plant Ductwork

EXECUTIVE SUMMARY

Why the OIG Did This Evaluation

We recently completed an organizational effectiveness evaluation of the Tennessee Valley Authority's (TVA) Cumberland Fossil Plant (Cumberland) that identified concerns with ductwork leaks and falling lagging at the site.[i] Based on our observations from that review, we initiated an evaluation of the actions TVA has taken to address risks related to coal plant ductwork.[ii] The objective of our evaluation was to determine if TVA is taking actions to address environmental and safety risks related to flue gas ductwork at coal plants.

What the OIG Found

We found TVA has completed repairs to address environmental risks associated with flue gas ductwork at coal plants. However, TVA's framework for repairing and reporting ductwork leaks could be improved by (1) clarifying thresholds to repair and report cumulative leaks, (2) establishing realistic repair timelines, and (3) prioritizing the most environmentally damaging leaks for repair.

We also found that TVA has completed some repairs designed to address safety risks associated with ductwork, but TVA site management indicated long-term capital projects are needed and planned for remediation at Bull Run Fossil Plant and Cumberland, where the worst material conditions were present. In addition, we found weakness in the identification of safety concerns related to ductwork at the sites.

Additionally, we determined TVA is assuming risk by adopting a strategy to apply thermal coatings to ductwork at Cumberland to resist corrosion. Thermal coatings have not previously been used for this application nor have they been through a technical review involving Generation Engineering. This could result in TVA spending several million dollars on a solution that may not work.

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[i] Evaluation 2015-15296, Cumberland Fossil Plant Organizational Effectiveness, November 4, 2015.

[ii] Subsequent to our initiation of this evaluation, we completed an organizational effectiveness review at TVA's Bull Run Fossil Plant that also identified ductwork as an area needing improvement: Evaluation 2016-15357, Bull Run Fossil Plant Organizational Effectiveness, March 30, 2016.

EXECUTIVE SUMMARY

What the OIG Recommends

We recommend the Senior Vice President, Power Operations:

- Modify the Air and Gas Inspection and Assessment Standard to establish workable time frames for repairing ductwork leaks and appropriately prioritize environmentally significant risks.
- Reinforce employee responsibilities for documenting safety concerns in Condition Reports and near misses in order to ensure employee safety issues are brought to management's attention.
- Involve Generation Engineering in a technical review of the planned ductwork coatings at Cumberland to validate the effectiveness for proposed applications.

We recommend the Vice President, Safety, River Management and Environment:

- Coordinate with the Office of the General Counsel to clarify Flue Gas Leak Reporting Guidance for ductwork leak repair and reporting thresholds and communicate the results as needed.
- Ensure site Safety Consultants are documenting safety concerns in Condition Reports and near misses, where possible, in order to ensure employee safety issues are brought to management's attention.

TVA Management's Comments

TVA management stated they agreed with the facts, conclusions, and recommendations provided in the report and provided planned actions to address 3 of the 5 recommendations. In addition, management stated initiatives are under way to reinforce use of TVA's injury and incident system for reporting injuries and near misses. TVA management also stated they have decided not to pursue the application of a thermal coating for ductwork at Cumberland. See the Appendix for TVA management's complete response.

Auditor's Response

We concur with TVA management's comments and planned actions for 3 of the 5 recommendations. However, management did not address how they would reinforce employee and Safety Consultants' responsibility for

entering Condition Reports for safety concerns. In addition, it should be noted that the thermal coatings discussed in management's comments are referring to external coatings. However, according to additional information provided by management, TVA continues to pursue internal coatings for ductwork at Cumberland.

BACKGROUND

The Tennessee Valley Authority (TVA) operates nine coal-fired fossil plants with a total of 39 active generating units. Each unit produces electricity by burning coal in a boiler to heat water, producing steam to spin a turbine. Along with steam, the coal combustion process produces hot gases (called flue gases) that include sulfur dioxide (SO_2), nitrogen oxides (NO_x), and ash particles. Flue gas moves through ductwork to various air pollution control devices[1] prior to being emitted through the stack. According to the Electric Power Research Institute, "Corrosion of carbon steel flue ducts is common in power stations." Air leaks and cold regions on the ductworks' surfaces lead to condensation of acid gases, which can create corrosive conditions and leaks. These acidic compounds in flue gas can make it into the atmosphere through leaks causing both public health and safety and environmental risks, according to TVA Environmental Systems. In addition, these acidic compounds can damage the ductwork exterior, which can pose risks to employee safety.

Environmental Risks – In 1990, Congress made changes to the Clean Air Act, introducing a nationwide approach to reducing acid pollution—called the Acid Rain Program. The law is designed to reduce acid rain and improve public health by dramatically reducing emissions of SO_2 and NO_x. The Acid Rain Program requires most power plants to obtain a permit[2] that establishes how the power plant plans to comply. Plants subject to acid rain emission limitations must install continuous monitoring systems for SO_2 and NO_x, or adopt an alternative monitoring method. TVA uses the Continuous Emissions Monitoring System to determine gaseous emission rates and to record the resulting data, which is submitted to regulatory agencies.

Employee Safety Risks – TVA's Safety Manual provides guidance to assist all employees with safely executing work activities. It is intended to be consistent with, or exceed the occupational safety and health standards under Section 6 of the Occupational Safety and Health Administration (OSHA) Act. According to TVA Safety personnel, potential employee safety risks associated with flue gas ductwork include (1) falling lagging, (2) flue gas exposure, and (3) compromised grating. The following provides descriptions and illustrations of each of these.

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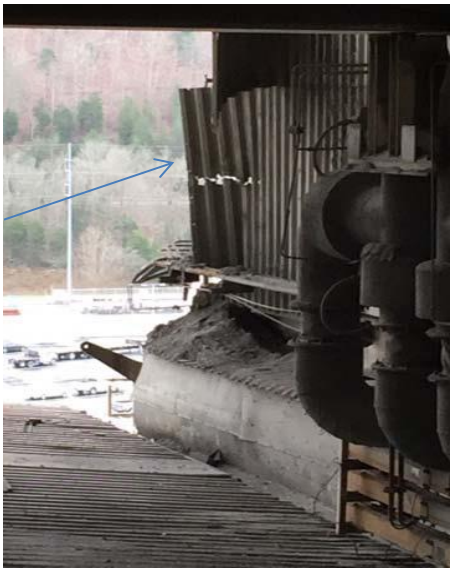
1 Air pollution control devices include selective catalytic reduction (SCR) systems, electrostatic precipitators, and flue gas desulfurization systems (scrubbers). SCR systems reduce NO_x emissions, electrostatic precipitators capture ash particles, and scrubber systems reduce SO_2 emissions.

2 Title V is the operating permit program that requires stationary sources (such as power plants) to obtain permits that includes information on which pollutants are being released, and what steps the source is taking to monitor or measure air pollution.

- Falling Lagging: Flue gas ductwork lagging is the finishing material used to cover insulation surrounding the duct. As shown in Illustration 1, flue gas leaks in the ductwork may cause deterioration resulting in visibly distressed lagging panels as well as locations where the lagging is hanging loosely or has completely fallen away from the duct. Loose lagging presents a safety concern for personnel working in the area due to its potential to fall to areas below. According to TVA Safety Operations personnel, loose lagging could be considered a safety hazard under OSHA's General Duty Clause, which mandates employers provide employees a place of employment "free from recognized hazards that are causing or are likely to cause death or serious physical harm."

Illustration 1
Loose Lagging on SCR Box,
Bull Run Fossil Plant,
December 2015



- Flue Gas Exposure: (See Illustration 2.) Flue gas is comprised of SO_2, NO_x, and ash particles, which are subject to OSHA regulations for toxic and hazardous substances in the workplace. Applicable OSHA standards for SO_2, NO_x, and ash particle levels are set for 8 hours of exposure and are to be measured by taking samples from impacted areas. According to OSHA, if air contaminated with harmful dust and gases cannot be controlled by engineering controls, appropriate respirators shall be used.

Illustration 2
Haze from Flue Gas Leaks
(Left of Stack Emissions),
Bull Run Fossil Plant,
March 2015

- Compromised Grating: Grating is an industrial flooring material made of metal. As such, it is susceptible to acidic compounds that can leak from ductwork, corroding the surface, as shown in Illustration 3. Corrosion may compromise structural integrity of the grating.

Illustration 3
Corroded Grating Near Flue Gas Ductwork, Cumberland Fossil Plant, January 2016

Identifying and Reporting Ductwork Leaks at TVA

The Alabama Department of Environmental Management (ADEM) and the Environmental Protection Agency (EPA) each issued Notices of Violation (NOV)[3] to TVA, in 2005 and 2007 respectively, related to ductwork leaks at Widows Creek Fossil Plant Unit 7. ADEM noted that TVA did not exhibit a standard of care commensurate with applicable regulatory requirements, specifically operating and maintaining control equipment in a manner so as to minimize emissions. ADEM further noted there was a significant delay between discovering the leaks and repairing them during a scheduled outage. Consequently, TVA agreed to pay a $100,000 civil penalty to ADEM. In 2011, TVA entered into a consent agreement and final order with EPA to resolve the 2007 NOV that TVA violated the Clean Air Act resulting from "ongoing and pervasive duct leaks" at Widows Creek Fossil Plant Unit 7. According to EPA, ductwork leaks were not adequately repaired, allowing SO_2 and NO_x to escape into the atmosphere from 2002 through 2005. TVA agreed to pay a civil fine of $450,000 and to retire 931 SO_2 allowances and 13 NO_x allowances under EPA's cap and trade programs.[4]

Prior to the final order with EPA, and in response to regulatory actions, TVA developed the Flue Gas Leak Reporting Guidance (Guidance)[5] to establish when leakage should be repaired and when emissions values should be corrected and

[3] According to EPA, a warning letter or a NOV to the alleged violator is a first step in their enforcement process. Such notification indicates to the regulated entity that the enforcement agency believes that the entity is in violation of the law and that it should come into compliance or be prepared to defend its actions in subsequent enforcement.

[4] According to EPA, an allowance authorizes a utility or industrial source to emit 1 ton of emissions during a given compliance period. Allowances are fully marketable commodities. Once allocated, allowances may be bought, sold, traded, or banked for use in future years.

[5] The Guidance contains advice from the Office of the General Counsel (OGC).

reported to EPA. Subsequently, TVA developed Standard Processes and Procedures (SPP) FPG-SPP-09.026, Air and Gas Duct Inspection and Assessment Standard. The SPP defines performance standards for inspecting and assessing air and gas ductwork systems as well as the process for identifying and reporting gas leaks to the atmosphere. Internal inspections of major air and gas ductwork to assess the material condition are required by the SPP during every regularly scheduled, planned outage. It also requires external inspections of the major air and gas ductwork to assess the ductwork's material condition and identify new leaks weekly by Operations personnel and monthly by a designated Ductwork inspector. The SPP assigns responsibility to the Environmental Permitting and Compliance (EP&C) group for determining when regulatory limits are exceeded. EP&C then determines if modifications to any data reported to regulators are required by the Guidance based on the inspection results and calculated volume of gas leakage.

Based on observations from a recent organizational effectiveness review we performed at TVA's Cumberland Fossil Plant (Cumberland),[6] we initiated an evaluation of actions taken to address risks related to coal plant ductwork. The Cumberland organizational effectiveness review identified ductwork leaks and falling lagging as concerns at the site. Subsequent to our initiation of this evaluation, we completed an organizational effectiveness review at TVA's Bull Run Fossil Plant (Bull Run) that also identified ductwork as an area needing improvement.[7]

OBJECTIVE, SCOPE, AND METHODOLOGY

The objective of our evaluation was to determine if TVA is taking actions to address environmental and safety risks related to flue gas ductwork at coal plants. The scope of the evaluation was limited to issues with flue gas ductwork during fiscal years (FY) 2014 and 2015. Since scrubbers increase the risk of corrosion within flue gas ductwork, our evaluation included plants with operational scrubbers: Bull Run, Cumberland, Kingston Fossil Plant (Kingston), and Paradise Fossil Plant (Paradise) Unit 3.

To achieve our objectives, we:

- Analyzed ductwork leak trends from Monthly Environmental Duct Leak Summaries to identify instances where ductwork leaks exceeded TVA's stated threshold of 1.0 percent of stack flow.
- Interviewed key TVA personnel in Safety Support and Safety Operations, EP&C, Generation Engineering, Generation Projects, OGC, and plant management to identify safety risks as well as regulatory and internal requirements for taking action to address identified risks and issues.
- Calculated average days to repair ductwork leaks based on first observed dates and repaired dates recorded in the Environmental Duct Inspection

[6] Evaluation 2015-15296, Cumberland Fossil Plant Organizational Effectiveness, November 4, 2015.

[7] Evaluation 2016-15357, Bull Run Fossil Plant Organizational Effectiveness, March 30, 2016.

Reports to determine timeliness of actions taken as compared to FPG-SPP-09.026, Air and Gas Inspection and Assessment Standard.

- Identified outstanding safety issues present by:
  - Searching Condition Reports (CR) in TVA's Maximo database[8] for keywords related to ductwork.
  - Reviewing recordable injuries and near misses obtained from the Medgate Reporting System (Medgate)[9] and the prior near-miss reporting system.
  - Reviewing site Health and Safety Committee (H&SC) Meeting minutes.
- We planned to use work orders from TVA's Maximo database to document actions taken to address safety issues related to ductwork identified in CRs. However, we determined status and closure change practices to be inconsistent and found work orders to be unreliable for the purpose of our evaluation objectives. Therefore, we gathered supporting documents from site personnel to attest to actions taken to address ductwork related CRs and issues brought forward by employees to site H&SC.
- Obtained and reviewed capital project justifications, closure reports and project plans to identify planned actions to address environmental and safety risks.
- Visited Bull Run, Cumberland, Kingston, and Paradise Unit 3 coal plants to observe ductwork conditions.

This evaluation was performed in accordance with the Council of the Inspectors General for Integrity and Efficiency's *Quality Standards for Inspection and Evaluation*.

FINDINGS

We found TVA has completed repairs to address environmental risks associated with flue gas ductwork at coal plants. However, TVA's framework for repairing and reporting ductwork leaks could be improved by (1) clarifying thresholds to repair and report cumulative leaks, (2) establishing realistic repair timelines and, (3) prioritizing the most environmentally damaging leaks for repair.

We also found that TVA has completed some repairs designed to address safety risks associated with ductwork, but TVA site management indicated long-term capital projects are needed and planned for remediation at Bull Run and Cumberland, where the worst material conditions were present. In addition, we found weakness in the identification of safety concerns related to ductwork at the sites.

[8] Employees enter CRs into TVA's Maximo system to describe issues with equipment, recommend a work order, provide actions taken to resolve the issue, and suggest solutions. Submissions are reviewed the next morning in the Work Screen review.

[9] Any employee can enter safety-related events directly into Medgate, which is used to report injuries, illnesses, vehicle accidents, near misses, and good catches.

Additionally, we determined TVA is assuming risk because of plans to apply internal thermal coatings to ductwork at Cumberland to resist corrosion. Thermal coatings have not previously been used for this application nor have they been through a technical review involving Generation Engineering. This could result in TVA spending several million dollars on a solution that may not work.

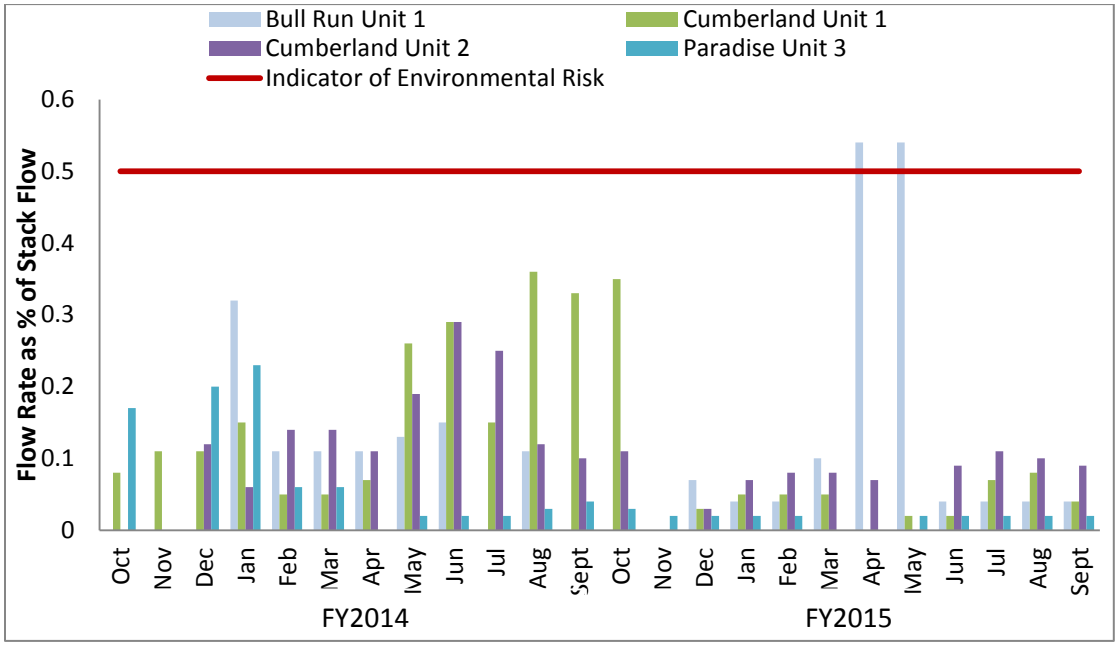
ACTIONS TAKEN TO ADDRESS ENVIRONMENTAL RISKS

TVA has completed repairs to address environmental risks associated with ductwork; however, the framework for repairing and reporting ductwork leaks could be improved. TVA established two documents to address environmental risks from ductwork, the Guidance and the Air and Gas Duct Inspection and Assessment Standard. These documents could be improved to (1) clarify thresholds to repair and report cumulative leaks, (2) establish realistic repair timelines, and (3) prioritize the most environmentally damaging leaks for repair.

Repairs Completed to Address Environmental Risks

Overall, TVA has completed repairs to address environmental risks associated with flue gas ductwork. TVA's Guidance established 0.5 percent flow rate as an indicator of potential pervasiveness, which we considered a signal of environmental risk. As shown in Figure 1, in April and May 2015, Bull Run's cumulative ductwork leaks on a unit exceeded 0.5 percent flow rate. Bull Run took actions to address the problem by replacing two expansion joints in May 2015.

Figure 1: Flow Rates of Leaks at TVA Coal Plants[10] FYs 2014 and 2015



[10] Monthly Environmental Duct Leak Summary reports showed no ductwork leaks at Kingston during our scope.

In general, TVA took actions to manage leaks before they reached 0.5 percent flow rate. For example, Cumberland Unit 1 had a flow rate of 0.35 percent in October 2014. The unit had an outage in November 2014, during which the site repaired 16 of the 22 reported leaks. When the unit came back online in December, its emissions attributable to ductwork leaks had decreased by 91 percent. Similarly, Paradise Unit 3 had a flow rate of 0.23 percent prior to repairing 3 of the 4 ductwork leaks reported in January 2014, decreasing the unit's emissions attributable to ductwork leaks by 74 percent.

Framework Could Be Improved

TVA established two documents to address environmental risks from ductwork, the Guidance and the SPP. These documents could be improved to (1) clarify thresholds to repair and report cumulative leaks, (2) establish realistic repair timelines, and (3) prioritize the most environmentally damaging leaks for repair.

Clarify Reporting and Repair Thresholds for Cumulative Leaks

The Guidance, which establishes the cumulative leak flow rate that would trigger prompt repair and reporting, is unclear and increases the risk of nonconformance with environmental regulations. According to the Guidance, "Leakage with a flow rate calculated to be 1.0 percent or greater should be considered potentially pervasive for purposes of adjusting emission reports . . . Reducing arbitrarily the leak rate to 0.5 percent of reported flow as an indicator of potential pervasiveness adds additional conservatism." This establishes a cumulative flow rate of 1.0 percent to be potentially pervasive and 0.5 percent to be an indicator of potential pervasiveness. This distinction is relevant because the Guidance relies on classification of pervasiveness to compel further action.

The Guidance states, "If a plant identifies a potential 'pervasive' amount of leakage, the following steps should be taken: (1) If pervasive leakage is identified, [EP&C] will report corrected emissions values for the affected quarter to [EPA] . . .; (2) Pervasive leakage should be promptly corrected if it has already not been corrected, including shutting down the unit until this has been accomplished; and (3) [EP&C] will continue to report with adjusted, measured emission values until the pervasive leaks are corrected."

As noted above, Bull Run experienced a cumulative flow rate above 0.5 percent in April and May 2015. EP&C informed us that a flow rate of 0.5 percent would prompt the development of an action plan, coordinated with the affected plant, to repair the leaks in order to prevent hitting 1.0 percent; however, this expectation is not established in the Guidance. Additionally, EP&C felt that the SPP provides additional assurance that leaks would be resolved prior to reaching a 1.0 percent flow rate because of its requirement to fix severe leaks immediately. However, as we discuss in the following section, plants are not adhering to the timelines established in the SPP.

EP&C and OGC acknowledged that the Guidance is unclear and that revisions should be made to clarify the threshold at which emissions values should be

corrected. However, EP&C maintained the threshold for adjusting Continuous Emissions Monitoring System reports to regulatory agencies was 1.0 percent flow rate. EP&C and OGC acknowledged that a leak with a flow rate of 1.0 percent would likely result in regulatory actions such as NOVs, fines, and/or retiring allowances. Leaving the threshold for prompt repair and unit shut down at the level at which a violation occurs increases the risk of noncompliance with environmental regulations.

Establish Realistic Repair Timelines

We found TVA coal plants were not making permanent repairs to individual ductwork leaks in accordance with the SPP. To address ductwork leaks, the SPP states:

- Severe leaks shall be repaired immediately.
- Moderate leaks shall be repaired immediately. If a permanent repair cannot be made with the unit online, then temporary repairs should be made, if feasible, until a permanent repair can be planned and completed.
- Minor leaks shall be repaired within 48 hours. If a permanent repair cannot be made with the unit online, then temporary repairs should be made, if feasible, until a permanent repair can be planned and completed.
- If repairs, permanent or temporary, cannot be made with the unit online, then plant management, Environmental Systems, and EP&C shall determine when or if the unit will be shut down for repairs.

Plant management informed us most leaks were temporarily patched until a permanent repair could be made while the unit was offline. As a result, plants were not making permanent repairs to severe leaks immediately. We identified 21 severe leaks within our scope. Of those, 14 were located at Cumberland and 7 were located at Bull Run, where the average days to permanently repair was 178 and 457, respectively.

According to plant management, the expectation for timeliness is unrealistic given operating conditions in the plant environment. Gases traveling through the ductwork system are very hot, making permanent repairs to ductwork leaks difficult while a unit is online. We were told that the units may not get cool enough during forced outages to make necessary repairs and that sites may have to wait for planned outages, where the unit will be offline for several days or weeks. As a result, we agreed the SPP establishes unrealistic timelines for repair in the plant operating environment.

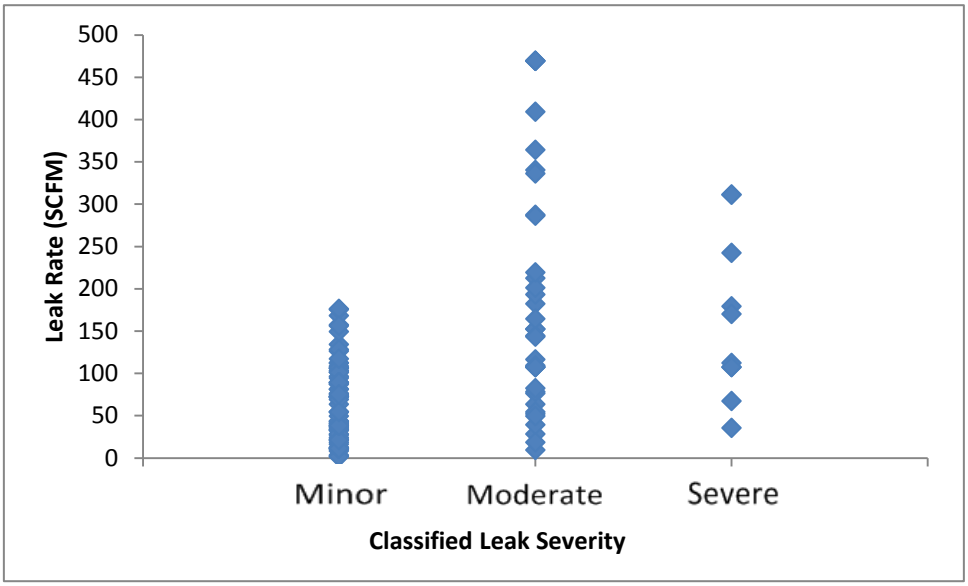
Prioritize the Most Environmentally Damaging Leaks for Repair

The SPP requires site-level ductwork inspectors to determine leak severity when leaks are identified during performance of monthly Environmental Ductwork Inspections. According to the SPP, ductwork inspectors are instructed to make their best guess at hole dimensions based on visual observation of leaks. To determine severity of the leak, inspectors use the following criteria: minor leaks

are difficult to detect; moderate leaks are fairly easily seen from distances less than 15 feet; and severe leaks can be seen from 15 feet or more and prevents work from being done in the area without respiratory protection. Using details from the ductwork inspectors' reports, Environmental Systems calculates the flow rate for each leak as well as the cumulative flow rate of leaks on each unit. These values are provided to EP&C and others on a monthly basis in the Monthly Environmental Duct Leak Summaries.

In discussions with TVA, we were informed that the intent of the SPP is primarily to resolve environmental concerns associated with ductwork leaks. Given the intent of the SPP, we examined the relationship between leak severity classifications made by the ductwork inspectors and the actual calculated leak rates. We reviewed the ductwork inspectors' reports and identified a total of 133 new leaks,[11] 2 at Paradise, 29 at Bull Run, and 102 at Cumberland. We analyzed the correlation between leak severity (as classified by ductwork inspectors) and leak rate (as reported on the Monthly Environmental Duct Leak Summaries). We determined that a weak correlation exists between classified leak severity and leak rate. As shown in Figure 2, after removing outliers,[12] we determined maximum leak rate values were highest for moderate leaks. Additionally, the average leak rates were 67, 180, and 164 standard cubic feet per minute (SCFM) for minor, moderate, and severe leaks, respectively.

Figure 2: Leak Rates (SCFM) Versus Classified Severity



Based on the above analysis, the SPP may not provide the best method for determining leak severity. Since classified leak severity determines repair prioritization and has a weak correlation with flow rate, the most environmentally

[11] We used initial observations only for this analysis.

[12] We identified 13 outliers–7 were minor, 4 were moderate and 2 were severe. All were above maximums shown in the chart. It should be noted that 3 of the minor leaks excluded had leak rates above 1,000 SCFM. The 2 severe leaks had leak rates of approximately 900 SCFM and 6,900 SCFM.

damaging leaks may not receive the proper prioritization using the current method.

ACTIONS TAKEN AND PLANNED TO ADDRESS SAFETY RISKS

We determined that TVA has completed some repairs designed to reduce the risk of falling lagging, minimize leaks, and improve grating integrity. However, site management indicated long-term capital projects are needed and planned for more complete remediation at Bull Run and Cumberland, where the worst material conditions were present.[13] We also found weakness in the identification of safety concerns related to ductwork at the sites.

Repairs Completed to Address Safety Risks

TVA has completed some repairs designed to reduce the risk of falling lagging, minimize leaks, and improve grating integrity. According to plant management and site safety personnel, when the potential for falling lagging is identified, there are a number of actions the plant can take to minimize the risk. Employees may be informed of the risk and encouraged to avoid the area. Other times, the risk is temporarily mitigated by removing or restraining loose lagging and/or barricading areas below for personnel safety. Flue gas leaks can appear in any section of the ductwork, but often occur near access doors, dampers, and expansion joints. Grating may be compromised any time it is exposed to flue gas leaks. During our plant visits, we saw evidence TVA had taken actions to address employee safety risks to include: installation of new insulation and lagging, removal of insulation and lagging, replaced grating, replaced expansion joints, replaced access doors, and areas below ductwork temporarily barricaded for safety.

Capital Projects Needed and Planned

Site management indicated long-term capital projects are needed and planned for more complete remediation at Bull Run and Cumberland, where the worst material conditions were present. The most recent system health report for Bull Run was performed in 2012, at which time the SCR system and ductwork were rated unacceptable. We were informed of minor repairs made to the system since that time. Similarly, the most recent system health report for Cumberland was performed in 2015, at which time the combustion air and gas system, which includes components in the flue gas path and associated ductwork, was rated as marginal. To address material conditions contributing to safety risks, Bull Run and Cumberland have expended funds during the scope of our evaluation and are planning upcoming capital projects as detailed below.

- **Bull Run** – A capital project to replace flue gas expansion joints was completed at Bull Run in November 2014 at a cost of $3.6 million. In addition, plant management indicated approximately $886,500 in operations and maintenance funds were expended on repairs to the SCR and ductwork during FYs 2014 and 2015. In December 2014, Bull Run was inspected by a

[13] We identified no safety risks related to ductwork material condition at Kingston or Paradise Unit 3.

joint project team (comprised of TVA and consulting engineers). The team recommended immediate repairs to restrain lagging and reduce flue gas leaks in the FY2014 outage. Since there was not sufficient time to plan and prepare for more extensive repairs in the 2014 outage, the team recommended minimum future work for the FY2017 outage should include removal and replacement of lagging and insulation, performing additional diagnostic testing, repairing casing leaks, replacing expansion joints and frames, reinforcing SCR box corners and replacing access doors. According to TVA, capital projects planned for Bull Run in FYs 2017 and 2019 are intended to address the identified work, with projected costs of $16.7 million and $5.8 million, respectively.

- **Cumberland** – Three capital projects were completed at Cumberland during our review period to replace expansion joints, insulation and lagging. Those projects cost a cumulative $6.1 million. In 2015, Cumberland was approved to spend $90 million over the next 10 years to address ductwork. As of January 2016, Cumberland was authorized to spend $5.1 million for 2016 projects.

Identification of Safety Concerns

We reviewed documentation from the Employee Concerns Program (ECP), H&SC meeting minutes, Safety Consultants, and CRs to identify safety concerns. The number of documented concerns identified during the scope of our evaluation does not match the level of concern expressed by employees during the organizational effectiveness evaluations. Through extensive employee input and Office of the Inspector General (OIG) observations at the two sites, ductwork was identified as a safety concern and area for improvement. At Cumberland, craft personnel believed safety concerns brought up were not considered as important if they did not currently affect generation; at Bull Run, employees indicated ductwork safety concerns were not addressed.

TVA's Safety Manual provides employees with both the responsibility and outlets for expressing safety concerns. Section TSP-18.202, Safety and Health Expectations states, "TVA is committed to providing a safe workplace by eliminating dangerous conditions and developing a highly motivated, multi-skilled, and trained workforce." It also states, "Employees have the right and responsibility to report unsafe and unhealthful working conditions to appropriate officials" that include ECP and agency safety and health officials, such as site safety consultants and H&SC[14] members. According to TVA, any employee can create and submit a CR to identify a safety concern. We reviewed documentation from each of these outlets to identify safety concerns related to ductwork.

- ECP Complaints: ECP reported they had not received any complaints related to ductwork in our scope.

[14] H&SCs are an integral element of TVA's safety program. The committees' objective is to play an active role in safety program implementation and contribute to the existence of safe and healthful working conditions and environments for TVA employees and visitors. Committees work closely with and submit recommendations to improve safety program implementation to the managers in charge.

- H&SC Meeting Minutes: We reviewed safety issues that were documented in H&SC meeting minutes. Across the four sites, we identified 11 issues brought forward to the HS&C. Of the 11, 6 were addressed at the time of our evaluation, 1 did not require action, 1 issue had not been addressed due to an oversight and a CR was created in response to our inquiry. The remaining 3 issues, all at Bull Run, were unaddressed as of March 2016. The issues were related to fly ash build up near precipitators, manual operation of dampers, and a need for easier identification of SCR and boiler doors.
- Safety Consultants: We were informed by safety consultants that they routinely received information about safety concerns related to ductwork; however, those concerns were not always formally documented as CRs, and there is no requirement to do so. It would be prudent to document concerns as CRs if action is warranted to prevent concerns from being overlooked.
- CRs: Across the four sites, we found one CR related to ductwork that was coded in Maximo system as safety related. The CR was opened in June 2014 to request repair to loose lagging at Cumberland. In response to our request for more information, it was determined actions had been taken to address the issue, and the CR was closed.

In addition, TVA's Safety Manual indicates every employee is responsible for knowing the hazards associated with his or her job and reporting each injury and near-miss accident.[15] We reviewed documented recordable injuries and near misses and found no documented recordable injuries or near misses resulting from ductwork. However, we were provided examples of near misses at Bull Run that were not recorded, possibly due to an employee's fear of reprimand. An example of an unrecorded near miss due to fallen lagging at Bull Run is shown in Illustration 4.

Illustration 4
Fallen Lagging on a Grated Walkway, Bull Run Fossil Plant

[15] A "near miss" is an incident that did not result in injury or illness, but had the potential to do so under slightly different conditions (e.g., time, position).

In summary, while employees have expressed ductwork safety concerns to the OIG during our organizational effectiveness reviews, they do not appear to be utilizing the formalized mechanisms to document safety concerns related to ductwork.

ADDITIONAL OBSERVATIONS

During the course of our evaluation, we were provided with details of planned actions to address ductwork issues at Cumberland, including a copy of the site's 10-Year Plan. Supporting documents included anticipated project scopes and costs for both units from FYs 2016 to 2026. As previously discussed, TVA opted to fund repairs to ductwork at Cumberland incrementally, with a total projected cost over the 10-year period of approximately $90 million.

The planned project scope encompasses (1) replacement of expansion joints; (2) removal of and replacement of insulation and lagging in certain areas; (3) repairs to ductwork to address leaks; and (4) in certain areas, application of internal and external thermal coatings. According to information provided to the OIG, the thermal coatings are intended to provide resistance to corrosion. Cumberland intends to use these coatings to preserve ductwork integrity as well as negate the need for insulation and lagging in certain areas of the ductwork, alleviating the safety issue of falling lagging. Approximately $34 million of the estimated $90 million in projected costs is identified for internal coatings. Projected costs also include $24 million to replace insulation and lagging. The plan indicates that, if external coatings are implemented, the $24 million proposed for insulation and lagging could be reduced to $12 million.

Through discussions with plant and corporate personnel, we determined the coatings had undergone testing at the site but had not undergone a technical review involving Generation Engineering. We were informed that the plant had benchmarked with chemical plants using similar coatings, but they identified no other power plants using similar materials in, or on, ductwork. We discussed use of coatings with Environmental Systems management, who indicated plans for the coating should undergo a technical review prior to application. We also became aware of dissenting views within TVA related to whether coatings would work in the planned application.

In summary, TVA is assuming risk by adopting a strategy that includes coatings that have not been through a technical review involving Generation Engineering and have not been used previously for the planned purpose. This could result in TVA spending several million dollars on a solution that may not work.

RECOMMENDATIONS

We recommend the Senior Vice President, Power Operations:

- Modify the Air and Gas Inspection and Assessment Standard to establish workable time frames for repairing ductwork leaks and appropriately prioritize environmentally significant risks.
- Reinforce employee responsibilities for documenting safety concerns in CRs and near misses in order to ensure employee safety issues are brought to management's attention.
- Involve Generation Engineering in a technical review of the planned ductwork coatings at Cumberland to validate the effectiveness for proposed applications.

We recommend the Vice President, Safety, River Management and Environment:

- Coordinate with OGC to clarify Guidance for ductwork leak repair and reporting thresholds and communicate the results as needed.
- Ensure site Safety Consultants are documenting safety concerns in CRs and near misses, where possible, in order to ensure employee safety issues are brought to management's attention.

TVA Management's Comments – TVA management stated they agreed with the facts, conclusions, and recommendations provided in the report. In response to the recommendations, management plans (1) to revise procedure FPG-SPP-09.026, Air and Gas Duct Inspection and Assessment Standard; (2) not to pursue the thermal coating for Cumberland ductwork and adhere to the Design Change Control procedure for new additions, modifications, or removals to ductwork at Cumberland; and (3) to review and clarify the Flue Gas Leak Reporting Guidance with OGC. In addition, current initiatives are under way to reinforce use of Medgate for reporting injuries and near misses.

See the Appendix for TVA's complete response.

Auditor's Response – We concur with TVA management's comments and planned actions for 3 of the 5 recommendations. However, management did not address how they would reinforce employee and Safety Consultants' responsibility for entering CRs for safety concerns. In addition, it should be noted that the thermal coatings discussed in management's comments are referring to external coatings. However, according to additional information provided by management, TVA continues to pursue internal coatings for ductwork at Cumberland.

July 8, 2016

David P. Wheeler, ET 3C-K

REQUEST FOR COMMENTS - DRAFT EVALUATION 2016-15359 - ACTIONS TAKEN TO ADDRESS RISKS RELATED TO COAL PLANT DUCTWORK

Thank you for the opportunity to review and comment on the draft evaluation report. Revised comments from Power Operations and Safety, River Management and Environment are consolidated below. We agree with each recommendation provided in the report and associated facts and conclusions.

Recommendations to Senior Vice President, Power Operations:

- Modify the Air and Gas Inspection and Assessment Standard to establish workable time frames for repairing ductwork leaks and appropriately prioritize environmentally significant risks.

  Action: TVA procedure FPG-SPP-09.026 (Air and Gas Duct Inspection and Assessment Standard) is currently under revision. Revisions will address recommendation and be completed by November 16, 2016.

- Reinforce employee responsibilities for documenting safety concerns in Condition Reports and near misses in order to ensure employee safety issues are brought to management.

  Action: Current initiatives are underway to reinforce this responsibility, utilizing TVA's injury and incident system (Medgate). Medgate is a TVA fleet tool which allows employees to report incidents including near misses and good catches. Incidents which are entered are then routed through management for awareness and proper corrective actions. This will be an ongoing effort.

- Involve Generation Engineering in a technical review of the planned ductwork coatings at Cumberland to validate the effectiveness for proposed applications.

  Action: Power Operations has a Design Change Control procedure for new additions, modifications, or removals within structures, systems, or components. The procedure will be adhered to as the applications are considered ensuring the review with Generation Engineering.

  Note: During the evaluation, it was noted that a thermal application was being considered at CUF without concurrence by Generation Engineering. Generation Engineering was requested from the site to give input into the process and the decision was made to not pursue this coating.

Recommendations to Vice President, Safety, River Management and Environment:

- Coordinate with the Office of the General Counsel to clarify Flue Gas Leak Reporting Guidance for ductwork leak repair and reporting thresholds and communicate the results as needed.

  Action: Environmental Permitting & Compliance will review and clarify with OGC the guidance document by November 18, 2016.

- Ensure site Safety Consultants are documenting safety concerns in Condition Reports and near misses, where possible, in order to ensure employee safety issues are brought to management's attention.

  Action: Current initiatives are underway to reinforce this responsibility, utilizing TVA's injury and incident system (Medgate). Medgate is a fleet tool which allows employees to report incidents including near misses and good catches. Incidents which are entered are then routed through management for awareness and proper corrective actions. This will be an ongoing effort.

If you have any questions or require any additional information, please do not hesitate to contact us.

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