Memorandum from the Office of the Inspector General

July 15, 2020

Jamie E. Choate
Preston P. Pratt
Jacinda B. Woodward

REQUEST FOR FINAL ACTION – EVALUATION 2019-15642 – POWER OPERATIONS ARC FLASH PROTECTION

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 when final action is complete. In accordance with the Inspector General Act of 1978, as amended, the Office of the Inspector General is required to report to Congress semiannually regarding evaluations that remain unresolved after 6 months from the date of report issuance.

If you have any questions or wish to discuss our findings, please contact Lucas W. Cotter, Senior Auditor, at (423) 785-4826 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)

LWC:FAJ
Attachment
cc (Attachment):
TVA Board of Directors
James R. Dalrymple
Megan T. Flynn
Jeffrey J. Lyash
Justin C. Maierhofer
Jill M. Matthews
Sherry A. Quirk
Ronald R. Sanders II
Michael D. Skaggs
OIG File No. 2019-15642

Office of the Inspector General

Evaluation Report

To the Director of Technical Training; Director of Safety and Enterprise Improvement; and Senior Vice President, Power Operations

POWER OPERATIONS ARC FLASH PROTECTION

Evaluation Team
Lucas W. Cotter
Meghan H. Petty

Evaluation 2019-15642
July 15, 2020

ABBREVIATIONS

Cal/cm^2	Calories per Centimeter Squared
ECM	Enterprise Content Management
JSA	Job Safety Analysis
OSHA	Occupational Safety and Health Administration
PJB	Pre-Job Briefing
PM	Preventive Maintenance
PO	Power Operations
PPE	Personal Protective Equipment
SVP	Senior Vice President
TSP	TVA Safety Procedure
TVA	Tennessee Valley Authority
WO	Work Order

TABLE OF CONTENTS

APPENDICES

Evaluation 2019-15642 – Power Operations Arc Flash Protection

EXECUTIVE SUMMARY

Why the OIG Did This Evaluation

According to the Occupational Safety and Health Administration, workers in the electric power industry are potentially exposed to a variety of serious hazards that can cause injury and death such as electric shock, thermal burn, and arc flash. Arc flash is a dangerous release of energy caused by an electric arc. Tennessee Valley Authority's (TVA) medical records system indicated there were seven arc flash injuries between 2015 and 2019.

Due to the risk of personnel injury from arc flash hazards, we initiated evaluations of arc flash programs in TVA Power Operations and Nuclear.[i] This report summarizes our evaluation of the arc flash program at Power Operations plants. The objectives of our evaluation were to determine if (1) TVA's arc flash procedure[ii] was being performed as required, (2) required personal protective equipment (PPE) was available and properly maintained, and (3) required training was completed.

What the OIG Found

We determined some requirements of TVA's arc flash procedure were not being performed. Specifically, we determined (1) some arc flash hazard analyses were not complete, reviewed timely, updated, or verified and submitted for record; (2) some identified arc flash hazards were not communicated accurately to workers; and (3) arc flash hazards were not consistently documented.

In addition, we determined arc flash training needs improvement. Specifically, we determined (1) not all personnel assigned arc flash training had completed the training curriculum, (2) TVA's identified population of individuals required to have arc flash training was incomplete and not a reliable indicator as to who is required by the Occupational Safety and Health Administration to receive the training, and (3) TVA does not require retraining at the frequency suggested by industry guidance. Also, while PPE was generally available and in good condition, PPE management practices could be improved.

---

[i] Our review, *Nuclear Arc Flash Protection*, was reported under Evaluation 2019-15644.

[ii] Tennessee Valley Authority Safety Procedure 18.1022, *Arc Flash Protection*, establishes requirements for minimizing risk when working around equipment that poses an arc flash hazard.

EXECUTIVE SUMMARY

What the OIG Recommends

We made recommendations to TVA management regarding arc flash (1) procedures, (2) training, and (3) PPE management practices. Our detailed recommendations are listed in the body of this report.

TVA Management's Comments

In response to our draft report, TVA management generally agreed with 10 of our 11 recommendations and stated that actions have been, or will be, taken to address the recommendations. In response to the other recommendation, TVA management stated they would continue the current process for assessing safety-related training assignments. See Appendix B for TVA's complete responses.

Auditor's Response

We concur with TVA management's planned and completed actions for 10 of the 11 recommendations. However, we believe TVA should implement a monitoring protocol to ensure the accuracy of the required training population because its current process did not prevent some individuals from being incorrectly assigned arc flash training.

BACKGROUND

According to the Occupational Safety and Health Administration (OSHA), workers in the electric power industry are potentially exposed to a variety of serious hazards that can cause injury and death such as electric shock, thermal burn, and arc flash. Arc flash is a dangerous release of energy caused by an electric arc. Electric arc flashes can expel large amounts of deadly energy and reach temperatures high enough to set fire to clothing and severely burn human skin. When workers can be exposed to electrical arcs, OSHA indicates the first effort should be to eliminate the exposure through engineering design. If elimination is not possible, exposures should be limited through other means, including work practices.

Tennessee Valley Authority (TVA) Safety Procedure (TSP) 18.1022, *Arc Flash Protection*, establishes requirements for minimizing risk when working around equipment that poses an arc flash hazard. Plants are required to identify and analyze electrical circuits and equipment with arc flash exposure potential operating at 480 volts through 500 kilo-volts. For analyzed equipment, arc flash hazard analyses provide calculated values for the worst-case potential exposure for the following:

- **Incident Energy** – The amount of energy impressed on a surface generated during an electrical arc event. Incident energy is measured in calories per centimeter squared (cal/cm^2).
- **Flash Protection Boundary** – An approach limit established at the distance from an exposed live part within which a person without personal protective equipment (PPE) could receive a second degree burn if an electrical arc flash were to occur (second degree burns can occur at 1.2 cal/cm^2).

When analyses are complete, TVA-TSP-18.1022 requires posting of signs or labels on equipment that can develop an incident energy greater than 1.2 cal/cm^2. Labels are required to be updated if calculations change. See Illustration 1 for an example of an arc flash label at a coal plant. Such labels must include the incident energy potential, flash protection boundary needed for work at that location, and level of PPE required. The PPE level required to conduct work at a location is determined by the calculated incident energy.

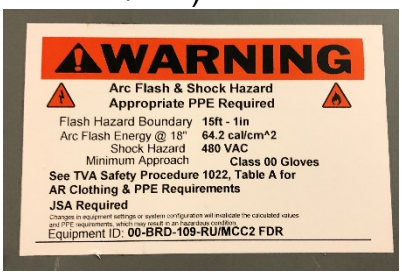

Illustration 1: Arc Flash Warning Label at Kingston Fossil Plant

TVA-TSP-18.1022 requirements for plants also include (1) adherence to requirements in TVA-TSP-18.006*, Plan Jobs Safely*, regarding pre-job briefings (PJB) and job safety analyses (JSA) under certain conditions; (2) training for personnel who enter a defined and marked arc flash protection boundary; (3) evaluation of controls[1] to reduce incident energies; and (4) use of controls

[1] Controls are intended to reduce risk of possible injury and limit effects of human error.

when available. In addition, TVA Standard Programs and Processes 09.001, *Engineering Calculations*, requires that all new and newly revised calculation packages shall become permanent TVA records by inputting them into TVA's Enterprise Content Management (ECM) system to ensure safekeeping of records and to have them readily retrievable.

TVA's medical records system indicated there were seven arc flash injuries between 2015 and 2019. Of the seven, four injuries occurred at Power Operations (PO) plants, including two injuries at Pickwick Hydro Plant and one injury at Gallatin Fossil Plant in 2016, and one injury at Lagoon Creek Combustion Turbine Plant in 2019. Due to the risk of personnel injury from arc flash hazards, we initiated evaluations of arc flash programs in TVA PO and Nuclear. This report summarizes our evaluation of the arc flash program at PO plants.[2]

OBJECTIVE, SCOPE, AND METHODOLOGY

The objectives of our evaluation were to determine if (1) TVA's arc flash procedure was being performed as required, (2) required PPE was available and properly maintained, and (3) required training was completed. The scope of our evaluation included the arc flash program at PO plants. See Appendix A for additional information regarding our objectives, scope, and methodology.

FINDINGS AND RECOMMENDATIONS

We determined (1) some requirements of the arc flash procedure were not being performed, and (2) arc flash training needs improvement. Also, while PPE was generally available and in good condition, PPE management practices could be improved.

SOME REQUIREMENTS OF THE ARC FLASH PROCEDURE WERE NOT PERFORMED

We determined some requirements of the arc flash procedure were not being performed. Specifically, (1) some arc flash hazard analyses were not complete, reviewed timely, updated, or verified and submitted for record; (2) some identified arc flash hazards were not communicated accurately to workers; and (3) arc flash hazards were not consistently documented.

[2] Our review, *Nuclear Arc Flash Protection*, was reported under Evaluation 2019-15644.

Some Hazard Analyses Were Not Complete, Reviewed Timely, Updated, or Verified and Submitted for Record

We determined procedural requirements for some arc flash hazard analyses were not met, including hazard analyses that were not (1) complete, (2) reviewed timely, (3) updated to reflect current values, and/or (4) verified or submitted for record. Arc flash hazards that have not undergone the required review and approval process and hazards that have not been evaluated increase safety risk to personnel.

Some Arc Flash Hazard Analyses Were Incomplete

We reviewed completeness of arc flash hazard analyses for a sample of 9 plants. Our review determined hazard analyses for 3 of the 9 plants were incomplete because they did not calculate incident energies and boundaries at all required locations.

We reviewed a sample of 103 work orders (WO) involving arc flash potential and identified 141 locations where work was performed that required calculated incident energies and boundaries. We determined 4 of the 141 locations did not have calculated arc flash incident energies or boundaries. However, temporary warning labels were posted at those locations noting that calculations had not been performed.

Some Arc Flash Hazard Reviews Were Not Completed Timely

Plant hazard analyses were not reviewed timely as required by procedure. TVA-TSP-18.1022 indicates the arc flash hazard analysis shall be reviewed periodically, not to exceed 5 years, to account for changes in the electrical distribution system that could affect the results of the arc flash hazard analysis. Such a review would include a walk down of electrical systems, software updates based on gathered field information, and verifying calculations.

While PO has taken steps to update arc flash hazard analyses in the last several years, we determined reviews of arc flash hazard analyses had not taken place within the required 5-year period at 20 of 52 plants. PO provided us a plan to address the remaining outstanding plant arc flash analysis reviews by the end of fiscal year 2021.

Some Arc Flash Hazard Analyses Did Not Contain Current Calculated Values

As discussed above, TVA-TSP-18.1022 requires arc flash hazard analyses to contain calculated values for all electrical circuits and equipment with arc flash exposure potential. We determined there were locations at 6 of the 9 plants in our sample for which the most current calculations were not included with the arc flash hazard analysis, but instead in supplemental documents or spreadsheets. While we were generally able to locate the calculations for these locations, maintaining plant calculations in multiple documents increases the risk that impacts to arc flash hazards resulting from system design changes are not reflected in warnings to personnel at plants.

Some Arc Flash Hazard Analyses Were Not Verified or Submitted for Record

We determined arc flash hazard calculations for locations in our work order sample were not verified as required by procedure. TVA-TSP-18.1022 requires arc flash hazard analyses be verified. We reviewed arc flash hazard calculations for all locations in our work order sample and determined 48 of the 141 locations referenced calculations for which TVA could not provide documentation of the necessary verification.

We also identified an issue related to the proper storage of arc flash calculation packages. TVA Standard Programs and Processes 09.001, *Engineering Calculations*, requires, upon completion, calculation packages to become permanent TVA records by inputting them into ECM. However, 63 of the 141 locations had not been submitted for record into ECM as required.

Verification of arc flash calculations used to assess hazards at plants and proper storage of TVA engineering calculations is necessary to ensure that calculations are verifiable, and clearly communicate the reasons for and the results of the calculation.

Some Identified Hazards Were Not Accurately Communicated

We identified missing and/or inaccurate warning labels at 5 of the 9 plants in our sample. As noted previously, TVA-TSP-18.1022 requires warning labels to include incident energy, boundaries, and PPE levels to reflect calculations performed during the arc flash hazard analysis. In addition, PO management indicated personnel at plants are expected to consult labels to determine necessary PPE and boundary restrictions required prior to performing work. However, 12 of the 141 locations in our sample were unlabeled or contained inaccurate labels.

After completing initial fieldwork to assess labels at each of the plants in our sample, an updated arc flash hazard analysis was approved and submitted for record into ECM for 1 of the 5 plants at which we had previously found inaccurate warning labels. The revised arc flash hazard analysis was approved in December 2019; however, labels had not been replaced at the plant to correspond with the revisions as of May 2020. We compared the outdated labels to the updated hazard analysis calculations to determine whether incident energy had changed for any of our sample locations. We determined labels at 5 locations would need to be updated based on the revised arc flash hazard analysis, and labels at 11 locations were missing recalculations in the updated hazard analysis. When we informed Generation Services about the apparent discrepancies, the relevant program manager stated the updated hazard analysis contained mistakes, including missing and inaccurate label calculations, and stated the calculations may need to be performed again.

Inaccurate or missing labels on equipment that can develop hazardous incident energy increase the possibility that workers are not adequately protected.

Arc Flash Hazards Were Not Consistently Documented

We determined arc flash hazards were not consistently documented. Specifically, plants did not maintain work packages and PJBs. As a result, we were unable to determine whether work was performed in accordance with procedure. In addition, discrepancies existed between two procedures when documented JSAs are required.

Work Packages and PJBs Were Not Maintained

We determined work packages and PJBs for WOs involving arc flash hazard were not maintained at plants in accordance with procedure. TVA-SPP-07.0, *Work Management*, states that work package records shall have a minimum retention time of 90 days from record closure. TVA-TSP-18.006 requires PJBs to be maintained with work packages for any work on or near energized equipment or fire/explosion burn hazards. PJBs are intended to identify hazards to those performing work and ensure hazards were eliminated or controlled prior to beginning work. Since we confirmed arc flash hazard potential for each of our sampled WOs, we anticipated each work package and associated PJB would have identified PPE or alternate methods of mitigation identified. However, we could not locate work packages onsite for 99 (96 percent) or PJBs for 96[3] (93 percent) of the 103 sampled WOs. As a result, we were unable to determine if PPE or other alternate mitigation methods were implemented.

Discrepancy in JSA Requirements

We determined that the standards for work requiring a documented JSA differed between two TVA procedures. JSAs are intended to identify conditions associated with tasks that pose a hazard to those performing the work. As with the PJB standard discussed above, TVA-TSP-18.006 requires JSAs for any work on or near energized equipment or fire/explosion burn hazards. In contrast, TVA-TSP-18.1022 only requires a JSA for work on any equipment with *high hazard* incident energies or exposed energized parts. TVA-TSP-18.1022 considers high hazard incident energies greater than or equal to 40 cal/cm^2. Having differing requirements for when JSAs should be performed could result in risk to personnel safety for those who perform arc flash hazard work.

Recommendations:

We recommend the Senior Vice President (SVP), PO:

- Execute the plan to update arc flash hazard analyses at plants currently overdue on their review cadence to ensure the analyses are reflective of current plant operating conditions and comply with requirements for a 5-year review.

  TVA Management's Comments – PO management agreed with this recommendation and is in the process of implementing a plan to perform the arc flash hazard analysis for the required 5-year baseline at the identified 20 plants. See Appendix B for TVA's complete response.

[3] Two of the four work packages we found contained a PJB. In addition, 1 plant in our sample had maintained PJBs separately and provided five PJBs pertaining to our sample WOs.

Auditor's Response – We concur with management's planned actions.

- Develop and implement a control to ensure arc flash hazard analyses contain all updated calculations at those respective plants.

  TVA Management's Comments – PO management agreed with this recommendation and will put a control measure in place to ensure cadence is not missed in the future. PO will also perform and issue the calculations for the identified 20 plants. See Appendix B for TVA's complete response.

  Auditor's Response – We concur with management's planned actions.

- Develop and implement a control to ensure arc flash hazard analyses are accurate, approved, and submitted for record into ECM.

  TVA Management's Comments – PO management agreed with this recommendation and will add steps in the PO Arc Flash Procedure that arc flash analysis, once approved, will be added to ECM. See Appendix B for TVA's complete response.

  Auditor's Response – We concur with management's planned actions.

- Implement a consistent method for placing updated arc flash labels at plants to provide workers accurate arc flash values in a timely manner.

  TVA Management's Comments – PO management agreed with this recommendation and will add language in the PO Arc Flash Procedure directing the method and proper timeliness of the placement of arc flash labels at the plants. See Appendix B for TVA's complete response.

  Auditor's Response – We concur with management's planned actions.

- In conjunction with the Director of Safety, implement a control to monitor documented PJB and JSA requirements and verify proper documentation is maintained.

  TVA Management's Comments – PO management agreed with this recommendation and will add attributes in their WO assessment process to ensure JSA and PJBs are included when they are required for electrical work involving potential arc flash. See Appendix B for TVA's complete response.

  Auditor's Response – We concur with management's planned actions.

We recommend the Director of Safety and Enterprise Improvement:

- Align its procedures to clarify when a JSA is required for work on electrical work involving potential for arc flash.

  TVA Management's Comments – Safety and Enterprise Improvement management agreed with this recommendation and has revised TVA-TSP-18.006 to require work with an arc flash potential >40 cal/cm^2 to have a JSA. The revision is currently going through the review process. See Appendix B for TVA's complete response.

Auditor Response – We concur with management's planned actions.

ARC FLASH TRAINING NEEDS IMPROVEMENT

We determined not all personnel assigned arc flash training had completed the training curriculum. We also determined TVA Technical Training's identified population of individuals required to have arc flash training was incomplete and not a reliable indicator as to who is required by OSHA to receive the training. In addition, TVA does not require retraining at the frequency suggested by industry guidance.

Some Personnel Did Not Receive Initial Arc Flash Training

TVA-TSP-18.1022 requires personnel who enter a defined and marked arc flash boundary to be trained to understand the specific hazards associated with arc flash. Training shall be specific to the individual's responsibilities to carry out the functions assigned. TVA-TSP-18.1022, Revision 14, Section 5.0 required[4] the following two courses (or an equivalent training block) during initial training: 00059115, *Electrical Safety per OSHA* and 00059242, *Arc Flash Hazard*.

Our review of 1,210 personnel assigned the arc flash training curriculum found 99 (8 percent) had not completed the curriculum as of March 31, 2019. We determined 50 individuals subsequently received the missing training, 3 left TVA, and 12 had the training curriculum requirement removed by TVA as of February 1, 2020. However, the remaining 34 personnel were still overdue on their training requirement as of February 1, 2020.

TVA's Identified Required Trainee Population Was Incomplete and Unreliable

OSHA requires employees who face a risk of electric shock or other electrical hazards to be trained in and familiar with certain safety-related work practices. We determined TVA's identified required trainee population was incomplete and not a reliable indicator as to personnel who would be required by OSHA to take the courses. Our conclusion was based on the following factors:

- Training was not assessed for all job codes. TVA's Technical Training group[5] assigns training to individuals within job codes assessed as requiring the arc flash curriculum. In September 2019, we were informed Technical Training had a backlog of unassessed job codes. Between March 31, 2019, and January 13, 2020, 57 job codes added arc flash curriculum as a requirement. As of February 1, 2020, 30 PO individuals were active in those job codes.
- PO management indicated some individuals were listed as requiring arc flash training who should not be included in the trainee population because the individuals did not conduct work involving arc flash potential.

[4] The TSP's current revision, effective May 2019, removed language identifying specific courses required. We followed up with personnel in TVA's Safety and Technical Trainings groups who indicated these courses continue to constitute TVA's arc flash training curriculum.

[5] During the course of the evaluation, TVA revised the name of the group responsible for assigning training from Enterprise Improvement to Technical Training.

According to Technical Training, there is no formal process for PO to routinely review the list of positions assigned the training for completeness and accuracy.

Retraining Requirements Do Not Align With Industry Standard
The National Fire Protection Agency standards recommend retraining in safety-related work practices at intervals not to exceed 3 years. TVA-TSP-18.1022 states personnel shall receive additional training in the event of noncompliance with safety related work practices or lack of knowledge; however, the procedure does not require regular retraining. Although a computer-based refresher course is available in the training catalog, it is currently not assigned as part of the required arc flash curriculum.

As an indication of the prevalence of retraining, we tested records for the 684 personnel potentially due for retraining.[6] We determined 678 (99 percent) of those personnel had not taken the refresher course as of March 31, 2019.

Recommendations:
We recommend the SVP, PO:

- Provide the required initial training as soon as is practicable to the 34 identified personnel missing the training.

  TVA Management's Comments – PO management agreed with this recommendation and will work with Technical Training to ensure the 34 identified delinquent employees are brought up to date on their training. See Appendix B for TVA's complete response.

  Auditor Response – We concur with management's planned actions.

We recommend, the SVP, PO, in coordination with Technical Training:

- Identify all job codes and personnel potentially exposed to arc flash risk at PO plants to ensure TVA's trainee population is in accordance with OSHA.

  TVA Management's Comments – PO management accepted this recommendation and stated all PO job codes have been assessed for arc flash risk and assigned training as applicable. See Appendix B for TVA's complete response.

  Auditor Response – We concur with management's actions and will verify completion prior to closing the recommendation.

- Establish a monitoring protocol for ensuring the training population is periodically reviewed and approved by plant management.

  TVA Management's Comments – PO management did not accept this recommendation and stated there is a current process to assess job codes for safety-related training. Management stated when new job codes are created, Technical Training works with the PO management team to assess the new

[6] For this analysis, we assumed all employees who took the initial training more than 3-years prior to March 31, 2019, would be due for retraining.

position. If work changes or position requirements change it is recommended that the manager review training assignments and request additions or removals through the training process. See Appendix B for TVA's complete response.

Auditor Response – As noted in the report, PO management indicated some individuals were listed as requiring arc flash training who should not be included in the trainee population because the individuals did not conduct work involving arc flash potential. Therefore, we disagree that the current process would be as effective as implementing a monitoring protocol for ensuring the accuracy of the required training population.

- Consider formalizing a routine retraining requirement to align with industry guidance.

  TVA Management's Comments – PO management agreed with this recommendation and stated refresher training will be assigned to individuals that receive initial arc flash training. See Appendix B for TVA's complete response.

  Auditor Response – We concur with management's planned actions.

REQUIRED PPE IS AVAILABLE AND MAINTAINED; HOWEVER, PPE MANAGEMENT PRACTICES COULD BE IMPROVED

According to TVA-TSP-18.1022, PPE shall ". . . be stored in a manner that prevents physical damage; damage from moisture, dust, or other deteriorating agents; or contamination from flammable or combustible materials." The PPE shall also be inspected before each use as well as cared for and maintained in accordance with the garment manufacturer's instructions to avoid loss of protection. Based on our observation of PPE storage areas, we concluded that PPE was generally stored in a manner to avoid loss of protection and was in good condition. We received positive feedback from plant personnel regarding both the quantity and quality of available PPE at the plants.

However, we determined during plant visits that while some plants maintained a current inventory listing of PPE or used preventive maintenance (PM) WOs to manage routine PPE inspection and maintenance,[7] others did not. While not required by procedure, we noted that PPE management practices at sites that do not have active inventory listings or perform PM, could be improved to ensure continued availability and good material condition.

[7] A 2016 assessment by TVA's Operational Assurance group also determined that routine inspections of arc rated equipment had not been consistently performed.

Recommendation

We recommend the SVP, PO:

- Consider implementing processes to maintain plant-level inventory listings of arc flash PPE and implementing a PM program to routinely inspect PPE.

  TVA Management's Comments – PO management agreed with this recommendation and will implement PMs at plants to inventory arc flash PPE and inventory will be recorded electronically at the close of the PM. See Appendix B for TVA's complete response.

  Auditor Response – We concur with TVA's planned actions.

OBJECTIVE, SCOPE, AND METHODOLOGY

The objectives of our evaluation were to determine if (1) TVA's arc flash procedure was being performed as required, (2) required personal protective equipment was available and properly maintained, and (3) required training was completed. The scope of our evaluation included the arc flash program at Power Operations (PO) plants for the time frames specified below. To achieve our objectives, we:

- Interviewed the following pertinent personnel to gain an understanding of the arc flash protection process, requirements, and potential areas for improvement:
  - Corporate Program Manager
  - Corporate safety personnel
  - Corporate and plant engineers
  - Plant operations and maintenance managers
- Reviewed relevant documentation to gain an understanding of the arc flash protection process and identify potential areas for improvement:
  - *TVA Safe Work Requirements Manual*
  - TVA-TSP-18.1022, *Arc Flash Protection*
  - TVA-TSP-18.006, *Plan Jobs Safely*
  - *OSHA 1910 Subpart S - Electrical Standard*
  - *OSHA Electric Power Generation, Transmission, and Distribution Standard (29 CFR §1910.269)*
  - *National Fire Prevention Association Standard for Electrical Safety in the Workplace (70E)*
  - TVA-SPP-07.0, *Work Management*
- Selected a judgmental sample of 9 PO plants to assess work-package documentation and accuracy of arc flash hazard labels. Our 9-plant sample was comprised of 3 plants each from the hydro, gas, and coal fleets based on several criteria.[1] The 9 plants selected for sample testing were Brownsville, Gallatin, and Johnsonville Combustion Turbines; Gallatin, Kingston, and Shawnee Fossil Plants; Fontana and Kentucky Hydro Plants; and Raccoon Mountain Pump Storage Facility.
- For each plant in our sample, we selected a random, nonstatistical sample of WOs involving arc flash potential closed in TVA's work management system, between June 30 and September 30, 2019, from each plant in our sample. We randomly selected 10 relevant WOs containing clearances and 5 relevant WOs without clearances for each plant. Where fewer than 10 relevant WOs

[1] Plants were selected based on several criteria, including TVA-produced risk ratings, available controls, safety observations, historical arc flash reviews, availability of plant-level procedures, and risks identified in condition reports.

with clearances or 5 relevant WOs without clearances existed within the date range at any given plant, we assessed all available relevant WOs. In total, we assessed 103 WOs of the 24,873 total WOs closed between June 30 and September 30, 2019, at the 9 plants. We requested work packages for each of the WOs in our sample to test for required documentation and approvals. In addition, we observed work locations to determine whether warning labels were accurate. For the 104 WOs reviewed, we observed and photographed 141 related work locations requiring calculated arc flash incident energies and boundaries.

- Reviewed arc flash hazard analyses for all PO plants to determine whether plant calculations had been reviewed and approved within the required 5-year interval.
- Analyzed data to determine if individuals had received required training. We identified arc flash training courses required. We obtained records as of March 31, 2019, for (1) active personnel from TVA's human resource management system assigned to the arc flash curriculum and (2) training completion records from TVA's learning management system. We also reviewed any status changes to our training exceptions using training data updated as of February 1, 2020.
- Conducted plant visits at the nine plants to observe physical location and condition of personal protective equipment.

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

July 10, 2020

David P. Wheeler, WT 2C-K

REQUEST FOR COMMENTS – DRAFT EVALUATION 2019-15642 – POWER OPERATIONS ARC FLASH PROTECTION

This is in response to your memorandum dated June 12, 2020. After review of the draft report, please see the following response to the Power Operations Arc Flash Protection audit.

We would like to thank Lucas Cotter and Meghan Petty for their diligence and support to enhance Power Operations Arc Flash Protection.

Recommendations:

We recommend the Senior Vice President (SVP), PO:

1. Execute the plan to update arc flash hazard analyses at plants currently overdue on their review cadence to ensure the analyses are reflective of current plant operating conditions and comply with requirements for a 5-year review.

Response
Power Operations agrees with this recommendation. We are in the process of implementing a plan to perform the arc flash hazard analysis for the required 5-year rebaseline at the identified 20 plants with a planned completion by the end of the fiscal year 2022.

2. Develop and implement a control to ensure arc flash hazard analyses contain all updated calculations at those respective plants.

Response
Power Operations agrees with this recommendation. A control measure (PM/ATI) is to be put in place on a recurring basis to ensure cadence not missed in the future. Perform and issue the calculations for the identified 20 plants.

3. Develop and implement a control to ensure arc flash hazard analyses are accurate, approved, and submitted for record into ECM.

Response
Power Operations agrees with this recommendation. We will add steps in our Arc Flash SPP (PO-SPP-09.127) that arc flash analysis, once approved, will be added to ECM.

4. Implement a consistent method for placing updated arc flash labels at plants to provide workers accurate arc flash values in a timely manner.

Response
Power Operations agrees with this recommendation. We will add language in our Arc Flash Procedure (PO-SPP-09.127) directing method and proper timeliness of the placement of arc flash labels at the plants.

5. In conjunction with the Director of Safety, implement a control to monitor documented PJB and JSA requirements and verify proper documentation is maintained.

Response
Power Operations agrees with this recommendation. We will add attributes in our work order assessment process to ensure JSA and PJBs are included when they are required for electrical work involving potential arc flash.

6. Provide the required initial training as soon as is practicable to the 34 identified personnel missing the training.

Response
Power Operations agrees with this recommendation. We will work with Technical Training, communicate to the outlying 34 employees of delinquent training and ensure they are brought up to date on their training.

7. Consider implementing processes to maintain plant-level inventory listings of arc flash PPE and implementing a preventative maintenance program to routinely inspect PPE.

Response
Power Operations agrees with this recommendation. We will implement PMs at our plants to inventory arc flash PPE. Inventory to be recorded electronically at the close of the PM.

We recommend the SVP, PO, in coordination with Technical Training:

8. Identify all job codes and personnel potentially exposed to arc flash risk at PO plants to ensure TVA's trainee population is in accordance with OSHA.

Response
Recommendation is accepted and actions are complete. All Power Operations job codes have been assessed for arc flash risk and assigned training as applicable.

9. Establish a monitoring protocol for ensuring the training population is periodically reviewed and approved by plant management.

Response
Recommendation is not accepted. There is a current process in place to assess job codes for safety-related training. When new job codes are created, Technical Training works with the Power Operations management team to assess the new position. If at any time work changes or position requirements change it is recommended that the manager review training assignments and request additions or removals through the training process.

10. Consider formalizing a routine retraining requirement to align with industry guidance.

Response
We agree with the recommendation to formalize a routine retraining requirement to align with industry guidance. Refresher training will be assigned to individuals that receive initial arc flash training. The retraining period will not exceed three years per industry guidance.

We recommend the Director of Safety:

11. Align its procedures to clarify when a JSA is required for work on electrical work involving potential for arc flash.

Response
We agree with the recommendation for the Director of Safety and Enterprise Improvement to align its procedure to clarify when a JSA is required for electrical work involving potential for arc flash. The TVA-TSP-18.006 Plan Jobs Safely decision tree has been revised to require work with an arc flash potential > 40 cal/cm2 to have a JSA and is currently going through the review process. Safety requests an October 31, 2020 due date to complete the review and approval for this recommendation.

Corporate Safety agrees with the facts and conclusions. Please consider the following comments for the final report:

- Page 1 – second paragraph, second sentence, "Plants are required to identify and analyze all electrical circuits and equipment with arc flash potential." The prior sentence in the report has the footnote stating TVA-TSP-18.1022 Arc Flash Protection applies to 480v to 500kv. For clarification, consider changing "all" to "480v to 500 kV." Arc flash events can happen at lower voltages, but they are not within the scope of this procedure.
- Page 1 – final paragraph, "… (2) Identification and training for all employees who have arc flash potential,…". For clarification, consider rewording to "… (2) Training for employees who enter a defined and marked arc flash boundary,…" to align with Section 4.0 Training in the TSP.

Thank you for allowing us to provide these comments. Please contact us if you have any questions.

Jamie Choate

Jamie E. Choate
Director,
Technical Training

Preston P. Pratt
Director,
Safety

Jacinda B. Woodward
Senior Vice President,
Power Operations

RBW:EBG:AEP
cc: James R. Dalrymple, MR 3H-C
Megan T. Flynn, LP 3A-C
Sherry A. Quirk, WT 6A-K
Ronald R. Sanders II, MR 5E-C
Michael D. Skaggs, WT 7B-K
OIG File No. 2019-15642