Memorandum from the Office of the Inspector General

November 14, 2013

James R. Dalrymple, LP 3K-C

REQUEST FOR FINAL ACTION – AUDIT 2012-14631 – REVIEW OF TVA'S MANAGEMENT OF COMBUSTIBLE COAL DUST

Attached is the subject final report for your review and final action. Your written comments, which addressed your management decision and actions planned or taken, have been included in the report. Please notify us within one year from the date of this memorandum when final action is complete.

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 Jamie M. Wykle, Auditor, at (865) 633-7382 or Lisa H. Hammer, Director, Operational Audits, at (865) 633-7342. We appreciate the courtesy and cooperation received from your staff during the audit.

Robert E. Martin
Assistant Inspector General
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ET 3C-K

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OIG File No. 2012-14631

Office of the Inspector General

Audit Report

To the Senior Vice President,
Power Operations

REVIEW OF TVA'S MANAGEMENT OF COMBUSTIBLE COAL DUST

Auditor
Jamie M. Wykle

Audit 2012-14631
November 14, 2013

ABBREVIATIONS

ALF	Allen Fossil Plant
BRF	Bull Run Fossil Plant
CUF	Cumberland Fossil Plant
ERM	Enterprise Risk Management
FY	Fiscal Year
KIF	Kingston Fossil Plant
LOI	Loss-on-Ignition
NEP	National Emphasis Program
NFPA	National Fire Protection Association
O&M	Operations and Maintenance
OIG	Office of the Inspector General
OSHA	Occupational Safety and Health Administration
PAF	Paradise Fossil Plant
SPP	Standard Process and Procedure
TSP	TVA Safety Procedure
TVA	Tennessee Valley Authority

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APPENDIX

Audit 2012-14631 – Review of TVA's Management of Combustible Coal Dust

EXECUTIVE SUMMARY

Background

Combustible dusts are fine particles that present an explosion hazard when suspended in air under certain conditions. Combustible coal dust presents a real and serious loss exposure to utility generating facilities and personnel safety. Coal handling and fueling operations are inherently dusty, requiring the highest standard of housekeeping, equipment tightness, and electrical integrity. Failure to establish and maintain such standards sets the stage for a potential catastrophic loss event that could jeopardize property, business operations, and life safety.

The Occupational Safety and Health Administration issues procedures in the National Emphasis Program for reducing combustible dust hazards. The Tennessee Valley Authority (TVA) issued TVA Safety Procedure (TSP) 816 Combustible Dust to provide direction in complying with the Occupational Safety and Health Administration's National Emphasis Program and describe the requirements for TVA's Combustible Dust Inspecting and Reporting Program. According to TSP 816, if the coal dust exceeds 1/32inch thickness accumulation over a surface area of at least 5 percent of the floor area of the facility or any given room, then cleaning of that area is required.

TVA's Coal and Gas Operations organization, within the Generation organization, is responsible for managing combustible coal dust. Mechanical Programs and Components, within Generation's Systems Engineering department, manages TVA's Combustible Dust Inspecting and Reporting Program.

What the OIG Found

We evaluated the adequacy of actions taken to mitigate combustible coal dust risk. To do so, we reviewed policies, procedures, and regulations related to combustible coal dust, performed walkdowns at three of TVA's coal plants to observe coal dust conditions, reviewed various documents and internal assessments, and interviewed TVA personnel. In summary, we found that despite some improvements in combustible dust management, actions to date have been inadequate to improve deteriorating equipment conditions, address housekeeping challenges, and provide appropriate monitoring of combustible dust conditions at TVA's coal plants.

We observed coal dust accumulations to be above the allowable 1/32 inch standard in many of the coal handling areas during our walkdowns at

three coal generation plants. TVA self-identified coal dust accumulations above the allowable standard in many of the coal handling areas throughout the coal fleet. Coal handling equipment has deteriorated faster than funding was available for repairs or replacement. For example, as described in more detail later, a September 2011 report by our office identified coal dust issues which TVA began to address through a variety of activities, the funding for which was later eliminated. Due to the deteriorated equipment, housekeeping activities have not kept pace with dust cleaning requirements. Tools for monitoring dust conditions, including site dust management plans, quarterly site assessments, Monthly Housekeeping reports, and sampling ash for combustibility, are not consistently used. TVA's aging equipment, housekeeping conditions, and inadequate monitoring present great challenges toward achieving compliance with combustible coal dust requirements.

What the OIG Recommends

We recommend the Senior Vice President, Power Operations:

1. Request corporate and plant staff to work together on a plan for correcting equipment deficiencies and work toward completion of the plan to improve coal dust containment. The plan should:
   a. Include estimates for resource requirements, such as funding, staff, and equipment needs.
   b. Include monitoring progress of equipment remediation quarterly using the same tracking method (similar to Work-Off Curves).
   c. Consider conducting plant walkdowns with peers from other plants and exchange ideas to improve coal dust management.

2. Work with coal plants to minimize dust accumulations and address housekeeping challenges. Include actions, such as keeping all chute doors closed while coal is being transported and ensuring there are properly operating sump pumps and drains for removing washdown water and coal slurry.

3. Dedicate more attention to address housekeeping challenges, particularly cleaning high overhead, hard-to-reach areas and other priority areas.

4. Develop site-specific dust management programs as required by TSP 816 to define expectations, establish standards, and monitor and document results. Develop site combustible dust teams and allocate adequate resources to meet the site-specific housekeeping goals.

5. Perform monthly and quarterly assessments for housekeeping compliance to the combustible dust standards, as required by TSP 816, and correct deficiencies in a timely manner to address housekeeping challenges.

6. Test fly ash dust quarterly to determine loss-on-ignition levels for combustibility.

TVA Management's Comments

TVA management agreed with our recommendations and has taken or is taking actions to address all recommendations. See the Appendix for TVA's complete response.

Auditor's Response

The OIG (Office of the Inspector General) agrees with the actions planned and taken by TVA management in regards to all recommendations.

BACKGROUND

Combustible dusts are fine particles that present an explosion hazard when suspended in air under certain conditions. The National Fire Protection Association (NFPA) defines combustible dust as ". . . a finely divided combustible particulate solid[1] that presents a flash fire or explosion hazard when suspended in air." Combustible coal dust presents a real and serious loss exposure to utility generating facilities and personnel safety. Although coal can be handled safely and can be an efficient fuel, there are explosion hazards that are heightened as the particle size is reduced. Coal handling and fueling operations are inherently dusty, requiring the highest standard of housekeeping,[2] equipment tightness, and electrical integrity. Failure to establish and maintain such standards sets the stage for a potential catastrophic loss event that could jeopardize property, business operations, and life safety.

If coal dust is suspended in air in the right concentration, under certain conditions, it can become explosive. Coal dust explosions are classified as being primary or secondary explosions. When combustible coal dust particles become suspended in air and find an ignition source, a rapidly expanding ball of fire and pulse of pressure results, which is referred to as a primary explosion. This event, in the confines of a building, starts a repeating cycle of dust suspension, ignition, and explosion called the secondary explosions. Secondary dust explosions are the result of dust accumulation inside the plant being disturbed and ignited by the primary explosion, resulting in a much more dangerous uncontrolled explosion. Coal dust that is carried into high areas of the plant, such as overhead beams, creates prime areas where secondary explosions can occur. These high areas are hard to reach and not easily seen due to the dark nature of the plants, making inspection and cleaning efforts more difficult. The coal dust that has settled on high surfaces, if disturbed, can become suspended in air, setting the stage for an explosion if exposed to an ignition source.

The Tennessee Valley Authority (TVA) has experienced fire events involving combustible coal dust. Between 2008 and 2012, TVA tracked 60 fires involving coal dust at eight coal plants. Many of the fires involved coal build-ups, mechanical failures, or spontaneous combustion. More of these fires have occurred at Allen Fossil Plant (ALF) and Shawnee Fossil Plant, which burn a significant percentage of Powder River Basin coal. It is especially critical to properly manage combustible dust when Powder River Basin coal is the fuel because it is more volatile and more subject to spontaneous combustion than other fossil fuels. Two of the biggest fires at TVA occurred about 20 years ago at Colbert Fossil Plant in 1993 and ALF in 1996 (see Figure 1 on the following page).

[1] NFPA defines combustible particulate solid as ". . . any solid material composed of distinct particles or pieces, regardless of size, shape, or chemical composition that presents a fire hazard."

[2] In the power industry, housekeeping means controlling dust and preventing spills.

Colbert Fossil Plant Fire, 1993 **ALF Fire, 1996**

Figure 1: Identified in a 2012 Yard Users' Group Meeting presentation.

Due to the number of industry-wide explosions related to combustible coal and the resulting deaths and damages,[3] the U.S. Chemical Safety and Hazard Investigation Board and Congress made recommendations to the Occupational Safety and Health Administration (OSHA) in 2006 for prevention of hazards that lead to worksite combustible dust explosions. In response to those recommendations, OSHA released new policies and procedures for the reduction or elimination of combustible dust hazards in the Combustible Dust National Emphasis Program (NEP).[4] This program affects more than 60 industries but emphasizes 16 industries where the combustible dust hazard is greatest. Coal fired power generation is number two on the list of the industries emphasized.

In response to the OSHA NEP, TVA issued TVA Safety Procedure (TSP) 816 Combustible Dust to provide direction in complying with the OSHA NEP and describe the requirements for TVA's Combustible Dust Inspecting and Reporting Program.[5] TVA's current Program began in 2010 as an effort to further define the standards in TSP 816 and each plant's level of compliance with these standards. As part of the Program, combustible coal dust site assessments were performed by Yard Systems Engineers, approximately every 6 months, at all TVA's coal plants. These assessments identified deficiencies and recommendations to reduce dust, address spillage issues, and enhance the efficiencies of cleaning.

As part of the Program, each plant is to conduct monthly combustible dust assessment reports, called Monthly Housekeeping reports, for coal yards and powerhouses. According to TSP 816, if the coal dust exceeds 1/32 inch thickness accumulation over a surface area of at least 5 percent of the floor area of the facility or any given room, then cleaning of that area is required.

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[3] The U.S. Chemical Safety and Hazard Investigation Board identified 23 combustible dust incidents related to the coal industry between 1984 and 2005 that killed 16 workers, injured 94 workers, and damaged electric service and other facilities.

[4] The OSHA NEP is based upon NFPA 654 "Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids" issued in 2006.

[5] Unless otherwise noted, the term "Program" refers to TVA's Combustible Dust Inspecting and Reporting Program.

TVA's Coal and Gas Operations organization, within the Generation organization, is responsible for managing combustible coal dust. Mechanical Programs and Components, within Generation's Systems Engineering department, manages TVA's Combustible Dust Inspecting and Reporting Program.

Belt Conveyor System

Coal is carried from an unloading point or reclaim storage area to the powerhouse by a belt conveyor system, which is composed of six major elements: the belt, pulleys, drive, structure, belt support systems, and transfer points. The continuous rubber belt is stretched between terminal pulleys, with one end called the tail, where coal loading occurs and the other end called the head, where coal is delivered. The belt is supported along the top and bottom with rollers called idlers. Conveyors are driven by motors attached to a drive pulley. In addition, conveyors consist of secondary equipment to improve the systems operation. This includes components, such as take-up pulleys, belt cleaners, tramp-iron detectors, skirtboards and seals, safety switches, and dust suppression/collection systems, as shown in Figure 2 below.

High-capacity conveying systems handle hundreds of tons of coal per hour. When even a small fraction of this tonnage is released, coal particles become airborne creating suspended combustible coal. As mentioned previously, the suspended coal dust eventually settles on a variety of surfaces, and over time, the thickest layers accumulate in less-visible or hard-to-reach areas if housekeeping activities are not routinely performed. One of the most common areas of dust occurrence is at conveyor transfer points where loading, unloading, crushing, or movement of the coal creates air currents that allow the coal particles to become airborne, creating suspended coal dust that is carried away from the conveyor system.

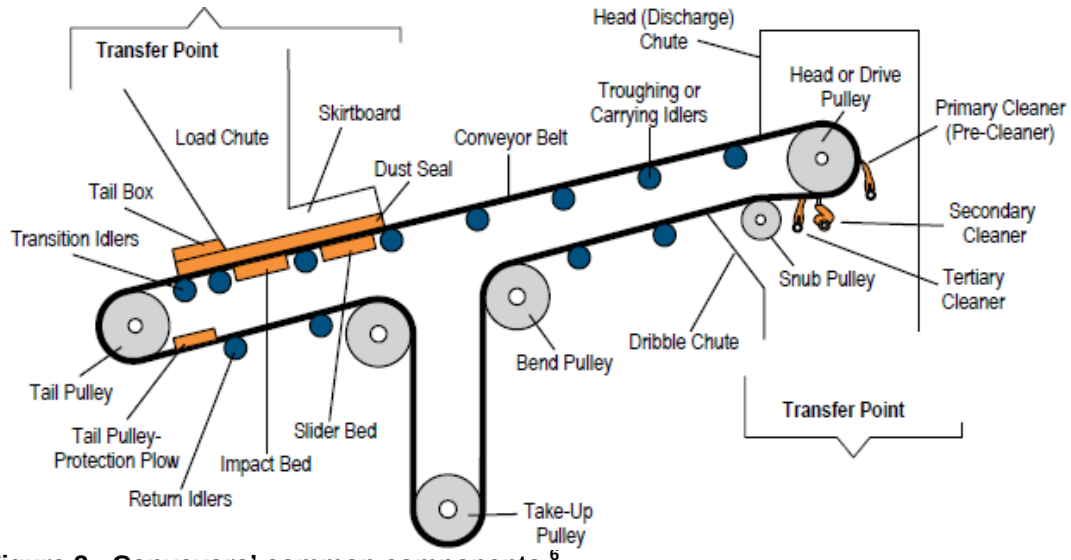

Figure 2: Conveyors' common components.[6]

[6] Illustration from "FOUNDATIONS™ The Practical Resource for Cleaner, Safer, More Productive Dust & Material Control, Fourth Edition" published in 2009 by Martin Engineering Company.

Coal Operations has identified coal dust explosions under the risk category of Catastrophic Plant Accident in its Enterprise Risk Management (ERM) risk map. The probability of occurrence is rated unlikely, and consequences are rated as severe. Specifically, the ERM indicates recent events, both within this industry and in other industries, handling combustible dust require more stringent standards and dust accumulation must be lowered. The mitigation plan is to reduce the risk of coal dust explosions by providing (1) combustible dust training for all Coal Operations employees, (2) several separate coal dust audits conducted by Generation Engineering and plant personnel and tracked for improvement, (3) increased housekeeping personnel, and (4) projects planned and in progress to minimize coal dust accumulations.

Specific activities included in the mitigation plan are: (1) coal dust explosion online awareness training; (2) coal yard condition assessments; (3) coal dust accumulation self-assessments; (4) capital projects, such as repairing dust collectors and coal chutes, to reduce dust accumulation or improve cleaning capability; (5) Operations and Maintenance (O&M)/staff augmentation programs to clean coal dust; (6) annual coal dust audit with Work-Off Curve developed; and (7) implement Class II, Division 2[7] electrical equipment studies and resultant projects.

Airborne dust is created whenever coal is moved, manipulated, and subjected to air currents strong enough to raise or redirect the small particles within the coal. Containment is the preferred method of controlling coal dust, which is more economical in the long run than continual cleanup. However; if dust is not initially contained, water is the most effective and preferred means of cleaning in a coal dust environment. Additional housekeeping methods include using explosion proof vacuums, sweeping, mopping, and foam cleaning.

OBJECTIVE, SCOPE, AND METHODOLOGY

Our audit objective was to evaluate the adequacy of actions taken to mitigate combustible coal dust risk. The scope of the audit was fiscal years (FY) 2010 to present. To achieve the audit objective, we:

- Identified and reviewed policies, procedures, and regulations related to combustible coal dust to identify requirements and maximum-allowed standard accumulations levels. We relied on TSP 816 for audit criteria because it established Program requirements based on industry standards. For the purposes of this report, we focused on the 1/32 inch dust accumulation standard, dust combustibility, written dust programs, equipment, operating conditions, and dust suppression identified in that procedure.

[7] Class II, Division 2 is the NFPA location classification where combustible dust accumulations could interfere with electrical safety, including coal handling areas, and sets the minimum safety standards for any electrical equipment in those areas.

- Interviewed personnel in TVA's Coal Operations organization, within the Generation organization, and coal plant sites selected in our sample (as described below) to gain an understanding of TVA's risks associated with combustible coal dust, identify financial resources allocated for combustible coal dust management, and determine the consequences of uncontrolled coal dust accumulations.
- Relied on the expertise of TVA's Fossil Fire Protection Manager and one of TVA's Yard Systems Engineers, both of whom were assigned to combustible dust management, to assist in identifying (1) areas of concern at plants visited and (2) combustible coal dust management best practices.
- Obtained and reviewed coal dust plant assessment Monthly Housekeeping reports to determine which plants had low, moderate, or high amounts of coal dust. Based on these reports, we judgmentally selected three of TVA's coal plants for review: Bull Run Fossil Plant (BRF), Cumberland Fossil Plant (CUF), and Paradise Fossil Plant (PAF). These three coal plants accounted for 42 percent of TVA's net generating capacity from coal. We performed site walkdowns at these plants, which were ranked with low, moderate, and high amounts of coal dust, in order to identify conditions associated with varying risk levels. Because we used a nonstatistical method for selecting our sample, there is no basis for projecting the results to the entire population.
- Reviewed site assessment reports prepared by TVA's Yard Systems Engineers for all TVA coal plants to determine what sources of combustible coal dust and associated challenges had been self-identified.
- Obtained and reviewed Compliance Reports related to coal dust housekeeping issues. Only one Compliance Report pertained specifically to housekeeping issues, ALF. As a result of TVA's Compliance Report from ALF, we did not perform a site walkdown.

We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objective. We believe the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective.

FINDINGS

We evaluated the adequacy of actions taken to mitigate combustible coal dust. Despite some improvements in combustible dust management, actions to date have been inadequate to improve deteriorating equipment conditions, address housekeeping challenges, and provide appropriate monitoring of combustible dust conditions at TVA's coal plants.

Although the probability of occurrence for coal dust explosions was rated in the ERM risk map as unlikely by TVA, the potential consequences of an explosion are severe and could result in disruption of generating capacity, costly clean up and repairs, and even loss of life. TVA's aging equipment presents a great challenge toward achieving compliance with Program requirements. Coal plant and coal handling conditions currently exceed acceptable dust level limits specified in TSP 816. We observed coal dust accumulations exceeding 1/32 inch in many of the coal handling areas during our walkdowns at BRF, CUF, and PAF. TVA self-identified coal dust accumulations above the allowable standard in many areas throughout the coal fleet. In addition, monitoring tools required by the Program are not being used consistently to improve plant conditions.

Site assessment reports performed by Yard Systems Engineers indicated some conditions improved between 2010 and 2012. Some equipment deficiencies are being addressed, and there are several programmatic practices in progress that will improve conditions over time.[8] However, equipment has deteriorated faster than funding has been available for repairs or replacements. Deficiencies resulting from inadequate equipment maintenance contribute to the increased presence of combustible coal dust and coal accumulations within the coal handling system. With deteriorating equipment and recent staff reductions for housekeeping, TVA faces significant challenges for keeping coal dust accumulations within limits provided by TSP 816. More focus is needed on the Program in order to better contain coal dust and reduce the necessity for extensive and repeated housekeeping activities to achieve dust accumulations below the 1/32 inch standard.

[8] For example, ALF and KIF (Kingston Fossil Plant) incorporated state of the art technology to reduce dusting and spilling of coal being transferred to conveyors; PAF added a water-fogging dust suppression system on multiple conveyors; ALF added a dust collector system and belt cleaners/scrapers; and ALF and CUF added spill pans to various areas of the belt line.

Picture 1: Dust accumulations greater than 1/32 inch, as observed during our walkdown at CUF on August 14, 2012. This is a beam on top of the Surge Hopper building.

Equipment Conditions Are Deteriorating

The primary method for preventing a coal dust explosion is to contain the coal dust in order to reduce or eliminate the amount of dust dispersed. The obvious place for a coal dust explosion to begin is where coal dust has accumulated. Inspection and maintenance of coal handling equipment is important because it identifies problems before they become a disaster, reduces the potential for ignition sources, and reduces the amount of combustible coal dust in coal handling areas.

As mentioned previously, TVA's Yard Systems Engineers have performed combustible coal dust site assessments at all TVA coal plants. We reviewed the most recent Yard Systems Engineers' site assessments as of September 2012 and TVA's 2012 Compliance Reports for ALF. Based on our review, we determined TVA self-identified excess coal dust accumulations at all coal plants.

By performing walkdowns of all coal handling areas at each coal plant, Yard Systems Engineers identified coal handling equipment deficiencies that contributed to coal dust accumulation. These assessments include recommendations to reduce dust, address spillage issues, and enhance the efficiencies of cleaning. Equipment deficiencies identified during the assessment are itemized by plant. All deficiencies are compiled into one spreadsheet which is used to create a graph called the Work-Off Curve, and provides the basis for prioritizing equipment deficiencies. The prioritization helps determine capital improvements and O&M budgets for items with associated estimated costs. Each plant has two Work-Off Curves: one for the coal yards and one for the powerhouse.

Together, the Yard Systems Engineers, Plant Systems Engineers, and other site personnel review the deficiencies identified and determine the funding available to remedy each deficiency as well as a target completion date. The goal of the Work-Off Curve is to add equipment deficiencies as they are discovered and add completion dates once deficiencies have been updated. The Master Work-Off Curve is maintained by the Yard Systems Engineers. The Work-Off Curve was designed to be updated quarterly by plant personnel and is only as accurate as the information entered by plant personnel. According to the Yard Systems Engineer, not all plants use the Work-Off Curve for its intended purpose, but rather some plants use the Work-Off Curve to maintain documents at the plant level describing equipment deficiencies. Where alternative tracking methods are being used to manage deficiencies related to combustible dust and monitor progress at the plant level, the Yard Systems Engineer stated the Work-Off Curves have become a redundant activity. In our opinion, regularly updated Work-Off Curves or similar tracking methods are needed at all plants to maintain consistency and manage funding that may become available at the corporate level.

We noted some plants have taken positive steps to improve containment and help reduce combustible coal dust in spite of equipment deficiencies. Specifically:

- ALF and KIF have incorporated state of the art technology in load zones to reduce dusting and spilling of coal being transferred to conveyors.
- PAF added a water-fogging dust suppression system on multiple conveyors and added fixed washdown systems on two conveyors.
- ALF added a dust collector system and belt cleaners/scrapers.
- ALF and CUF added spill pans to various areas of the belt line, as shown in Picture 2 on the following page.

Picture 2: A spill pan as observed at CUF on August 14, 2012, in the Rotary Breaker building. Spill pans help eliminate accumulation of coal dust.

Despite these and other efforts to address coal dust issues, we observed deteriorating equipment conditions during our site walkdowns at BRF, CUF, and PAF and discussed our observations with each plant manager. The following eight photos provide examples of some of the conditions we observed.

Picture 3: A deteriorated seal around the chute door as observed at PAF on August 28, 2012, located at the Alpha Station Breaker. Deterioration in the chute allows coal dust to escape.

Picture 4: A deteriorated chute allowing coal dust to escape as observed at CUF on August 13, 2012, located at Transfer Station B.

Picture 5: Deterioration around the skirt box opening allowing coal dust to escape as observed at PAF on August 27, 2012, in the West Bunker room.

Picture 6: A skirting system in need of adjustment or replacement as observed at PAF on August 27, 2012, in the West Bunker room (BC-22). Misaligned skirts cause coal dust leaks. This picture illustrates coal leaking onto a white notebook held by the Auditor.

Picture 7: A skirt seal in need of alignment as observed at CUF on August 14, 2012, in Silo 1 (BC-9).

Picture 8: A worn belt due to misalignment causing coal dust leaks as observed at BRF on September 25, 2012, along Belt Feeder 2.

Picture 9: A skirt box too wide as observed at BRF on September 25, 2012, along BC-7. Skirt boxes that are too wide cause coal leaks.

Picture 10: A gouge in a belt cleaner causing coal dust leaks as observed at CUF on August 13, 2012, along BC-16.

Funding Has Not Kept Pace With Equipment Deterioration

Each coal plant operates with limited funding for correcting equipment deficiencies. According to TVA personnel, for the past several years funding for equipment deficiencies that contribute to dust accumulation was included in each plant's O&M budget with no additional funding dedicated to fixing equipment deficiencies identified on the Work-Off Curves. Over time, equipment has deteriorated faster than funding was available to repair or replace the equipment. These equipment inadequacies and deficiencies contribute to increased presence of combustible coal dust and coal accumulations within the coal handling system. In our opinion, TVA's aging equipment presents a great challenge toward achieving compliance.

We observed numerous conditions contributing to excess coal dust accumulations and increasing the need for additional equipment and housekeeping efforts:

- As part of the plants' washdown[9] process, whether it is by hosing or using fixed systems, accumulations of water and coal slurry[10] can build up and clog drains. TVA coal plants have sump pumps which are used to remove excess coal slurry and unwanted accumulations of water from washdown. During our walkdown at BRF, we observed the existing sump pumps under the Silo, Beaker building bottom floor, and the basement of Transfer A were inadequate or deficient which caused unwanted accumulations of water and coal slurry during washdown. Specifically, water and slurry were standing in

[9] If dust is not initially contained and is allowed to accumulate, water is the most effective means of cleaning in a coal dust environment, which is referred to as washdown

[10] Coal slurry is a waste fluid produced by washing coal with water.

the areas shown below in Pictures 11 and 12. This problem causes additional housekeeping challenges and limits the use of washdowns by clogging drains.

Picture 11: Slurry several inches deep covering the Auditor's boot as observed at BRF on September 25, 2012, in the Breaker building.

Picture 12: Footprints the Auditor made in slurry as observed at BRF on September 25, 2012, in the Breaker building.

- A dust collector system is used in coal handling areas to enhance the quality of air released by collecting dust and other impurities from the air. Designed to handle high volume dust loads, a dust collector system consists of a blower, dust filter, filter-cleaning system, and dust receptacle or dust removal system. During our site walkdowns at BRF, CUF, and PAF, we observed abandoned dust collector systems and associated duct work. These abandoned systems increase the need for housekeeping efforts because coal dust accumulates on the abandoned equipment and has to be cleaned. According to the TVA Yard Systems Engineer, these systems have not been in service for years due to the lack of funding to repair or replace nonworking equipment.

Picture 13: Duct work from an abandoned dust collector system as observed at CUF on August 13, 2012, in the Unit 1 South Bunker room (BC-25).

Picture 14: An abandoned dust collector system as observed at CUF on August 13, 2012, in the Unit 1 North Bunker room (BC-23).

Picture 15: Open coal chute doors above the feeder platform as observed at PAF on August 28, 2012. We also observed open and deteriorating chute doors at head pulleys, tail pulleys, transfer points, and feeders at BRF and CUF. Open chute doors allow dust to be expelled into the surrounding area, adding to housekeeping efforts and increasing the hazard of coal dust explosions.

TVA designated an additional $17.4 million from capital reserves to supplement the plants' combined O&M budgets of $4.9 million for combustible coal dust improvements in FY2013. This additional funding will be used for repairs to belts, breakers, barge unloader buckets, chutes, skirts, and seals, all of which impact combustible coal dust.

Housekeeping Challenges Are Not Being Met

In the power industry, housekeeping means controlling dust and preventing spills. Particular attention must be paid to cleaning because the buildup of dust on the walls of bunkers, silos, along conveyors, and transfer points poses safety problems if the coal dust is left unattended. These cleaning efforts could include washing, vacuuming, sweeping and mopping (adequate only for floors), and foaming. Housekeeping must be a priority within the plant's culture and be continually supported by management in order to keep combustible coal dust levels below the 1/32 inch OSHA NEP standard. According to TSP 816, all surfaces should be cleaned, including beams, walls, equipment, ducts, and floors, among other surfaces.

As previously stated, if dust is not initially contained and is allowed to accumulate, water is the most effective means of cleaning in a coal dust environment, which is referred to as washdown. To operate effectively, washdowns require proper equipment seals and adequate drainage. Methods of washdown include simply a laborer pointing a hose to the area, installing fixed washdown systems consisting of a series of engineered spray nozzles throughout conveyer areas, or utilizing fixed fire suppression water spray systems to clean coal dust from conveyor belts. Fixed washdown systems are the most efficient and effective ways to get water to the correct places for cleaning combustible dust. Fixed systems reduce labor cost, require less water, and result in cleaner areas. Generally speaking, a fixed washdown system cleans the target area in one quarter of the time needed for manual washdowns and typically requires only one person to operate. We observed a fixed washdown system in use during our site walkdown at PAF. Due to the cost of these systems and the cost to retrofit plants for the systems, PAF is the only TVA plant that has these systems. Additionally, all TVA coal plants have fixed fire suppression water spray systems along the belt conveyors that may provide viable washdown methods, if adequate drainage is provided.

The Office of the Inspector General conducted an Inspection of TVA's Fossil Fire Protection Systems in 2011[11] which identified areas of significant coal dust accumulations at several sites and recommended regular coal washdowns to minimize coal dust accumulations. TVA management agreed with our recommendation and committed to regular coal washdowns in FY2012 and beyond.

According to TVA personnel, staff augmented labor was used for cleaning combustible dust but was cut in 2012 under TVA's Diet and Exercise program. There is not enough annual plant staff to keep up with the housekeeping related to combustible coal dust. TVA personnel stated that without enough labor to clean everything, plants need to prioritize areas to be cleaned and set a high priority for cleaning areas next to the boilers to minimize exposure to sparks and hot cinders.

[11] Inspection 2010-13530 – Review of TVA's Fossil Fire Protection Systems, issued on September 30, 2011.

Although housekeeping efforts are active throughout the coal fleet, several factors contribute greatly to TVA's inability to keep pace with housekeeping requirements and leave TVA facing significant challenges to meet TVA's requirements for compliance with OSHA NEP standards. Among the most notable factors are recent reductions of staff dedicated for housekeeping and reductions in the funding for equipment improvements and upgrades.

High Priority Areas of Coal Dust Accumulation Need Attention

Coal dust that is carried into high areas of the plant, such as overhead beams, creates prime areas where secondary explosions can occur because these areas may not be inspected or cleaned as frequently as they should be due to unreachability or poor visibility. We observed dust accumulations on overhead beams, joists, tops of equipment, cable trays, piping, conduits, and duct work that exceeded 1/32 inch. We also observed ½ to 1 inch of coal on floors under boiler archways. These are somewhat enclosed areas located dangerously near boilers and should be considered high priority for cleaning to remove the dust accumulations. More attention is needed for cleaning high overhead and hard-to-reach areas and susceptible areas near boilers.

We observed coal and dust accumulations on idlers during our walkdowns at BRF, CUF, and PAF. Cleaning of idlers should be high priority as idlers embedded in coal can seize or generate heat and may eventually ignite the surrounding combustible material.

Picture 16: Coal and dust accumulations on idlers at a tail pulley as observed at CUF on August 13, 2012. We observed similar conditions at BRF and PAF.

Tools for Monitoring Combustible Dust Conditions Are Not Consistently Used

The Program involves several tools for managing combustible dust risks, monitoring plant conditions, and setting priorities for remediation. These tools include site-specific dust management plans, quarterly site assessments, Monthly Housekeeping reports, and sampling for combustibility.

TSP 816 states that a written dust management plan should be developed by all coal plants for hazardous dust inspection, combustibility testing, housekeeping, and controls. Specifically, a dust management plan should:

- Define responsibilities for Program controls at each plant.
- Require documentation of daily, weekly, monthly, and quarterly inspections for housekeeping compliance to the combustible dust standards.
- Define requirements for placing warning signs for combustible coal dust.
- Detail cleaning frequencies needed to achieve compliance.

According to TVA personnel, some plants do not have a site-specific dust management plan. BRF, KIF, and Shawnee Fossil Plant are the only plants that had site-specific dust management plans available in TVA's Procedure Center. Dust management plans were not available for the other seven operating coal plants. Until recently, TVA has not enforced the necessity to develop site-specific plans. Although several of the coal plants that do not have dust management plans will most likely be idled or closed in the next few years, dust management plans are needed for the coal plants that will remain in service in order to properly mitigate combustible dust accumulations and prevent damage from dust hazards.

Quarterly combustible coal dust site assessments identify combustible coal dust hazards and help personnel understand the gaps that exist between safe practices and compliance and actual conditions. According to the Yard Systems Engineer, staff reductions and budget crunches have impacted the ability to perform quarterly site assessments. As a result, only one site assessment has been conducted since September 2012.

Although the plant housekeeping reports are completed monthly, these reports are not an accurate tool for evaluating dust conditions because the reports occur at a particular point in time and may not accurately reflect overall plant conditions that can change quickly. This reporting could be conducted at the dirtiest time or the cleanest time for plant conditions. If an assessment is conducted while the plant is not running, conditions could reflect positively in the housekeeping report. Within hours, the plant could start running and conditions would change drastically and reflect poorly in the housekeeping report. Additionally, reported plant conditions are subject to personal interpretation which varies from plant to plant, further contributing to the questionable accuracy of these monthly reports.

According to TVA personnel, to evaluate the combustibility of any dust, including fly ash, the dust should be sampled and analyzed to determine the loss-on-ignition (LOI). Based upon Factory Mutual Testing that was performed for the American Electric Power Company, TVA requires that any dust testing with 15 percent or greater combustible product should be treated as a combustible dust, and the 1/32 inch maximum accumulation standard applies. We observed areas where fly ash dust[12] accumulations were being cleaned at BRF before areas of combustible coal dust. However, LOI sampling to date has only been performed upon request from TVA's Fire Protection staff when it is probable there is a combustible dust problem, particularly after a fire has occurred in the upper elevations of a powerhouse around the boiler. A draft revision to TSP 816, which is under review, requires a minimum of quarterly LOI testing of fly ash dust. Regular sampling and analysis is necessary to determine the dust combustibility and establish housekeeping priorities.

Without site-specific dust management plans, quarterly site assessments, accurate monthly reports, or routine LOI sampling, plants cannot effectively monitor conditions or set appropriate remediation priorities.

RECOMMENDATIONS

We recommend the Senior Vice President, Power Operations:

1. Request corporate and plant staff to work together on a plan for correcting equipment deficiencies and work toward completion of the plan to improve coal dust containment. The plan should:
   a. Include estimates for resource requirements, such as funding, staff, and equipment needs.
   b. Include monitoring progress of equipment remediation quarterly using the same tracking method (similar to Work-Off Curves).
   c. Consider conducting plant walkdowns with peers from other plants and exchange ideas to improve coal dust management.

2. Work with coal plants to minimize dust accumulations and address housekeeping challenges. Include actions, such as keeping all chute doors closed while coal is being transported and ensuring there are properly operating sump pumps and drains for removing washdown water and coal slurry.

3. Dedicate more attention to address housekeeping challenges, particularly cleaning high overhead, hard-to-reach areas and other priority areas.

4. Develop site-specific dust management programs as required by TSP 816 to define expectations, establish standards, and monitor and document results.

[12] Fly ash dust is very fine, powdery material resulting from the combustion of coal. Fly ash alone is not considered combustible.

Develop site combustible dust teams and allocate adequate resources to meet the site-specific housekeeping goals.

5. Perform monthly and quarterly assessments for housekeeping compliance to the combustible dust standards, as required by TSP 816, and correct deficiencies in a timely manner to address housekeeping challenges.

6. Test fly ash dust quarterly to determine LOI levels for combustibility.

MANAGEMENT'S RESPONSE AND OUR EVALUATION

TVA management responded to a draft of this report and agreed with our recommendations. Management has taken or is taking the following actions:

- Committed to using a previously created short- and long-term combustible dust projects spreadsheet that includes fleet wide prioritization and funding requirements and is updated quarterly. Power Operations Performance & Oversight will coordinate with Corporate Engineering personnel to work with TVA plant employees to update this spreadsheet by December 31, 2013. Subsequent updates will be performed quarterly.
- Developed a Combustible Dust Program document with collaboration between Power Operations personnel, Corporate Engineering, and Corporate Safety. This document contains 16 Combustible Dust Program milestones that define standards and set expectations including minimizing coal dust accumulations, preventing housekeeping challenges, developing site-specific dust management programs, performing combustible dust assessments, and testing LOI levels for combustibility. An SPP will be developed and approved during FY2014 to replace the program document.
- In addition to the inspection and housekeeping details provided in the program document, Power Operations will continue to evaluate projects, such as installing shed plates to prevent reaccumulation of dust in hard-to-reach areas.
- Develop a site-specific combustible dust procedure template that will be provided to all coal sites. This template will be completed by December 31, 2013. Each site will use the template to develop site-specific combustible dust procedures by May 30, 2014.

With regard to our recommendation to perform monthly and quarterly assessments for housekeeping compliance as required by TSP 816, TVA management responded that TSP 816 is being phased out and replaced with TSP 1205 which no longer requires quarterly assessments. However, TSP 1205 does require daily, monthly, and annual assessments which will be part of Power Operations Combustible Dust Program.

The Office of the Inspector General agrees with the actions planned and taken by TVA management in regards to all recommendations.

November 5, 2013

Robert E. Martin, ET 3C-K

REQUEST FOR COMMENTS – DRAFT AUDIT 2012-14631 – REVIEW OF TVA'S MANAGEMENT OF COMBUSTIBLE COAL DUST

We appreciate the opportunity to provide further comments on the draft report of TVA's management of combustible coal dust dated October 8, 2013.

Responses for recommendations are summarized below.

Recommendations

1. Request corporate and plant staff to work together on a plan for correcting equipment deficiencies and work toward completion of the plan to improve coal dust containment. The plan should:
    a. Include estimates for resource requirements, such as funding, staff, and equipment needs.
    b. Include monitoring progress of equipment remediation quarterly using the same tracking method (similar to Work-Off Curves).
    c. Consider conducting plant walkdowns with peers from other plants and exchange ideas to improve coal dust management.

Response

A short- and long-term combustible dust projects spreadsheet, which includes fleet-wide prioritization and funding requirements, was developed several years ago by Fossil Engineering. This tool will be used to address recommendations 1(a) and 1(b). This living document will reside on the Power Operations Performance & Oversight "Plant Compliance" SharePoint site (http://gen.tva.gov/coalOps/os/PC/Pages/default.aspx). Over the past year, Coal Operations invested $17.4M on combustible dust and coal yard improvements. Many of the items funded were on this spreadsheet and will now be able to be removed.

Power Operations Performance & Oversight will coordinate with Corporate Engineering personnel to work with plant employees to update this spreadsheet. The target date for update completion is December 31, 2013.

Subsequent updates will be performed quarterly as recommended.

2. Work with coal plants to minimize dust accumulations and address housekeeping challenges. Include actions, such as keeping all chute doors closed while coal is being transported and ensure there are properly operating sump pumps and drains for removing washdown water and coal slurry.

Response

A Combustible Dust Program Document has been developed by Power Operations personnel with collaboration and input from Corporate Engineering and Safety to define standards and set expectations. This program will address all of recommendations 1(c) - 6. A draft copy of the

program document is attached to this transmittal. An SPP will be developed and approved during Fiscal Year 2014 to replace the program document.

As shown in the program document, 16 milestones have been defined to get this program up and running. All milestones are expected to be complete by September 30, 2014. Until complete, the ongoing status of these milestones will be reported to Power Operations senior management along with other compliance milestones in the Monthly Asset Performance Report.

3. Dedicate more attention to address housekeeping challenges, particularly cleaning high overhead, hard-to-reach areas and other priority areas.

Response

See response for recommendation 2. In addition to the inspection and housekeeping details provided in the program document, Power Operations will continue to evaluate projects such as installing shed plates to prevent re-accumulation of dust in hard-to-reach areas.

4. Develop site-specific dust management programs as required by TSP 816 to define expectations, establish standards, and monitor and document results. Develop site combustible dust teams and allocate adequate resources to meet the site-specific housekeeping goals.

Response

With support from Corporate Engineering, Power Operations will develop a site-specific combustible dust procedure template that will be provided to all coal sites. This template will be completed by December 31, 2013. Each site will use that template to develop site-specific combustible dust procedures that include all site-specific procedure requirements by May 30, 2014. Both of these activities are included in the program milestones that are provided in the Combustible Dust Program Document.

5. Perform monthly and quarterly assessments for housekeeping compliance to the combustible dust standards, as required by TSP 816, and correct deficiencies in a timely manner to address housekeeping challenges.

Response

TSP 816 is being phased out and replaced with TSP 1205 which no longer requires quarterly assessments. It does require daily, monthly, and annual assessments which will be part of the Power Operations Combustible Dust Program.

6. Test fly ash dust quarterly to determine LOI levels for combustibility.

Response

See response for recommendation 2.

Please let us know if you have any other questions or need additional information.

James R. Dalrymple
Senior Vice President
Power Operations
LP 3K-C

JLR:AEP
Attachment
cc (Attachment):
Suzanne H. Biddle, LP 2R-C
Dwain K. Lanier, MR 3K-C
Daniel C. McIntire, LP 3K-C
William W. Morrison, LP 3K-C
Kenneth L. Mullinax, CUF 1A-CCT
Andrea L. Williams, WT 9B-K
OIG File No. 2012-14631

Power Operations - Coal

Combustible Dust Program Document

TVA Operations

Program Mission

Define standards and set expectations and to provide practical guidance and description of how Power Operations will address findings and recommendations outlined in OIG audit 2012-14631 as well as manage risks and close gaps in compliance with combustible dust regulations described in TSP1205.

This program document is to be used in conjunction with TSP1205. If conflicting information is discovered, the content of TSP1205 supersedes the content in this document.

This program document will later be replaced by an SPP.

Combustible Dust Program Philosophy

- Assign accountability and keep accurate records
- Validity and repeatability of coal dust inspections must be improved across the fleet. This will be necessary to ensure compliance gaps and risks for the fleet are accurately understood, prioritized, communicated, and managed.
- Continually improve and revise housekeeping practices, inspections, etc and make good decisions related to prioritizing efforts to make the most out of available resources to minimize risks associated with combustible dust.
- Corporate personnel to provide support toward the development of program requirements (site-specific procedure development, etc) through the creation of templates and sharing of best practices.
- Containment is the best method of complying with combustible dust regulations. For areas & equipment where containment is compromised, water washing is the most effective method to remove dust. All plants should work to improve ability to wash trouble areas by sealing rooms and equipment, adding drains, etc.
- Lighting improvements and painting combustible dust areas white will improve the quality of inspections and truly identifying breaches in containment.
- It is the responsibility of each employee to maintain good housekeeping in his/her assigned area. It is each employee's responsibility to identify and correct, if possible, any housekeeping issues during daily operations. If the issue is small and can be handled safely by one person, the employee is expected to do so.
- Any coal pipe leak found will be addressed immediately. If the leak cannot be stopped within a reasonable amount of time, the equipment will be removed from service until repairs can be made.

Core Program Elements

- Combustible Dust Program Coordinator + two SME's at each plant
  - One SME for the plant and one for the yard. These SME's will perform monthly Combustible Dust inspections at their site.
  - Prepare budget requests for corporate funding.
  - Provide data to update the Combustible Dust score card.
  - Ensure daily, monthly and annual inspections are completed and documented as required.

Power Operations - Coal

Combustible Dust Program Document

TVA Operations

        - Write WO's using "combustible dust" coding in Maximo (to be developed - see Milestone #3) and ensure conditions are addressed in a timely manner
    - Review & evaluate the effectiveness of inspections, audits and assessments.
    - Advise the MOIC of the effectiveness of the facility Combustible Dust program and areas needing improvement.
- Site-specific written combustible dust procedure
    - Power Operations Performance & Oversight to provide a template, Program Coordinator at each site to develop
    - Inspection plans (daily, monthly, annual)
        - During all inspections, ensure all chute doors are closed while coal is being transported and ensure there are properly operating sump pumps and drains for removing washdown water and coal slurry where applicable
        - Each plant inspector to carry with them glass jars with known LOI content (example 10%, 20%, 30%) during monthly inspections. The samples will be used to quickly and effectively approximate carbon content / combustibility of accumulations of dust identified.
    - Combustibility testing
        - Each plant develop the ability to perform LOI testing onsite to reduce costs and decrease wait time for results
        - This is to encourage more sampling, providing a better understanding and documentation of locations in the powerhouse where ash contains enough carbon to be combustible
        - Flyash dust shall be collected from various locations in the powerhouse and tested quarterly
    - Housekeeping methods and frequencies (living document)
        - These plans will reside on the Power Operations Performance & Oversight "Plant Compliance" sharepoint site. This will allow each plant to review other plants' plans which may be beneficial from a "sharing best practices" standpoint.
        - Housekeeping plans will include plans to address housekeeping challenges such as high overhead, hard-to-reach areas
            - Evaluate projects such as installing shed plates to prevent re-accumulation of dust in hard-to-reach areas
        - Results of monthly inspections are to be used to continually refine the housekeeping plan.
        - Housekeeping methods and frequencies will be updated over time as conditions change.
    - Plan view drawings showing areas of plant with hazardous electrical classifications
        - These drawings have already been created for each site (see 25W100 series drawings)
    - Hazard assessments
        - All plants required to have PHA (Process Hazard Assessment) for coal handling

        - TVA Safety will lead these assessments at each site, expect 3-5 days onsite, will require competent plant employee participation from Ops, Maint, and Engineering during hazard assessments
        - Power Operations Performance & Oversight will schedule Process Hazard Analysis for all sites
- Prioritization guidelines will be developed and used to help each plant provide sound judgment in prioritizing areas of excessive accumulation of combustible dust
    - The explosion pentagon
        - Potential ignition source (heat)
        - Fuel (combustible dust)
        - Air
        - Dispersion, or could become suspended (any elevated dust should be considered capable of being thrown into suspension)
        - Confinement of the dust cloud
- Training
    - Per TSP1205, all TVA employees, contractors, and unescorted visitors shall complete ATIS 75616 training within 30-days of hire or transfer to a facility with combustible dust, then annually thereafter
    - The combustible dust program coordinator and SME's will attend training specific to this Combustible Dust Program coordinated by Power Operations Performance & Oversight and Corporate Engineering.
- Vendor contracts
    - Each plant to set up monthly vendor contract / service agreement (Benetech or similar) to inspect, adjust, replace belt cleaners, skirts, etc
        - Expected budget $20k/month for coal fleet
- Develop Maximo coding to designate combustible dust WO's for streamlined tracking, trending
    - Ensure all deficiencies identified during regularly scheduled Combustible Dust inspections are captured in Maximo and tracked until completion
    - COGNOS reports can then be built to pull WO information
- Update and manage the short and long term combustible dust projects spreadsheet
    - This spreadsheet will be used as a tool to prioritize and communicate equipment deficiencies that lead to ongoing gaps in compliance and/or ongoing difficulty maintaining compliance with combustible dust regulations
    - Each plant to update this spreadsheet no less than quarterly

Power Operations - Coal

Combustible Dust Program Document

TVA Operations

Combustible Dust Program Milestones & Due Dates

#	Milestone
1	Each site to ensure required signs posted to warn of combustible dust areas. Due date 12/1/2013 (in line with HazCom due date which has been communicated to Yard Ops Supervisors).
2	Power Operations Performance & Oversight to work with Corporate Engineering and personnel from each plant to update the Long and Short Term Combustible Dust Projects spreadsheet by 12/31/2013.
3	Power Operations Performance & Oversight to develop Maximo coding that will be used to designate combustible dust work orders. Due date 12/31/2013.
4	Power Operations Performance & Oversight to develop quarterly scorecard. Due date 12/31/2013.
5	Engineering and Power Operations Performance & Oversight to develop site-specific combustible dust procedure template. REFERENCE ITEM 12. Due date 12/31/2013.
6	Plant managers will designate a combustible dust program coordinator that will be responsible for managing the program at their site. Due date 1/31/2014.
7	The combustible dust program coordinator will assign two SME's (one plant, one yard) who will be responsible for all combustible dust inspections. Due date 1/31/2014.
8	Engineering and Power Operations Performance & Oversight to develop combustible dust program training module (REFERENCE ITEM 11) for program coordinators and SME's. Due date 1/31/2014.
9	Power Operations Performance & Oversight to develop priority guidelines based on Explosion Pentagon to help plants make good decisions on prioritizing risks associated with combustible dust accumulations. Due date 1/31/2014.
10	Power Operations Performance & Oversight to schedule Process Hazard Assessments with TVA Safety for all sites. Due date for schedule 2/28/2014.
11	The combustible dust program coordinator and SME's will attend combustible dust program training (REFERENCE ITEM 8) coordinated by Power Operations Performance & Oversight. Due date 3/28/2014.
12	Combustible dust program coordinator / SME's will develop a site level Combustible Dust procedure using template provided by Engineering / Power Operations Performance & Oversight. This procedure will include inspection plans (daily, monthly, annual), combustibility testing, Hazard Assessments, and plan view drawings showing areas of plant with electrical requirements. REFERENCE ITEM 5. Due date 5/30/2014.
13	Combustible dust program coordinator / SME's will develop housekeeping plan which specifies cleaning frequencies and methods (some plants already have this complete). This will be a living document that will be stored on the Power Operations Performance & Oversight compliance sharepoint site. Due date 5/30/2014.
14	Verify facility has LOI measurement capability. Perform and document sampling of flyash at multiple locations throughout powerhouse to document expected boundaries of "combustible" dust. Follow up measurements will be performed quarterly. Create glass jars with known LOI content (10%, 20%, 30%) to be used to approximate combustibility of ash accumulations during monthly inspections. Due date 6/26/2014.
15	Each site to set up vendor (Benetech or similar) monthly service agreement to inspect, adjust, replace belt cleaners, skirts, etc. Due date 6/26/2014.
16	Power Operations Performance & Oversight to create Combustible Dust SPP to replace Program Document. Due date 9/30/2014.