UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
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ARLINGTON, TEXAS 76011-4511

October 29, 2019

EA-17-028

Mr. Brad Sawatzke, Chief Executive Officer
Energy Northwest
MD 1023
P.O. Box 968
Richland, WA 99352

SUBJECT: COLUMBIA GENERATING STATION – NRC SUPPLEMENTAL INSPECTION REPORT 05000397/2017011

Dear Mr. Sawatzke:

On December 1, 2017, the United States Nuclear Regulatory Commission (NRC) completed a supplemental inspection using NRC Inspection Procedure 95001, "Supplemental Inspection Response to Action Matrix Column 2 Inputs." On January 30, 2018, the NRC documented the inspection results in NRC Inspection Report 05000397/2017011 (ADAMS Accession No. ML18032A754).

On February 5, 2018, an NRC staff member submitted a Differing Professional Opinion (DPO-2018-001) stating that the Agency decision for closing the White finding associated with a transportation issue at Columbia Generating Station was not supported by the Inspection Report (05000397/2017011) details. On January 31, 2019, the NRC Region IV (RIV) Regional Administrator (RA) concluded, after considering all available information associated with DPO-2018-001, that the inspection team conducted a thorough review of Columbia Generating Station's staff actions to assess the root and contributing cause(s) of the transportation issue, and that the White finding was appropriately closed; however, the scope and level of detail documented in Inspection Report 05000397/2017011 was not sufficient to enable an independent reader to attain the level of confidence necessary to reach a conclusion that Columbia Generating Station's staff fully and independently assessed the transportation issue. The RIV RA concluded Inspection Report 05000397/2017011 should be revised accordingly and reissued.

On February 4, 2019, the NRC staff member submitted an appeal to the Executive Director for Operations (EDO) raising concerns with the decision issued by the RIV RA. On September 6, 2019, the EDO issued a letter to the NRC staff member describing her considerations and conclusions concerning the appeal. The EDO upheld the RIV RA's decision to revise the inspection report and reissue that report in accordance with Inspection Manual Chapter 0611, "Power Reactor Inspection Reports." The RIV RA then directed the staff to prepare and issue this revised inspection report.

A number of factors contributed to the level of detail documented in the original inspection report. The inspectors identified that several unrelated human performance errors, organizational challenges, and programmatic weaknesses that occurred over a several year period ultimately culminated in the transportation issue. Columbia Generating Station's staff performed a number of independent and interrelated causal evaluations over an extended period of time, each of which contributed to a detailed understanding of the causes and contributors to the transportation issue.

Although the inspectors thoroughly evaluated each causal analysis, the original report purposely did not describe how all of these analyses combined to form an overall assessment, to simplify the report and avoid reiterating assessments that had been previously reached in other publicly available NRC inspection reports. These inspection reports included the special inspection conducted shortly after the transportation issue, an occupational radiation safety baseline inspection, a public radiation safety baseline inspection, and a problem identification and resolution inspection.

Ultimately, the level of detail documented in the original report was intended to simplify a complex issue by focusing on the objectives of the inspection and answering the fundamental question of whether Columbia Generating Station's staff had identified and corrected the causes of the transportation issue. Consistent with the result of the Agency's review of the Differing Professional Opinion, a more thorough discussion of the inspection activities, including assessments and causal evaluations reviewed, has been added to the enclosed revised inspection report.

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/

Ryan E. Lantz, Director
Division of Reactor Safety

Docket No. 50-397
License No. NPF-21

Enclosure:
Inspection Report 05000397/2017011
w/Attachment: Supplemental Information

cc: Electronic Distribution to Columbia Generating Station

U.S. NUCLEAR REGULATORY COMMISSION
Inspection Report

Docket Number:	05000397
License Number:	NPF-21
Report Number:	05000397/2017011
Licensee:	Energy Northwest
Facility:	Columbia Generating Station
Location:	Richland, Washington
Inspection Dates:	November 28, 2017, to December 19, 2017
Inspectors:	P. Hernandez, Health Physicist J. O'Donnell, CHP, Health Physicist
Approved By:	Heather J. Gepford, Ph.D., CHP Chief, Plant Support Branch 2 Division of Reactor Safety

Enclosure

SUMMARY

Inspection Report 05000397/2017011; 11/28/2017 - 12/19/2017; Columbia Generating Station; Supplemental Inspection – Inspection Procedure 95001

This report covers a one-week announced supplemental inspection of a White finding in the Public Radiation Safety Cornerstone. The inspection was conducted by two health physics inspectors from the NRC Region IV office. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process."

The NRC staff performed the supplemental inspection in accordance with Inspection Procedure 95001, "Supplemental Inspection Response to Action Matrix Column 2 Inputs," to assess the licensee's evaluation associated with the failure to ensure that the contents of a radioactive waste container did not exceed the radiation level requirements for shipping. The NRC staff previously characterized this issue as having low to moderate safety significance (White), as documented in NRC Inspection Report 05000397/2017009 (ADAMS Accession No. ML17187A364).

During this supplemental inspection, the inspectors determined that, when the collection of work products developed by the licensee were taken as a whole, the licensee performed an adequate evaluation of the causes of the self-revealed failure to comply with the external radiation limits for shipping radioactive materials, which occurred for a shipment of radioactive waste to the U.S. Ecology waste disposal facility. The licensee identified the primary root cause of the issue to be that management did not have the organizational alignment in place that would ensure proper decision-making, effective supervisor oversight, and programmatic validation to assure execution of critical radioactive waste packaging and shipping activities in accordance with regulations. The licensee has taken corrective actions to address the organizational alignment issue and to ensure that proper decision-making, effective supervisor oversight, and programmatic validation occur for radioactive waste packaging and shipping activities.

Given the licensee's acceptable performance in evaluating the cause of a package exceeding the radiation levels for transporting low specific activity material, the White finding associated with this issue was only considered in assessing plant performance for a total of four quarters in accordance with the guidance in Inspection Manual Chapter 0305, "Operating Reactor Assessment Program."

No findings were identified.

REPORT DETAILS

4. OTHER ACTIVITIES

Cornerstone: Public Radiation Safety

4OA4 Supplemental Inspection (95001)

.01 Inspection Scope

The NRC staff performed this supplemental inspection in accordance with Inspection Procedure 95001, "Supplemental Inspection Response to Action Matrix Column 2 Inputs," to assess the licensee's evaluation of one White finding in the Public Radiation Safety Cornerstone. The inspection objectives were to:

- Provide assurance that the root and contributing causes of significant performance issues were understood.
- Provide assurance that the extent of condition and extent of cause of significant performance issues were identified.
- Provide assurance that corrective actions taken to address and preclude repetition of significant performance issues were prompt and effective.
- Provide assurance that corrective plans directed prompt actions to effectively address and preclude repetition of significant performance issues.

Columbia Generating Station (CGS) entered the Regulatory Response Column (Column 2) of the NRC's Action Matrix in the first quarter of 2017 as a result of a White (low-to-moderate safety significance) finding in the Public Radiation Safety Cornerstone. The finding was associated with the November 9, 2016, shipment of radioactive material as low specific activity (LSA) material that exceeded the LSA external dose rate limit of 1.0 rem/hr at 3 meters from the unshielded material. Specifically, the licensee transported a package as LSA material with an external radiation level of 2.1 rem/hr at a distance of 3 meters from the unshielded material. The finding was characterized as having low to moderate safety significance (White) using the NRC Inspection Manual Chapter 0609, Appendix M, "Significance Determination Process Using Qualitative Criteria." This issue was documented in NRC Inspection Reports 05000397/2016009 and 05000397/2017009.

The licensee staff informed the NRC by letter on September 26, 2017, of their readiness for the supplemental inspection. In preparation for this inspection, the licensee performed a root cause evaluation documented in Action Request (AR) 360236, "Radwaste Liner Dose Rate Exceeds 1 rem/hr at 3 meters," to identify weaknesses that existed in various organizations and processes. The licensee later indicated that the final version, Revision 7, dated November 16, 2017, documented their conclusions.

The inspectors reviewed each revision of the licensee's root cause evaluation, related apparent cause evaluations, related self-assessments, and other information provided by the licensee. The inspectors reviewed corrective actions that were taken or planned

to address the identified causes. The inspectors conducted interviews and had discussions with licensee personnel to determine if the root and contributing causes of the issue were understood, and whether corrective actions taken or planned were appropriate to address the causes and preclude repetition. In addition, the inspectors reviewed the results of previously completed NRC inspections, and discussed the inspection results, observations, and assessments with the inspectors who performed the inspections. These inspections included the special inspection conducted shortly after the shipping event, an occupational radiation safety baseline inspection, a public radiation safety baseline inspection, and a problem identification and resolution inspection. A table summarizing the reports reviewed and discussed follows.

Inspection Procedure	Inspection Report Number and Issue Date	ML Number
93812, "Special Inspection"	05000397/2016009 April 10, 2017	ML17100A499
71152, "Problem Identification and Resolution"	05000397/2017007 April 6, 2017	ML17100A117
71124.01, "Radiological Hazard Assessment and Exposure Controls"	05000397/2017002 August 10, 2017	ML17223A125
71124.08, "Radioactive Solid Waste Processing & Radioactive Material Handling, Storage, & Transportation"	05000397/2017010 October 25, 2017	ML17298C186

.02 Evaluation of the Inspection Requirements

As outlined in the special inspection report, there were three distinct phases of the spent fuel pool cleanup evolution that culminated in the transportation event: (1) preparation and characterization of the radioactive waste contained in the shipment, (2) packaging the radioactive waste in the waste liner and shipping cask, and (3) preparation and shipping of the radioactive waste package to the disposal facility. As each phase of the evolution was multifaceted and the activities occurred over an extended period of time, the inspectors found the licensee had performed a number of causal evaluations, audits, and assessments either directly or indirectly related to the event. The inspectors determined that the work products developed had to be considered as a whole to assess the licensee's understanding of the root and contributing causes, the extent of condition and extent of cause, and the appropriateness of the completed or planned corrective actions.

The inspectors reviewed each of nine revisions of the root cause evaluation, concluding there were essentially two main efforts: (1) Revisions 0, 1, 2, 3, and 3a and (2) Revisions 4, 5, 6, and 7. Generally, the changes from revision to revision within each effort were to incorporate feedback and/or editorial comments. A significant step-change occurred between Revision 3a and Revision 4 based on a self-assessment of the root cause evaluation. The inspectors also reviewed an apparent cause evaluation and a common cause evaluation, both of which were previously assessed by the special inspection team, because they contributed to the progression of the licensee's understanding of the issue, identified some of the interrelated causes, and resulted in the implementation of relevant corrective actions. The following list summarizes the

main causal evaluations reviewed by the inspectors to assess whether to close the White finding.

- AR 353247, “Trend: Radioactive Waste Packing/Shipping Issues,” dated October 20, 2016. This common cause evaluation reviewed eight shipping incidents that had previously occurred. The conclusions helped formulate the causes in the later revisions of the root cause evaluation AR 360236.

    - Problem Statement: Since October 2014 there has been an increase in the number of human performance errors documented in condition reports involving radioactive waste packaging/shipping.

    - Apparent Cause: Decision-making at the appropriate level or by someone with adequate expertise.

- AR 357593, “Disposal Container has Higher Dose Rate than Anticipated,” dated December 12, 2016. This apparent cause evaluation, initiated three days after the shipping event, was the licensee’s initial effort to understand the event.

    - Problem Statement: On 11/09/16, Shipment 16-40 which contained a radioactive waste disposal container was rejected by US Ecology due to the dose rates reading higher than documented on the manifest (90 rem/hr vs 11.8 rem/hr). This rejection resulted in a suspension of Columbia’s ability to ship radioactive waste for disposal to US Ecology.

    - Apparent Cause: Survey documentation was inaccurately recorded and communicated to the characterization vendor which led to errors in the calculated dose rates on the characterization used to ship the radioactive waste disposal container.

    - Identified three contributing causes.

- AR 360326, “Incorrect Container for Radioactive Waste Shipment 16-40,” including Rev. 0 (2/16/17), Rev. 1 (3/1/17), Rev. 2 (3/15/17), Rev. 3 (4/11/17), and Rev. 3a (4/26/17). The first five revisions of the root cause evaluation built on the work completed in the apparent cause evaluation, expanding the scope from the waste characterization to also include the packing and preparation for shipment phases of the evolution.

    - Problem Statement: The initial characterization completed for the shipment was incorrect and resulted in an incorrect waste classification and use of an incorrect shipping container.

    - Root Cause: Inadequate procedures for the spent fuel pool clean up (SFPCU) and associated radwaste surveys, processing, and shipping activities.

    - Identified two contributing causes.

- AR 360326, “RadWaste Liner Dose Rate Exceeds 1 rem/hr at 3 meters,” including Rev. 4 (8/31/17), Rev. 5 (9/22/17), Rev. 6 (10/20/17), and Rev. 7 (11/16/17). Following a focused self-assessment of the root cause evaluation, a major revision to the problem statement was made to align it with the NRC violation. In addition, the team noted that the identified causes changed from focusing on procedural issues to programmatic issues.

    - Problem Statement: On November 9, 2016, Energy Northwest transported Class B Low Specific Activity material in a Type A radioactive waste container to the US Ecology disposal facility that exceeded the external radiation dose rate limit required by Department of Transportation regulations in 49 Code of Federal Regulations Part 173.427(a)(1). This shipment was rejected by the disposal facility and immediately returned to CGS.

    - Root Cause: CGS Management did not have the organizational alignment in place that would ensure proper decision-making, effective supervisor oversight and Programmatic validation to assure execution of critical radwaste packaging and shipping activities in accordance with regulations.

    - Identified one contributing cause.

The inspectors concluded that the evolution of the problem statement was linked to changes in the licensee’s understanding of the significance of the issue, beginning with the rejection of the package by US Ecology, followed by issuance of the special inspection report with the apparent violation, and the subsequent issuance of the final significance and Notice of Violation.

The inspectors determined from discussions with the licensee that all of the corrective actions implemented for the causes identified in each of the causal evaluations (including the multiple revisions of the root cause evaluation) were tracked until closed. The inspectors independently verified that all the corrective actions that had not been completed were being tracked.

Unless otherwise specified, when the inspection report discusses the root cause evaluation, it is referring to Revision 7 of AR 360326. In the following sections of this inspection report, “RCE3a” refers to root cause evaluation AR 360326, Revisions 0 through 3a, “RCE7” refers to root cause evaluation AR 360326, Revisions 4 through 7, “CCE” refers to common cause evaluation AR 353247, and “ACE” refers to apparent cause evaluation AR 357593.

02.01 Problem Identification

a. Determine that the licensee’s evaluation documents who identified the issue and the conditions under which the issue was identified

The root cause evaluation documented that the failure to transport LSA material with external dose rates not exceeding an external radiation level of 1 rem/hr at 3 meters from the unshielded material was self-revealed on November 9, 2016, as a result of US Ecology, the low-level radioactive waste disposal facility, validating the manifested dose rates during package receipt. US Ecology personnel removed the liner containing the

radioactive material from the shipping cask to conduct radiation survey measurements. US Ecology personnel measured contact dose rates of 30 rem/hr and 90 rem/hr on opposite sides of the liner, in contrast to the dose rate documented on the manifest of 11.8 rem/hr. The shipment was rejected and returned to CGS the same day. The licensee performed radiation surveys at 3 meters from the unshielded material on January 13, 2017, and recorded dose rates of up to 2.1 rem/hr.

The inspectors determined that the self-revealed nature, as well as the conditions under which the issue was identified, were documented in the licensee's evaluation.

b. Determine that the evaluation documents how long the issue existed and prior opportunities for identification

The problem statement for the root cause evaluation (RCE7) was defined as the licensee's transport of a radioactive waste container that exceeded the external radiation dose rate limit required by the Department of Transportation (DOT). Based on this problem statement, the licensee concluded that the issue (i.e. the violation) existed only during the time that the shipment was in transit on public roads from CGS to US Ecology and back to CGS on November 9, 2016. The inspectors concluded that the licensee's determination accurately documented the duration of the violation of regulatory requirements.

However, the inspectors recognized that the precursors to the transportation violation preceded, and were not encompassed by, the time the package was on the road. Further, the inspectors recognized that the performance deficiency which resulted in the violation, failure to ensure that the contents of a radioactive waste container did not exceed the radiation level requirements for shipping, did capture the precursors. Because of this, the inspectors reviewed RCE3a and ACE to determine whether the licensee's broader reviews of the issue identified the duration of the performance deficiency.

The inspectors determined that the licensee recognized and documented that the precursors to the event started with the errors made during the waste characterization surveys in 2015 and continued through the loading of the liner and final preparations for transportation.

The final root cause evaluation discussed prior opportunities for the licensee to identify the issue. Examples of these included:

- An increase in radwaste shipping issues and negative observations by oversight groups indicated an adverse trend. However, the identified trend did not lead to effective corrective actions being taken for the behavioral and organizational issues driving the decline.

- The radiation surveys performed for the waste characterization were informally communicated, resulting in confusion over the accuracy of the survey results and waste inventory data. However, no action was taken to formally resolve or validate the information when questions were raised by the characterization vendor.

- Formal decision-making processes were not used for important decisions, such as selection of the proper shipping cask. Rather, the radwaste transportation specialist's (hereinafter shipping specialist) decision to use a Type A cask rather than the Type B cask used for previous shipments was based on the (flawed) waste characterization and an opportunity to reduce cost.

- When surveys identified the contact dose rates on the cask exceeded DOT and the licensee's administrative shipping limits, actions focused on making the dose rates low enough for shipment rather than determining why the dose rates were higher than expected. Specifically, a decision was made to build an enclosure (i.e. cage) around the cask to prevent access to the elevated dose rates.

- The unshielded liner dose rates were not verified by direct measurement or back-calculation (i.e. inverse shield calculation) prior to shipment. Doing so would have identified the unacceptable liner dose rates and the significant discrepancy from the waste characterization prior to transport. However, the licensee's procedures did not require a survey of the unshielded container (liner) prior to making the shipment.

The inspectors noted additional prior opportunities for the licensee to identify the issue in the licensee's causal evaluations. While they may not have been specifically labeled as opportunities to identify the issue, the licensee recognized they contributed to the outcome.

- A self-assessment performed in 2015 following a similar shipping event at Plant Vogtle concluded that shipping a Type B quantity of radioactive material in a Type A container did not appear to be a risk for CGS. The outcome of this self-assessment contributed to the licensee's overconfidence in the strength of CGS's shipping program.

- Workers repeatedly found dose rates higher than anticipated during the evolution, but the dose rates were either not questioned or the licensee failed to address the underlying causes. As an example, after finding and removing a hot particle and some filters from the liner, higher than expected dose rates continued to exist. However, the waste characterization was not revised or validated. The basis for the decision was that because items had been removed from the liner, the package contents remained bounded by the original characterization.

- The former Radiation Protection Manager (RPM) challenged the shipping specialist about proceeding with the shipment, but the decision was made to proceed based on the waste characterization results and the shipping specialist's confidence that the shipment met all the requirements. Based on interviews and review of corrective actions, the inspectors determined the RPM did not have sufficient knowledge of shipping requirements to require a validation survey of the dose rates to demonstrate compliance with the LSA transportation requirements.

The inspectors determined that the licensee appropriately documented prior opportunities to identify the issue and reasons why the opportunities were missed.

c. Determine that the evaluation documents the plant-specific risk consequences, as applicable, and compliance concerns associated with the issue

The inspectors determined that the transportation violation and the events leading to it had no impact on the core damage frequency or large early release frequency. Therefore, the licensee appropriately did not complete a quantitative assessment of plant-specific risk consequences.

The licensee's root cause evaluation included a qualitative assessment of risk consequences and compliance concerns. The assessment discussed how non-compliance with regulations led to the White violation issued by the NRC for exceeding the radiation limit for this shipment type. In addition to the NRC violation, the licensee noted they received two violations for noncompliance with the Washington Administrative Code for this shipment. The immediate consequence of those violations was the suspension of the licensee's permit to dispose low-level radioactive waste at the disposal site operated by US Ecology. Additional consequences described were increased radiation exposure risk to the public and decreased NRC and public confidence in the licensee's ability to safely control its radioactive material. The inspectors noted that, within the context of the problem statement for RCE7, the licensee qualitatively assessed the risk consequences.

The inspectors noted that, prior to the 95001 inspection, the special inspection and two radiation safety baseline inspections had reviewed the activities associated with the waste classification and loading of the liner. The inspection results are documented in NRC Inspection Reports 05000397/2016009, 05000397/2017002, and 05000397/2017010. (See table in Section .01, page 4, for ML numbers.)

The inspectors concluded that the licensee appropriately documented the risk consequences and compliance concerns associated with the issue.

d. Findings

No findings were identified.

02.02 Root Cause, Extent of Condition, and Extent of Cause Evaluation

a. Determine that the issue was evaluated using a systematic methodology to identify the root and contributing causes

In determining whether the licensee evaluated the issue using a systematic methodology to identify the root and contributing causes, the inspectors reviewed the ACE, RCE3a, and RCE7. In addition to these causal evaluations, the inspectors reviewed the CCE since it considered problems in the radwaste program prior to this shipping violation. These causal evaluations (described in Section .02, page 4) approached the situation and causal determinations from different perspectives; however, each contributed to the licensee's understanding of the complexities of the issue and led to the determination of the root and contributing causes.

CCE

During the timeframe that many of the precursor events to the shipping event were occurring, the radwaste processing and shipping program experienced a number of challenges. The licensee initiated a common cause evaluation to review eight incidents related to the radwaste processing and shipping program between October 2014 and October 2016. A common cause analysis was performed to identify causes, enablers missed, and organizational/programmatic causes of these events, and to implement appropriate corrective actions. Decision-making was determined to be the most common theme, followed by worker practices, lack of verification/validation, and not challenging the unknown.

A human performance, organizational, and programmatic evaluation (HU/O&P) was used to identify organizational and programmatic weaknesses. Identified weaknesses were decision-making (not at the right level or adequate expertise), policies (procedure use, validation/verification and assumptions), error prevention tools, and communications.

A performance analysis was conducted by the licensee's training organization to determine if lack of knowledge or skill was a potential common causal factor. It was determined that both training and non-training solutions could be used in closing the performance gap.

The inspectors found that this common cause evaluation concluded that there were several areas needing improvement in the radwaste and shipping program, the most significant of which (apparent cause) was decision-making at the appropriate level or by someone with adequate expertise. The inspectors noted that the CCE apparent cause was included in the RCE7 as one aspect of the root cause.

This causal evaluation was previously evaluated by the special inspection team and the team's conclusions were documented in the special inspection report. Although this causal evaluation was completed prior to the shipping incident, the special inspection team determined the implemented corrective actions would not have been in place prior to the precursors to this event.

The inspectors concluded that the licensee used a systematic method to determine the common causes of the prior events. This information later informed the licensee's determination of the root cause of the 2016 transportation issue.

ACE

The licensee initiated the apparent cause evaluation three days after the shipment was returned to the site. The focus of this causal evaluation was the difference between the dose rates documented on the shipping manifest and the measured dose rates on the unshielded liner at the disposal site. The licensee constructed an event timeline to assist with the causal analyses. The causal analysis tools used were barrier analysis, change analysis, and an HU/O&P evaluation.

The barrier analysis addressed missing or ineffective surveys and characterization, error prevention tools, and project planning. The change analysis looked at specific differences that resulted in success in previous spent fuel pool cleanup evolutions (most

recently 2010) and failures in this evolution. Lastly, the HU/O&P evaluation helped identify organizational and programmatic weaknesses. These weaknesses were similar to those found in the CCE, but also included management oversight.

The causal analysis tools used established the causal factors, leading to one apparent and three contributing causes. The licensee determined the apparent cause was that survey documentation was inaccurately recorded and communicated to the characterization vendor, leading to errors in the calculated dose rates on the characterization. The contributing causes were the lack of verification and validation of the waste characterization, lack of verification and validation of the liner dose rates, and not having a formalized process/plan for filter management and tracking.

The inspectors concluded that the licensee used a systematic method to identify the apparent cause in this evaluation.

RCE3a

The licensee initiated a root cause evaluation on January 16, 2017, after validating (by radiation survey) the 3-meter dose rate of the unshielded liner. The licensee followed the simplified process flow to look at each major step for causal factors. The major process flow steps addressed in the evaluation were surveys, characterization, decision-making, and organizational and programmatic causes.

The casual analysis tools used by the licensee in RCE3a included barrier analysis, change analysis, event and causal factors charting, and a “why” staircase. The inspectors reviewed licensee Procedure CDM-01, “Cause Determination Manual,” for insights and found that it was up to the evaluation team to choose the most appropriate analysis tools. The procedure provided the cause evaluation team with advantages and disadvantages for each analysis tool listed. The inspectors determined the team selected appropriate analysis tools based on the problem statement.

The barrier and change analyses were based on the analyses conducted during the ACE and included additional information. The barrier analysis in RCE3a assessed work order/instructions for surveys and for loading the liner. In addition, assessments of conservative decision-making and supervisor oversight were added. The change analysis expanded or changed some of the inputs from the ACE and added casual inputs (mostly decision-making). The inspectors determined that the changes from the ACE to RCE3a were consistent with expectations for a root cause evaluation and the revised problem statement.

An event and causal factors chart which identified the events, decisions, associated facts, actions, and causal factors was included in RCE3a. The timeline of the chart begins in September 2015 and continues to January 2017 when the liner was removed from the cask and surveyed. The chart illustrated where the root cause and contributing causes affected the events on the timeline. The chart also highlighted decisions made that affected the outcome of the shipment.

Another analysis tool used in RCE3a was a “why” staircase questioning three aspects of the incident: 1) the incorrect cask, 2) the dose rates of the liner, and 3) the enclosure constructed around the cask. The RCE3a documentation did not specifically address the results of this analysis tool other than to associate the root and contributing causes

to the related steps on the staircase. The inspectors reviewed RCE3a and determined that the results of this analysis tool were associated with the decision-making aspect of the causal analysis section.

As a result of these analyses, the cause evaluation team determined the root cause to be inadequate procedures for the spent fuel pool cleanup project and associated activities (e.g. surveys). The contributing causes were 1) key decisions made during the spent fuel pool cleanup lacked rigorous challenge and were non-conservative and 2) a lack of adequate management/supervisor oversight for both the spent fuel pool cleanup project and the radwaste processing and shipping program.

Through document review and discussions with licensee personnel, the inspectors concluded that the use of these causal analysis tools were part of a systematic method used by the licensee to identify the root and contributing causes.

RCE7

This phase of the root cause evaluation was initiated after the licensee determined RCE3a did not meet the 95001 inspection criteria. Based on concerns raised in the focused self-assessment performed for 95001 readiness, changes were made to the problem statement, the focus of the evaluation, and the causal analysis tools. Specifically, the focus of the evaluation changed from the waste characterization and spent fuel pool cleanup activities to the behaviors and actions that led to the shipping violation.

The event timeline was expanded to begin with the prior spent fuel pool cleanup campaign in 2010 with two experienced shipping specialists supporting the project. As a result, the timeline captured the loss of experienced shipping staff/supervision between November 2012 and May 2016.

Causal analyses used by the licensee for this phase of the root cause evaluation included interviews, a comparative timeline, event and causal factor charting, and an HU/O&P evaluation. The barrier and change analyses were not carried over from RCE3a. Unlike RCE3a, the causal analyses in this revision focused on the underlying organizational and programmatic causes which likely contributed to the analysis methods selected.

The licensee's root cause team gained insights from interviews performed during the evaluation. These insights were validated to ensure accuracy and used as data points during subsequent analysis activities.

Insights gained from the comparative timeline were used to develop the event and causal factor chart and define the inappropriate actions that led to the incident, and to contrast them with what should have been done. The chart graphically showed the sequence of events, identified inappropriate actions leading to the event, determined causal factors, and validated the root and contributing causes. Three inappropriate actions were identified and analyzed for this incident: the decision to use a Type A cask instead of a Type B cask, not lowering the inventory of radioactive material loaded in the cask to a level where contact dose rates met shipping requirements, and not validating the dose rates on the liner prior to shipping.

The HU/O&P evaluation was conducted to examine actions, determine causal factors, and identify weaknesses in the management system that allowed this incident to occur. The licensee analyzed these causal factors to determine what drove the performance that led to the inappropriate actions. The identified causal factors included personnel resource management, decision-making, supervisor oversight, and the corrective action program.

As a result of these analyses, the cause evaluation team determined the root cause to be CGS management not having the organizational alignment in place that would ensure proper decision-making, effective supervisor oversight, and programmatic validation to assure execution of critical radwaste packaging and shipping activities in accordance with regulations. The contributing cause was the failure of Chemistry management to implement effective corrective actions to address precursor organizational and programmatic issues within the radwaste shipping program previously identified by the station's performance improvement and oversight programs.

Through document reviews and discussions with licensee personnel, the inspectors concluded that the use of these causal analysis tools in RCE7 were part of a systematic method used by the licensee to identify the root and contributing causes.

In summary, the inspectors concluded that throughout the evolution of the licensee's evaluation (i.e. CCE, ACE, RCE3a, and RCE7), the licensee used systematic methods to identify the root and contributing causes for this multifaceted event. Specifically, each of these causal analyses, and the analysis tools used, helped develop the licensee's understanding of the interrelated and independent causes that ultimately resulted in the shipping event.

b. Determine that the root cause evaluation was conducted to a level of detail commensurate with the significance of the issue

As previously described, there were many components to the licensee's efforts to understand the root cause(s) of the issue. Developing an understanding of this issue involved multiple root and apparent cause evaluations as well as evaluations by Quality Assurance auditors and external experts.

In the final root cause evaluation (RCE7), the licensee focused on consolidating the information they had learned from the various causal evaluations and assessments into a single root cause. As prescribed by Procedure CDM-01, "Cause Determination Manual," Step 4.16.1, the licensee developed a single, concise statement to explain why the event occurred. The procedure emphasized the expectation of a single, concise statement by stating in Step 4.16.1.a. that ancillary discussion should be within the narrative description, not the cause statement. As a result, the licensee felt constrained to operate within the procedural requirements and develop a single root cause statement, despite the complexities of the issue.

The inspectors noted that this procedural requirement resulted in a root cause statement that, without a review and understanding of all the work products that preceded and informed its development, did not on the surface appear to identify the root cause(s). The inspectors also learned, through discussions with inspectors who had performed problem identification and resolution inspections at CGS, that concerns with Step 4.16.1

of the procedure had been raised previously although nothing contrary to regulatory requirements had been identified or documented.

As a result of the apparent/perceived weakness in the licensee's stated root cause statement (including the lack of clarity and direct tie to the event), the inspectors discussed its derivation/development with licensee staff. The licensee agreed with the inspectors' perspective that there was not one single cause, but that a sequence of events, conditions, decisions, and errors culminated in the transportation violation. The licensee acknowledged that the root cause identified in RCE7 could have been expressed more clearly had multiple root causes been enumerated, rather than trying to consolidate several causes into a single statement.

During the inspection, a "roadmap" was provided to the inspectors that established how each of the earlier causal evaluations and assessments fed into development of the final root cause statement in RCE7. Through use of the roadmap, the inspectors were able to validate that the root cause statement, although cumbersome, captured the root of the matter.

In addition to these causal evaluations, the licensee conducted self-assessments focused on the radioactive waste program and the site's readiness for this inspection. Through these various assessments, causal evaluations, and other corrective action processes, the licensee identified several issues with their radioactive waste program, as a whole, and several that led to or contributed to the White violation. The licensee found that the circumstances that led to the incident were more complex than could be addressed by a single, concise statement or single cause evaluation. However, as previously discussed, licensee procedure required them to have a single root cause.

The inspectors determined that when these causal evaluations and assessments were considered as an all-inclusive product, a more complete understanding of the causes leading to the incident was achieved. In addition, because of the number of causal evaluations conducted and techniques used throughout the process of reviewing the multifaceted evolution, the licensee gained more insights into their performance than had only a single root cause evaluation been performed/documented.

Therefore, based on the collection of work products reviewed, the inspectors concluded that the root cause and other causal evaluations were conducted to a level of detail commensurate with the significance of the problem.

c. <u>Determine that the root cause evaluation included a consideration of prior occurrences of the issue and knowledge of operating experience</u>

The licensee's consideration of prior occurrences and operating experience changed in the causal evaluations and revisions. Through these evaluations, the licensee identified and reviewed both internal and external operating experience related to the packaging and shipping of radioactive waste.

In the CCE, there was not a separate consideration of prior occurrences or operating experience, rather, a programmatic look at past human performance errors involving radioactive waste packaging/shipping at CGS since October 2014. The purpose of the CCE was to evaluate, validate any commonalities or themes, and create actions necessary to improve performance. Eight prior shipping events, each of which included

a human performance error, were reviewed to identify causes, corrective actions, enablers missed, and organizational and programmatic causes to determine if a common theme existed between the events. The inspectors concluded that this activity served as a review of internal operating experience for radwaste packaging and shipping.

In the ACE, the licensee stated that several condition reports related to radioactive waste shipping had been found in a search of the condition report database, all of which had recently been reviewed/evaluated during the conduct of the CCE. The licensee also reviewed the Institute for Nuclear Power Operations database for related events over the past 5 years, finding several events related to radioactive waste shipping containers exceeding dose rate limits. The licensee characterized the internal and external operating experience as examples of lessons learned, but determined that applying those lessons would not have prevented this event.

In RCE3a, internal and external operating experience was identified that was determined to be applicable to this event. The internal operating experience included many of the human performance errors addressed previously in the CCE and ACE. The licensee included the ACE in the internal operating experience and a second causal evaluation related to the cask dose rates being higher than can be shipped. The licensee stated that the review of internal operating experience identified a range of weaknesses related to radwaste shipping, handling, and documentation that had been identified in self-assessments and internal audits over the prior 2-year period. The licensee recognized that corrective actions taken to address these issues had not been effective, as evidenced by the continued declining performance culminating in the shipping violation. These radwaste shipping and handling issues represented missed opportunities for the station to restore the program to satisfactory performance.

The licensee noted that a quality assurance surveillance completed in May 2016 determined that an increased awareness was warranted for radioactive material control. Specifically, the surveillance identified that in some cases, controls in place to ensure that radiological shipments were properly prepared and surveyed were ineffective.

For related external operating experience, the licensee searched the industry operating experience database and initially identified eight related items (RCE, Rev. 0). Six of the eight items were not formally evaluated by CGS because they were flagged with a significance of noteworthy/nonconsequential. Consequently, no actions were taken by the site.

Two of the eight external operating experience items were formally evaluated by the licensee and documented in RCE7. The first was related to the use of RO-7 survey meters. The licensee determined their procedures were adequate and no actions were taken. The second was a liner with a higher dose rate than indicated on the shipping papers. This operating experience issue addressed a resin shipment that was not fully characterized or surveyed prior to shipment. The licensee found this item to be generically applicable, but concluded they had existing barriers to preclude a similar event. Specifically, the review stated that Columbia had procedures in place that required every waste stream going into a liner to be sampled and used in the characterization, and that liners to be shipped were rigorously surveyed prior to shipment.

The licensee subsequently determined that the external operating experience that applied represented missed opportunities due to the similarity of the CGS event. For example, a gap was identified in the conclusion that existing procedures for sampling waste streams would prevent an issue similar to the resin shipment because the spent fuel pool cleanup waste was previously surveyed and could not be sampled, the waste characterization was performed off-site, and it was an infrequent evolution not performed by or under the oversight of Radiation Protection. The licensee also stated that the credited barriers were only valid for typical low-level radioactive waste shipments and not those from the spent fuel pool cleanup project.

One of the items not evaluated was the Plant Vogtle incident where a Type B quantity of radioactive material was shipped in a Type A cask. This incident was later assessed by the licensee as part of a focused self-assessment, where the licensee determined that the barrier in place was adequate to prevent this type of event. The inspectors questioned the licensee's conclusion, because Plant Vogtle determined the root cause of their event to be a lack of adequate controls to ensure radioactive waste processing was properly documented, and verified, during storage and shipment. Plant Vogtle's contributing causes were also similar to the CGS event: an inadequate self-assessment of the radwaste/shipping program and lack of detail in work orders used to accomplish re-characterization. Specifically, the work orders did not contain inventory specifics such as liner numbers, and pre and post movement liner storage locations. These causes were documented in NRC Inspection Report 05000424/2015009 and 05000425/2015009 (ML15258A572).

In RCE7, the licensee stated that applicable internal operating experience had been included in their analysis, referencing the work done in previous revisions. This review included an assessment of previous corrective actions, which included ineffective actions to address shipping specialist oversight. A radwaste supervisor was hired to correct the shortfall.

Regarding external operating experience in RCE7, the licensee searched for operational experience in industry and NRC databases. The review of operating experience focused on the key words high dose rates, shipment, and shipping; four events were identified. The licensee determined that these events were not related to poor organizational alignment, therefore were not applicable. The inspectors concluded that the licensee had determined the root cause and then performed the operating experience evaluation, which was contrary to the expectation that the operating experience inform the root cause determination.

Although the licensee's evaluation of external operating experience prior to the event may have been lacking, during the other causal evaluations the licensee revisited the operating experience and identified these weaknesses. In addition, the licensee reviewed internal operating experience during their other causal analyses and identified contributing causes of the shipping event as a result.

Based on the collection of work products reviewed, the inspectors concluded that the licensee's causal evaluations considered prior occurrences of the issue and knowledge of operating experience.

d. Determine that the root cause evaluation addressed the extent of condition and the extent of cause of the issue

As the focus and perspective of the causal evaluations and the apparent/root causes changed through this process, so did the licensee's extent of condition and extent of cause determinations. The events leading up to the shipping issue were not easy for the licensee to address, as demonstrated by the different ways the licensee addressed the extent of condition and extent of cause for the various causal evaluations.

CCE

The licensee addressed the extent of condition in the CCE by focusing on other opportunities to improve their procedures related to regulatory requirements.

Consistent with procedural requirements in Procedure CDM-01 for an apparent cause evaluation, the licensee did not evaluate the extent of cause.

ACE

The licensee's extent of condition in the ACE focused on disposal containers that had already been shipped and buried from the spent fuel pool cleanup project and items that remained in the spent fuel pool slated for disposal (e.g., control rod blades, low power range monitors, source range monitors, Tri Nuclear filters).

Consistent with procedural requirements in Procedure CDM-01 for an apparent cause evaluation, the licensee did not evaluate the extent of cause.

RCE3a

The licensee's extent of condition addressed the incorrect classification of radwaste and the selection of the incorrect container for shipping. The evaluation considered and expanded upon the extent of condition conducted under the ACE, which focused on other disposal containers previously shipped for burial and items remaining in the spent fuel pool slated for disposal. The review included evaluating the waste characterizations performed for a representative sample of radwaste shipments from the previous 5 years. The licensee identified and corrected several documentation issues. In addition, the current RPM reviewed 10 in-process shipments prior to corrective actions being implemented. One of the reviewed shipments arrived at the disposal site with the driver's copy of the manifest being incorrect and not matching the manifest sent to the disposal site in advance. This resulted in the suspension of disposal privileges by the State of Washington. The results of the licensee's extent of condition review, including the incorrect shipment, were evaluated during the baseline public radiation safety cornerstone inspection (NRC Inspection Report 05000397/2017010).

The licensee's extent of cause evaluated other infrequently performed processes or projects, like the spent fuel pool cleanup project, that involved high risk and potential impact where similar process breakdowns could occur. Specifically selected for review were the independent spent fuel storage installation program, the wet well cleanup project in refueling outage 23, and the scram discharge volume project in refueling outage 23. These extent of cause assessments by the licensee were thorough and determined that management and preparation for the three projects were acceptable.

Performance improvements were identified that would reduce aspects of risk for the independent spent fuel storage installation program. Review of the wet well and the scram discharge projects did not identify any issues or needed improvements.

The inspectors concluded that RCE3a addressed the extent of condition for the issue and the extent of cause for the determined root cause.

RCE7

The licensee's evaluation considered the extent of condition associated with an offsite shipment of LSA radioactive material that exceeded the external radiation and dose rate limits for a Type A container required by DOT regulations in 49 CFR 173.427(a)(1). The licensee determined that the underlying issue was not limited to LSA material. Similar activities that could be vulnerable to the same defect included waste shipments where transport limits could be exceeded, waste shipments where other regulations could be challenged, hazardous material shipments, and other non-waste radioactive material shipments. Therefore, the licensee expanded the extent of condition to include all radioactive material shipments. The licensee determined that non-radioactive hazardous material shipments should not be included in the extent of condition because hazardous material was transferred to a vendor who was then responsible for its removal. The licensee identified a potential vulnerability to another shipping violation should the same staff practices occur. However, the licensee concluded that the corrective actions implemented for the violation would effectively address similar shipping errors for all radioactive material shipments.

The licensee's evaluation also considered the extent of cause associated with organizational alignment to ensure proper decision-making, effective supervisor oversight, and programmatic validation. The licensee's extent of cause considered areas/disciplines where the stated root cause existed within other plant processes, equipment, or human performance that could result in a future consequential event at the station. The licensee stated that they looked at decision-making, effective supervisor oversight, and programmatic validation individually and combined to determine other areas with the potential for a future consequential event. The licensee determined that the vulnerability to look for was areas with an organizational structure in which a specialized position lacked supervision knowledgeable in that area of expertise or had other programmatic challenges to the supervisor's decision-making.

The extent of cause review contacted nearly every department to identify situations with the vulnerability. The licensee reviewed departments including Operations, Engineering, Maintenance, Emergency Preparedness, Quality, and Training. The licensee reviewed internal documentation and determined the site did not have a pervasive issue around organization alignment. Most either did not have the vulnerability or had identified it previously and were addressing it. The one department that had the vulnerability that had not been previously identified or addressed was Technical Services Engineering. This condition was entered into the corrective action program.

In addition, the licensee found that the organizational structure in Chemistry was challenged with the early departure of radwaste/transportation subject matter experts. There was a generic weakness found in knowledge transfer and retention where departments planned for individuals near retirement, but not for specialized individuals or

seasoned supervisors leaving for reasons other than retirement. This weakness was entered into the corrective action program.

The inspectors concluded that the licensee's root cause evaluation appropriately addressed the extent of condition and the extent of cause of the issue.

e. Determine that the root cause, extent of condition, and extent of cause evaluations appropriately considered safety culture traits

The licensee demonstrated the complexity of the issue through their evaluation of the safety culture traits associated with the event. The safety culture assessment performed for the final root cause evaluation identified four attributes that contributed to the event. Those attributes were:

- Leadership Safety Values and Actions attribute of Resources (LA.1): This related to the failure to select a supervisor with the appropriate skill set to oversee the radwaste shipping activities.

- Decision-making attribute of Conservative Bias (DM.2): This related to the failures in decision-making to 1) not use a Type B cask, 2) construct a fence around the shipment, and 3) not survey the liner or cask prior to shipment.

- Personal Accountability attribute of Standards (PA.1): This related to the failures of 1) management to ensure organizational alignment for radwaste activities, 2) the Chemistry supervisor to meet expectations to monitor and enforce standards of behavior, and 3) the radwaste transportation specialist to be trained, monitored, or coached to the expected behaviors.

- Problem Identification and Resolution attribute of Resolution (PI.3): This related to the failure to take effective and timely corrective actions to correct organizational weaknesses that were identified prior to the event.

The first three safety culture aspects were addressed by RCE7 and corrective actions to preclude repetition. The fourth safety culture aspect was addressed by the contributing cause and its associated corrective actions. (See Section 02.03a.)

The inspectors determined that the licensee's root cause, extent of condition, and extent of cause evaluations appropriately considered safety culture traits.

f. Findings

No findings were identified.

02.03 Corrective Actions Taken and Planned

a. Determine that appropriate corrective actions are specified for each root and contributing cause

As discussed in Section .02 above, there were a large number of inter-related actions involved in the resolution of this issue. Corrective actions were developed and

implemented over the course of the previously discussed causal evaluations beginning with the CCE, continuing with the ACE, and following through both phases of the root cause evaluation (RCE3a and RCE7).

CCE

The common cause evaluation identified several additional corrective actions beyond those initially taken for each of the eight incidents reviewed. These corrective actions addressed the apparent cause – decision-making related to handling, packaging, and shipping of radioactive material were not made at the appropriate level or by person(s) with adequate expertise.

For the first action taken, the Training department evaluated providing training on the importance of radwaste shipping/packing, lessons learned, actions done to correct and impact to the station now and in the future. The inspectors determined that licensee Procedure CDM-01, Section 4.18.4.c, stated that actions such as evaluate and initiate were not corrective. Based on documents provided by the licensee and interviews, the inspectors concluded that these actions would contribute to the licensee's understanding of the issues facing the radwaste/shipping program but would not correct the underlying causes.

A second action required the conduct of a minimum of two focused observations per individual by individuals with a radiation protection background. These observations were to occur over several months for radioactive material handling, packaging, and shipping personnel.

The contributing causes – personnel not using error prevention tools or stopping when faced with uncertain conditions – were addressed through the distribution of the CCE for review by Chemistry and Radiation Protection staff to communicate and raise awareness of the CCE results. These actions were also considered to address, in part, the apparent cause.

The implementation of the actions identified for the apparent and contributing causes of the CCE were not implemented in time to prevent the violation from occurring. However, the inspectors noted that this causal evaluation identified several of the issues that would subsequently be identified as a cause or contribute to the violation.

ACE

The ACE was the first causal evaluation of the shipping event. The apparent cause focused on determining the causes of the flawed survey documentation for the waste characterization, which was the basis for several other decisions made during the evolution that culminated in the incorrect shipment. The licensee identified the apparent cause to be that survey documentation was inaccurately recorded and communicated to the characterization vendor which led to errors in the calculated dose rates on the characterization used to ship the radioactive waste disposal container.

The contributing causes were identified as: 1) a formalized process and plan specific to Tri Nuclear filter management, tracking, and disposal was not developed, 2) radiological conditions on the disposal container were not verified and validated prior to shipment, and 3) characterization results provided by the vendor based on CGS data were not

verified or validated.

As corrective actions following the event and apparent cause evaluation, the licensee suspended radwaste shipping activities, conducted an event investigation, benchmarked another station on Tri Nuclear filter handling and tracking in the spent fuel pool, created a new procedure for spent fuel pool clean-up container loading, revised the procedure for processing of irradiated nonfuel material to include Tri Nuclear filters, labeled filter cans in the spent fuel pool, and evaluated performance gaps for culpability.

The corrective action for the apparent cause was the development of a procedure for the spent fuel pool cleanup container loading to address surveys, characterization, and verification prior to shipment. Additional actions included evaluating performance gaps within Reactor Maintenance, Chemistry and Radiation Protection, and conducting an assessment of the radwaste/shipping program using outside experts. The latter of these actions was specified as being non-corrective, but the inspectors noted that the assessment highlighted programmatic and process issues within the radwaste/shipping program, which were subsequently addressed by corrective actions for root and/or contributing causes in RCE3a and RCE7.

The inspectors determined that the licensee had specified appropriate corrective actions for the apparent and contributing causes identified in the ACE based on the problem statement used. However, during the special inspection, the NRC inspectors identified a Green finding for failure to follow procedures because the licensee failed to conduct a root cause evaluation for this issue (NRC IR 05000397/2016009). The licensee initiated a root cause evaluation (AR 360236) on January 16, 2017, after classifying the issue as a significant condition adverse to quality.

RCE3a

In RCE3a, the licensee identified the following root cause: Station procedures to implement spent fuel pool cleanup activities and the associated radioactive waste surveys, processing, and shipping activities are not sufficient to ensure compliance with all requirements. The contributing causes were identified to be: (1) Some key decisions made during the spent fuel pool cleanup project lacked rigorous challenge and vetting and were not conservative, and (2) Lack of adequate management/supervisor oversight for the project and radwaste processing and shipping program.

As interim corrective actions, the licensee inventoried and mapped the remaining Tri Nuclear filters in the spent fuel pool, conducted a self-assessment of the radwaste shipping and handling program, required the RPM to review all radwaste shipments to validate the surveys and characterization, and developed a procedure for spent fuel pool clean-up activities integrated with radwaste shipping and handling.

The contributing causes in RCE3a were described as adequately addressed by the interim corrective action and the corrective action to preclude repetition (CAPR). In discussions with the licensee, the inspectors learned that the interim corrective action of having the RPM conduct ten radwaste shipping reviews and be trained in radwaste shipping requirements was not as effective as intended.

The root cause in RCE3a was focused on inadequate procedures for the spent fuel pool cleanup and associated activities. Therefore, the corrective action to develop an

integrated and detailed procedure for the project and associated activities by a cross functional team seemed appropriate. The corrective action for the root cause was changed to a CAPR when the licensee determined the issue to be a significant condition adverse to quality. However, in the licensee's focused self-assessment of RCE3a, they identified that a shipping event occurred following the implementation of the corrective actions. As a result, the review concluded the CAPR for the root cause was ineffective. In this same review, the licensee determined that there were underlying behaviors that were not addressed.

The inspectors concluded that, regardless of the failure of the identified corrective actions to preclude repetition of shipping errors, the corrective actions were appropriate for the problem statement and root cause identified in this phase of the causal evaluation. Additionally, the inspectors concluded that development of procedures governing the activities associated spent fuel pool cleanup evolutions was critical to ensuring the radwaste from future cleanups would be properly characterized. Specifically, had the radwaste for this shipment been properly characterized, the subsequent errors related to loading the liner and preparing the package for shipment likely would not have occurred.

The inspectors concluded that the corrective actions taken in RCE3a benefited the radwaste/shipping program but did not correct the root of the problem.

RCE7

The licensee determined, and the inspectors agreed, that there were underlying behaviors that RCE3a had not addressed. This determination led to the second phase of the root cause evaluation, including the change in the problem statement.
In RCE7, the licensee identified the following root cause: Station management did not have the organizational alignment in place that will ensure proper decision-making, effective supervisor oversight, and programmatic validation to assure execution of critical radwaste packaging and shipping activities in accordance with regulations.

The licensee determined that their first CAPR for the root cause was to realign the Chemistry/Radiation Protection department organization to include oversight positions with individuals knowledgeable in radioactive shipments. The licensee determined the realignment of the radwaste shipping function under Radiation Protection with a knowledgeable supervisor was an appropriate corrective action. The site also required the RPM to be trained in radwaste shipping.

As corrective actions, the licensee realigned the Chemistry/Radiation Protection organization to include oversight positions knowledgeable in radioactive shipments. Specifically, for both the RPM and the individual responsible for oversight of the shipping specialist, the requirement for knowledgeable oversight was added to Procedure SWP-RPP-01, "Radiation Protection Program." Position descriptions were modified to include the required knowledge.

The inspectors reviewed the revised Radiation Protection organization's structure and discussed it with the RPM and the new Chemistry/Radiation Protection supervisor. The inspectors also interviewed the current shipping specialist and a second, recently hired and very experienced shipping specialist reporting directly to the new supervisor position. In addition to assessing the effectiveness of the organizational changes, the

inspectors learned that the addition of a third shipping specialist position had been approved to ensure continuity of the program. The inspectors concluded that these actions (organizational and functional realignment, knowledgeable supervision and management, and additional shipping specialists) were appropriate to preclude another occurrence.

Procedural requirements to validate dose rates documented on shipping manifests via either direct surveys or shielding calculations were added to applicable procedures. Finally, the lessons learned from this event were added to SOER 10-2 training for managers/supervisors.

A second CAPR implemented a requirement to validate the dose rates documented on shipping manifests via either direct surveys or shielding calculations. The validation requirements were placed in three radioactive waste shipping procedures, referencing the CAPR. The inspectors verified the requirements had been added to these procedures. The inspectors concluded that these changes would add an additional layer to preclude another occurrence.

The contributing cause identified in RCE7 was that Chemistry management did not implement effective corrective actions to address precursor organizational and programmatic issues within the radwaste/shipping program. As a corrective action, the licensee updated performance appraisals for Chemistry/Radiation Protection management and supervision to focus on increasing proficiency in implementing corrective actions. The licensee also conducted a workshop to align Chemistry/Radiation Protection management on how to implement proper corrective action to address organizational and programmatic issues. The inspectors found these corrective actions for the contributing cause to be appropriate because of the previous missed opportunities to address the decline in radwaste/shipping program performance.

The inspectors noted that the CAPR for RCE7 addressed a deeper programmatic issue and while the risk of recurrence may not be zero, the actions taken to preclude repetition should significantly reduce the likelihood of future shipping errors. The inspectors concluded that the organizational alignment, addition of knowledgeable shipping personnel and knowledgeable supervision, the direct lines of communication, and a creation of a quiet location to prepare shipping documents made a positive impact on the radwaste/shipping program.

The inspectors determined that all issues identified in the apparent, root, and contributing causes and other related documents would be corrected and that the corrective actions for each of the causal evaluations were being tracked to completion. As a result, the inspectors determined that the corrective actions implemented for the ACE, RCE3a, and RCE7 were appropriate and addressed the root and contributing causes identified in each of the licensee's causal evaluations.

b. Determine that corrective actions have been prioritized with consideration of significance and regulatory compliance

CCE

The CCE looked to identify any common causes of previous shipping issues in an effort to address the declining performance of the radwaste/shipping program. Each of the

eight incidents in this review previously had causal analyses performed and corrective actions assigned, so they were not re-evaluated. The licensee identified an apparent (common) cause that decision-making related to handling, packaging, and shipping of radioactive material was not being made at the appropriate level or by person(s) with adequate expertise. The contributing causes were personnel not using error prevention tools and not stopping when faced with uncertain conditions. The corrective actions for these causal factors focused on knowledge and behaviors. They raised awareness and reinforced the importance of regulatory compliance with focused observations.

ACE

The ACE looked for the probable cause of the radioactive waste shipping incident that, if corrected, would reduce the potential for recurrence. The apparent cause focused on determining the causes of the flawed survey documentation for the waste characterization, which was the basis for several other decisions made during the evolution that culminated in the improper shipment. The contributing causes were (1) a formalized process and plan specific to Tri Nuclear filter management, tracking, and disposal was not developed, (2) radiological conditions on the disposal container were not verified and validated prior to shipment, and (3) characterization results provided by the vendor based on CGS data were not verified or validated.

The corrective actions for these causal factors were focused on development of a spent fuel pool cleanup procedure (where there had been none) and revising other procedures to address inventory, control, and tracking of items within the spent fuel pool. In addition, performance gaps were evaluated within the three involved disciplines (Chemistry, Radiation Protection, and Reactor Maintenance).

However, during the special inspection, the inspectors communicated to the licensee that the level of this causal evaluation was not consistent with the significance of the violation. The corrective actions, while needed and beneficial, would not preclude repetition. It was determined later by the licensee that there were underlying issues that needed to be resolved.

RCE3a

The licensee categorized AR 360236 as a Severity Level A (high risk) action request, which requires a root cause evaluation. In accordance with Procedure SWP-CAP-01, “Corrective Action Program,” the AR received a significant condition adverse to quality priority. This priority requires the issue to be addressed by a higher level of corrective actions (i.e., corrective actions to preclude repetition known as CAPRs). The procedure stated that CAPRs should be completed within 180 days.

The initial root cause evaluation (RCE3a) looked for a cause that, if corrected, would preclude repetition. The root cause in this evaluation focused on station procedures, but expanded the review to associated radioactive waste survey, processing, and shipping activities. Two contributing causes focused on decision-making and oversight.

The corrective action to preclude recurrence for the root cause was the development of a spent fuel pool cleanup procedure integrated with associated radioactive waste shipping and handling procedures. The focus of the corrective action for the contributing

causes was to have the RPM, trained in shipping requirements, review and approve the next ten radioactive waste shipments.

The inspectors concluded that developing procedures for spent fuel pool cleanup activities and managing filters in the spent fuel pool were worthwhile actions addressing specific aspects of the causal chain, but determined the procedures themselves could not correct the underlying behaviors and knowledge gaps. The CAPR in RCE3a ultimately proved to be ineffective in preventing future shipping errors, as did the corrective action for the contributing causes.

RCE7

The licensee categorized AR 360236 as a Severity Level A (high risk) action request, which requires a root cause evaluation. In accordance with Procedure SWP-CAP-01, "Corrective Action Program," the AR received a significant condition adverse to quality priority. This priority requires the issue to be addressed by a higher level of corrective actions (i.e., corrective actions to preclude repetition known as CAPRs). The procedure stated that CAPRs should be completed within 180 days.

The final root cause evaluation (RCE7) looked for a cause that, if corrected, would preclude repetition. The evaluation focused on organizational alignment, knowledge, and behaviors.

The corrective actions to preclude recurrence for the root cause were to realign the Chemistry/Radiation Protection department organization to include oversight positions knowledgeable in radioactive shipments and to require validation of dose rates documented on shipping manifests. As described in Section 02.03(a), the licensee added a knowledgeable supervisor and shipper, providing depth and strength to the radwaste/shipping program. The inspectors learned that the site management decision to add these key resources required deviating from the site's staffing plan of reducing overall site resources. The corrective actions for the contributing cause focused on improving the proficiency of Chemistry/Radiation Protection management personnel in implementing corrective actions.

Based on review of all the causal evaluations taken together, the inspectors concluded that the corrective actions were prioritized with the appropriate consideration of significance and regulatory compliance.

c. Determine that corrective actions taken to address and preclude repetition of significant performance issues are prompt and effective

Over the course of these causal evaluations, corrective actions and corrective actions that preclude repetition were developed and implemented by the licensee within a reasonable timeframe. Reasonable adjustments were made for completing actions based on the availability of actionable items. The effectiveness of corrective actions varied as some actions did not produce the desired or expected result.

CCE

For the CCE, the implementation of the actions identified for the apparent and contributing causes were implemented in a reasonably prompt manner, although not

implemented in time to prevent the violation from occurring since many of the precursor errors had already occurred.

Regarding the effectiveness of the corrective actions for the CCE, focused observations on the handling, packaging, and shipping were completed. However, the inspectors noted that the observations depended on the availability of activities and observers. No significant issues were identified from the documents reviewed by the inspectors.

ACE

For the ACE, the corrective action to create a procedure for Chemistry/Radiation Protection personnel for spent fuel pool cleanup container loading was completed within a few months. The inspectors concluded that the effectiveness of the new procedure would not be tested until the next spent fuel pool cleanup campaign. In addition, the licensee revised four other procedures to manage the inventory, control, and tracking of irradiated non-fuel materials. The revisions to these procedures were completed within a reasonable timeframe.

RCE3a

In RCE3a, the corrective action to preclude repetition, similar to the ACE corrective action, was to develop a detailed procedure for spent fuel pool cleanup activities integrated with associated radwaste shipping and handling procedures. The inspectors reviewed the CAPR and determined that because only a single procedure was developed, specifically for spent fuel pool cleanup activities, it would not have been effective in preventing future transportation issues. This conclusion was validated by the fact that after the implementation of the RCE3a CAPR, the licensee's burial site privileges were suspended following another radwaste shipping noncompliance (NRC IR 05000397/2017010). So, although promptly developed, the CAPR was determined by the licensee to be ineffective.

The corrective action associated with the contributing causes was an interim corrective action for the RPM to review and approve the next ten radwaste shipments. The noncompliance in shipping documents described in the paragraph above was on one of those ten shipments. Through interviews, the inspectors learned that the human performance error occurred after the RPM had reviewed and approved the shipment. This failure also demonstrated the ineffectiveness of the corrective action for the contributing cause.

RCE7

In RCE7, the corrective action to preclude repetition was different from that in RCE3a and the ACE, in that the corrective action addressed organizational alignment and ensuring there were knowledgeable individuals within the organizational structure. This aspect of the evaluation, added in RCE7, was after identification of the turnover of experienced personnel and eventual dilution of technical expertise within the radwaste/shipping program. That aspect was addressed promptly and effectively by hiring experienced individuals with this specialized skill set.

The licensee described the corrective action taken to address the root cause as the movement of the radwaste/shipping function from Chemistry to Radiation Protection under a recently hired supervisor with a radwaste/shipping background. The inspectors interviewed the new supervisor to assess his knowledge of radwaste and shipping and found it adequate. An action to establish a shipping office where the preparation of shipping documents could be performed with minimal distractions was a prompt and effective action that was a direct outcome of the radwaste/shipping program's move to Radiation Protection. The licensee also hired a second experienced shipper who would bring additional benefit to the program.

An effectiveness review completed by the licensee found the CAPR actions had been successfully implemented and were effective.

The inspectors concluded the movement of the radwaste/shipping program under a knowledgeable supervisor in the Radiation Protection department and the addition of knowledgeable shipping personnel were appropriate actions to preclude repetition of significant performance issues.

In reviewing the actions taken, the licensee was prompt in taking action to address significant performance issues with a few exceptions. The contributing cause of RCE7 was the failure to implement timely corrective actions regarding performance issues in the radwaste/shipping program. According to the event and causal factor chart for RCE7, there were three opportunities identified where this failure occurred. The licensee addressed this issue by instituting criteria for Chemistry and Radiation Protection management performance appraisals to specifically address implementation of corrective actions. A workshop on how to implement proper corrective actions was conducted for the Chemistry and Radiation Protection department's management.

The licensee promptly initiated corrective actions as issues were identified throughout the performance of the causal evaluations. The licensee also initiated corrective actions that were identified in the apparent cause evaluation and early root cause evaluation revisions prior to completing the final evaluation and as they identified related issues throughout the process.

The inspectors determined that the corrective actions taken to address and preclude repetition of the performance issues were prompt and should be effective.

d. Determine that a corrective action plan and schedule has been established for implementing and completing the corrective actions

The corrective action plan for the ACE was completed and documented in Action Request & Assigns Package 357593. There were fifteen actions assigned for the ACE, but only six were considered corrective actions. The inspectors concluded those were completed or an acceptable alternative was completed within a reasonable time period.

The corrective action plan for AR 360236 encompassed both phases of the root cause evaluation (i.e. RCE3a and RCE7). There were thirty-three actions assigned, nine of which were corrective actions. The inspectors concluded the actions were completed or in progress at the time of the inspection. The actions assigned were completed or were scheduled to be completed in a reasonable timeframe.

The inspectors determined through interviews that effectiveness reviews would be the final actions taken by the licensee under the root cause evaluation, but that they would be conducted after the other actions had been completed and sufficient run time was given for the new organization and shipping personnel to learn and exercise the changes that were made.

The inspectors discussed the corrective action plan with the licensee. Some of the due dates were captured in the final revision of the root cause evaluation; however, many of the due dates for corrective actions not directly mentioned in the evaluation were spread across other performance improvement tools. Specifically, the licensee used a performance improvement database to track corrective actions. The many facets of the causal evaluation, including previous revisions, assessments, work orders, and actions, are being tracked with the AR 360236 identifier with cross-references to other associated action requests. The licensee's database tracks all the associated actions, due dates, responsible parties, and effectiveness reviews to be performed.

The inspectors determined the corrective actions for each causal evaluation were tracked to completion as appropriate. The inspectors determined that a schedule had been established for implementing and completing the open corrective actions.

e. Determine that quantitative or qualitative measures of success have been developed for determining the effectiveness of the corrective actions to preclude repetition

As documented in the final root cause evaluation, the licensee established measures for determining the effectiveness of the corrective actions. These measures included the following:

- The trained and knowledgeable Radiation Protection Manager will review shipment manifests and paperwork to identify deficiencies. Success is defined as the documents containing less than 5 percent deficiencies.

- A self-assessment of the radwaste shipping and handling program corrective actions will be performed after an acceptable implementation period with a due date of April 30, 2018. Areas of focus include compliance with burial site requirements (i.e., no loss of burial site privileges) and zero regulatory noncompliance issues related to radwaste shipments.

The effectiveness reviews have been added into the corrective action program as corrective action items to ensure they are performed.

The inspectors determined that quantitative and qualitative measures of success had been developed for determining the effectiveness of the corrective actions to preclude repetition.

f. Determine that the corrective actions planned or taken adequately address a Notice of Violation (NOV) that was the basis for the supplemental inspection

Based on the review and assessment of the licensee's causal evaluations and planned/completed corrective actions, the inspectors determined that the corrective actions taken and planned to correct the identified causes adequately addressed the NOV.

g. Findings

No findings were identified.

4OA6 Meetings, Including Exit

Exit Meeting Summary

On December 1, 2017, the inspectors conducted a technical debrief for Mr. M. Reddemann, Chief Executive Officer, and other members of the licensee staff. The licensee confirmed that any proprietary information reviewed by the inspectors had been returned or destroyed.

On December 19, 2017, the inspectors presented the inspection results to Mr. M. Reddemann, Chief Executive Officer, and other members of the licensee staff. The licensee acknowledged the issues presented.

On October 28, 2019, Mr. R. Lantz, Director, Division of Reactor Safety, Region IV, NRC, discussed the reissuance of this inspection report, including the circumstances leading to its reissuance, with Mr. D. Gregoire, Manager, Regulatory Affairs.

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee Personnel

S. Brush, Health Physics Planner, Chemistry/Radiation Protection
M. Davis, Manager, Chemistry/Radiation Protection
K. Gillard, Analyst, Chemistry/Radiation Protection
D. Gregoire, Manager, Regulatory Affairs
T. Hedges, Chemistry/Radiation Support Supervisor, Chemistry/Radiation Protection
G. Hettel, Vice President, Operations
J. Houston, Radwaste Transportation Specialist, Chemistry/Radiation Protection
T. McNabb, Health Physics Planner, Chemistry/Radiation Protection
S. Nappi, Assistant to the Vice President, Operations
M. Nolan, Senior Radwaste Transportation Specialist, Chemistry/Radiation Protection
T. Parmalee, Compliance Engineer, Licensing and Regulatory Affairs
M. Reddemann, Chief Executive Officer
R. Sanker, Radiological Support Supervisor, Chemistry/Radiation Protection
M. Shobe, Chemistry Specialist IV, Chemistry/Radiation Protection
J. C. Smith, Radiological Operations Supervisor, Chemistry/Radiation Protection
C. Smoot, Supervisor, Human Performance/Industrial Safety
D. Wolfgramm, Supervisor, Regulatory Compliance

NRC Personnel

G. Kolcum, Senior Resident Inspector
L. Merker, Resident Inspector

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Closed

05000397/2016009-01	VIO	Shipment of a Type B Quantity of Radioactive Material in a Type A Package (Section 4OA4)

LIST OF ACRONYMS

AR	Action Request
ACE	Apparent Cause Evaluation [AR 357593]
CAPR	corrective action to preclude repetition
CCE	Common Cause Evaluation [AR 353247]
CGS	Columbia Generating Station
DOT	Department of Transportation
IR	Inspection Report
LSA	Low Specific Activity
HU/O&P	Human Performance, Organizational and Programmatic Evaluation
NOV	Notice of Violation
NRC	Nuclear Regulatory Commission
Radwaste	radioactive waste
RCE	root cause evaluation
RCE3a	Root Cause Evaluation [AR 360326, Revisions 0 through 3a]
RCE7	Root Cause Evaluation [AR 360326, Revisions 4 through 7]
RPM	Radiation Protection Manager
SFPCU	spent fuel pool cleanup

LIST OF DOCUMENTS REVIEWED

Section 4OA4: Supplemental Inspection (95001)

Procedures

Number	Title	Revisions
SWP-RMP-01	Radioactive Waste Management Program	4
PPM 1.11.15	Control of Radioactive Material	11, 12, 13
PPM 6.1.1	Spent Fuel Pool Inventory	9, 10
PPM 11.2.2.12	Radiological Risk Assessment and Management	8
PPM 11.2.13.1	Radiation and Contamination Surveys	36, 37
PPM 11.2.23.1	Shipping Radioactive Materials and Waste	18, 19
PPM 11.2.23.1	Shipping Radioactive Materials and Waste	19
PPM 11.2.23.2	Computerized Radioactive Waste and Material Characterization	20, 21
PPM 11.2.23.9	Packaging, Transportation and Disposal of Radioactive Waste at the US Ecology, Richland Radioactive Waste Disposal Facility	0, 1
PPM 11.2.23.45	Management of Spent Fuel Pool Filters, Irradiated, and Non-Irradiated Items to Support Packaging, Transportation, and Disposal as Low-Level Radwaste	0

Procedures

Number	Title	Revisions
CDM-01	Cause Determination Manual	16
SWP-CAP-01	Corrective Action Program	36, 37
GBP-HR-48	Knowledge Retention	0

Audits and Self-Assessments

Number	Title	Date
361427	Peer Self-Assessment Report Radioactive Waste Program	February 2, 2017
AU-RP-RW-15	Quality Services Audit Report – Radiation Protection and Process Controls Program	November 5, 2015
AR-SA 305111	Focused Self-Assessment Report – Radioactive Solid Waste Processing, Radioactive Material Handling, Storage, and Transportation	June 19, 2015
AR-SA 337267	Snapshot Self-Assessment Report – Radioactive Waste Management and Transportation	June 28, 2017
AR-SA 369058	Focused Self-Assessment Report – Radwaste Shipping 95001 Preparatory Assessment	September 11, 2017
AR-SA 361427	Peer Self-Assessment Report – Radioactive Waste Program	February 2, 2017
SR-17-12	Radwaste Program Assessment Report	April 27, 2017
SR-17-09	Radwaste Processing and Shipping	August 23, 2017

Root Cause Evaluations

AR Number	Title	Revision Date
360326	RadWaste Liner dose rate exceeds 1 rem/hr at 3 meters	Rev. 7 November 16, 2017
360326	RadWaste Liner dose rate exceeds 1 rem/hr at 3 meters	Rev. 6 October 30, 2017
360326	Incorrect Container for Radioactive Shipment 16-40	Rev. 3a April 26, 2017

Apparent Cause Evaluations

AR Number	Title	Revision Date
353427	Trend: Radioactive Waste Packing/Shipping Issues	Rev. 1 October 20, 2016
352217	Radwaste Box Sent to Disposal Site with Greater than 15% Voids	September 12, 2016
357593	Radioactive Waste Disposal Container has Higher Dose Rates than Anticipated	December 12, 2016
369215	Liner 17-084-OT Shipped for Disposal with Incorrect Manifest	August 29, 2017

Action Requests (AR)

338421	352217	357593	360148
360572	369215	370193	371583

Work Orders

Number	Title	Date
02070690	Spent Fuel Pool Clean Up Project Plan	February 15, 2016
02104894	Move SFPCU Liner from Reactor Building Truck Bay to Radwaste	December 29, 2016
02070690	Perform Spent Fuel Pool Cleanup in FY16	February 9, 2016
02095196	Perform Spent Fuel Pool Cleanup in FY17	September 28, 2016

Miscellaneous Documents

Number	Title	Date
	Causal Evaluation Roadmap	November 30, 2017
	Chemistry/Radiation Protection Organization Chart	November 28, 2017
WAC 246-249-090	Transfer for Disposal and Manifests	November 9, 2017
	Excellence Model Handbook	2016

COLUMBIA GENERATING STATION – NRC SUPPLEMENTAL INSPECTION
REPORT 05000397/2017011 – OCTOBER 29, 2019

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☒ SUNSI Review: By: JJO | ADAMS: ☒ Yes ☐ No | ☐ Non-Publicly Available ☒ Publicly Available | ☒ Non-Sensitive ☐ Sensitive | Keyword: NRC-002

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