



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
REGION II  
245 PEACHTREE CENTER AVENUE N.E., SUITE 1200  
ATLANTA, GEORGIA 30303-1200

January 23, 2019

Mr. J. W. Shea  
Vice President, Nuclear  
Regulatory Affairs and  
Support Services  
Tennessee Valley Authority  
1101 Market Street, LP 4A  
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNIT 1 - NRC SPECIAL INSPECTION  
REPORT 05000259/2018050

Dear Mr. Shea:

On December 14, 2018, the U.S. Nuclear Regulatory Commission (NRC) completed a reactive inspection pursuant to Inspection Procedure 93812, "Special Inspection," at your Browns Ferry Nuclear Plant, Unit 1. On December 14, the NRC inspectors discussed the final results of this inspection with M. Oliver and other members of the licensee staff during a re-exit via telecom. The results of this inspection are documented in the enclosed report.

The special inspection began on November 14, 2018, in accordance with NRC Management Directive 8.3, "NRC Incident Investigation Program," and Inspection Manual Chapter 0309, "Reactive Inspection Decisions Basis for Reactors," based on the deterministic criteria evaluation performed by the NRC. The special inspection reviewed the circumstances surrounding a diver receiving an electronic dosimeter (ED) dose rate alarm of 71 Rem/hr while performing underwater steam dryer cut up support work in the BFN Unit 1 equipment pit on November 7, 2018. The inspectors examined activities conducted under your license as they related to radiological safety and compliance with the Agency's rules and regulations and with the conditions of your license.

One finding, which was determined to be of very low safety significance (Green), is documented in this report. The finding involved a violation of NRC requirements. Because of the very low safety significance, the NRC is treating the violation as a non-cited violation (NCV) consistent with Section 2.3.2.a of the Enforcement Policy.

If you contest any of the violation or significance of the NCV, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001; with copies to the Regional Administrator, Region II; the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; and the NRC Resident Inspector at Browns Ferry Nuclear Plant.

If you disagree with a cross-cutting aspect assignment in this report, you should provide a response within 30 days of the date of this inspection report, with the basis for your

disagreement, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001; with copies to the Regional Administrator, Region II, and the NRC Resident Inspector at Browns Ferry Nuclear Plant.

This letter, its enclosure, and your response (if any) will be made available for public inspection and copying at <http://www.nrc.gov/reading-rm/adams.html> and at the NRC Public Document Room in accordance with 10 CFR 2.390, "Public Inspections, Exemptions, Requests for Withholding."

Sincerely,

**/RA/**

Anthony D. Masters, Chief  
Reactor Projects Branch 5  
Division of Reactor Projects

Docket No.: 50-259  
License No.: DPR-33

Enclosure: NRC Special Inspection Report 05000259/2018050

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SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNIT 1 - NRC SPECIAL  
INSPECTION REPORT 05000259/2018050 January 23, 2019

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**U.S. NUCLEAR REGULATORY COMMISSION**  
**Inspection Report**

Docket Number: 50-259

License Number: DPR-33

Report Number: 05000259/2018050

Enterprise Identifier: I-2018-050-0003

Licensee: Tennessee Valley Authority (TVA)

Facility: Browns Ferry Nuclear Plant, Unit 1

Location: Corner of Shaw and Nuclear Plant Road  
Athens, AL 35611

Inspection Dates: November 14, 2018 - December 14, 2018

Inspectors: R. Kellner, Senior Health Physics Inspector (Team Lead)  
J. Seat, Project Engineer

Approved By: A. Masters, Chief  
Reactor Projects Branch 5  
Division of Reactor Projects

Enclosure

## SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) continued monitoring licensee's performance by conducting a Special Inspection at Browns Ferry Nuclear Plant (BFN), Unit 1 in accordance with the Reactor Oversight Process. The Reactor Oversight Process is the NRC's program for overseeing the safe operation of commercial nuclear power reactors. Refer to <https://www.nrc.gov/reactors/operating/oversight.html> for more information. NRC and self-revealed findings, violations, and additional items are summarized in the table below.

### List of Findings and Violations

Failure to Perform Adequate Radiation Surveys			
Cornerstone	Significance	Cross-cutting Aspect	Report Section
Occupational Radiation Safety	Green Non-Cited Violation (NCV) 05000259/2018050-01 Closed	[H.5] – Work Management	93812 – Special Inspection
A self-revealing, Green, NCV of Title 10 Code of Federal Regulations (10 CFR) 20.1501, "Surveys and Monitoring: General," was identified when TVA failed to perform adequate surveys of the Unit 1 refuel floor equipment pit during diving operations. Specifically, a detailed survey of the dive area was performed on October 19, 2018, prior to the start of diving activities. From October 19 to November 7, 2018, multiple dives were performed; however, no surveys of the dive area were documented to confirm radiological conditions. On November 7, 2018, a diver received multiple electronic dosimeter (ED) dose rate alarms, the highest of which was 71.7 Rem/hr, and the diver received 90 millirem (mrem) of unplanned dose.			

### Additional Tracking Items

Type	Issue number	Title	Report Section	Status
URI	05000259/2018050-02	Potential failure to maintain and implement adequate work and radiological control procedures for the control of diving activities, control of High Radiation Areas and Very High Radiation Areas, and the control of highly radioactive materials.	93812	Open

## INSPECTION SCOPES

Inspections were conducted using the appropriate portions of the inspection procedures (IPs) in effect at the beginning of the inspection unless otherwise noted. Currently approved IPs with their attached revision histories are located on the public website at <http://www.nrc.gov/reading-rm/doc-collections/insp-manual/inspection-procedure/index.html>. Samples were declared complete when the IP requirements most appropriate to the inspection activity were met consistent with Inspection Manual Chapter (IMC) 2515, "Light-Water Reactor Inspection Program - Operations Phase." The inspectors reviewed selected procedures and records,

observed activities, and interviewed personnel to assess licensee performance and compliance with Commission rules and regulations, license conditions, site procedures, and standards.”

## **OTHER ACTIVITIES – TEMPORARY INSTRUCTIONS, INFREQUENT AND ABNORMAL**

### **93812 - Special Inspection**

In accordance with IP 93812, Special Inspection, and the attached Special Inspection Team Charter, the inspection team conducted a detailed review of the event involving a diver encountering elevated dose rates and receiving an electronic dosimeter (ED) dose rate alarm of 71.7 Rem/hr while performing underwater diving activities in support of steam dryer cut-up and removal work in the BFN Unit 1 equipment pit, on November 7, 2018.

#### **Description of Event:**

On November 7, 2018, a diver was cutting up the steam dryer in the Browns Ferry Nuclear (BFN) Unit 1 equipment pit and received multiple electronic dosimeter (ED) dose rate alarms. The highest of dose rate was 71.7 Rem/hr, and the diver received 90 mrem of unplanned dose. Radiation protection (RP) technicians monitoring the work had the diver immediately back away from the area and exit the equipment pit. Diving was suspended until underwater radiation surveys of the area were completed. Initial radiation surveys identified a used filter rack in the dive area containing filters reading 228 Rem/hr on contact, 25 Rem/hr at 30cm, and 1.5 Rem/hr at 1m (as measured underwater). Subsequent detailed radiation surveys of the filter rack, after it was moved out of the dive area, identified two used Tri-Nuke filters reading 400 and 450 Rem/hr on contact, and 20 and 21 Rem/hr at 30 cm respectively.

#### **Special Inspection Team Charter Scope**

1. Develop a time line of events leading up to the dose rate alarm, including a clear understanding of changing radiological conditions.

- a. Inspection Scope

The inspectors interviewed station personnel and reviewed statements of personnel working on the refuel floor at the time of event, corrective action documents, radiation control shift logs, radiological survey records, archived video footage of the area, shift turnover sheets, work documents, procedures, and additional documents as part of the inspection activity.

- b. Observations and Findings

The following timeline is an overview of the major actions leading up to the diver receiving multiple ED dose rate alarm(s), and subsequent actions taken.

- 10/19/2018 - Detailed underwater radiation surveys performed prior to initial diving operations in the equipment pit for steam dryer cut-up work.

- 10/19 to 11/07- Diving operations occurred on day and night shift, as needed, to support steam dryer cut-up activities. During this time, no documented underwater surveys were performed.
- 11/06 - Empty filter rack located in the dive area moved to east end of equipment pit for Tri-Nuke filter unit filter change out (time unknown).
- 11/06 - (Day shift, time unknown) Boilermakers change out Tri-Nuke filters and place used filters in the filter rack. No underwater survey of used filters performed.
- 11/7
  - 0525 - Last night shift diver exits the water.
  - 0525 - Boilermakers moved the filter rack [now containing used Tri-Nuke filters] back to original location in the dive area.
  - 0700 - Dayshift dive crew safety and high radiation area (HRA)/locked high radiation (LHRA) briefing held.
  - 0840 to 0849 - Diving checklists completed for diver #1 and #2 and divers entered the water in the equipment pit.
  - 1140 (approximately) - Diver #1 and #2 started to exit the water. While waiting to exit, diver #2 was told by the dive supervisor to go to the south side of the equipment pit and free up a camera cable that was entangled. RP was not informed of the work scope change.
  - 1213 - Multiple remotely monitored EDs on diver #2 alarmed on dose rate, the highest dose rate logged was 71.7 R/hr. RP directed that the diver immediately back out of the area and exit the water.
  - 1219 - All ED alarms cleared and diver #2 was out of the water. Review of remote monitor data indicated that the highest ED dose for the diver was 209 mrem on the left leg. Underwater radiation survey identifies the cause of the ED alarms to be used Tri-Nuke filters with a contact dose rate of 228 Rem/hr, and 20 R/hr at 30 cm.
  - 1300 - Additional dive crew briefed on high dose rates on filters and to remain away from the filter rack. Diver #3 and diver #4 entered the water at 1404 to 1510 to place equipment in a safe condition.
  - 1605 - Diver #3 and #4 out of the water. No ED alarms were received.
  - 1650 - Diving suspended. All personnel on the refuel floor in equipment pit area, and those involved in diving activities, requested to provide statements about knowledge of what had occurred regarding the Tri-Nuke filters and filter racks during the last two days.
- 11/7 - 11/8 - Stop work initiated, condition report (CR) 1464279 generated, prompt investigation completed, dive procedure revised (RCI-33), dive crew and RP staff briefed on event, and additional supervisory oversight assigned to diving activity.
- 11/8 - Diving resumed
- 11/9 - Diving complete.

2. Review and evaluate the licensee's immediate actions following the alarm including removal of the diver from the area and a stand down of all diving activities.

- a. Inspection Scope

The inspectors interviewed station personnel and reviewed statements of personnel working on the refuel floor and the time of event, corrective action documents, radiation control shift logs, radiological survey records, archived video footage of the area, shift turnover sheets, work documents, procedures, and additional documents as part of the inspection activity.

- b. Observations and Findings

The inspectors determined that the immediate actions taken by the licensee in response to the ED alarm were appropriate and per procedural guidance.

3. Evaluate the licensee's programs for diving operations, including control of diver movements and underwater survey techniques and frequencies.

- a. Inspection Scope

The inspectors interviewed station personnel and reviewed statements of personnel working on the refuel floor and the time of event, corrective action documents, radiation control shift logs, radiological survey records, archived video footage of the area, shift turnover sheets, work documents, procedures, and additional documents as part of the inspection activity.

- b. Observations and Findings

The licensee has a program and procedural guidance for performing diving in radiological areas.

Licensee procedures RCI-17, "Control of High Radiation Areas and Very High Radiation Areas", and RCI-33, "Diving Operations on the Refuel Floor" are the main implementation procedures used to control diving operations. Additionally, procedures NPG-SPP-05.1, "Radiological Controls", and NISP-RP-05, "Nuclear Industry Standard Process Access Controls for High Radiation Areas" establish radiation protection program requirements and contain implementation guidance.

Procedures identified that used Tri-Nuke filters stored in the spent fuel pool and refuel pool areas could present a major radiological hazard and that precautions should be taken when removing them from the water. However, the procedures lacked specific requirements for the: 1) frequency of underwater surveys during extended diving operations; 2) performing underwater surveys when used filters are removed from filtration units and placed in 'filter racks'; 3) identifying and/or controlling the location of used filters within the refueling area; 4) requirements for evaluating potential radiological impacts that used filters could have on other activities in the refueling area; and 5) work control requirements for coordinating movement of used filters with radiation protection. Additionally, some procedural



controls and oversight activities are specifically exempt for work in the refuel floor equipment pit.

Unresolved Item (URI) 05000259/2018050-02 was identified for Charter Items 3, 4, and 8, to determine if; 1) performance deficiencies exist regarding perceived procedural shortfalls related to work control and coordination between workgroups, survey frequency when diving, and control of underwater movement and storage of highly radioactive, non-fuel items in the spent fuel pool/ refuel pool/ equipment pit areas in general and during refueling operations; and 2) if procedural inadequacies were a root or contributing cause of the diving event which occurred on November 7, 2018.

4. Evaluate the licensee's program for work control and coordination between groups in regards to movement of highly radioactive components, including programs for turnover of information from one shift to the next.

a. Inspection Scope

The inspectors interviewed station personnel and reviewed statements of personnel working on the refuel floor and the time of event, corrective action documents, radiation control shift logs, radiological survey records, archived video footage of the area, shift turnover sheets, work control documents, and procedures as part of the inspection activity.

b. Observations and Findings

The team determined that the licensee's program and procedural guidance regarding control and movement of highly radioactive, non-fuel, items in the spent fuel pool/ refuel pool/ equipment pit area may lack sufficient specificity to control and coordinate movement of highly radioactive, non-fuel items that remain underwater.

Unresolved Item (URI) 05000259/2018050-02 was identified for charter items 3, 4, and 8, to determine if performance deficiencies exist regarding perceived procedural inadequacies related to; control and coordination between groups, survey frequency when diving, and control of underwater movement and storage of highly radioactive, non-fuel items in the spent fuel pool/ refuel pool/ equipment pit area in general and during refueling operations. (See Charter Item 3 above for complete discussion.)

5. Review and evaluate the licensee's corrective actions and causal evaluation related to this event, including the cause of the communication issues between groups as well as any programmatic contributors.

a. Inspection Scope

The inspectors reviewed corrective action documents including the prompt investigation initial corrective actions taken, reviewed statements of personnel working on the refuel floor and the time of event, reviewed radiological survey records, and reviewed procedures as part of the inspection activity.

b. Observations and Findings

Condition Report (CR) 1464279 was initiated in response to the event and the licensee documented preliminary findings in a prompt investigation and implemented several corrective actions prior to resuming dive activity in the equipment pit on November 8, 2018.

The prompt investigation documented that during the early morning hours of the night shift on November 7, 2018, divers identified a filter rack and Tri-Nuke underwater vacuum system located at the southwest end of the equipment pit that would interfere with work to be performed on day shift. The divers requested that it be moved. Several boilermakers and an RP tech [from the refuel floor, not the dive team] moved the filter rack farther west in the equipment pit and into the primary dive area [at 0525]. The divers completed their nightshift activities and exited the water [logged out at 0525]. No RP log entry was made about the filter rack movement and it was not discussed during RP dive team staff shift turnover. RP shift turnover did not discuss any change in radiological conditions.

The prompt investigation identified that the cause of the event was movement of the filter rack containing used high dose rate filters into the dive area, in conjunction with the lack of RP turnover concerning movement of the filter rack, and possible changes in radiological conditions. The investigation also identified that RP not performing a survey of the removed filters, and the lack of communication between work groups in the refueling area about activities that could impact diving evolutions, were contributing causes.

Immediate corrective actions taken included removing the diver from the high radiation area, performing underwater surveys to determine the source of high radiation, restricting Radiologically Controlled Area (RCA) access of the diver, and initiating a prompt investigation of the event. Follow-up corrective actions included initiating a "Stop Work" for diving work, surveying and removing high dose rate filter racks from the dive area, resurveying the dive area and clearly identifying filter rack locations on survey maps, and performing a stand down with workers. Additional actions included, requiring a once per shift survey for diving, communicating with work groups to reinforce that movement of any material in the equipment pit, spent fuel pool, or cavity requires RP presence and concurrence, and assigning a dedicated RP supervisor to oversee diving activities.

The licensee determined that a root cause evaluation was needed to fully understand the event and develop appropriate corrective action(s). The root cause evaluation was not completed at completion of the inspection.

Since review of the root cause evaluation, and implementation of corrective action(s), will not be complete prior issuing this report, additional communication with the licensee to validate the progress and direction the investigation will be required. Closure of the URI opened for charter items 3, 4, and 8 (URI 05000259/2018050-02) will complete this charter item.

6. Verify that instruments used to measure dose rates for this event, including EDs and high-range underwater survey instruments, were functioning correctly and were properly calibrated.

- a. Inspection Scope

The inspectors reviewed ED and portable survey instrument calibration and source check records, reviewed radiological survey records, and reviewed the on-site and vendor results for the dosimetry (dose of record) worn by the diver, including extremity dosimetry.

- b. Observations and Findings

Portable instruments and EDs used for monitoring and survey activities for diving were functioning correctly and were within their calibration period, licensee dosimetry is supplied by a NVLAP accredited vendor. The inspectors noted that on-site and vendor dosimetry results agreed within the acceptance criteria and the results were consistent with the ED dose results.

7. Review and evaluate the licensee's assignment of occupational exposure to the diver, including dosimeter positioning and evaluation of effective dose equivalent.

- a. Inspection Scope

The inspectors reviewed the on-site and vendor results for the dosimetry (dose of record) worn by the diver, including extremity dosimetry, and reviewed multi-badging dosimetry records.

- b. Observations and Findings

The divers ED readings, initial onsite Optically Stimulated Luminescence Dosimeter (OSLD) results determined by the licensee, and vendor supplied OSLD results were consistent. As would be expected by the work activities, the diver's extremity dosimetry results (finger and toe rings) indicated a higher accumulated dose (approximately 30%) for the hands vs. the forearms. No licensee or regulatory dose limits were exceeded.

8. Evaluate the licensee's procedural controls for underwater storage of highly radioactive, non-fuel, items in the spent fuel pool.

- a. Inspection Scope

The inspectors interviewed station personnel and reviewed statements of personnel working on the refuel floor and the time of event, corrective action documents, radiation control shift logs, radiological survey records, archived video footage of the area, shift turnover sheets, work documents, procedures, and additional documents as part of the inspection activity.

b. Observations and Findings

Normal practice by the licensee is to survey all items being removed from the water however, not all items that remain underwater are surveyed. The licensee's prompt investigation identified lack of underwater survey requirements as being a contributing cause of the diving event. Licensee procedures for spent fuel inventory control and surveillance activities are focused on material control and accountability of special nuclear material and may not adequately address underwater storage and control of highly radioactive, non-fuel, items in the spent fuel pool/ refuel pool/ equipment pit area.

URI 05000259/2018050-02 was identified for charter items 3, 4, and 8, to determine if performance deficiencies exist regarding identified procedural inadequacies related to; control and coordination between groups, survey frequency when diving, and control of underwater movement and storage of highly radioactive, non-fuel, items in the spent fuel pool/ refuel pool/ equipment pit area in general and during refueling operations. (See Charter Item 3 above for complete discussion.)

9. Collect data necessary to support completion of the significance determination process, if applicable.

a. Inspection Scope

The inspectors interviewed station personnel and reviewed statements of personnel working on the refuel floor and the time of event, corrective action documents, radiation control shift logs, radiological survey records, archived video footage of the area, shift turnover sheets, work documents, procedures, and additional documents as part of the inspection activity.

b. Observations and Findings

The inspectors were able to obtain sufficient documentation and information to support the significance determination for the identified performance deficiency. However, completion of this charter item will require closure of URI 05000259/2018050-02.

10. Identify any potential generic safety issues and make recommendations for appropriate follow-up action (e.g., Information Notices, Generic Letters, and Bulletins).

a. Inspection Scope

The inspectors interviewed station personnel and reviewed statements of personnel working on the refuel floor at the time of the event, corrective action documents, radiation control shift logs, radiological survey records, archived video footage of the area, shift turnover sheets, work documents, procedures, and additional documents as part of the inspection activity.

b. Observations and Findings

No potential generic safety issues were identified however, there may be lessons learned that could be communicated to the industry. How, and to what extent,

lessons learned should be communicated will be determined and coordinated through NRR HQ Staff after review and evaluation of the licensee's root cause determination and implementation of corrective actions.

## INSPECTION RESULTS

Failure to Perform Adequate Radiation Surveys			
Cornerstone	Significance	Cross-cutting Aspect	Report Section
Occupational Radiation Safety	Green NCV 05000259/2018050-01 Closed	[H.5] – Work Management	93812 – Special Inspection
<p><b>Introduction:</b> A self-revealing, Green, NCV of Title 10 Code of Federal Regulations (10 CFR) 20.1501, “Surveys and Monitoring: General,” was identified when TVA failed to perform adequate surveys of the Unit 1 refuel floor equipment pit during diving operations. Specifically, a detailed survey of the dive area was performed on October 19, 2018, prior to the start of diving activities. From October 19 to November 7, 2018, multiple dives were performed; however, no surveys of the dive area were documented to confirm the radiological conditions. On November 7, 2018, a diver received multiple electronic dosimeter (ED) dose rate alarms, the highest of which was 71.7 Rem/hr, and the diver received 90 mrem of unplanned dose.</p>			
<p><b>Description:</b> A detailed survey of the dive area was performed on October 19, 2018, prior to the start of diving. Between October 19 and November 7, 2018, multiple dives were performed on day and night shift without any underwater surveys of the dive area being documented. At approximately 1300 on November 7, 2018, a diver was directed by the dive supervisor to move a cable that was entangled on the side of the equipment pit wall, without informing the RP technician monitoring the work. When the diver moved to the directed location, the diver received multiple ED dose rate alarms, the highest of which was 71.7 Rem/hr, and the diver received 90 mrem of unplanned dose. The diver was immediately removed from the area and the ED alarms cleared. Subsequent underwater surveys of the area identified two used Tri-Nuke filters reading 400 and 450 Rem/hr on contact, and 20 and 21 Rem/hr at 30 cm, respectively. Review of video camera footage of the area determined that the filter rack containing the used Tri-Nuke filters had been moved into the dive area at approximately 0530 on November 7, 2018.</p>			
<p><b>Corrective Action(s):</b> The licensee took immediate corrective actions including removing the diver from the high radiation area, performing underwater surveys to determine the source of high radiation, restricting Radiologically Controlled Area (RCA) access of the individual, and initiating a prompt investigation of the event. Follow-up actions included suspension of diving activities until the cause of the ED alarms was determined, re-briefing the dive team, and additional supervisory oversight put in place to oversee diving activities.</p>			
<p><b>Corrective Action Reference(s):</b> CR 1464279</p>			
<p><b>Performance Assessment:</b></p>			
<p><b>Performance Deficiency:</b> TVA’s failure to perform adequate surveys to characterize the work area and establish appropriate radiological control of access to high radiation areas during diving operations within the equipment pit, was determined to be a performance deficiency.</p>			
<p><b>Screening:</b> The performance deficiency was more than minor because it was associated with the Occupational Radiation Safety Cornerstone attribute of program and process and adversely affected the associated cornerstone objective of ensuring adequate protection of worker health and safety from exposure to radiation from radioactive material during routine</p>			

civilian nuclear reactor operation. Specifically, the failure to perform adequate radiation surveys resulted in inadequate controls being implemented causing unplanned and unintended personnel dose.

**Significance:** The inspectors assessed the significance of the finding using Inspection Manual Chapter (IMC) 0609 C, "Occupational Radiation Safety Significance Determination Process". The finding was not related to As Low As Reasonably Achievable (ALARA) planning, nor did it involve an overexposure or substantial potential for overexposure, and the ability to assess dose was not compromised. Therefore, the inspectors determined the finding to be of very low safety significance (Green).

**Cross-cutting Aspect:** [H.5] – Work Management. Because the organization failed to implement a process of planning, controlling, and executing work activities such that nuclear safety is the overriding priority, the licensee's organization and work processes failed to include the identification and management of radiological risk commensurate with the old steam dryer cut up project and the need for strict coordination with different groups or job activities.

**Enforcement:**

**Violation:** 10 CFR 20.1501 requires, in part, that each licensee make, or cause to be made, surveys that - (1) may be necessary for the licensee to comply with the regulations in Part 20; and (2) are reasonable under the circumstances to evaluate, (i) the magnitude and extent of radiation levels; (ii) concentrations or quantities of residual radioactivity; and (iii) potential radiological hazards of the radiation levels and residual radioactivity detected. 10 CFR 20.1003, defines, in part, that survey means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation and that when appropriate, the evaluation include a physical survey and measurement of levels of radiation. In addition, 10 CFR 20.1601, requires that licensee's control personnel access to high radiation areas (HRAs). An HRA is defined as an area where an individual might receive a deep dose equivalent of 0.1 rem (1 mSv) in 1 hour at 30 cm from the source.

Contrary to the above, from October 19, 2018 to November 7, 2018, the licensee did not make necessary surveys to assure compliance with 10 CFR 20.1601, which requires that licensee's control personnel access to high radiation areas (HRA). Specifically, on November 7, 2018, a diver working in the Browns Ferry Nuclear (BFN) Unit 1 equipment pit, received multiple electronic dosimeter (ED) dose rate alarms, and received 90 mrem of unplanned dose, due to the licensee's failure perform a survey of used, high activity, Tri-Nuke filters that were moved into the dive area. Subsequent surveys identified dose rates of 400 and 450 Rem/hr on contact, and 20 and 21 Rem/hr at 30 cm, respectively on two filters.

**Severity:** Green

**Enforcement Action:** This violation is being treated as a NCV, consistent with Section 2.3.2 of the Enforcement Policy.

Unresolved Item (Open)	Potential failure to maintain and implement adequate work and radiological control procedures for the control of diving activities, control of High Radiation Areas and Very High Radiation Areas, and the control of highly radioactive materials.  URI 05000259/2018050-02	93812
<p><u>Description:</u> During the review of procedures for the Special Inspection to evaluate unexpected high radiation levels during diving operations at Unit 1 of the Browns Ferry Nuclear Plant, NRC inspectors identified potential procedural inadequacies related to; control and coordination between groups, survey frequency when diving, and control and underwater movement and storage of highly radioactive, non-fuel, items in the spent fuel pool/ refuel pool/ equipment pit area in general and during refueling operations. The procedures lack specific requirements concerning: 1) performance frequency of underwater surveys during extended diving operations; 2) performing underwater surveys when used filters are removed and placed in 'filter racks'; 3) identifying and/or controlling the location of used filters within the refueling area; 4) requirements for evaluating potential radiological impacts that used filters could have on other activities in the refueling area; and 5) work control requirements for coordinating movement of used filters with radiation protection.</p> <p>The purpose of the URI is for the NRC to review the results of the licensees root cause evaluation to determine if; 1) performance deficiencies exist regarding perceived procedural shortfalls related to work control and coordination between workgroups, survey frequency when diving, and control of underwater movement and storage of highly radioactive, non-fuel, items in the spent fuel pool/ refuel pool/ equipment pit areas in general and during refueling operations; and 2) if procedural inadequacies were a root or contributing cause of the diving event which occurred on November 7, 2018.</p> <p><u>Planned Closure Action(s):</u> NRC will review the licensees root cause evaluation to determine if any performance deficiencies existed related to procedural guidance deficiencies that may have contributed to the diving event which occurred on November 7, 2018.</p> <p><u>Licensee Action(s):</u> Complete the November 7, 2018 diving event root cause evaluation.</p> <p><u>Corrective Action Reference(s):</u> CR 1464279</p>		

## EXIT MEETINGS AND DEBRIEFS

The inspectors confirmed that proprietary information was controlled to protect it from public disclosure.

- On November 16, 2018, a debrief of interim inspection results and the completion status of the Diver ED Dose Rate Alarm Special Inspection charter items were presented to W. Paulhardt and other members of the licensee staff.
- On December 6, 2018, the initial results of the Diver ED Dose Rate Alarm Special Inspection were presented to G. Pry and other members of the licensee staff.
- On December 14, 2018, the final results of the Diver ED Dose Rate Alarm Special Inspection were presented to M. Oliver and other members of the licensee staff during a re-exit via telecom.



## DOCUMENTS REVIEWED

### Procedures

0-TI-540, Storage of Material in the Spent Fuel Storage Pool (SFSP) and Transfer Canal (U1/U2), Revision 4  
 NISP-RP-01, Portable Survey Instruments, Revision 0  
 NISP-RP-02, Radiation and Contamination Surveys, Revision 0  
 NISP-RP-04, Radiological Posting and Labeling, Revision 0  
 NISP-RP-05, Access Controls for High Radiation Areas, Revision 0  
 NISP-RP-07, Control of Radioactive Material, Revision 0  
 NISP-RP-10, Radiological Job Coverage, Revision 0  
 NISP-RP-11, Radiation Protection Fundamentals, Revision 0  
 NPG-SPP-05.1, Radiological Controls, Revision 9  
 NPG-SPP-05.2.1, Operational ALARA Planning and Controls, Revision 7  
 NPG-SPP-05.2.6, Radiological Risk Management, Revision 2  
 NPG-SPP-05.18, Radiation Work Permits, Revision 5  
 NPG-SPP-07.1, On Line Work Management, Revision 21  
 NPG-SPP-22.201, Oversight of the Human Performance Program, Revision 4  
 RCDP-17, Radiological Postings, Revision 1  
 RCDP-7, Bioassay and Internal Dose Program, Revision 8  
 RCI-1.1, Radiation Operations Program Implementation, Revision 169  
 RCI-2.1, External Dosimetry Program Implementation, Revision 67  
 RCI-8.1, Internal Dosimetry Program Implementation, Revision 51  
 RCI-17, Control of High Radiation Areas and Very High Radiation Areas, Revision 89  
 RCI-33, Diving Operations on the Refuel Floor, Revision 15  
 RCI-40.0, RP Actions for Operation's Unit 0 (Common) Procedural Hold Points, Revision 33  
 RCI-40.1, RP Actions for Operation's Unit 1 Procedural Hold Points, Revision 45  
 RCI-40.2, RP Actions for Operation's Unit 2 Procedural Hold Points, Revision 50  
 RCI-40.3, RP Actions for Operation's Unit 3 Procedural Hold Points, Revision 44  
 RCI-47, Diving Operations in the Radiologically Controlled Area, Revision 6  
 Vendor Procedure, GWP-SMAW-1A, General Welder Procedure for Shielded Metal Arc Welding, Rev. 15  
 Vendor Procedure, UCC/GE-VT-1, Remote Visual Inspection of Underwater Welds, Rev. 8

### Documents, Records

Calibration Datasheets for the following Radiation Survey Instruments and Electronic Dosimeters: 1) Ludlum 9-3 Ion Chamber; S/N 279904, 07/20/2018; S/N 299608, 09/17/2018; S/N 299649, 03/12/2018; and S/N 333147, 09/23/2018; 2) Mirion Wide Range Telepole; S/N 6613-104, 03/13/2018; S/N 6612-128, 05/14/2018; and S/N 0911-079, 10/02/2018; 3) Mirion AMP-100; S/N 5006-062, 07/20/2018; and S/N 5007-122, 08/29/2018; 4) Thermo RadEye B20-ER Frisker; S/N 30432, 10/02/2018; and S/N 30435, 09/15/2018; 5) Mirion DMC2000S Electronic Dosimeter; S/N 871680, 07/26/2018; S/N 879800, 07/26/2018; S/N 876185, 07/03/2018; S/N 859666, 07/03/2018; S/N 875700, 07/26/2018; S/N 889852, 07/03/2018, S/N 854510, 10/24/2018; and S/N 863365, 07/26/2018  
 DMC 2000 Electronic Dosimeter Operating History Report/Results for Diver #2, 11/06/2018  
 Email from licensee with attached MS Word document containing Tri-Nuke Filter rack picture, dimensions, and store stock information, 11/30/2018  
 Email from licensee stating that no surveys were documented in VSIDS for supporting diving operations in the equipment pit between October 19 and November 7, 2018, 11/16/2018

Form, TVA 41630, HRA, LHRA, and VHRA Posting Checklist, for the U-1 RFF Equipment pit from 10/31 to 11/08/2018, 11/14/2018

Form, TVA 41631, HRA, LHRA, and VHRA DownPosting Checklist, for the U-1 RFF Equipment pit from 10/31 to 11/08/2018, 11/14/2018

Form, TVA 41633, LHRA Access Guard Responsibilities Checklist, for the U-1 RFF Equipment pit from 10/18 to 11/08/2018, 11/14/2018

Form, TVA 41660, Locked High Radiation Area Door/Area Access Control Logs, for the U-1 RFF Equipment pit from 10/18 to 11/08/2018, 11/14/2018

Radiological Control eSOMS Log Entries from 11/07 to 11/08/2018, 11/14/2018

Radiological Survey # M-20181019-33, U-1 STEAM DRYER, 10/19/2018

Radiological Survey # M-20181108-6, Update Survey, U-1 RFF I/S Equipment Pit, 11/08/2018

Radiological Survey # M-20181113-13, Survey of Tri-Nuke Filters in U-1 SFP, 11/13/2018

RCI-33, Attachment 1, Pre Diving Activities Checklist, from 10/18/2018 through 11/08/2018, 11/14/2018

RCI-33, Attachment 2, Diving Operations Checklist - BFN, from 10/18/2018 through 11/08/2018, 11/14/2018

RFF Diving Shift Turnover Sheets, from 10/18/2018 through 11/08/2018, 11/14/2018

Radiation Work Permits (RWPs) Reviewed:

- RWP 18190031, U1R12 Refuel Floor Dryer Replacement Activities, Radiation Area Entry, Revision 0
- RWP 18190032, U1R12 Refuel Floor Dryer Replacement Activities, HRA Entry, Revision 0
- RWP 18190033, U1R12 Refuel Floor Dryer Replacement Activities, LHRA Entry, Revision 0
- RWP 18190036, U1R12 Refuel Floor Dryer Replacement Activities, HRA Entry, Revision 0
- RWP 18190038, U1R12 Refuel, LHRA Entry, Revision 0
- RWP 18190039, U1R12 Refuel Floor Dryer Replacement Activities, LHRA Entry, Revision 0

U-1 RFF Equipment Pit Video Footage of Filter Rack Move on 11/07/2018

Work Order # 119068694, Cut-up of U1 OEM dryer in the equipment pit [Info Only Copy], 11/15/2018

Written Statements from personnel working on the refuel floor on 11/6 and 11/07/ 2018, 11/07/2018 and 11/08/2018

#### Corrective Action Program Documents

CR 1220647, BFN INPO 2016 Plant Evaluation Identified Area For Improvement - AFI RP.1

CR 1388425, MOD's Carpenter received a valid dose rate alarm

CR 1398145, RP technicians not following expectations

CR 1464279, RFF Diver Received 89.9 mrem unplanned dose

CR 1464585, PCR to RCI-33 for Additional Dive Area Requirements

CR 1446286, WANO 2018 AFI RP.1 (related to 2016 RP.1)

Form, TVA 41620, Prompt Investigation Report Out Form, Condition Report: 1464279, 11/10/2018