



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION**

REGION IV  
1600 E. LAMAR BLVD.  
ARLINGTON, TX 76011-4511

August 7, 2017

EA-17-028  
EA-17-085

Mr. Mark E. Reddemann  
Chief Executive Officer  
Energy Northwest  
P.O. Box 968 (Mail Drop 1023)  
Richland, WA 99352-0968

**SUBJECT: COLUMBIA GENERATING STATION – REVISED NRC SPECIAL INSPECTION  
REPORT 05000397/2016009; PRELIMINARY WHITE FINDING**

Dear Mr. Reddemann:

On July 31, 2017, the U.S. Nuclear Regulatory Commission (NRC) sent you a letter (Agencywide Document Access and Management System (ADAMS) Accession ML17212A914) in which we stated that non-cited violation NCV 05000397/2016009-03 would be revised. This document transmits the revision to the NRC's Special Inspection Report 05000397/2016009.

On May 9, 2017, Energy Northwest, the licensee for Columbia Generating Station (CGS), provided a response (ADAMS Accession ML17129A627) to the NRC's Inspection Report 05000397/2016009 (ADAMS Accession ML17100A499) issued on April 10, 2017.

In this letter, Energy Northwest contested: (1) an NCV of Title 10 of the Code of Federal Regulations (10 CFR) 20.1904 for the failure to ensure that each container of licensed material in the spent fuel pool bore a label or had documentation providing sufficient information to permit individuals handling the licensed material to minimize exposure; (2) an NCV of 10 CFR 50.71(e) for the failure to periodically provide the NRC a final safety analysis report update with all changes made in the facility or procedures; (3) a Green finding for the failure to follow the requirements of Procedure SWP-CAP-06, "Condition Report Review," when determining the type of cause evaluation required to assess the causes of the higher than expected dose rates on a radwaste container; and (4) an NCV of 10 CFR 61.56(b)(3) for the failure to assure that void spaces within waste packages were reduced to the extent practicable.

After careful consideration of the bases for your contention, the NRC concluded in our letter, dated July 31, 2017, that two of the NCVs and the Green finding would be upheld. Specifically, the NCV of 10 CFR 61.56(b)(3) and the finding associated with the failure to follow the requirements of Procedure SWP-CAP-06 are upheld. The NCV of 10 CFR 20.1904 is upheld, but revised to clearly articulate that the exemptions of 10 CFR 20.1905 were not met. The resolution of the contested NCV associated with 10 CFR 50.71(e) is being held in abeyance pending further review.

Based on the above, the NRC revised the non-cited violation documented in Section 2.10c of the enclosed Inspection Report 05000397/2016009.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice and Procedure," a copy of this letter and its enclosure will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's ADAMS, accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html>.

Sincerely,

***/RA Jeffrey Clark Acting for/***

Anton Vogel, Director  
Division of Reactor Safety

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

Enclosure:

Inspection Report 05000397/2016009

w/ Attachments:

1. Supplemental Information
2. List of Acronyms
3. Appendix M – Significance Determination  
Using Qualitative Criteria

**U.S. NUCLEAR REGULATORY COMMISSION**

**REGION IV**

Docket: 05000397

License: NPF-21

Report: 05000397/2016009

Licensee: Energy Northwest

Facility: Columbia Generating Station

Location: North Power Plant Loop  
Richland, WA 99354

Dates: December 12, 2016, through February 24, 2017

Inspectors: L. Carson, Senior Health Physicist  
N. Greene, Ph.D., Health Physicist  
B. Tharakan, CHP, State Agreements Officer

Approved By: Heather J. Gepford, Ph.D., CHP  
Chief, Plant Support Branch 2  
Division of Reactor Safety

Enclosure

## SUMMARY

IR 05000397/2016009; 12/12/2016 – 02/24/2017; Columbia Generating Station; Special Inspection to Evaluate the Circumstances Surrounding a Radwaste Shipment that Arrived at the Burial Site with Higher than Anticipated Dose Rates

The special inspection activities described in this report were performed between December 12, 2016, and February 24, 2017, by three Nuclear Regulatory Commission (NRC) region-based inspectors. One preliminary White apparent violation, six Green non-cited violations, one Severity Level IV non-cited violation, and one Green finding were identified.

The significance of most inspection findings is indicated by their color (Green, White, Yellow, or Red), which is determined using Inspection Manual Chapter 0609, "Significance Determination Process," dated April 29, 2015. Their cross-cutting aspects are determined using Inspection Manual Chapter 0310, "Aspects within the Cross-Cutting Areas," dated December 4, 2014. Violations of NRC requirements are dispositioned in accordance with the NRC Enforcement Policy, dated November 1, 2016. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," dated July 2016.

### A. NRC-Identified Findings and Self-Revealing Findings

#### Cornerstone: Public Radiation Safety

- TBD. The team reviewed a self-revealed finding and apparent violation of 49 CFR 173.427 associated with a shipment of low specific activity (LSA) material consisting of radioactive filters, irradiated components, and dry active waste. The licensee failed to ensure that the radioactive contents in a radwaste liner did not exceed the radiation level requirements for shipping. Specifically, the licensee transported a Type A package containing a Type B quantity of radioactive material as LSA even though it had an external radiation level of 2.1 rem/hr at a distance of 3 meters from the unshielded material, exceeding the 1 rem/hr at 3 meters limit for LSA. This issue was entered into the corrective action program as Action Requests 357593 and 360236.

The failure to ensure that the radioactive contents of a radwaste container of low specific activity material did not exceed the requirements for shipping was a performance deficiency. The performance deficiency was more than minor because it was associated with the program and process (Transportation Program) attribute of the Public Radiation Safety Cornerstone and adversely affected the cornerstone objective of ensuring adequate protection of public health and safety from exposure to radioactive material released into the public domain. Specifically, the licensee's failure to ensure that the contents of a radwaste container did not exceed the requirements for shipping resulted in radioactive material being transported in Type A packaging rather than the required Type B packaging. The finding was evaluated using NRC Inspection Manual Chapter 0609, Appendix M, "Significance Determination Process Using Qualitative Criteria," because Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," does not specifically address the situation where a Type A package was used to ship quantities of radioactive material requiring a Type B package. In accordance with Appendix M, an initial qualitative bounding evaluation was performed. This was accomplished using the Transportation Branch of

the, "Public Radiation Safety Significance Determination Process," and examples from the Enforcement Policy.

The finding has a cross-cutting aspect in the area of human performance, associated with conservative bias, because licensee personnel did not use decision making practices that emphasized prudent choices over those that were simply allowable. Specifically, on several occasions throughout the radwaste processing and packaging evolution for shipment No. 16-40, decisions were made that did not exhibit the appropriate conservative bias [H.14]. (Section 2.10a)

- Green. The team reviewed three examples of a self-revealed, non-cited violation of 10 CFR 20.1501 associated with the failure to conduct adequate surveys of the solid radwaste contents of a shipment that was packaged and transported for ultimate disposal. As a result of the inadequate surveys, the radwaste in shipment No. 16-40 was packaged in the incorrect type of shipping cask, the radwaste manifest and shipping paperwork contained numerous errors, and the waste was not correctly classified in accordance with 10 CFR Part 61. This issue was entered into the corrective action program as Action Request 357593.

The failure to conduct adequate surveys of the solid radwaste contents in a shipment that was packaged and transferred for ultimate disposal was a performance deficiency. The team determined that the performance deficiency was more than minor, and therefore a finding, because it was associated with the program and process aspect of the Public Radiation Safety Cornerstone and adversely affected the cornerstone objective to ensure adequate protection of public health and safety from exposure to radioactive materials released in the public domain. Specifically, as a result of the inadequate surveys, the radwaste in shipment No. 16-40 was packaged in the incorrect type of shipping container, the radwaste manifest and shipping paperwork contained numerous errors, and the waste was misclassified in accordance with 10 CFR Part 61. Using NRC Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," the violation was determined to be of very low safety significance (Green) because it was a finding in the transportation branch in which: (1) radiation limits were not exceeded, (2) there was no breach of the package during transit, (3) there were no Certificate of Compliance issues, and (4) the low-level burial ground nonconformance did not involve a 10 CFR 61.55 waste underclassification. The finding has a cross-cutting aspect in the area of human performance, associated with documentation, because the organization failed to maintain complete, accurate, and up-to-date documentation [H.7]. (Section 2.10b)

- Green. The team identified a non-cited violation of 10 CFR 20.1904 associated with the licensee's failure to ensure that each container of licensed material in the spent fuel was conspicuously marked commensurate with the radiological hazard or that the contents were identified by a readily available written record. The immediate corrective actions were to generate a condition report and assess the extent of the failure to label, or provide sufficient information for all items in the spent fuel pool, reevaluate the latest spent fuel pool annual inventory to identify any missing information, and update applicable procedures. This issue was entered into the corrective action program as Action Requests 357593 and 360148.

The licensee's failure to ensure that each container of licensed material stored in the spent fuel pool was conspicuously marked commensurate with the radiological hazard or that the contents were identified by a readily available written record was a performance deficiency. The performance deficiency was more than minor, and therefore a finding, because it was associated with the programs and process (exposure control) attribute of the Occupational Radiation Safety Cornerstone and adversely affected the cornerstone objective to ensure the adequate protection of the worker health and safety from exposure to radiation from radioactive material. Specifically, accessing highly radioactive material of unknown radiological hazard could result in unanticipated dose rates and unplanned exposures. Using NRC Inspection Manual Chapter 0609, Appendix C, "Occupational Radiation Safety Significance Determination Process," the finding was determined to be of very low safety significance (Green) because it did not: (1) involve as low as is reasonable achievable (ALARA) planning or work controls, (2) did not involve an overexposure, (3) did not have a substantial potential to be an overexposure, and (4) the ability to assess dose was not compromised. The finding has a cross-cutting aspect in the area of human performance, associated with avoiding complacency, because licensee personnel failed to recognize and plan for the possibility of mistakes and inherent risk, even while expecting a successful outcome, once these items are accessed [H.12]. (Section 2.10c)

- Green. The team identified a non-cited violation of 10 CFR 20.2006(b) for the licensee's failure to ship radwaste with an accurate shipping manifest. Specifically, the licensee failed to provide the correct identification number and proper shipping name, radionuclide activity, net waste volume, surface radiation level, and waste classification. The incorrect surface radiation levels resulted in rejection of the package and the licensee's immediate suspension from usage of the land disposal site at US Ecology. This issue was entered into the corrective action program as Action Requests 357593 and 359498.

The licensee's failure to ship radwaste intended for ultimate disposal with an accurate shipping manifest was a performance deficiency. The performance deficiency was more than minor, and therefore a finding, because it was associated with the program and process attribute of the Public Radiation Safety Cornerstone and adversely affected the cornerstone objective to ensure adequate protection of public health and safety from exposure to radioactive material released in the public domain. Specifically, inaccurate information on a shipping manifest could result in inappropriate handling of radioactive material while in the public domain. Using NRC Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," the finding was determined to be of very low safety significance (Green) because: (1) radiation limits were not exceeded, (2) there was no breach of a package during transit, (3) it did not involve a certificate of compliance issue, (4) it was not a low-level burial ground nonconformance, and (5) it did not involve a failure to make notifications or provide emergency information. The finding has a cross-cutting aspect in the area of human performance, associated with avoiding complacency, because licensee personnel failed to recognize and plan for the possibility of mistakes, latent issues, and inherent risk, even while expecting successful outcomes, by not implementing appropriate error reduction tools. Due to the lack of appropriate error prevention tools, inaccurate survey data was provided to the vendor and errors in the waste characterization and shipping manifest were not identified in a timely fashion [H.12]. (Section 2.10d)

- Green. The team identified a non-cited violation of 10 CFR Part 20, Appendix G, for the failure to manage a quality assurance program to ensure compliance with 10 CFR 61.55 and 10 CFR 61.56. Additionally, licensee management failed to effectively evaluate the significance of quality assurance audit findings in the area of radwaste processing and radioactive material shipments.

The failure to manage a quality assurance program to assure compliance with 10 CFR 61.55 and 10 CFR 61.56 was a performance deficiency. The team determined that the performance deficiency was more than minor, and therefore a finding, because it was associated with the Public Radiation Safety Cornerstone attribute of program and process, and adversely affected the cornerstone objective to ensure adequate protection of public health and safety from exposure to radioactive materials released in the public domain. Specifically, the failure to manage quality assurance activities as part of the radwaste processing and packaging program resulted in wastes that were not properly classified or did not possess the proper characteristics for burial. Using NRC Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," the violation was determined to be of very low safety significance (Green) because it was a finding in the transportation branch in which: (1) radiation limits were not exceeded, (2) there was no breach of the package during transit, (3) there were no Certificate of Compliance issues, and (4) the low-level burial ground nonconformance did not involve a 10 CFR 61.55 waste under-classification. The finding has a cross-cutting aspect in the area of human performance, associated with avoiding complacency, because licensee personnel failed to recognize and plan for the possibility of mistakes, latent issues, and inherent risk, even while expecting successful outcomes, by not implementing appropriate error reduction tools, such as a proper quality assurance program. Specifically, the licensee has failed to ensure the appropriate level of quality assurance/quality control oversight and verification with respect to risk-significant radwaste processing and radioactive material shipment activities [H.12]. (Section 2.10e)

- SLIV. The team identified a Severity Level IV non-cited violation of 10 CFR 50.71(e) for the failure of the licensee to periodically provide the NRC a Final Safety Analysis Report (FSAR) update with all changes made to the facility or procedures. Specifically, the licensee changed its radwaste management strategy for the spent fuel pool cooling and cleanup system and material being stored in the spent fuel pool. However, the licensee had not changed its process control program or updated the FSAR to reflect the impact on waste streams from processing items stored in the spent fuel pool including activated metals, Tri-Nuke filters, filter socks, and demineralizer filter resins. This issue was entered into the corrective action program as Action Requests 359293 and 359296.

The failure to update the final safety analysis report to reflect changes in solid radwaste management and the process control program was a performance deficiency. The Reactor Oversight Program's Significance Determination Process (SDP) does not specifically consider the regulatory process impact in its assessment of licensee performance. Therefore, it is necessary to address this violation which involves the ability of the NRC to perform its regulatory oversight function using traditional enforcement to adequately deter non-compliance. Referring to Section 6.1.d. of the Enforcement Policy, the finding is being characterized as a Severity Level IV violation. Traditional enforcement violations are not assessed for cross-cutting aspects. (Section 2.10f)

- Green. The team identified a finding for the failure to follow the requirements of Procedure SWP-CAP-06, "Condition Report Review," when determining the type of cause evaluation required to assess the causes of the higher than expected dose rates on a radwaste container. Specifically, Procedure SWP-CAP-06 required that if an event has high risk and high uncertainty, the level of evaluation required is a root cause evaluation. However, the licensee failed to adequately assess the uncertainty associated with the causes of the event and performed an apparent cause evaluation rather than a root cause evaluation. The licensee entered this finding into the corrective action program as Action Request 360236.

The failure to follow the requirements of Procedure SWP-CAP-06 when determining the type of cause evaluation required to assess the higher than expected dose rates on a radwaste container and performing an apparent cause evaluation instead of a root cause evaluation was a performance deficiency. The team determined that the performance deficiency was more than minor, and therefore a finding, because it was associated with the Public Radiation Safety Cornerstone attribute of program and process, and adversely affected the cornerstone objective to ensure adequate protection of public health and safety from exposure to radioactive materials released in the public domain. Specifically, the failure to adequately assess the causes of the event left the licensee vulnerable to future radwaste processing and transportation errors of significance. Using NRC Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," the finding was determined to be of very low safety significance (Green). The finding has a cross-cutting aspect in the area of problem identification and resolution, associated with evaluation, because the licensee failed to thoroughly evaluate the issue to ensure resolutions address causes and extent of conditions commensurate with their safety significance [P.2]. (Section 2.10g)

- Green. The team reviewed a self-revealed non-cited violation of 10 CFR 30.41(b)(5) for the failure to transfer byproduct material to an authorized waste disposal facility in accordance with the terms of the facility's license. Specifically, License Condition No. 22.C of the US Ecology license required that all radwaste shall be packaged in such a manner that waste containers received at the facility do not show an increase in the external radiation levels as recorded on the manifest, within instrument tolerances. On November 9, 2016, the licensee transferred byproduct material to US Ecology for disposal; the disposal facility's surveys revealed that the dose rate on contact with the waste liner was 90 rem per hour, whereas the manifest recorded a dose rate 11.8 rem per hour. The licensee retrieved the shipment, stored it safely, and entered the condition into the corrective action program as Action Request 357593.

The failure to transfer byproduct material to a low-level radwaste disposal facility in accordance with the facility's license was a performance deficiency. The performance deficiency was more than minor because it was associated with the program and process attribute of the Public Radiation Safety Cornerstone and adversely affected the associated cornerstone objective to ensure adequate protection of public health and safety from exposure to radioactive materials released into the public domain as a result of routine civilian nuclear reactor operation. Using NRC Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," the finding was determined to be of very low safety significance (Green) because it was a low-level burial ground nonconformance and a 10 CFR 61.55 waste under-classification; however, it was not Class C waste or greater and the waste did conform to the waste characteristics of 10 CFR 61.56. The finding has a cross-cutting

aspect in the area of human performance, associated with conservative bias, because station personnel failed to use decision making practices that emphasize prudent choices over those that are simply allowed considering the licensee had multiple opportunities to re-evaluate the shipment and determine the appropriate requirements [H.14]. (Section 2.10h)

- Green. The team reviewed a self-revealed non-cited violation of 10 CFR 61.56(a)(3) for the licensee's failure to assure that void spaces within the waste packages were reduced to the extent practicable. Specifically, a shipment of dry active waste sent to US Ecology in May 2016 arrived at the disposal facility with voids in excess of 15 percent of the total waste volume, contrary to the requirements of US Ecology's Radioactive Material License WN-I019-2, License Condition No. 23. Corrective actions included inspecting the other containers from waste shipment No.16-27 and testing each container for voids. The licensee documented this issue in their corrective action program as Action Request 352217 and performed an apparent cause evaluation.

The failure to ship radwaste for disposal without reducing void spaces to the extent practicable was a performance deficiency. The team determined that the performance deficiency was more than minor because it adversely affected the Public Radiation Safety Cornerstone objective to ensure adequate protection of public health and safety from exposure to radioactive materials released in the public domain. Specifically, the failure to ensure that void spaces were removed in the radwaste container shipped to US Ecology subjected the disposal facility to the possibility of improper disposal of the waste, in that, the package was susceptible to stability issues. Using NRC Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," the violation was determined to be of very low safety significance (Green) because: (1) radiation limits were not exceeded, (2) there was no breach of the package during transit, (3) there were no Certificate of Compliance issues, and (4) the low-level burial ground nonconformance did not involve a 10 CFR 61.55 waste under-classification. The finding has a cross-cutting aspect in the area of human performance, associated with teamwork, because individuals and work groups failed to communicate and coordinate their activities within and across organizational boundaries to ensure nuclear safety is maintained [H.4]. (Section 2.10i)

## **B. Licensee-Identified Violations**

A violation of very low safety significance that was identified by the licensee was reviewed by the team. Corrective actions taken or planned by the licensee have been entered into the licensee's corrective action program. This violation and associated corrective action tracking numbers are listed in Section 4OA7 of this report.

## REPORT DETAILS

### 4. OTHER ACTIVITIES

#### Cornerstone: Public Radiation Safety Cornerstone

#### 40A5 Other Activities

##### .1 Basis for Special Inspection

On November 9, 2016, Columbia Generating Station (CGS) shipment No. 16-40, which contained a single package of non-fissile items removed from the spent fuel pool (SFP), was sent to a low-level radioactive waste (LLRW) facility (US Ecology, Richland, Washington) for disposal. Shipment No. 16-40 consisted of a carbon steel open top waste liner (16-059-OT) containing Tri-Nuke filters, sock filters, and irradiated control rod velocity limiters. The waste liner was transported within a Duratek Model CNS 14-190H cask. The package was shipped as an exclusive use shipment of low specific activity (LSA) radioactive material.

The manifest specified an unshielded contact dose rate on the liner within the shipping cask of 11.8 rem per hour (rem/hr). The 11.8 rem/hr dose rate specified on the manifest was a calculated value and was not measured using a survey instrument. Upon unloading the waste liner from the shipping cask, US Ecology personnel measured unshielded contact dose rates of up to 90 rem/hr on the liner. As a result of the significant discrepancy between the manifested dose rate and the actual dose rates measured on the liner, the shipment was rejected by US Ecology and returned to CGS.

Columbia Generating Station was contacted by the Washington State Department of Health (WSDOH) on November 10, 2016, and notified that their disposal use permit privileges to the low-level waste facility had been suspended until a written plan containing corrective actions was approved and an on-site inspection was completed by WSDOH. A revised notification was sent on November 16, 2016, which documented three violations.

Management Directive 8.3, "NRC Incident Investigation Program," was used to evaluate the level of NRC response for this event. In evaluating the criteria of Management Directive 8.3, it was determined that this event met two of the deterministic criteria for a special inspection. Specifically, this event resulted in unanticipated dose rates in excess of 20 rem/hr in a restricted area and was related to the health and safety of the public expected to cause significant, heightened public, or government concern.

Based on these deterministic criteria, Region IV management determined that the appropriate level of NRC response was to conduct a special inspection. The special inspection was chartered to identify the circumstances surrounding the radwaste shipping event and review the licensee's actions to address the causes of the event.

##### .2 Inspection Results

- 2.1 Charter Item 2: Develop a complete sequence of events related to the preparation, shipment, and subsequent return of radioactive waste shipment No. 16-40. The

chronology should include any radiological surveys performed, determination of the radiological contents of the liner, creation of the manifest, and communications between the licensee, the waste disposal facility, and the State of Washington.

a. Inspection Scope

The team developed and evaluated a timeline of the circumstances and events leading up to a shipment from CGS that arrived at the US Ecology waste disposal facility with higher than expected dose rates. The team developed the timeline, in part, through a review of shipping documents, licensee corrective action documents, and interviews with station personnel.

b. Findings and Observations

The team established a timeline for three distinct phases associated with the shipment: (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) shipping and transportation of the radioactive waste package to the disposal facility.

Preparation

Circa 2010	Tri-Nuke filters, sock filters, control rod velocity limiters, and control rod blades were stored in the spent fuel pool in preparation for the spent fuel pool cleanup (SFPCU) project. These items were not properly labeled or inventoried with sufficient information.
July 22, 2015	Contract was established with DW James Services (DWJ) to perform waste characterizations of the SFPCU project.
September 22, 2015	Radiation Surveys 5048 and 5049 were performed and incorrectly labeled as, "Local Power Range Monitor (LPRM) Characterization," when they were actually 18 Tri-Nuke filters, stored in 9 canisters, two in each canister. As a result of this error the Tri-Nuke filters were not appropriately accounted for in the waste characterization. This resulted in at least 20 Ci of radwaste being excluded from the original shipment manifest.
September 23-28, 2015	Radiation Surveys 5067, 5105, and 5113 were performed of the Tri-Nuke and sock filters in the SFP. The lowest dose rate was 100 mrem/hr; the highest dose rate was 84 rem/hr.
October 2, 2015	CGS SFPCU project team sent radiation survey documents to DWJ for waste characterization. DWJ had stated they preferred 6-inch survey measurements. CGS performed the survey measurements at 6 inches; however, they were improperly recorded as on contact dose rates.

March 1-8, 2016	Radiation surveys were performed of the control rod velocity limiters in the SFP (Surveys 6385, 6402, 6411, 6422, 6437, and 6448). The lowest dose rate was 170 mrem/hr; the highest dose rate was 10 rem/hr.
April 5, 2016	DWJ contacted CGS to confirm surveys were taken at 6 inches for the filter data. The licensee incorrectly stated they were contact dose rates, which resulted in radiation filter surveys being reported 40 percent lower than they actually were.
April 21, 2016	<p>Preliminary characterization of the Tri-Nuke filters was performed by DWJ and included 66 Tri-Nuke filters and 9 sock filters.</p> <p>Note: The characterization failed to include 18 Tri-Nuke filters because the survey data was mislabeled as, "LPRM Characterization."</p>
May 2016	Licensee made the decision to split the SFPCU project into two phases for economic and dose purposes. Disposal of control rod blades would occur in the spring; disposal of filters, control rod velocity limiters, and instruments would occur in the fall.
May 23, 2016	Characterization of Tri-Nuke filters and control rod velocity limiters completed by DWJ and documented in Report DAC-0382. (Note: 18 Tri-Nuke filters incorrectly characterized as LPRMs.)
May 2016	Radwaste Transportation Specialist (RWTS) and Reactor Maintenance (RxM) personnel made the decision to use one carbon steel open top liner in a 14-190-H Type A cask, instead of two separate polyethylene high integrity containers shipped in Type B casks. This decision was made based on the waste characterization performed by DWJ.
June 2016	SFPCU campaign suspended due to fiscal budget overruns. Sock filters, Tri-Nuke filters, and control rod velocity limiters were left in the SFP and scheduled for disposal after July 1, 2016.
September 2016	Plan for loading Tri-Nuke filters and control rod velocity limiters discussed by the RWTS and RxM supervisor. The plan was to surround the outer perimeter of the liner with control rod velocity limiters, and place Tri-Nuke and sock filters in the middle, with the filters with the highest dose rates in the center. This loading plan for the liner was not documented or implemented.

## Packaging

June 2016	Waste liner was pre-loaded in a Type A shipping cask for direct transfer of items from SFP to liner/cask unit.
October 13, 2016	Loading of waste liner with items from SFP began.
October 13, 2016	Six filters were raised from the SFP to “drip dry” prior to moving them into liner. When the filters broke the water surface, several radiation monitors alarmed. Filters were placed in the liner/cask, despite instructions to have them placed back into SFP. SFPCU project stopped due to unexpected radiological conditions.
October 21, 2016	Survey performed on three Tri-Nuke filters to verify dose rates. Maximum dose rate identified was 14,000 rem/hr on contact, inside of the filter.
October 14-31, 2016	Radiation Protection (RP), RxM, and RWTS worked to develop a formal recovery plan to reduce dose rates for shipment. ALARA challenge meetings were held.
November 1, 2016	Off-cycle Senior Site ALARA Committee meeting was held and approved the high risk and ALARA plans.
November 2-4, 2016	Licensee removed the four “highest dose rate” filters from shipping liner/cask to reduce the dose rates. Items were shifted around and filters redistributed within liner to meet Department of Transportation (DOT) regulations outside cask (i.e., 200 mrem/hr).
November 3, 2016	Control rod velocity limiters were transferred from the SFP to the waste liner. Contact dose rates were measured while the control rod velocity limiters were underwater. Survey 8089 documented a maximum dose rate of 9.5 rem/hr.
November 4, 2016	Additional control rod velocity limiters were transferred from SFP to the waste liner. Survey 8091 documented a maximum dose rate of 32 rem/hr.
November 5, 2016	Last items (dry active waste) were loaded into the liner and the cask lid was closed for transport.
November 5, 2016	Survey 8099 was performed on 14-190-H cask in the reactor building 441' truck bay. Maximum dose rates were on the bottom, 500 mrem/hr on contact, and 60 mrem/hr at 1 meter. The licensee documented a transport index (dose rate in mrem/hr at 1 meter) of 18 based on front/right side on the

shipping cask, which was deemed the maximum accessible dose rate.

### Shipping

- November 5, 2016 Surveys were performed on the cask after being loaded on a trailer to verify contact dose rates were below 200 mrem/hr on all accessible surfaces. Maximum dose rate was determined to be 250 mrem/hr with an RO2 survey meter.
- November 7, 2016 Licensee contacted WSDOH to notify them shipment No.16-40 was prepared for shipment and verified the US Ecology license was authorized to receive the documented waste type and class. US Ecology's license conditions were confirmed by WSDOH on November 7.
- November 8, 2016 The shipping manifest and waste characterization package for shipment No. 16-40 was approved and certified by the CGS RWTS. Manifest specified a contact dose rate on the waste liner of 11.8 rem/hr. Dose rate was calculated by DWJ using the Integrated Shipping and Inventory Program (ISIP) computer code.
- November 8, 2016 As a result of the measured 250 mrem/hr contact dose rate on the cask, approval was obtained to construct a fenced barrier around the cask on the open transport trailer to convert it into a closed transport vehicle, allowing contact dose rates of 1,000 mrem/hr on cask.
- November 8, 2016 Upon review of the waste manifest and shipping papers, US Ecology notified CGS that the shipment would be rejected if the unshielded dose rate on contact with the liner exceeded 22 rem/hour.
- November 9, 2016 Radiation Survey 8105 was performed on the 14-190-H cask before it left the CGS site. The maximum dose rate on contact with the fence barrier was 110 mrem/hr and the maximum 2-meter reading was 7 mrem/hr.
- November 9, 2016 @ 9:30 am Shipment No. 16-40 was transported to US Ecology as an exclusive use, closed transport shipment. The package and shipping documentation was labeled as Yellow-III, UN 3321, Radioactive Material - LSA-II, fissile-excepted, 7 RQ.
- November 9, 2016 @ 10:20 am US Ecology confirmed receipt of shipment No. 16-40 within 50 minutes of departure from CGS.

November 9, 2016 @ 1:00 pm	US Ecology contacted RWTS to inform CGS that the shipment was rejected because the liner was surveyed at 90 rem/hr on contact of one side and 30 rem/hr on the other side.
November 9, 2016	US Ecology contacted WSDOH to inform them of the unexpected dose rates.
November 9, 2016	WSDOH contacted the CGS RWTS and informed him that CGS' disposal use permit privileges have been suspended.
November 9, 2016	RWTS contacted the radiation protection manager, shift manager, and licensing supervisor to make them aware that US Ecology had rejected shipment No. 16-40.
November 9, 2016	RWTS traveled to US Ecology with shipping papers and returned the cask to CGS. WSDOH was aware of this action.
November 9, 2016	The licensee completed an evaluation of the events surrounding shipment No. 16-40 for applicability of 10 CFR 50.72 reporting requirements and determined it was not reportable.
November 10, 2016	WSDOH confirmed that authorization to use the commercial low-level radioactive waste disposal site had been suspended until a point-of-origin inspection was satisfactorily completed.
November 10, 2016	Licensee contacted the NRC resident inspector and regional health physics inspector to inform them of the event.
November 30, 2016	CGS received a letter from WSDOH stating that shipment No. 16-40 containing liner 16-059-OT violated requirements and was not LSA-II based on radiation levels being greater than 1 rem/hr at 3 meters from the liner.

2.2 Charter Item 3: Determine what actions were taken by US Ecology prior to and after receipt of shipment No. 16-40. Evaluate the licensee's response to discussions with US Ecology prior to and subsequent to the shipment arriving at US Ecology.

a. Inspection Scope

The team reviewed the US Ecology disposal site permit and radioactive materials license issued by the state of WSDOH, the licensee's procedures for shipping radioactive material, the waste manifest and shipping paper for shipment No. 16-40, the waste characterization data, radiation surveys performed on the package, and the licensee's corrective action documents.

The team also interviewed station personnel involved with shipment No. 16-40, and held discussions with WSDOH personnel to determine the actions taken by US Ecology prior to and after the receipt of shipment No. 16-40.

b. Observations and Findings

On November 7, 2016, CGS personnel contacted WSDOH to verify that US Ecology's license authorized them to receive and dispose of the type and class of waste contained in shipment No. 16-40. WSDOH personnel confirmed to CGS that US Ecology was authorized to receive and dispose of the waste presumed to be in shipment No. 16-40.

On November 8, 2016, CGS personnel finalized the Uniform Low-Level Radioactive Waste Manifest (NRC Forms 540 and 541) for shipment No. 16-40 and provided a copy to US Ecology for review. After reviewing the waste manifest, US Ecology contacted CGS and informed them that the calculated 11.8 rem/hr dose rate on contact with the waste liner appeared to be excessively high for the type and class of waste indicated on the manifest. US Ecology informed the licensee that if the contact dose rates on the waste liner exceeded 22 rem/hr, they would not accept the waste package for disposal at their site. Licensee personnel acknowledged the establishment of this upper limit on the contact dose rates and assured US Ecology that the waste liner would not exceed the established limit.

Licensee personnel prepared the shipping cask for transport on an open transport vehicle (i.e., flatbed trailer). However, measured dose rates on contact with the shipping cask were 250 mrem/hr, which exceeded the Department of Transportation (DOT) limit of 200 mrem/hr on the external surfaces of a package for an open transport vehicle. To address this, licensee personnel constructed a chain-link fence around the cask to create the equivalent of a closed transport vehicle. Use of a closed transport vehicle allowed for dose rates up to 1,000 mrem/hr on contact with the package, provided the dose rates did not exceed 200 mrem/hr at any point on the outer surfaces of the vehicle.

On November 9, 2016, CGS shipped the cask to US Ecology. Upon arrival at the disposal facility, US Ecology personnel performed radiation surveys of the cask and the waste liner. While lifting the waste liner from the shipping cask, dose rates as high as 90 rem/hr on contact were identified. The measured dose rates were significantly higher than the 11.8 rem/hr stated on the manifest and the 22 rem/hr limit that US Ecology previously stated would be allowed for this package. Upon identifying the high dose rates, US Ecology lowered the waste liner back into the shipping cask. US Ecology then contacted CGS personnel to inform them that the contact dose rates were too high and the package would not be accepted for burial at the site.

The team evaluated the discussions between the licensee and disposal site, and determined that given the information available to the two parties at the time, the level and scope of the discussion were appropriate for the circumstances encountered. However, the team also determined that the level of concern expressed by the disposal site should have prompted additional scrutiny by the licensee such as performing physical surveys of the waste liner.

2.3 Charter Item 4: Assess the licensee's immediate actions and short-term corrective actions following return of the shipment. Determine if the actions taken are sufficient to ensure shipment No. 16-40 is correctly manifested, packaged, and prepared for shipment prior to being returned to US Ecology for disposal.

a. Inspection Scope

To assess the licensee's immediate actions and short-term corrective actions following the return of shipment No. 16-40 to CGS, the team interviewed the CGS personnel directly involved with the shipment. The team also reviewed documented radiation surveys, action requests (ARs) and corrective actions, waste manifests, shipping packages, licensee procedures, and apparent cause evaluations (ACEs).

b. Observations and Findings

Upon notification of the dose rates identified by US Ecology on the waste liner contained in shipment No. 16-40, CGS personnel initiated plans to retrieve the shipment and store the package on-site. A senior radwaste transportation specialist (RWTS) traveled to the US Ecology site to return the shipment to CGS. The shipment was received at CGS at approximately 4:00 pm local time and stored in a safe and secure condition pending further investigation. In addition to initiating a condition report, the RWTS notified CGS management and the NRC resident inspectors about the elevated dose rates identified on the waste liner and the rejection of the package by US Ecology.

As will be discussed in greater detail in Sections 2.4 and 2.5, the licensee determined that errors in the survey and inventory data provided to the waste characterization vendor resulted in the errors in the waste manifest and shipping papers. As corrective actions, the licensee reevaluated the survey data and provided corrected information to the vendor. The vendor provided the licensee a revised waste characterization and shipping paper for the contents of shipment No. 16-40 on January 13, 2017.

On January 13, 2017, CGS personnel removed the waste liner from the shipping cask and conducted extensive surveys of the liner. The licensee measured dose rates as high as 154 rem/hr on contact and 2.1 rem/hr at 3 meters from the waste liner. The measured 3-meter dose rate exceeded the maximum allowed for a shipment of low specific activity material. After completing the surveys, the licensee moved the waste liner to a safe and secure location behind a substantial concrete barrier in the radwaste building pending a future decision on the disposition of the waste.

The team determined that the licensee completed appropriate immediate and short-term corrective actions following the return of shipment No. 16-40 to ensure it was safely and securely stored at CGS.

2.4 Charter Item 5: Evaluate the licensee's compliance with, and adequacy of, procedural guidance for loading and tracking the contents of radwaste liners, characterizing and manifesting radwaste shipments, and preparing radwaste shipments for transport as it pertains to the cause(s) of these events.

a. Inspection Scope

The team evaluated the effectiveness of the licensee's programs for processing, handling, storage, and transportation of radioactive material. The team reviewed the solid radioactive waste system description in the final safety analysis report (FSAR) and the licensee's process control program (PCP).

The inspection team reviewed the licensee's procedures and work orders related to implementation of the SFPCU project and the process used for loading and tracking the contents of radwaste liner 16-059-OT, in particular, and other liners in general. The team evaluated whether the licensee effectively used procedures during the SFPCU campaign to load radwaste into liners, characterize and classify the waste, and process radwaste packages for shipment.

Lastly, the team evaluated whether containers and items from the SFP were labeled in accordance with 10 CFR 20.1904, "Labeling containers," or controlled in accordance with 10 CFR 20.1905, "Exemptions to labeling requirements," as appropriate. The team verified whether solid radwaste and SFP materials were processed as described in the FSAR.

b. Observations and Findings

Relative to characterizing and manifesting shipment No. 16-40, the team identified several human performance errors. The waste characterization used to manifest the shipment was inadequate as a result of inaccurate information provided to the vendor by the licensee. The licensee provided the vendor incorrect survey and inventory data, such as documenting 6-inch survey measurements as contact measurements for filters. In another error, surveys of filters were incorrectly documented as being for LPRMs, resulting in mischaracterization. These and other inaccurate inputs used for the waste characterization resulted in incorrect information on the waste manifest, such as significantly lower activity (24 curies vs. 101 curies), surface radiation levels (11.8 rem/hr vs. 154 rem/hr), and 10 CFR Part 61 waste classification (Class A vs. Class B).

The team reviewed at least four documents associated with the certified shipping record and manifest that attested to the accuracy of shipment No. 16-40 contents, radiation levels, and activity. The licensee was reasonably certain that 73 control rod velocity limiters were placed in the shipment. However, the characterization data for the control rod velocity limiters was uncertain because the validity of the dose rate measurements had been questioned by the vendor. In addition, the survey package provided to the vendor identified 13 LPRMs each having at least 36 inches of activated stainless steel dry tubing. However, since return of the shipment, the licensee has not been able to determine whether the LPRMs were in the SFP or the radwaste liner. Additionally, the number of filters actually loaded in the shipment may have been 18 more than specified in the manifest and characterization record. On January 12, 2017, the licensee determined that the liner contained 18 more Tri-Nuke filters than was certified on the waste manifest and shipping records.

The team determined there were no specific procedures for performing the characterization surveys nor for validating the survey data prior to submission to the waste characterization vendor. Additionally, there were no procedures or guidance to ensure the surveyed items were identified/labelled or placed in a specific location in the SFP for later retrieval.

The team also determined that there were no documented instructions for loading waste liner 16-059-OT for shipment No. 16-40. Rather, the team learned that conversations were held regarding how to place radioactive materials within the liner in order to minimize external dose rates. However, this verbal plan was not implemented during the loading of the liner. The failure to document and follow a loading plan may have contributed to the unexpected dose rates on the exterior of the shipping cask.

The inspection team also determined there was no written documentation provided to aid the inventory of items in the SFP as they were retrieved for loading into the liner, nor were these items labeled to provide the radionuclides present, an estimate of the quantity of radioactivity, or radiation levels in order to minimize exposure. This lack of inventory resulted in a mismatch between the information provided to the waste characterization vendor and what was loaded into the liner.

As the licensee prepared the shipment for transport, several procedures were used, including Procedure PPM 11.2.23.1, "Shipping Radioactive Material and Waste," Procedure PPM 11.2.23.2, "Computerized Radioactive Waste and Material Characterization," Procedure PPM 11.2.23.4, "Packaging Radioactive Material and Waste," and Procedure PPM 11.2.23.20, "The Use of Transport Cask Model 14/190L." The team identified a few occurrences in which the procedures were not completely followed. As examples, Procedure PPM 11.2.23.4 required the licensee to maintain an accurate log of items placed into the liner (including contact dose rate) and attach the log to the container, and Procedure PPM 11.2.23.20 required the licensee to survey the top of the liner; the licensee was unable to provide documentation of either. The lack of inventory and surveys contributed to the licensee's failure to identify that the contents of the waste liner would not meet the 10 CFR Part 71 and 49 CFR Part 173 criteria for shipping LSA materials.

The licensee's short-term corrective actions were to generate action requests, assess the extent of their failure to label or provide sufficient information for all items in the SFP, and reevaluate the latest SFP annual inventory to identify any missing information. The identified issues were documented in the corrective action program as ARs 356390, 357593, 360148, and 360236.

- 2.5 Charter Item 6: Evaluate the adequacy of the licensee's radiation surveys during the various stages of liner loading, preparation, and final release of shipment No. 16-40. Additionally, evaluate the licensee's compliance with applicable DOT and NRC transportation requirements for the shipment.

a. Inspection Scope

The team reviewed the licensee's plans and procedures for the 2015-2016 SFPCU project. The team assessed and evaluated the licensee's survey methods used to measure the radiation levels and radioactivity for the items in the SFP being disposed of as radwaste. The team evaluated whether the licensee's surveys methods were

adequate in the areas of waste stream analysis and classification as necessary to meet the requirements of 10 CFR Part 20, 10 CFR Part 61, 10 CFR Part 71, and 49 CFR Parts 172-173.

b. Observations and Findings

The team identified and reviewed a number of problems with the way the licensee performed and documented the radiation surveys used for the waste characterization. A number of errors resulted in inaccurate survey data being provided to the waste characterization vendor.

- Radiation surveys were taken at 6 inches from the items being surveyed, as requested by the vendor, but were recorded as contact measurements. When the vendor asked for verification with regard to the distance at which the dose rates had been measured, contract Radiation Protection (RP) personnel working on the SFPCU project stated that they were contact dose rates after reviewing the survey documentation. However, the in-house RP personnel that performed the surveys were not consulted. As a result, when entering the survey data into the software program used for the waste characterization, the vendor entered the dose rates as contact readings.
- The survey form for 18 additional Tri-Nuke filters was titled, "LPRM Characterization." During characterization, these were treated as irradiation components instead of spent filters.

These errors and others resulted in erroneous information being calculated for the waste manifest and shipping documentation.

The team also determined that inadequate radiation surveys were performed during the loading of the waste liner. For example, the team noted that Procedure PPM 11.2.23.20, "Use of Transport Cask Model 14-190H," Steps 4.12.9 through 4.12.11 for in-cask processing and loading, had required actions that were not completed. Specifically, Step 4.12.9 required a radiation survey of the accessible top of liner or high integrity container, including documenting the container identification number, the highest contact dose rate, and contamination levels. However, the licensee did not document a survey measurement for the top of the in-cask liner. In a second example, the team noted that Procedure PPM 11.2.23.4, "Packaging Radioactive Material and Waste," Step 3.4.3, required the licensee to keep a log of all items placed into the shipment container and to attach the log as Attachment 7.1 and 7.2. The attachments were to document information such as the description from the radioactive material label, contact dose rate in mrem/hour, and estimated item surface area. However, the team could find no records documenting the inventory or surveys.

The team noted that radiation surveys performed during the preparation of shipment No. 16-40 for transport could have alerted the licensee to the inadequate packaging (i.e., Type A vs. Type B cask). Specifically, during radiation surveys performed prior to shipment, CGS personnel identified dose rates on contact with the shipping cask of 250 mrem/hr, exceeding the DOT limit of 200 mrem/hr for the external surface of a package on an open transport vehicle (i.e., flatbed trailer). Rather than question the adequacy of the cask for the radioactive contents of the shipment, the licensee constructed a chain-link enclosure around the cask and flatbed trailer, effectively

creating a closed transport vehicle. Use of a closed transport vehicle allowed for dose rates up to 1,000 mrem/hr on contact with the package, provided the dose rates did not exceed 200 mrem/hr at any point on the outer surfaces of the vehicle.

As corrective actions, the licensee reevaluated the survey data and inventory, providing updated information to the waste characterization vendor. On January 13, 2017, the vendor provided the licensee a revised waste characterization and updated the shipping manifest. The team determined the licensee's actions seemed appropriate.

- 2.6 Charter Item 7: Review the licensee's ACE efforts and determine if the evaluation is being conducted at a level of detail commensurate with the significance of the problem. Independently determine the probable cause(s) for the improper characterization of shipment No. 16-40.

a. Inspection Scope

The team reviewed licensee procedures, corrective action documents, apparent cause evaluations (ACEs), and interviewed CGS personnel to make an independent determination of the causes of the improper characterization of shipment No. 16-40. In addition, the team reviewed AR and ACE 357394 to determine if the evaluation was being conducted at a level of detail commensurate with the significance of the problem.

b. Observations and Findings

In accordance with Procedure SWP-CAP-01, "Corrective Action Program," the licensee initiated AR 357593 to evaluate and resolve the condition of the radwaste container reading higher than expected dose rates when shipment No. 16-40 reached the disposal site on November 9, 2016.

To determine the type of cause evaluation required for this condition, the licensee used station Procedure SWP-CAP-06, "Condition Report Review." Procedure SWP-CAP-06 provided guidance on how to determine the severity of conditions and identify the level of cause evaluation that was required. The licensee determined that, based on the high severity and partial uncertainty associated with shipment No. 16-40, an ACE was sufficient to identify the cause(s) of the shipping event and implement corrective actions to reduce the likelihood of recurrence.

The ACE team used barrier and change analysis techniques and conducted a Human Performance, Organizational, and Programmatic Evaluation to determine the apparent and contributing causes. The ACE was completed on December 12, 2016. The ACE team concluded that the analysis methods used confirmed the causal factors which led to the following apparent cause and three contributing causes.

- 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.
- Contributing Cause 1: A formalized process and plan specific to Tri-Nuke filter management, tracking, and disposal was not developed.

- Contributing Cause 2: Radiological conditions on the disposal container were not verified and validated prior to shipment.
- Contributing Cause 3: Characterization results provided by the vendor based on CGS data were not verified or validated.

The team determined that, while the ACE was successful in identifying an apparent cause and several contributing causes for the elevated dose rates on the waste liner, the ACE did not address the process or procedures used for obtaining accurate survey results to ensure accurate information would be evaluated for the waste manifest. For example, the ACE determined that surveys were taken at 6 inches from the source, but were recorded as contact measurements. When the waste characterization vendor asked for verification on the distance at which the dose rates were measured, contract RP personnel working on the SFPCU project stated they were contact dose rates based on the survey documentation. However, the in-house RP personnel that performed the surveys were not consulted. As a result, the vendor input the numbers into the software as contact dose rates instead of the actual 6-inch dose rates, resulting in erroneous information being calculated for the waste manifest and shipping documentation. The inspectors asked licensee staff what documents were created to ensure that the data provided to the waste characterization vendor was correctly identified, tracked, and validated. Licensee personnel stated that other than emails, verbal discussions, and meeting notes between the vendor and the licensee, there was no formal verification or validation of the data provided to the vendor. The ACE identified these contributors to the vendor receiving incorrect survey data, but did not identify any procedural or process weaknesses that caused these errors.

The team discussed with the licensee whether a root cause evaluation would have been more appropriate to evaluate the event. The team determined that in addition to the use of barrier analysis and change analysis techniques, the licensee's cause evaluation could have benefitted from a "why" charting analysis to determine the root cause of the event. The team noted that if the licensee had performed a root cause analysis, additional cause evaluation techniques such as analytic trees or events, and causal factors analysis may have provided additional insights not gained from the barrier and change analysis used in the ACE. The inspectors concluded that performance of a root cause evaluation, rather than an ACE, would have enabled the licensee to identify the procedural and process weaknesses that contributed to the event. The inspectors also concluded that licensee Procedure SWP-CAP-06, if used as written, directed the licensee to perform a root cause analysis. The team, specifically, addresses this failure by the licensee of page 43 of this report.

The team independently determined that, in addition to the causes identified by the licensee's ACE, the probable causes of this event were the licensee's failure to establish a program or procedure to identify, track, review, validate, and document the information and data requested by the waste characterization vendor. Such a program or procedure would have ensured an accurate waste characterization and shipping manifest were developed for shipment No. 16-40.

- 2.7 Charter Items 8 and 10: Review the licensee's ACE efforts for the April 2016 and October 2014 shipping events. Determine whether any similar/common causes to the November 2016 shipping event or programmatic concerns in the radwaste processing and/or shipping programs have been identified. Review actions taken or planned by the licensee to evaluate and develop plans to address gaps in radwaste processing and radioactive material shipment preparation issues at the station, as evidenced by recent events discussed in this charter.

a. Inspection Scope

The NRC team reviewed documentation associated with the licensee's ACEs for ARs 348071 and 31676, as specified in the inspection charter. Specifically, the team reviewed procedures, ARs, and cause evaluations.

The team also reviewed problems associated with radwaste processing, handling, storage, and transportation that occurred in calendar years 2011 through 2016. The team reviewed a trending action request, AR 353427, which documented a number of recent radwaste packaging and shipping events since 2014, including events not specifically identified in the charter.

The team reviewed the licensee's plans to address gaps in radwaste processing and radioactive material shipping preparation including immediate, short-term, and long-term corrective actions. The team also interviewed station personnel to identify the licensee's plans to address gaps in the radwaste processing and radioactive material shipping program.

During review of these issues, the inspectors assessed whether problems were being identified by the licensee at an appropriate threshold, properly characterized, and properly addressed for resolution in the corrective action program. In addition to the above, the inspectors verified the appropriateness of the corrective actions for selected problems documented by the licensee.

b. Observations and Findings

The team identified a number of ARs in the licensee's corrective action program associated with radioactive waste and radioactive material processing, disposal, and transportation problems in 2015 and 2016. The team noted that seven of these ARs required the performance of an ACE. The licensee performs ACEs when an event or negative trend in an area requires analysis to determine the causes of the problem and to ascertain if human performance, organizational, or programmatic factors are the cause of the deficiencies.

- (1) On April 15, 2016, the licensee determined that they had staged a shipping cask of radioactive material outside the protected area without ensuring the appropriate controls were in place. This issue was evaluated by the licensee in AR 348057 and ACE 348071.

The licensee determined that the apparent cause was a failure to ensure that all necessary controls, storage, and shipment requirements had been developed and approved by appropriate personnel. The inspection team determined that this apparent cause was common to the shipment No. 16-40 event, in that, controls and storage

procedures for radioactive material in the SFP had not been fully developed and approved by appropriate reactor engineering, chemistry, and radiation protection personnel.

In ACE 348071, the licensee investigated organizational and programmatic causes of the event. The licensee determined that decision making was not being made at the appropriate levels as evidenced by ineffective communication of responsibilities between the various groups. The licensee found a lack of clear lines of communication between organizations, lack of appropriate interface between groups, and deviations from plans. Similarly, the organizational and programmatic section of the shipment No. 16-40 ACE indicated that decision making was not made at the appropriate level, specialized expertise such as the RWTS or RP personnel were not solicited in the SFPCU project, and this was a first experience for the team tasked to manage the SFPCU project.

The licensee identified weaknesses related to this issue that needed correction. Specifically, the licensee identified the need to prepare a calculation to aid RP staff in determining the storage location for radioactive materials. Additionally, the licensee determined they needed to develop a radioactive material accountability process and procedure.

The inspection team determined that these identified weaknesses were common to the shipment No. 16-40 event, in that, the calculation methods and radioactive material accountability process that the licensee used to estimate the amount of radioactivity in shipment No. 16-40 was not documented by procedure.

Because the event documented in AR 348057 overlapped in time with the activities which culminated in shipment No. 16-40, the team concluded that corrective actions would not have been implemented in a time such that the contributors to the problems with shipment No. 16-40 could have been prevented.

- (2) On October 28, 2014, the licensee sent a package of radwaste with greater than 0.5 percent freestanding water, in violation of 10 CFR 61.55, to US Ecology for disposal. The NRC previously dispositioned this violation in NRC Inspection Report 05000397/2015003. This event was evaluated by the licensee in ACE 316676.

The licensee identified two issues related to this problem, the first being that changes were made to the dewatering process without a proper 50.59 screening. Additionally, the licensee determined the dewatering process sequence, as outlined in Procedure PPM 11.2.23.19, "Operation of the Pacific Nuclear Resin Drying System Steps," was not in accordance with manufacturer's design and instructions to ensure liners were effectively dewatered. The licensee also noted that the vendor manual had clear guidance on how to operate the system that was not incorporated into the procedures.

The inspection team identified three similarities between the dewatering event from October 2014 and the issues with shipment No. 16-40:

- There were manufacturer instructions/guidance available that were not incorporated into licensee procedures. Specifically, manufacturer guidance on the use of the shipping cask, "Energy Solutions Cask Book for Model CNS 14-190H," includes a chart that shows the maximum liner dose rate for dewatered ion-exchanged resin

that would result in dose rates that are acceptable for shipping in this Type A cask. This information was not found in any licensee procedures reviewed by the team.

- Failures to follow procedural requirements and inadequate procedures.
- Issues with the Process Control Program (PCP).
- The scope of the ACE for AR 316676 was very narrowly focused to issues specifically associated with the dewatering process. Similarly, the ACE for the shipment No. 16-40 event was narrowly focused to issues specifically related to the event.

Because this event occurred in late 2014, the team concluded that had the ACE not been so narrowly focused, some of the precursors to the issues with shipment No. 16-40 may have been corrected. Specifically, the inspectors concluded that if the licensee had performed a more thorough extent-of-condition for the PCP issues following the dewatering event, additional weaknesses in the PCP may have been identified and corrected.

- (3) On October 21, 2016, the licensee initiated a trending action request, AR 353247, to evaluate radwaste packing and shipping issues at the site. The licensee recognized an increasing trend in human performance errors associated with radwaste packaging and shipping beginning in 2014. Therefore, they initiated a common cause ACE to identify and validate any commonalities or themes, and create actions necessary to improve performance. Each event had been evaluated separately for significance and the effect on nuclear safety, equipment safety, design basis, industrial safety, or radiological safety. This trend document captured the nine ARs listed below.
- AR 316676, "Radwaste resin liner exceeding freestanding liquid requirements." On October 28, 2014, a condensate filter demineralizer radwaste disposal container exceeded the radwaste disposal facilities freestanding liquid requirement which resulted in a suspension of CGS' ability to ship radwaste for disposal.
  - ARs 323678 and 323841, "Issues involving shipment No. 15-14." On March 10, 2015, a C-van shipping container full of contaminated scaffold parts was shipped to an offsite vendor using a vendor supplied tractor-trailer when the C-van shifted during movement on licensee property.
  - AR 338421, "Radwaste container used without going through Quality Control (QC) inspection." In June 2015 a radwaste transport cask and 8-120 polyethylene high integrity container was ordered with the high-integrity container pre-loaded into the cask at the vendor facility. Since the cask was ordered/delivered pre-loaded, the procedurally required inspection was not completed prior to use.
  - AR 340546, "Unable to locate traversing in core probe (TIP) detector." On November 30, 2015, an irradiated TIP detector could not be located in the designated storage area. It was subsequently determined that the TIP had been added to a radwaste shipment without proper documentation.

- AR 339249, “Incomplete/Inaccurate Radioactive Shipping Documentation.” In December 1, 2015, during the Radiation Protection and Process Control Programs Audit, AURP-RW-15, several examples of incomplete and/or inaccurate radioactive shipment supporting documents were identified which did not meet procedural requirements.
- AR 348057, “Shipping cask of radioactive material outside protected area.” On April 15, 2016, the licensee determined that they had staged a shipping cask of radioactive material outside the protected area without ensuring the appropriate controls were in place.
- AR 351509, “Movement of items containing radioactive material did not meet DOT requirements.” Between March 16 and 17, 2016, a spare Entry Scan explosives detector containing radioactive material was transported on a public road without meeting DOT regulations.
- AR 352217, “Radwaste box sent to disposal site with more than 15 percent voids.” On July 13, 2016, a B-25 box containing radioactive material was shipped to US Ecology with greater than 15 percent void space, which was not in compliance with US Ecology’s radioactive materials license or 10 CFR Part 61.

The ACE team used the analysis methods of Common Cause Analysis, Performance Analysis, and Human Performance/Organizational and Programmatic Evaluation to determine the causal factors. The apparent cause identified for the increasing trend in human performance errors was that decisions related to the handling, packaging, and shipping of radioactive material were not made at the appropriate level or by persons with adequate expertise. Additional contributing causes were that personnel did not use established error prevention tools, individuals did not stop when faced with uncertain conditions, and the risk was not appropriately evaluated and managed before proceeding. To address these causes, the licensee evaluated providing additional training on the importance of radwaste shipping/packaging, distributing the ACE to applicable stakeholders, and conducting focused observations of relevant activities.

The trend ACE was completed on October 5, 2016. As a result, the inspection team concluded that any relevant corrective actions would not have affected the causes of the issues with the shipment No. 16-40, which were revealed on November 9, 2016.

The team determined that the licensee’s efforts, including the trend AR, failed to identify a significant omission in their radwaste processing and radioactive materials shipping programs. Specifically, the licensee had essentially removed the QC department from activities associated with radwaste processing and shipment preparation. Further, the inspectors questioned the adequacy of the quality assurance (QA) program to assure compliance with the requirements of 10 CFR Part 61. The inspectors also concluded that the trend AR failed to identify programmatic and procedural weaknesses in the areas of radwaste processing and radioactive material shipments.

Because the licensee had completed the ACE for shipment No. 16-40 at the time of the inspection, the team also reviewed the proposed corrective actions to determine if they would address any identified gaps. As a result of the shipment No. 16-40 event, the licensee planned to address gaps in radwaste processing and radioactive material

shipment by creating a new procedure for chemistry/RP personnel for SFPCU container loading. The procedure would include when to survey and associated requirements for characterization purposes, the characterization geometry, dose rate survey distance (e.g., on contact, at 6 inches, etc.) and other survey documentation requirements. In addition, verification surveys will be required prior to shipment, and the licensee will exclusively be using polyethylene high integrity containers for waste disposal and Type B casks for shipping. In addition to the new procedure, the licensee is revising other procedures to better track and inventory irradiated nonfuel material. The revisions will include dose rate tracking, labeling existing filter cans in the SFP, and ensuring adequate engagement and availability of health physics and radwaste transportation personnel to support these activities.

The team assessed the planned corrective actions and determined that they should reduce the likelihood of future events. However, the team noted that additional NRC follow-up will be required to evaluate the effectiveness of the long-term corrective actions for the issues identified above.

On January 13, 2017, the licensee conducted radiation survey measurements on the radwaste liner from shipment No. 16-40. Based on the results of the surveys, the licensee initiated a root cause evaluation on January 16, 2017, to determine the causes of this event. The team noted that the appropriateness and effectiveness of any corrective actions developed as a result of the root cause evaluation will require additional NRC follow-up.

2.8 Charter Item 9: Determine whether applicable internal or external operating experience (OE) involving radwaste processing, manifesting, and shipment preparation was evaluated by the licensee and assess the effectiveness of any action(s) taken by the licensee in response to any such OE.

a. Inspection Scope

The inspection team reviewed written documents, plans, and schedules associated with the 2015-2016 SFPCU project in order to ascertain what types internal and external OE was used. Specifically, the team reviewed licensee procedures, work orders, radiation work permits (RWPs), QA/QC audits, and corrective actions recorded in ARs. The team also evaluated the effectiveness of actions taken by the licensee to incorporate available OE involving radwaste processing and shipping of radioactive materials.

b. Observations and Findings

At the start of the SFPCU project planning in July 2015 the licensee did not use or find any industry external OE related to processing items from the SFP. The team also determined that the licensee did not benchmark or engage other licensees about their SFPCU experiences until October 2016.

The team determined that reactor maintenance had overall responsibility for the SFPCU campaign; however, none of the reactor maintenance staff had prior experience with SFPCU activities. Further, the team identified that reactor maintenance personnel failed to solicit input from radwaste subject matter experts, individuals who had been involved with prior SFPCU campaigns at CGS, RP staff, or chemistry staff until late in the project. This failure to engage individuals with prior experience with SFPCU campaigns or

subject matter expertise in radwaste processing and/or radwaste shipment contributed to the errors in the waste characterization and loading of the waste liner.

The inspection team found, from an occupational radiation safety perspective, that the licensee incorporated external OE into their SFPCU project RWPs. Specifically, the licensee used external OE lessons learned from two radiation safety worker events in 2011 involving the movement of highly radioactive nuclear instruments. The SFPCU project management also used lessons learned from the 2010 SFPCU and industry best practices from Babcock Services, Incorporated, and Energy Solutions, Incorporated. The inspectors noted that, based on historical data, dose rates were projected to be higher than in the 2010 campaign because there were four times the number of items in the SFP in 2015. The team reviewed licensee Procedure HPI 15.4, "Operation of Tri-Nuclear Underwater Filter/Vacuum." This procedure provided industry OE and lessons learned regarding the following subjects:

- Radioactive filter handling
- Disintegrating materials stored in the SFPs
- Highly radioactive particles associated with SFP work
- Underwater vacuum hose broke into Pieces during removal from the SFP
- Unanticipated dose rates discovered on filters during SFPCU Campaign

Overall, the team determined that the licensee did not fully utilize relevant internal and external OE associated with handling highly radioactive material and radwaste stored in SFPs during the planning of the campaign.

2.9 Charter Item 11: Evaluate the licensee's actions to comply with reporting requirements associated with this event.

a. Inspection Scope

The team reviewed Procedure PPM 1.10.1, "Notifications and Reportable Events," and two ARs associated with events that resulted in CGS being temporarily suspended from using US Ecology for low-level radwaste disposal by the State of Washington. The team assessed the licensee's procedural guidance and basis for the decisions not to report the events in accordance with 10 CFR 50.72(b)(2)(xi).

b. Observations and Findings

Two waste shipments previously discussed, an October 2014 shipment in which the radwaste resin liner exceeded the freestanding liquid requirements and the November 2016 shipment with dose rates higher than anticipated, resulted in the licensee's disposal site permit for the low-level radioactive waste facility being temporarily suspended by the State of Washington. In both events, the licensee did not notify the NRC Operations Center of the notification made by the WSDOH about the violations of Department of Transportation radioactive material shipping requirements and State of Washington radwaste burial site requirements. Following the October 2014 and November 2016 events, the licensee promptly informed the resident inspector. The licensee also notified a region-based health physics inspector of the November 2016 event.

The inspectors noted that 10 CFR 50.72(b)(2)(xi) requires notification reports to the NRC Operations Center within four hours of any event or situation, related to the health and safety of the public or on-site personnel, or protection of the environment, for which a news release is planned or notification to other government agencies has been or will be made. The inspectors concluded that a radwaste shipping event, including an event in which a package was offered for disposal without meeting the burial requirements, were related to the health and safety of the public or protection of the environment.

For both events, the licensee reviewed their reporting requirements as directed by Procedure PPM 1.10.1. The licensee performed a review of the potentially applicable reporting criteria in 10 CFR 50.72, 10 CFR Part 71, 10 CFR Part 20, 10 CFR Part 37, and the DOT requirements. In both examples, the licensee's Licensing Compliance and Regulatory Affairs staff concluded that none of the reporting criteria were met. Specifically, the licensee determined that the events were not reportable in accordance with 10 CFR 50.72(b)(2)(xi) because the State of Washington (i.e., other government agency) notified CGS of the issues, rather than CGS notifying the other government agency. For both events, the licensee was officially contacted by the WSDOH and notified that disposal use permit privileges to the low-level waste facility had been suspended until a written plan containing corrective actions was approved and an on-site inspection was completed by WSDOH.

The team noted that NUREG-1022, Section 3.2.12, "News Release or Notification of Other Government Agency," states, in part, that, "The purpose of this criterion is to ensure that the NRC is made aware of issues that will cause heightened public or government concern related to the radiological health and safety of the public or on-site personnel or protection of the environment." As such, especially in light of the potential for heightened public interest as well as interest by the NRC, the team questioned the licensee's decision not to report the event. The team, in consultation with Office of Nuclear Reactor Regulation subject matter experts, evaluated these events against the notification criteria in 10 CFR 50.72(b)(2)(xi) and the statement in NUREG-1022 regarding reporting governmental interactions to the NRC. The NRC determined that these events met the threshold for public or government concern related to the radiological health and safety of the public or on-site personnel or protection of the environment. Additionally, because WSDOH was notified of the event by US Ecology, this was a notification to another government agency. However, 10 CFR 50.72(b)(2)(xi) is unclear as to whether the notification to another government agency must be from the licensee. As a result, no violation of NRC requirements was identified.

## 2.10 Specific findings identified during this inspection.

### a. Shipment of a Type B Quantity of Radioactive Material in a Type A Package

Introduction. The inspectors reviewed a self-revealed finding and apparent violation of 49 CFR 173.427 associated with a shipment of low specific activity (LSA) material consisting of radioactive filters, irradiated components, and dry active waste. The licensee failed to ensure that the radioactive contents in the radwaste liner did not exceed the radiation level requirements for shipping. Specifically, the licensee transported a Type A package containing a Type B quantity of radioactive material as LSA even though it had an external radiation level of 2.1 rem/hr at a distance of 3 meters from the unshielded material, exceeding the 1 rem/hr at 3 meters limit for LSA.

Description. During the 2016 SFPCU campaign, the licensee loaded a carbon steel open top waste liner with a variety of radwaste items, including Tri-Nuke filters, sock filters, control rod velocity limiters, source and intermediate range monitors, and miscellaneous bags of dry active waste. The waste liner (16-059-OT) would serve as the ultimate disposal container for the radwaste when buried at a low-level radwaste disposal facility. The waste liner was packaged in a Type A shipping cask (Duratek Model CNS 14-190H) and denoted as shipment No. 16-40. The shipping cask provides a shielded, structurally sound container in which to transport radioactive material. The shipment was transported to the US Ecology, Richland, WA low-level radwaste disposal facility for disposal and burial as an exclusive use shipment of LSA-II radioactive material.

Upon arrival at the disposal facility, US Ecology personnel removed the waste liner from the shipping cask in which it had been transported to conduct radiation survey measurements. The survey measurements identified significantly higher surface radiation levels on liner 16-059-OT than documented on the associated waste manifest. Specifically, US Ecology personnel measured unshielded contact dose rates on liner 16-059-OT of 90 rem/hr on one side of the liner and 30 rem/hr on the opposite side of the liner. In contrast, the waste manifest stated the contact dose rate was 11.8 rem/hr. In response, US Ecology returned the liner to the shipping cask and documented their findings.

US Ecology contacted the WSDOH to inform them of the significant discrepancy and survey measurements. US Ecology also notified CGS personnel that the package would not be accepted because of the significant discrepancy between the manifested dose rate and the actual dose rates measured on the liner. Based on the information provided by US Ecology, WSDOH suspended CGS' disposal use permit privileges at US Ecology on November 10, 2016. The State stated that restoration of privileges was contingent upon their approval of a written plan containing corrective actions and completion of an on-site inspection.

On January 13, 2017, the licensee performed radiation surveys of waste liner 16-059-OT and determined that the external radiation level at 3 meters from the liner exceeded a dose rate of 1 rem/hr, the limit for material to be shipped as LSA. Specifically, during surveys of the entire liner, the licensee identified maximum dose rate readings of 154 rem/hr on contact with the liner and 2.1 rem/hr at a distance of 3 meters from the liner. In parallel, the vendor who performed the initial waste characterization reevaluated the characterization using an updated inventory of the waste liner contents and corrected radiation survey data for the inventoried items. The vendor's updated waste characterization documented a calculated 3-meter dose rate of approximately 2.7 rem/hr. Further, the updated waste manifest identified that the contents of this liner did not meet the criteria for LSA-II, but rather, was required to be shipped as "Radioactive Material, Type B Package."

Regulatory Information Summary (RIS) 2013-04, "Content Specification and Shielding Evaluations for Type B Transportation Packages," notes that in 1996 the NRC amended 10 CFR Part 71 to conform NRC regulations to those of the International Atomic Energy Agency. As part of this amendment, the definition of low specific activity material became more explicit, and a quantity limit of radioactive material for shipment of LSA material was added. The updated regulations required that packages containing LSA material exceeding this limit would be subject to NRC Type B package regulations.

The RIS continues, "In 10 CFR 71.14, "Exemption for Low-Level Materials," it is required that material quantity above these limits be shipped in an NRC-regulated Type B package (versus a Type A package) and meet the requirements in 10 CFR Part 71. An NRC Type B package has specific requirements for shielding and survivability of the package during and after an accident that are different from a Type A package. The limit above which LSA material has to be shipped in a Type B package can be found in 10 CFR 71.14(b)(3)(i) and is based on an external dose rate measurement from the unshielded source at a specific distance." The external dose rate measurement limit in 10 CFR 71.14 is 1 rem/hr at a distance of 3 meters.

NUREG-1608, "Categorizing and Transporting Low Specific Activity Materials and Surface Contaminated Objects," states that NRC certification of the package design for shipment of LSA materials is required if the dose rate from the unshielded material exceeds 1 rem/h at 3 meters from the unshielded material. The NUREG further states that if the unshielded LSA material exceeds 1 rem/hr at 3 meters, a Type B package is required due to the quantity of material. The NUREG continues by stating if a material can otherwise satisfy the LSA requirements, but the 1 rem/hr at 3 meters unshielded dose rate limit is exceeded, then the material no longer meets the intent of the LSA material regulations justifying the use of less robust packaging that would otherwise be required for Type B quantities of material. The NUREG further states that, for packages marked low specific activity, the Emergency Response Guidebook Guide does not acknowledge that Type B quantities could be present and is therefore inappropriate for packages containing LSA material exceeding 1 rem/hr at 3 meters.

The team noted that because Type B packages can be used to transport larger amounts of radioactive material than Type A packages, the design and testing requirements are more rigorous. Specifically, they are required to be designed and tested to withstand and to retain the integrity of containment and shielding when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10 CFR Part 71. Type A packages can be used to transport LSA material; however, an unshielded dose rate limit of 1 rem/hr at 3 meters was established to ensure adequate protection of members of the public and emergency response personnel during accident conditions. In this case, a Type A package was used to transport the material in spite of the unshielded dose rate limit being more than double the limit, thereby increasing the safety significance of the finding.

The inspection team noted that the licensee had several opportunities during the waste characterization, loading of the liner, and preparation of the shipping package to identify the excessive dose rates and the need for a more robust cask (i.e., Type B). The team concluded that inadequate radiation surveys performed as part of the waste characterization, combined with poor communication with the characterization vendor, resulted in a waste manifest that documented incorrect (calculated) dose rates for the liner. During loading of the liner, radiation surveys that would have identified the higher than expected dose rates were not performed by the licensee. In addition, the team identified discrepancies between what was loaded into the liner and the inventory provided to the vendor performing the waste characterization. Lastly, during radiation surveys performed prior to shipment, CGS personnel identified dose rates on contact with the shipping cask of 250 mrem/hr, exceeding the DOT limit of 200 mrem/hr for the external surface of a package on an open transport vehicle (i.e., flatbed trailer). Rather than question the adequacy of the cask for the radioactive contents of the shipment, the licensee constructed a chain-link enclosure around the cask and flatbed trailer,

effectively creating a closed transport vehicle. Use of a closed transport vehicle allowed dose rates up to 1,000 mrem/hr on contact with the package, provided dose rates did not exceed 200 mrem/hr at any point on the outer surfaces of the vehicle.

The issue was entered in the licensee's corrective action program as AR 357593 and ACE 357593. The licensee's immediate corrective actions were to retrieve the shipment, develop plans to reevaluate the shipment, and update the shipping manifest as appropriate. The licensee initiated a root cause evaluation, documented in AR 360236, on January 16, 2017, following the performance of radiation surveys that confirmed dose rates in excess of 1 rem/hr at 3 meters.

Analysis. The licensee's failure to ensure that the radioactive contents of a radwaste container did not exceed the requirements for shipping was a performance deficiency. The performance deficiency was more than minor, and therefore a finding, because it was associated with the program and process (transportation program) attribute of the Public Radiation Safety Cornerstone and adversely affected the cornerstone objective of ensuring adequate protection of public health and safety from exposure to radioactive material released into the public domain. Specifically, the licensee's failure to ensure that the contents of a radwaste container did not exceed the requirements for shipping (i.e., low specific activity material must have an unshielded dose rate less than 1 rem/hr at 3 meters) resulted in radioactive material being transported in Type A packaging rather than the required Type B packaging.

NRC Inspection Manual Chapter 0609, Appendix M, "Significance Determination Process Using Qualitative Criteria," was used to determine the significance of the finding because Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," does not specifically address the situation where a Type A package was used to ship radioactive quantities requiring a Type B package. In accordance with Appendix M, an initial qualitative bounding evaluation was performed. This was accomplished using the transportation branch of the Public Radiation Safety Significance Determination Process and examples from Section 6.8 of the NRC Enforcement Policy. Using the radiation levels leg of the Transportation Branch of the "Public Radiation Safety Significance Determination Process," it was determined that radiation levels exceeding twice the limit, but less than five times the limit would screen to White. However, it was noted that the radiation levels addressed by the SDP are specified in 49 CFR 173.411 not 49 CFR 173.427. Additionally, it was determined that the Enforcement Policy, Section 6.8.c, "Transportation," states that SL-III violations involve, for example, external radiation which exceeds 1 times, but not more than 5 times the NRC limit. Further, Section 6.8.c of the Enforcement Policy states, in part, that an SL-III violation would involve a violation related to packaging that could reasonably result in a significant failure to identify the type/quantity of material, a failure of the carrier to exercise adequate controls, or a substantial potential for personnel exposure above regulatory limits or improper transfer of material. The attributes in Appendix M were then evaluated qualitatively, as described in Attachment 1. Based on the qualitative analysis, this self-revealed finding has preliminarily been determined to have low to moderate safety significance (White).

The finding has a cross-cutting aspect in the area of human performance, associated with conservative bias, because licensee personnel did not use decision making practices that emphasized prudent choices over those that were simply allowable. Specifically, on several occasions throughout the radwaste processing and packaging evolution for shipment No. 16-40, decisions were made that did not exhibit the appropriate conservative bias [H.14].

Enforcement. Title 10 CFR 71.5(a) requires, in part, that each licensee who transports licensed material outside the site of usage, as specified in the NRC license, or where transport is on public highways, shall comply with the applicable requirements of the DOT regulations in 49 CFR parts 171 through 180.

Title 49 CFR 173.427(a)(1) requires, in part, that low specific activity material must be transported in accordance with the condition that the external dose rate may not exceed an external radiation level of 10 mSv/hr (1 rem/hr) at 3 meters (10 feet) from the unshielded material.

Contrary to the above, on November 9, 2016, the licensee failed to transport low specific activity material in accordance with the condition that the external dose rate may not exceed an external radiation level of 10 mSv/hr (1 rem/hr) at 3 meters (10 feet) 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) in a Type A package instead of the required Type B package.

This finding was entered in the licensee's corrective action program as AR and ACE 0357593. Pending determination of the finding's final safety significance, this finding is identified as AV 05000397/2016009-01, "Shipment of a Type B Quantity of Radioactive Material in a Type A Package."

b. Failure to Conduct Adequate Surveys of a Solid Radwaste Shipment

Introduction. The team reviewed three examples of a Green, self-revealed non-cited violation of 10 CFR 20.1501 associated with the failure to conduct adequate surveys of the solid radwaste contents (activated metals, filters, etc.) of a shipment that was packaged and transported for ultimate disposal. As a result of the inadequate surveys, the radwaste in shipment No. 16-40 was packaged in the incorrect type of shipping cask, radwaste manifest and shipping paperwork contained numerous errors, and the waste was not correctly classified in accordance with 10 CFR Part 61.

Description. On November 9, 2016, US Ecology LLRW disposal site receipt surveys on Columbia shipment No. 16-40 identified dose rates significantly higher than stated on the manifest. The LLRW site operator measured dose rates as high as 90 rem/hr on contact with the radwaste liner. The certified shipping manifest, in contrast, documented a maximum dose rate of 11.8 rem/hr. The package was rejected, returned to the licensee, and the licensee's LLRW disposal privileges were suspended by the State of Washington.

As part of SFPCU campaign, the licensee performed waste characterization and classification radiation surveys on control rod blades, nuclear instruments, and filters intended for disposal as radwaste. During the course of the SFPCU campaign, the licensee performed several radiation surveys. In September 2015 and March 2016, the

licensee conducted SFP characterization surveys of the items to be included in radwaste liner (16-059-OT). During the fall of 2016, the licensee had several opportunities to perform surveys on items in the SFP, both prior to being placed in the waste liner and while being placed in the liner. In October 2016, some surveys were performed during the transfer of radwaste from the SFP to the liner (16-059-OT). Additionally, surveys were taken of the liner and shipping cask while preparing it for transit to verify conformance with DOT shipping requirements.

- The team reviewed an example of inadequate surveys used to support the vendor's classification activities. Based on reviews of the September 2015 and March 2016 surveys conducted by health physics technicians as part of the waste characterization activities, the inspectors identified survey technique errors and concerns: (1) In October 2015, the vendor performing the waste characterization questioned if the filter dose rate measurement distance was on contact or at 6 inches from each filter. Survey records indicated that the surveys were taken at contact; however, the vendor had requested the surveys be performed at 6 inches. Subsequent to the shipping event, it was determined that, although the vendor was informed the surveys were taken on contact (in agreement with the documentation), they had in fact been taken at 6 inches. (2) The vendor identified that the license provided LPRM survey data that did not match inventory serial numbers previously given. (3) During review of the survey documentation, the vendor determined that the surveys conducted on the control rod blades by the licensee were not as specified. Each of these surveys was to be taken with a fixed detector geometry standoff distance of 4.5 inches to 6 inches, but had not been. (4) The licensee did not provide the vendor the 10 CFR Part 61 radionuclide spectrum for the control rod blades and filters. As of November 2016, the licensee had not provided the correct radiological survey data to the vendor necessary to accurately characterize the SFP campaign radwaste shipments. The team noted that the inadequate surveys and poor documentation of surveys resulted in the vendor's characterization of the waste shipment to be in error. However, the team acknowledged that the licensee eventually recognized, during their event investigation, that these radiation surveys had been conducted by the licensee's staff, inadequately.
- The team reviewed a second example of inadequate surveys associated with the licensee's failure to survey items during the loading of radwaste liner 16-059-OT. The team noted that Procedure 11.2.23.4, "Packaging Radioactive Material and Waste," Step 3.4.3, required the licensee to keep a log of all items placed into the shipment container and attach the log as Attachments 7.1 and 7.2. The attachments were to document information including the description from the radioactive material label, general item accounting, contact dose rate in mrem/hour, and estimated item surface area. The team concluded the licensee failed to maintain an accurate log of items placed into the shipment container. Further, the licensee's RP staff, senior radwaste technical specialist, and radiation protection manager did not supervise the liner loading. The team determined that the lack of surveys during the loading of the waste liner resulted in uncertainty with respect to which and how many items were placed into the liner. Additionally, the lack of surveys contributed to discrepancies between the inventory provided to the characterization vendor and inventories of liner contents maintained by different licensee organizations.

- The team reviewed a third example of inadequate surveys during the loading of radwaste liner 16-059-OT. The inadequate surveys involved procedurally required surveys of the liner. During loading of the liner, the licensee used Procedure PPM 11.2.23.20, "Use of Transport Cask Model 14-190H." The team noted that Steps 4.12.9 through 4.12.11, for in-cask processing and loading, required actions that were not completed. Specifically, Step 4.12.9 required a radiation survey of the accessible top of liner or high integrity container, including documenting the container identification number, the highest contact dose rate, and contamination levels. However, the licensee did not document a survey measurement for the top of the in-cask liner. Step 4.12.10 required the acceptance of the above survey and liner/high integrity container contamination levels. This action was signed off as complete by the radwaste transportation specialist even though the survey had not been performed. The team further noted that Section 4.10.1 of the procedure documented the approval to load the liner into the 14-190H cask with a contact dose rate exceeding 100 R/hr. However, the licensee was unable to provide insights into the basis for approving this action.

The three examples of inadequate surveys described above either directly caused, or contributed to, the inaccuracies in the waste manifest and shipping papers. Ultimately, after the vendor made corrections to the shipment No. 16-40 manifest following the event based on a revised number of filters and radioactivity, and clarification on the survey data itself, the shipping type for the package changed from "Radioactive Material, LSA-II" to "Radioactive Material, Type B" and the 10 CFR Part 61 waste class changed from Class A to Class B. The activity of the shipment was revised from 24.7 curies to 100 curies, the maximum contact dose rate on the liner was revised from 11.8 rem/hr to 154 rem/hr, and the 3-meter dose rate revised from 0.652 rem/hr to 2.66 rem/hr. In addition, and more significantly, the inaccurate surveys directly contributed to the failure to identify that the contents of the waste liner did not meet the requirements for shipment as LSA material and, as a result, required transport in a Type B cask. In each of the three examples above, the team independently evaluated licensee survey data and techniques. Consequently, the team concluded that the licensee's surveys for shipment No. 16-40 were inadequate.

Analysis. The failure to conduct adequate surveys of the radwaste contents (activated metals, filters, etc.) in a shipment that was packaged, transported, and transferred for ultimate disposal was a performance deficiency. The team determined that the performance deficiency was more than minor, and therefore a finding, because it was associated with the program and process aspect of the Public Radiation Safety Cornerstone and adversely affected the cornerstone objective to ensure adequate protection of public health and safety from exposure to radioactive materials released in the public domain. Specifically, as a result of the inadequate surveys, the radwaste in shipment No. 16-40 was packaged in the incorrect type of shipping container, the radwaste manifest and shipping paperwork contained numerous errors, and the waste was misclassified in accordance with 10 CFR Part 61. Using Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," the team determined the violation was of very low safety significance (Green) because it was a finding in the transportation branch in which: (1) radiation limits were not exceeded, (2) there was no breach of the package during transit, (3) there were no Certificate of Compliance issues, and (4) the low-level burial ground nonconformance did not involve a 10 CFR 61.55 waste under-classification. The finding has a cross-

cutting aspect in the area of human performance, associated with documentation, because the organization failed to maintain complete, accurate, and up-to-date documentation. Specifically, the failure to accurately document the characterization surveys (e.g., distance from source, type of item) and failure to document procedurally required surveys resulted in several issues with the shipment [H.7].

Enforcement. Title 10 CFR 20.1501(a)(1) requires, in part, that each licensee shall make surveys that may be necessary for the licensee to comply with the regulations in 10 CFR Part 20. Title 10 CFR 20.2006(e) requires, in part, that each licensee shipping byproduct material intended for ultimate disposal at a land disposal facility document the information required on the NRC's Uniform Low-Level Radioactive Waste Manifest.

Contrary to the above, on November 9, 2016, the licensee failed to make surveys necessary to comply with the regulations in 10 CFR 20.2006(e). Specifically, inadequate surveys and survey documentation completed at several stages during the preparation of shipment No. 16-40, including survey data provided to a vendor for waste characterization, resulted in significant errors in the waste manifest including the total radioactivity in the package, calculated external dose rates on the waste liner (and thereby type of packaging required), proper shipping name, and waste class.

Because the violation is of very low safety significance (Green) and the licensee has entered the issue into their corrective action program, this violation is being treated as an NCV, consistent with Section 2.3.2.a of the NRC Enforcement Policy: NCV 05000397/2016009-02, "Failure to Conduct Adequate Surveys of a Solid Radwaste Shipment."

c. Failure to Label or Provide Written Information for Items Stored in the Spent Fuel Pool

Introduction. The team identified a Green, non-cited violation of 10 CFR 20.1905 associated with the licensee's failure to ensure that each container of licensed material in the SFP was conspicuously marked commensurate with the radiological hazard or that the contents were identified by a readily available written record. This condition had existed since 2010 and continued throughout 2016.

Description. In 2010, the licensee began storing radioactive materials in the SFP for future disposal. These items included Tri-Nuke filters, sock filters, control rod blades, control rod velocity limiters, and various instrumentation such as source and intermediate range monitors.

In 2015, the licensee began preparing for the SFPCU project. In October 2016, radworkers began removing items from the SFP to load into a waste liner. However, there was no written documentation provided to the workers to aid in inventorying these items as they were retrieved. Additionally, none of the items were marked or labeled commensurate with the radiological hazard. Neither information on the radionuclides present, an estimate of the quantity of radioactivity, nor radiation levels was provided. Furthermore, the licensee not use a system of color coding to specifically identify containers and its radiological hazard.

Approximately 70 spent filters were piled up in the spent fuel pool to be removed for disposal. These filters were not labeled or marked commensurate with their radiological hazard, nor was there a readily available written record that adequately provided

personnel sufficient information to ensure that proper radiological controls were implemented.

As individual items were removed from the pool the workers were uninformed of the radiological characteristics to expect when the items cleared the surface. The unknown radiological characteristics of the items resulted in unexpected radiological conditions and unplanned exposure to workers accessing these items during the SFPCU project. The team determined that the failure to mark the contents of each container or identify the contents via a written record was a direct contributor to elevated dose rates, area radiation monitor alarms, and an unanticipated electronic dosimeter dose rate alarm during the evolution.

Discussions with the licensee revealed that a lack of documentation, tracking, or labeling of the items stored in the SFP contributed to inaccurate logs of items placed in the waste liner for shipment No. 16-40. Additionally, imprecise and incomplete information was provided to the vendor performing the waste characterization, which resulted in errors in the waste manifest and shipment documentation.

The inspectors evaluated the exemptions to the labeling requirements provided in 10 CFR 20.1905, and identified that two specific exemptions were relevant to the items stored in the spent fuel pool. The first relevant exemption, 10 CFR 20.1905(e), relates to labeling containers that are accessible only to individuals authorized to handle or use them, or to work in the vicinity of the containers, if the contents are identified to these individuals by a readily available written record (examples of containers of this type are containers in locations such as water-filled canals, storage vaults, or hot cells). The inspectors concluded that, although the individuals retrieving items from the spent fuel pool were authorized to work in the vicinity of the containers, the contents were not identified to those individuals by a readily available written record.

The second relevant exemption, 10 CFR 20.1905(g), relates to the labeling of containers holding licensed material at a facility licensed under Part 50 that are within an area posted under the requirements in 10 CFR 20.1902. The requirement states that the containers are exempt from labeling requirements if the containers are conspicuously marked (such as by providing a system of color coding of containers) commensurate with their radiological hazard. The inspectors determined that the containers and other items in the spent fuel pool were not conspicuously marked and provided no means by which to assess their radiological hazard. Because the licensee's practices did not meet the exemption requirements of 10 CFR 20.1905, labelling containers in accordance with 10 CFR 20.1904 was required.

Analysis. The licensee's failure to ensure that each container of licensed material in the SFP was conspicuously marked commensurate with the radiological hazard or that the contents were identified by a readily available written record was a performance deficiency. The performance deficiency was more than minor, and therefore a finding, because it was associated with the programs and process (exposure control) attribute of the Occupational Radiation Safety Cornerstone and adversely affected the cornerstone objective to ensure the adequate protection of the worker health and safety from exposure to radiation from radioactive material. Specifically, accessing highly radioactive material of unknown radiological hazard could result in unanticipated dose rates and unplanned exposures. Using NRC Inspection Manual Chapter 0609, Appendix, C, "Occupational Radiation Safety Significance Determination Process," the

team determined that the finding was of very low safety significance (Green) because it did not: (1) involve ALARA planning or work controls, (2) did not involve an overexposure, (3) did not have a substantial potential to be an overexposure, and (4) the ability to assess dose was not compromised. The finding has a cross-cutting aspect in the area of human performance, associated with avoid complacency, because licensee personnel failed to recognize and plan for the possibility of mistakes and inherent risk, even while expecting a successful outcome. Specifically, licensee staff placed items in the SFP without ensuring labels or a readily available written record existed to assure individuals accessing them would be adequately informed of the radiological risks [H.12].

Enforcement. Title 10 CFR 20.1904(a) requires, in part, that the licensee ensure that each container of licensed material bears a durable, clearly visible label that provides sufficient information (such as the radionuclides present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels) to permit individuals handling or using the containers, or working in the vicinity of the containers, to take precautions to avoid or minimize exposures. Contrary to the above, from 2010 through 2016, the licensee failed to ensure that each container of licensed material bore a durable, clearly visible label that provided sufficient information (e.g., the radionuclides present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels) to permit the individuals handling or working in the vicinity of the items to take precautions to avoid or minimize exposures. Specifically, the licensee did not conspicuously mark or provide a readily available written record to inform workers of the radiological hazards associated with the items in the SFP, as provided by the exemptions to 10 CFR 20.1904 prescribed in 10 CFR 20.1905. The licensee's immediate corrective actions were to generate an action request and assess the extent of their failure to label or provide sufficient information for all items in the SFP, as well as reevaluate their latest SFP annual inventory to identify any missing information. Because this violation was determined to be of very low safety significance (Green) and was entered into the licensee's corrective action program as AR 360148, this violation is being treated as a non-cited violation, consistent with Section 2.3.2.a of the Enforcement Policy: NCV 05000397/2016009-03, "Failure to Label or Provide Written Information for Items Stored in the Spent Fuel Pool."

d. Failure to Provide an Accurate Shipping Manifest

Introduction. The team identified a Green, non-cited violation of 10 CFR 20.2006(b) for the licensee's failure to ship radwaste with an accurate shipping manifest. Specifically, the licensee failed to provide the correct identification number and proper shipping name, radionuclide activity, net waste volume, surface radiation level, and waste classification. The incorrect radwaste liner radiation levels resulted in rejection of the package and the licensee's immediate suspension from usage of the land disposal site at US Ecology.

Description. In July 2015 the licensee established a contract with a vendor to perform the waste characterization for their upcoming SFP clean-up project. In support of this project, the licensee conducted surveys and provided the vendor the survey data and an inventory of items to be shipped. The items included in the waste characterization were Tri-Nuke filters, sock filters, control rod blades, control rod velocity limiters, nuclear instruments (source and intermediate range), and bags of dry active waste. However, it was later determined that a significant portion of the survey data provided to the vendor, as well as the inventory of items, was erroneous as a result of the failure to use error

reduction techniques such as peer checking and proper documentation of activities. This resulted in flawed waste characterization results, incorrect information for the shipping paper, and inaccurate calculations of the liner dose rates. All of this erroneous information was recorded on the manifest for shipment No. 16-40.

On November 9, 2016, the Uniform Low-Level Radioactive Waste Manifest (NRC Forms 540 and 541) for shipment No. 16-40 was approved. The team noted that information requested on NRC Form 540 includes the proper shipping name, UN identification number, and total radionuclide activity in the package; information requested on NRC Form 540 for each container includes the volume of waste, the maximum radiation level at the surface of the disposal container, and the waste classification pursuant to 10 CFR 61.55. The manifest for shipment No. 16-40 recorded the following information that was subsequently determined to be incorrect:

- Identification number: UN3321
- Proper shipping name: Radioactive Material – low specific activity, (LSA II), fissile-excepted
- Total package activity: 24.7 curies
- Net waste volume: 152 cubic feet
- Surface radiation level: 11.8 rem/hr
- 10 CFR Part 61 waste classification: Class A

The licensee provided corrected survey data to the waste characterization vendor. Based on the revised waste characterization provided by the vendor, the team determined the manifest for shipment No. 16-40 should have documented the following:

- Identification number: UN2916
- Proper shipping name: Radioactive Material – Type B(U)
- Total package activity: 101 curies
- Identification Net waste volume: 180 cubic feet
- Surface radiation level: 154 rem/hr
- 10 CFR Part 61 waste classification: Class B

Upon rejection of shipment No. 16-40 by US Ecology and its return to CGS, the licensee's immediate corrective actions were to reevaluate the package contents and have the vendor perform a revised waste characterization.

Analysis. The licensee's failure to ship radwaste intended for ultimate disposal with an accurate shipping manifest was a performance deficiency. The performance deficiency was more than minor, and therefore a finding, because it was associated with the program and process attribute of the Public Radiation Safety Cornerstone and adversely affected the cornerstone objective to ensure adequate protection of public health and safety from exposure to radioactive material released in the public domain. Specifically, inaccurate information on a shipping manifest could result in inappropriate handling of radioactive material while in the public domain. Using NRC Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," the inspector determined the finding to be of very low safety significance (Green) because: (1) radiation limits were not exceeded; (2) there was no breach of a package during transit; (3) it did not involve a certificate of compliance issue; (4) it was not a low-level burial ground nonconformance; and (5) it did not involve a failure to make

notifications or provide emergency information. The finding has a cross-cutting aspect in the area of human performance, associated with avoid complacency, because licensee personnel failed to recognize and plan for the possibility of mistakes, latent issues, and inherent risk, even while expecting successful outcomes, by not implementing appropriate error reduction tools. Due to the lack of appropriate error prevention tools, inaccurate survey data was provided to the vendor and errors in the waste characterization and shipping manifest were not identified [H.12].

Enforcement. Title 10 CFR 20.2006(b) requires, in part, that any licensee shipping radwaste intended for ultimate disposal at a licensed land disposal facility must document the information required on NRC's Uniform Low-Level Radioactive Waste Manifest and transfer this recorded manifest information to the intended consignee in accordance with Appendix G to 10 CFR Part 20. Appendix G to 10 CFR Part 20, Section I, requires, in part, that a waste generator who transports, or offers for transportation, low-level radioactive waste intended for ultimate disposal at a licensed low-level radioactive waste land disposal facility to prepare a manifest reflecting information requested on applicable NRC Forms 540 (Uniform Low-Level Radioactive Waste Manifest (Shipping Paper)) and 541 (Uniform Low-Level Radioactive Waste Manifest (Container and Waste Description)). Contrary to the above, on November 9, 2016, the licensee failed to prepare a manifest that correctly reflected the information requested on applicable NRC Forms 540 and 541. Specifically, for shipment No. 16-40, the licensee failed to provide correct information for the proper shipping name, UN identification number, total radionuclide activity, volume of waste in the container, maximum radiation level at the surface of the disposal container, and classification of the waste. The licensee's immediate corrective actions were to reevaluate the package contents and have the vendor perform a revised waste characterization. Because this violation was determined to be of very low safety significance (Green) and was entered into the licensee's corrective action program as ARs 359496 and 359498, this violation is being treated as a non-cited violation consistent with Section 2.3.2.a of the Enforcement Policy: NCV 05000397/2016009-04, "Failure to Provide an Accurate Shipping Manifest."

- e. Failure of the QA program to assure compliance with 10 CFR 61.55 and 10 CFR 61.56

Introduction. The team identified a Green, non-cited violation of 10 CFR Part 20, Appendix G, for the failure to manage a QA program to ensure compliance with 10 CFR 61.55 and 61.56. Specifically, licensee management has failed to effectively evaluate the significance of audit findings in the area of radwaste processing and radioactive material shipments.

Description. The team reviewed several examples of QA audit weaknesses and deficiencies in the radwaste process and shipping program that were not effectively evaluated by licensee management. This failure of the licensee's QA program and audit program to ensure compliance with 10 CFR 61.55 or 61.56 was evidenced by the relatively high number of radwaste problems the licensee had recently experienced. Specifically, the following items brought into question the adequacy of the licensee's QA program for radwaste:

- On November 9, 2016, the licensee transferred radwaste shipment No. 16-40 for disposal at a licensed land disposal facility without adequate QA program or processes to ensure compliance with 10 CFR 20.2006, 10 CFR 61.55, and the disposal facility's radioactive materials license.

- On July 13, 2016, the licensee shipped a B-25 box of radwaste for disposal. Upon receipt, the waste disposal site operator identified that the box had greater than 15 percent void space in it. The licensee failed to have an adequate quality assurance program or processes to ensure compliance with 10 CFR 61.56(b)(3) which requires that void spaces within and between a waste package to be reduced to the extent practical, as well as the disposal facility's radioactive materials license.
- On August 11, 2014, the licensee's resin dewatering and drying process failed to reduce the free water, by disposal package volume, to less than 0.5 percent when waste was packaged. Consequently, a radwaste liner 14-033-L containing condensate resin was shipped for disposal to US Ecology with approximately 0.75 percent free standing liquid.
- In April and June 2015, new 8-120 polyethylene high integrity containers (PHICs) were received on-site and not inspected by QA/QC. However, the licensee loaded the PHICs with radwaste from the reactor water cleanup resin; the PHICs were subsequently shipped for disposal and burial without inspections. The licensee did not notice one of these oversights until October 2015.
- Computer software programs used by the vendor (e.g., Integrated Shipping and Inventory Program [ISIP], MICROSHIELD, SCAN, ORIGIN, etc.) that are used for radwaste and radioactive material classifications, characterization, and calculations are Quality Class D, but are not QA audited.
- For the SFPCU Project in 2015 and 2016, activities critical to ensuring compliance with 10 CFR 61.55 and 10 CFR 61.56 related to radwaste characterization, classification, measurement, and packaging, vendor services were provided by DW James, Incorporated, and Babcock Services, Incorporated. However, these two vendors were not listed under the licensee's Operating Quality Assurance Program's approved vendors list. Because DW James, Incorporated, and Babcock Services, Incorporated, were not on the approved vendors list, they are not subject to QA audits by the licensee.
- The licensee's QA/QC program was not involved with the 2016 SFP radwaste disposal project, which used contractors to develop survey methods and computer software in addition to hiring contractors for the packaging and shipment of highly radioactive material for disposal.

In an effort to ascertain if the licensee's management was appropriately evaluating audit findings, the team reviewed the report on "Select Continuous Monitoring Activities Summary, Radwaste." The team determined that from 2011 through 2016, the licensee's Operational Quality Assurance Program Description (OQAPD) audits and management evaluations of specific aspects of waste classification and waste characterization activities, as necessary to assure compliance in the transfer for disposal and disposal of waste, were not adequate to ensure compliance with 10 CFR 61.55 or 10 CFR 61.56.

The team reviewed QA audits, Quality's Continuous Monitoring "Quality Activity Report," focused self-assessments, ARs, and ACEs associated with radwaste and radioactive material shipments since 2011. In addition, the team reviewed the license's QA program for solid radwaste, radioactive material shipment, the FSAR, and the PCP. The PCP describes how the OQAPD is applied to radwaste and radioactive material activities. The team also found that FSAR Chapter 11.4 describes the OQAPD. The team determined that Procedure SWP-RMP-02, "Radioactive Waste Process Control Program," Section 2.11, "Quality" requires a QA program that meets 10 CFR 71, Subpart H, "Quality Assurance," and 49 CFR 173.475 QC requirements prior to each shipment of Class 7 radioactive material, as specified in the OQAPD. Activities included in these requirements are commercial grade or procurement level 3 items (radwaste shipping containers), computer software codes supporting radioactive material shipping and disposal activities, compliance monitoring computer codes supporting adherence to 10 CFR 61, 49 CFR 100-180, and 10 CFR 71, and validation computer codes supporting radioactive material transport and disposal. Section 2.13 of SWP-RMP-02 requires that procurement of items and services supporting radioactive material transport and disposal be performed per SWP-PUR-01, "Procurement of Services," and SWP-PUR-04, "Material, Equipment, Parts and Supplies Procurement." In addition, SWP-RMP-02, Section 2.13.4, "Processing Services and Equipment," requires that radwaste processing items, systems, and services supporting disposal meet the requirements of 10 CFR 61.56 and of the specific disposal site license as applicable.

Since 2011, NRC inspectors have identified or documented at least five findings associated with radwaste processing, handling, storage, and transportation. Similarly, the license's QA audits conducted in 2011-2015 (AU-RP-RW-11, 13, and 15) identified at least 12 radwaste shipping program findings, weaknesses, and deficiencies. The following are examples of QA audit identified findings, weaknesses, and deficiencies:

- Multiple examples were identified with incomplete or inaccurate radioactive shipment documents.
- The radwaste liner was shipped to US Ecology and was buried without a QC inspection or an evaluation stating it was acceptable for burial.
- Untimely identification of issues dealing with QC activities could lead to negative consequences to the station including NRC violations.
- The Chemistry Department has not formally designated personnel that have responsibilities for the Radwaste Technical Reviewer (RWTR) function described in SWP-RMP-01 and SWP-RMP-02.
- The audit team recommended revising procedures governing the use of radioactive shipment transportation casks (11.2.23.20, 11.2.23.42, 11.2.23.37, and 11.2.23.43) to ensure that they meet the guidance for documenting verification steps.
- The audit team recommended that CGS perform benchmarking for industry excellence to determine if chemistry oversight of the radwaste shipping

process is an accepted industry practice and to determine if any additional process controls are needed to assure continuity between the departments if this practice is retained.

- CGS is not in alignment with industry standards in regards to some aspects of radioactive material packaging.

A focused self-assessment of the licensee's radwaste, PCP, and radioactive material shipment programs was performed in May 2015. The team found that the focused self-assessment was comprehensive, in that, it reviewed the details of specific radioactive material shipping packages and at least 20 corrective actions in ARs. There were no significant program deficiencies or weaknesses identified. However, the following observation was made from the focused self-assessment: Solid waste processing is included in the OQAPD, but only to the extent that a quality audit is required every 24 months. The team interpreted the previous comment to mean that radwaste audits are conducted routinely. However, audit evaluations of findings by management do not result in significant and meaningful outcomes. The team interviewed staff regarding the licensee's QA/QC program for radioactive material and solid radwaste shipments. The team determined that the licensee had no specific requirements for QC services to be used to ensure manifest dose rates and radioactivity were correct. The licensee's QA/QC audits did not assure compliance with regulations or assure that radioactive material/solid radwaste procedures contained second verification signoffs by supervision or QA/QC as validation that a requirement was met. Further, licensee management stated that based on QA audits and performance surveillances, it was unnecessary for QC program to be intrusive in routine operations.

Analysis. The failure to manage a QA program to assure compliance with 10 CFR 61.55 and 10 CFR 61.56 was a performance deficiency. The team determined that the performance deficiency was more than minor, and therefore a finding, because it was associated with the Public Radiation Safety Cornerstone attribute of program and process and adversely affected the cornerstone objective to ensure adequate protection of public health and safety from exposure to radioactive materials released in the public domain. Specifically, the failure to manage quality assurance activities as part the radwaste processing and packaging program has resulted in wastes that were not properly classified or did not possess the proper characteristics for burial. Using NRC Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," the team determined the violation was of very low safety significance (Green) because it was a finding in the Transportation Branch in which: (1) radiation limits were not exceeded, (2) there was no breach of the package during transit, (3) there were no Certificate of Compliance issues, and (4) the low-level burial ground nonconformance did not involve a 10 CFR 61.55 waste under-classification. The finding has a cross-cutting aspect in the area of human performance, associated with avoid complacency, because licensee personnel failed to recognize and plan for the possibility of mistakes, latent issues, and inherent risk, even while expecting successful outcomes by not implementing appropriate error reduction tools, such as a proper quality assurance program. Specifically, the licensee has failed to ensure the appropriate level of QA/QC oversight and verification was provided for risk-significant radwaste processing and radioactive material shipment activities [H.12].

Enforcement. Title 10 CFR Part 20.2006(d) requires, in part, that each person involved in the transfer for disposal and disposal of waste shall comply with the requirements

specified in Section III of Appendix G to 10 CFR Part 20. Appendix G, Section III(A)(3), states, in part, that any licensee who transfers radioactive waste to a land disposal facility shall conduct a quality assurance program to assure compliance with 10 CFR 61.55 and 10 CFR 61.56 (the program must include management evaluation of audits).

Contrary to the above, from 2014 through 2016 the licensee's QA program and management did not assure compliance with 10 CFR 61.55 and 10 CFR 61.56 for transfer of radioactive waste to a land disposal facility. Examples of the failure of the QA program to assure compliance include radwaste shipments that arrived at the disposal facility with greater than 15 percent void space, greater than 0.5 percent water, and dose rates significantly higher than documented on the manifest. Management's evaluation of these findings were ineffective.

Because this violation is of very low safety significance and has been entered into the licensee's corrective action program as AR 360236, it is being treated as a non-cited violation, consistent with Section 2.3.2.a of the NRC Enforcement Policy: NCV 05000397/2016009-05, "Failure of the QA program to assure compliance with 10 CFR 61.55 and 10 CFR 61.56."

f. Failure to Update the Final Safety Analysis Report with Changes to Radioactive Waste Processing

Introduction. The team identified a Severity Level IV non-cited violation of 10 CFR 50.71(e) for the failure of the licensee to periodically provide the NRC a Final Safety Analysis Report (FSAR) update with all changes made in the facility or procedures. Specifically, the licensee changed its radwaste management strategy for the SFP cooling and cleanup system and material being stored in the SFP. However, the licensee has not changed its PCP or the FSAR to reflect the impact on waste streams from processing items stored in the SFP including activated metals, Tri-Nuke filters, filter socks, demineralizer filter resins.

Description. The team conducted a review of CGS' solid radwaste system operations and identified that the system was not being operated in as described in the Final Safety Analysis Report Update, Chapter 11. Section 11.4.1 of the FSAR states that plant operations result in various types of solid radwaste that require disposal. Waste forms can be wet solids like powdered ion exchange and expended bead resins from demineralizers, miscellaneous liquids, and dry materials such as paper, rags, plastic, and laboratory wastes. The objective of the system is to collect, monitor, process, and package these waste in a suitable form for offsite shipment and burial.

Sections 11.4.3 and 11.4.3.4 of the FSAR describe the PCP and waste characterization, respectively. Section 11.4.3.4 states that wet wastes at CGS are to be processed and characterized in individual streams for reactor water cleanup resins, equipment drain and floor drain powdered resins, equipment drain and floor drain bead resins, and condensate resins. However, the team determined that the FSAR did not describe and include the backwash resins from the SFP system filter demineralizers as an individual waste stream. The team also determined that waste stream characterizations had not been performed for SFP filter media and items stored in the SFP since at least 2011.

The team noted that the FSAR stated that individual waste stream activities and

concentrations are determined for each batch prior to shipment for disposal. Further, Section 11.4.2.1 of the FSAR describes the sources of the various radioactive wet resin waste inputs to the solid radwaste system. The FSAR states that wet solid wastes include backwash resin from the reactor water cleanup (RWCU) system, the condensate filter demineralizer system, the fuel pool filter demineralizers, the floor drain and equipment drain filter demineralizers, and spent resin from the floor drain demineralizer and the waste demineralizer. However, the team determined that the licensee does not process the waste streams on a per batch basis or per system as intended by the original design. Instead, backwash resin wastes from the fuel pool filter demins, floor drain, and waste collector filter demins are backwashed together. The team concluded the FSAR description was not consistent with how the licensee is performing solid radwaste operations for backwash resins.

The team determined that for a significant period of time, the licensee had been blending and processing three distinct waste streams as a single batch in the waste sludge phase separator tank, which is not in accordance with the system design. Further, the team determined that this aspect of the PCP and solid radwaste management operations were not appropriately described in the FSAR. Therefore, the team concluded that the licensee had been operating outside of the FSAR design basis for at least 15 years.

A second example of inconsistencies between the FSAR and actual practice involves dry active waste (DAW). Section 11.4.2.7, "Miscellaneous Dry Solid Waste System," of the FSAR states DAW may consist of air filtration media, miscellaneous paper, plastic, and rags from contaminated areas, contaminated clothing, tools, and equipment parts which cannot be effectively decontaminated, solid laboratory wastes, and other similar materials. However, Section 11.4 of the FSAR, which describes the PCP, waste characterization, and solid radwaste management did not describe the processing of Tri-Nuke or sock filters. In addition, the solid radwaste management procedure (SWP-RMP-01) and the PCP program (SWP-RMP-02) did not address processing Tri-Nuke and sock filters. The team concluded the licensee had been collecting and storing Tri-Nuke and sock filters since their last SFPCU campaign in 2011 without a description of this operation in Chapter 11.4 of the FSAR.

Analysis. The failure to update the FSAR to reflect changes in solid radwaste management and the PCP was a performance deficiency. The Reactor Oversight Program's SDP does not specifically consider the regulatory process impact in its assessment of licensee performance. Therefore, it is necessary to address this violation which involves the ability of the NRC to perform its regulatory oversight function using traditional enforcement to adequately deter non-compliance. Referring to Section 6.1.d. of the Enforcement Policy, the finding was characterized as Severity Level IV because the licensee failed to update the FSAR as required by 10 CFR 50.71(e) and the lack of up-to-date information had a material impact on safety or licensed activities. Specifically, the licensee's failure to process solid radwaste in accordance with FSAR Chapter 11.4 and the PCP increased the likelihood of incorrectly characterized releases of radioactive material to the public domain and environment. Traditional enforcement violations are not assessed for cross-cutting aspects.

Enforcement. Title 10 CFR 50.71(e) requires, in part, that the licensee shall update periodically, as provided in paragraph (e)(4), the FSAR, to assure that the information included in the report contains the latest information developed. Paragraph (e)(4) states, in part, subsequent revisions must be filed annually or 6 months after each refueling

outage provided the interval between successive updates does not exceed 24 months. Contrary to the above, from 2011 through January 2017 the licensee failed to update periodically, as provided in paragraph (e)(4), the FSAR, to assure that the information included in the report contained the latest information developed. Specifically, during this 40-month period the licensee made two significant changes to solid radwaste management operations and the Process Control Program but did not update the FSAR. The failure to update the FSAR was characterized as a Severity Level IV non-cited violation. Because this violation was entered into the licensee's corrective action program as AR 359293, this violation is being treated as a non-cited violation, consistent with Section 2.3.2.a of the NRC Enforcement Policy: NCV 05000397/2016009-06: "Failure to Update the Final Safety Analysis Report with Changes to Radioactive Waste Processing."

g. Failure to Follow Procedure and Perform a Root Cause Evaluation to Assess the Causes of a Radwaste Shipping Event

Introduction. The team identified a finding for the failure to follow the requirements of Procedure SWP-CAP-06, "Condition Report Review," when determining the type of cause evaluation required to assess the causes of the higher than expected dose rates on a radwaste container. Specifically, Procedure SWP-CAP-06 required that if an event has high risk and high uncertainty, the level of evaluation required is a root cause evaluation (RCE). However, the licensee failed to adequately assess the uncertainty associated with the causes of the event and performed an ACE rather than a root cause. The licensee entered this finding into the corrective action program as AR 360236.

Description. On November 9, 2016, shipment No. 16-40 from CGS arrived at the US Ecology radioactive waste disposal facility with higher than expected dose rates. US Ecology personnel measured dose rates as high as 90 rem/hr compared to 11.8 rem/hr that was documented on the manifest. Because of the discrepancy, the shipment was returned to CGS. The licensee initiated AR 357593 to document the event, as required by Procedure SWP-CAP-01, "Corrective Action Program." One day after the event, the licensee held a Condition Report Group (CRG) meeting to assign a priority to the event and determine the required level of evaluation as required by station Procedure, SWP-CAP-06, "Condition Report Review." The CRG determined an ACE was the appropriate level of review.

During 2015-2016, there were numerous ARs documented in the licensee's corrective action program associated with radwaste and radioactive material processing, disposal, and transportation. The team reviewed three of these ARs from 2015 and six ARs from 2016. Eight of the following ARs had ACEs performed; one was evaluated using an RCE.

AR 316676	Radwaste resin liner exceeding freestanding liquid requirements	January 12, 2015
AR 338421	Radwaste liner used to ship reactor water cleanup decontamination resin without a QC inspection	October 21, 2015

AR 340546	A traversing incore probe detector stored without proper labeling was mistakenly shipped offsite for radwaste disposal (RCE)	December 8, 2015
AR 339249	Incomplete and Inaccurate radioactive shipping documents.	January 13, 2016
AR 348057	Radioactive material in quantities of concern (RAMQC) outside the protected area without proper notification/control.	June 9, 2016
AR 351509	Movement of Items Containing Radioactive Material did not meet DOT requirements	August 15, 2016
AR 352217	Radwaste B-25 box sent to the disposal site with greater than 15 percent voids	September 12, 2016
AR 353427	Trend: Radwaste packing/shipping issues	October 21, 2016
AR 357593	Radwaste disposal container has higher dose rates than anticipated	December 12, 2016

Apparent cause evaluations are performed by the licensee when an event or negative trend in an area requires analysis by a team to determine the causes of the problem and to ascertain if human performance, organizational, programmatic factors are the cause of the deficiencies. The ACE identifies the probable cause of the event that, if corrected, will reduce the potential for recurrence to an acceptable level, commensurate with significance and risk. An RCE is conducted when there is a need to determine the deepest, fundamental, or underlying cause(s) of a significant event in a causal chain that can be resolved. Formal analysis is required to determine what causal factors, if corrected, will preclude repetition. The team evaluated whether AR 357593 should have risen to the level of an RCE.

The team interviewed licensee personnel directly involved with shipment No. 16-40 and the subsequent ACE to verify whether the evaluation was conducted at a level of detail commensurate with the significance of the event. Procedure SWP-CAP-06, Step 4.6.1.e, states that the CRG determines AR severity and level of evaluation for action requests. Procedure Step 4.6.1.e.1 states that if an AR has been assigned a condition adverse to quality (CAQ) or significant condition adverse to quality priority, then the AR is evaluated according to Attachment 8.2, CAQ Risk and Evaluation Level Guidance. Attachment 8.2 requires an RCE if both the risk (severity) and uncertainty of an event or condition is high.

The priority of AR 357593 was assigned as a CAQ. The CRG determined that the risk (severity) was high and the uncertainty assessment was medium. The team reviewed Procedure SWP-CAP-06 and determined the uncertainty assessment is based on answering two questions: (1) Are the causes known and (2) are the corrective actions known? The answers to these questions can be – Yes, No, or Partial. The answers are

cross-referenced against the Uncertainty Assessment table in Step 2 of Attachment 8.2 of Procedure SWP-CAP-06 to determine the level of uncertainty – High, Medium, or Low. The procedure states, “Partial can be used when direct causes are known and verified. If the underlying causes are not known, consider ‘no’.” The licensee determined that the answer to both questions was Partial, which resulted in a Medium uncertainty assessment. Coupled with the high risk (severity) of the event, the licensee concluded that the level of evaluation warranted for the event was an ACE.

The team reached a different conclusion after reviewing the ACE, station procedures, and conducting several interviews of station personnel directly involved with the shipping event and personnel that attended the CRG. While the team agreed with the licensee that there was a high level of risk (severity) associated with the event, the team concluded that on the day after the event, the direct cause of the event (higher than expected dose rates on the waste container) was not known and verified; nor could the underlying causes of the event have been known until after the event investigation or ACE was completed. Thus, the team concluded that corrective actions to mitigate the higher than expected dose rates were also not known one day after the event.

The team concluded that the licensee should have answered ‘No’ to both uncertainty assessment questions, which would have resulted in a high level of uncertainty coupled with a high level of risk (severity) and warranted an RCE. The team concluded the licensee did not follow their procedures, which would have required them to perform an RCE. Had the licensee performed an RCE on AR 357593, they would have identified the underlying causal factor(s) rather than the probable causes, and subsequently they would have developed corrective actions to address the root cause(s).

Analysis. The failure to follow the requirements of Procedure SWP-CAP-06 when determining the type of cause evaluation required to assess the higher than expected dose rates on a radwaste container and performing an apparent cause evaluation instead of a root cause evaluation was a performance deficiency. The team determined that the performance deficiency was more than minor, and therefore a finding, because it was associated with the Public Radiation Safety Cornerstone attribute of program and process and adversely affected the cornerstone objective to ensure adequate protection of public health and safety from exposure to radioactive materials released in the public domain. Specifically, the failure to adequately assess the causes of the event left the licensee vulnerable to future radwaste processing and transportation errors of significance. Using NRC Inspection Manual Chapter 0609, Appendix D, “Public Radiation Safety Significance Determination Process,” the finding was determined to be of very low safety significance (Green). The finding has a cross-cutting aspect in the area of problem identification and resolution associated with evaluation, because the licensee failed to thoroughly evaluate the issue to ensure resolutions address causes and extent of conditions commensurate with their safety significance. Specifically, the licensee failed to evaluate the uncertainty with which the causes were known at the time of the event in accordance with procedural guidance [P.2].

Enforcement. The team did not identify a violation of regulatory requirements associated with this finding. Although the licensee failed to follow the requirements of Procedure SWP-CAP-06 for AR 357593, the team determined that this was a self-imposed standard and did not constitute a regulatory requirement. The licensee entered this finding into the corrective action program as AR 360236. Finding (FIN) 05000397/2016009-07, “Failure to Follow Procedure and Perform a Root

Cause Evaluation to Assess the Causes of a Radwaste Shipping Event.”

h. Failure to Transfer Byproduct Material to a Disposal Facility in Accordance with the Terms of the Facility’s License

Introduction: The team reviewed a self-revealed, Green non-cited violation of 10 CFR 30.41(b)(5) for the failure to transfer byproduct material to an authorized waste disposal facility in accordance with the terms of the facility’s license.

Description: On November 9, 2016, CGS sent radwaste shipment No. 16-40 to the US Ecology LLRW disposal facility for land burial. Upon arrival at the US Ecology facility, a receipt survey was performed on the shipping cask by US Ecology personnel. As the waste liner was being lifted out of the shipping cask for processing, the survey instruments measured dose rates as high as 90 rem/hr on contact with the waste liner. The waste manifest indicated that the dose rates on contact with the waste liner were 11.8 rem/hr. Because the measured dose rates were significantly higher than expected, US Ecology personnel immediately lowered the waste liner back into the shipping cask. The receipt survey was terminated, and US Ecology rejected the package for disposal at the LLRW disposal facility. The package was returned to CGS using the same closed transport vehicle that was used to ship the cask to US Ecology. Upon arrival at CGS, the shipping cask was properly stored and secured pending further investigation into the elevated radiation levels. During transit, the package met the external dose rate requirements of 49 CFR 173.441.

License Condition No. 22.C of US Ecology’s radioactive materials license WN-I019-2 requires that radioactive waste be packaged in such a manner that waste containers received at the facility do not show an increase in the external radiation levels as recorded on the manifest. US Ecology notified the WSDOH and CGS that shipment No. 16-40 was rejected because the measured dose rates on contact with the waste liner showed a significant increase in the external radiation levels from what was recorded the waste manifest.

The team noted that US Ecology personnel had discussed concerns with the dose rates documented on the manifest with CGS personnel prior to receipt of the package. Specifically, US Ecology personnel contacted CGS and informed them that the calculated 11.8 rem/hr dose rate on contact with the waste package appeared to be excessively high for the type and class of waste indicated on the manifest. US Ecology further informed the licensee that if the contact dose rates on the waste package exceeded 22 rem/hr that they would not accept the waste package for disposal at their site. Licensee personnel acknowledged the establishment of this upper limit on the contact dose rates and assured US Ecology that the package would not exceed the established limit.

The team also noted that when the initial outgoing shipping surveys of the cask indicated dose rates that exceeded those allowed for an open transport shipment, licensee personnel constructed a fence around the shipping cask to meet transportation requirements.

On January 13, 2017, CGS personnel performed a survey of the waste container and measured external radiation levels as high as 154 rem/hr on contact with the waste container. The survey confirmed that the waste container exhibited significantly higher

external radiation levels that were recorded on the manifest.

Analysis: The failure to transfer byproduct material to an LLRW disposal facility in accordance with the facility's license is a performance deficiency. The performance deficiency is more than minor because it was associated with the program and process attribute of the Public Radiation Safety Cornerstone and adversely affected the associated cornerstone objective to ensure adequate protection of public health and safety from exposure to radioactive materials released into the public domain as a result of routine civilian nuclear reactor operation. Using NRC Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," the team determined that the finding was of very low safety significance (Green) because it was a low-level burial ground nonconformance and a 10 CFR 61.55 waste under-classification; however, it was not Class C waste or greater and the waste did conform to the waste characteristics of 10 CFR 61.56. The finding has a cross-cutting aspect in the area of human performance, associated with conservative bias, because station personnel failed to use decision making practices that emphasize prudent choices over those that are simply allowed. For example, when the initial outgoing shipping surveys indicated dose rates that exceeded those allowed for an open transport shipment, licensee personnel constructed a fence around the shipping cask to meet transportation requirements [H.14].

Enforcement: Title 10 CFR 30.41(b)(5) states, in part, that any licensee may transfer byproduct material to any person authorized to receive such byproduct material under terms of a specific license or a general license or their equivalents issued by the Commission or an Agreement State. Contrary to the above, on November 9, 2016, CGS transferred byproduct material to US Ecology (an Agreement State licensee) that was not in accordance with the terms of the US Ecology License WN-I019-2. Specifically, License Condition 22.C of the US Ecology license requires that all radioactive waste be packaged in such a manner that waste containers received at the facility do not show an increase in the external radiation levels as recorded on the manifest. However, on November 9, 2016, CGS shipped a waste container to the US Ecology disposal facility that showed external radiation levels as high as 90 rem/hr on contact with the waste container, whereas the highest external radiation level on contact as recorded on the manifest was 11.8 rem/hr.

Because this violation was determined to be of very low safety significance and was entered into the licensee's corrective action program as AR 360236, this violation is being treated as a non-cited violation consistent with the Enforcement Policy: NCV 05000397/2016009-08, "Failure to Transfer Byproduct Material to a Disposal Facility in Accordance with the Terms of the Facility's License."

i. Failure to Minimize Void Spaces in a Radioactive Waste Package

Introduction. The team reviewed a Green, self-revealed non-cited violation of 10 CFR 61.56(b)(3) for the licensee's failure to assure that void spaces within a waste package were reduced to the extent practicable. Specifically, a shipment of dry active waste sent to US Ecology in May of 2016 arrived at the disposal facility with voids in excess of 15 percent of the total waste volume, contrary to the requirements of US Ecology's Radioactive Material License WN-I019-2, License Condition No. 23.

Description. In late May of 2016 as part of the SFPCU project, reactor maintenance

personnel, contractors, and health physics technicians loaded DAW into 55 gallon drums, and B-25 and B-80 boxes. Various metals and several bags of DAW were loaded into B-25 box No. 10056. On June 1, 2016, workers reported to the radwaste laborer, radwaste coordinator, and the radwaste transportation specialist that B-25 box No. 10056 was fully loaded. By observation on June 1, 2016, the licensee determined that the box was completely full. The B-25 box was fully prepped for shipment on July 6, 2016, and shipped offsite July 13, 2016. However, the licensee failed to verify that the bags and materials in the box had not settled or otherwise created void spaces.

Procedure PPM 11.2.23.4, "Packaging Radioactive Material and Waste," provides direction for preparing radioactive waste and radioactive material for shipment. This procedure is used to load containers such as B-25 and B-88 boxes and drums of non-compactable DAW contents for transportation. Licensee Procedure PPM 11.2.23.36, "Operation of Rad Waste Compactor," describes the use of compaction and sorting methods. Licensee Procedure PPM 11.2.23.36, Attachment 7.1, requires evaluation and visual inspection of radwaste box contents by the radwaste transportation specialist or radioactive material control supervisor, to ensure that void spaces are minimized prior to shipment for disposal. However, for shipping package No.16-27, a health physics technician and reactor maintenance worker led the filling of seven containers with DAW associated with the SFPCU project and failed to ensure a visual inspection was performed by appropriate personnel.

In spite of these procedural requirements, the team determined that the licensee failed to verify that void spaces did not exist in B-25 container No. 10056 prior to its shipment to US Ecology on July 13, 2016. Additionally, the team concluded that this resulted in a violation of License Condition No. 23 of US Ecology's Radioactive Materials License WN-I019-2. The team learned that this issue also resulted in a "Warning Call" from the State of Washington, informing them that a matter such as this one could result in the suspension of their shipping privileges to the disposal site.

Analysis. Shipping radwaste for disposal without assuring void spaces were reduced to the extent practicable was a performance deficiency. The team determined that the performance deficiency was more than minor, and therefore a finding, because it was associated with the Public Radiation Safety Cornerstone attribute of program and process and adversely affected the cornerstone objective to ensure adequate protection of public health and safety from exposure to radioactive materials released in the public domain. Specifically, the failure to ensure that void spaces were removed in the radwaste container shipped to US Ecology subjected the disposal facility to the possibility of improper disposal of the waste, in that, the package was susceptible to stability issues. Using NRC Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," the team determined the violation was of very low safety significance (Green) because it was a finding in the Transportation Branch in which: (1) radiation limits were not exceeded, (2) there was no breach of the package during transit, (3) there were no Certificate of Compliance issues, and (4) the low-level burial ground nonconformance did not involve a 10 CFR 61.55 waste under-classification. The finding has a cross-cutting aspect in the area of human performance, associated with teamwork, because individuals and work groups communicate and coordinate their activities within and across organizational boundaries to ensure nuclear safety is maintained. Specifically, the coordination of activities among reactor maintenance, health physics, and radwaste personnel failed to prevent this event [H.4].

Enforcement. Title 10 CFR 61.56(b)(3) states, in part, that void spaces within the waste and between the waste and its package must be reduced to the extent practicable. US Ecology Radioactive Material License WN-I019-2, License Condition No. 23, requires that waste disposal containers have less than 15 percent void spaces. Contrary to the above, on July 13, 2016, the licensee transferred a package of radwaste for disposal with void spaces within the waste and between the waste and its package that were not reduced to the extent practicable. Specifically, upon receipt of B-25 box No. 10056, US Ecology identified void spaces in excess of 15 percent, in violation of the limit specified in their radioactive materials license. Corrective actions included inspecting the other containers from waste shipment No. 16-27, including testing each container for voids. Because this violation is of very low safety significance and has been entered into the licensee's corrective action program as AR 00352217, it is being treated as a non-cited violation, consistent with Section 2.3.2.a of the NRC Enforcement Policy: NCV 05000397/2016009-09, "Failure to Minimize Void Spaces in a Radioactive Waste Package."

#### **40A6 Meetings, Including Exit**

##### Exit Meeting Summary

On December 15, 2016, following the on-site portion of the inspection, the team provided a debrief of the preliminary results to Mr. W. G. Hettel, Vice President, Operations, and other members of the licensee staff. The licensee acknowledged the issues presented.

On March 17, 2017, the team presented the final inspection results to Mr. B. Sawatzke, Chief Operating Officer and Chief Nuclear Officer, and other members of the licensee staff. The licensee acknowledged the issues presented. The licensee confirmed that any proprietary information reviewed by the team had been returned or destroyed.

#### **40A7 Licensee-Identified Violations**

The following violation of very low safety (Green) significance was identified by the licensee and is a violation of NRC requirements which meet the criteria of the NRC Enforcement Policy for being dispositioned as a non-cited violation.

##### Failure to Perform QC Inspections of Radwaste Shipping Liners Prior to Use

Technical Specification 5.4.1.a requires, in part, that procedures be written, implemented, and established for those areas recommended in Regulatory Guide 1.33, Appendix A, Revision 2, 1978. Section 7(b) of Regulatory Guide 1.33, Appendix A, requires procedures for control of radioactive materials to minimize potential releases to the environment associated with solid radwaste. Procedure SWP-RMP-02, "Radioactive Waste Process Control Program," Sections 2.11, 'Quality,' and 2.13, 'Procurement,' stated, in part, that:

- Procurement of items and services supporting radioactive material transport and disposal shall be performed in accordance with procedure SWP-PUR-01, "Procurement of Services," procedure SWP-PUR-04, "Material, Equipment, Parts and Supplies Procurement," and procedure SWP-MMP-03, "Packaging and Shipping of Material or Equipment," and should be designated as Commercial Grade or Procurement Quality Level 3 as applicable.

- Columbia Generating Station Programs and Procedures OQAPD, SWP-RMP-02, SWP-PUR-01, and SWP-PUR-04 required the licensee's QC staff to inspect PHIC liners when received on-site and prior to first use.

Contrary to the above, in April and June of 2015, PHIC liners (later used in shipment Nos. 15-23 and 15-49) arrived on-site and were used without having QC procurement inspections performed prior to use. Consequently, RWCU resin was disposed of at the US Ecology site on April 29 and June 15, 2015, in PHIC liners that were not appropriately inspected. Because this violation was determined to be of very low safety significance and was entered into the licensee's corrective action program as ARs 360572 and 338421, this violation is being treated as a licensee-identified non-cited violation consistent with the NRC Enforcement Policy. The failure to perform QC inspection of radwaste shipment liners is a performance deficiency. It adversely affects the Public Radiation Safety Cornerstone objective to ensure adequate protection of the public. Using NRC Inspection Manual Chapter 0609, Appendix D, "Public Radiation Safety Significance Determination Process," the team determined this violation to be of very low safety significance (Green) because: (1) radiation limits were not exceeded, (2) there was no breach of a package during transit, (3) it did not involve a certificate of compliance issue, (4) it was not a low level burial ground nonconformance, and (5) it did not involve a failure to make notifications or provide emergency response information.

## **SUPPLEMENTAL INFORMATION**

### **KEY POINTS OF CONTACT**

#### **Licensee Personnel**

B. Sawatzke, Chief Operating Officer and CNO  
V. Bhardwaj, Manager, Planning/Sched/Outage  
D. Brown, Manager, System Engineering  
S. Clizbe, Manager, Emergency Preparedness  
M. Davis, Manager, Chemistry/Rad Safety  
B. Dutton, General Counsel  
D. Gregoire, Manager, Regulatory Affairs  
G. Hettel, Vice President, Operations  
G. Higgs, Manager, Maintenance  
M. Hummer, Engineer, Licensing  
A. Javorik, Vice President, Engineering  
M. Kinmark, Health Physics Staff Advisor, Radiation Protection  
D. Kovacs, Information Services Mgr/CIO  
E. Kuhn, Auditor, Quality  
M. Laudisio, Manager, Radiation Protection  
S. Lorence, Manager, Human Relations  
C. Moon, Manager, Quality  
M. Nolan, Senior Radwaste Transportation Specialist  
T. Parmalee, Compliance Engineer, Licensing and Regulatory Affairs  
J. Pierce, Manager, Continuous Improvement  
G. Pierce, Manager, Training  
R. Prewett, Manager, Operations  
A. Rice, Supervisor, Chemistry Operations  
B. Ridge, Vice President, Corporate Services and Chief Financial/Risk Officer  
R. Sanker, Supervisor, Radiation Protection  
B. Schuetz, Plant General Manager  
D. Wolfgramm, Supervisor, Regulatory Compliance

#### **NRC Personnel**

G. Kolcum, Senior Resident Inspector  
D. Bradley, Resident Inspector

### **LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED**

#### **Opened**

05000397/2016003-01    TBD    Shipment of a Type B Quantity of Radioactive Material in a Type A Package (Section 2.10a.)

#### **Opened and Closed**

05000397/2016009-02    NCV    Failure to Conduct Adequate Surveys of a Solid Radwaste Shipment (Section 2.10b.)

Opened and Closed

05000397/2016009-03	NCV	Failure to Label or Provide Written Information for Items Stored in the Spent Fuel Pool (Section 2.10c.)
05000397/2016009-04	NCV	Failure to Provide an Accurate Shipping Manifest (Section 2.10d.)
05000397/2016009-05	NCV	Failure of the QA program to assure compliance with 10 CFR 61.55 and 10 CFR 61.56 (Section 2.10e.)
05000397/2016009-06	NCV	Failure to Update the Final Safety Analysis Report with Changes to Radioactive Waste Processing (Section 2.10f.)
05000397/2016009-07	FIN	Failure to Follow Procedure and Perform a Root Cause Evaluation to Assess the Causes of a Radwaste Shipping Event (Section 2.10g.)
05000397/2016009-08	NCV	Failure to Transfer Byproduct Material to a Disposal Facility in Accordance with the Terms of the Facility's License (Section 2.10h.)
05000397/2016009-09	NCV	Failure to Minimize Void Spaces in a Radioactive Waste Package (Section 2.10i.)

Closed

None

**LIST OF DOCUMENTS REVIEWED**

**Section 4OA5: Other Activities**

Procedures

<u>Number</u>	<u>Title</u>	<u>Revision</u>
CDM-01	Cause Determination Manual	16
HPI 15.4	Operation of Tri-Nuke Underwater Filter/Vacuum	001
M1-1.6	Peer Verification Program	010
SWP-CAP-01	Corrective Action Program	036
SWP-CAP-06	CR Review	023
SWP-CSW-01	Computer Software Quality Assurance Program Description and Implementation	010
SWP-CSW-011	Software Quality Assurance and Configuration Control of	008

<u>Procedures</u>		
<u>Number</u>	<u>Title</u>	<u>Revision</u>
	Non-SSC Software	
SWP-PRO-04	Preparation, Review, Approval and Distribution of Procedures	045
SWP-PUR-04	Material, Equipment, Parts and Supplies Procurement	015
SWP-PUR-01	Procurement of Services	015
SWP-MMP-01	Packaging and Shipping of Material or Equipment	001
SWP-RMP-01	Radioactive Waste Management Program	004
SWP-RMP-02	Radioactive Waste Process Control Program	006
SWP-RMP-02	Radioactive Waste Process Control Program	007
PPM 10.3.24	Processing of Irradiated Nonfuel Material	005
PPM11.2.23.1	Shipping Radioactive Materials and Waste	018
PPM11.2.23.2	Computerized Radioactive Waste and Material Characterization	020
PPM11.2.23.4	Packaging Radioactive Material and Waste	025
PPM 11.2.23.14	Sampling of Radioactive Waste Streams	013
PPM 11.2.23.19	Operation of The Pacific Nuclear Resin Drying System	014
PPM11.2.23.20	Use of the Transport Cask Model 14/190L, 14/190M, 14/190H, 14/210L, or 14/210H	014
PPM11.2.23.37	Use of the 14D-2.0 Type A Transportation Cask	005
PPM 11.2.23.44	Operation of the Self-Engaging Rapid Dewatering System (SERDS)	044
PPM 1.10.1	Notifications and Reportable Events	039
QAP-ASU-007	Peer Verification Program Planning	002

Procedures

<u>Number</u>	<u>Title</u>	<u>Revision</u>
QAI-02	Stop Work Authority	000
QSI 19	Escalation Process	009
QSI 8	Quality AR Type Condition Report (AR-CR) Resolution	010
QSI 2	Quality Oversight Activities for Continuous Monitoring	021
OQAPD-01	Operational Quality Assurance Program Description (EN-QA-004)	051

Audits and Self-Assessment

<u>Number</u>	<u>Title</u>	<u>Date</u>
AU-RP-RW-15	Radiation Protection & Process Controls Audit Report	November 5, 2015
AU-RP-RW-13	Radiation Protection & Process Controls Audit Report	November 14, 2013
AU-RP-RW-11	Radiation Protection & Process Controls Audit Report	November 10, 2011
AR-SA 305111	Focused Self-Assessment Report	June 19, 2015
	Select Continuous Monitoring Activities Summary, Radwaste	2013–2016
QSI-8 & 19	Inadequate Management of Radioactive Material Stored Outside	October 17, 2016

Action Requests

357593	352217	338421	316676
356397	351509	336940	316555
356390	348071	336939	297560
353427	339249	316835	248151

Action Requests Generated During this Inspection

360391	360572	360236	360148
359498	359496	359296	359293

Radiation and Radiological Surveys

<u>Number</u>	<u>Title</u>	<u>Date</u>
M-20170115-3	Bottom of Liner 16-059-OT Survey	January 13, 2017
M-20170117-8	Liner 16-059-OT Grid Survey	January 13, 2017
M-20170116-4	Radwaste 437 Survey Title: Liner 16-059-OT	January, 13, 2017
WOT 02104894	Move SFPCU Liner	
RWP 30003788	SFPCU Cask Load	

Radioactive Material Shipments

<u>Number</u>	<u>Title</u>	<u>Date</u>
16-40	SFPCU Project Cask/Liner 16-059-OT	November 9, 2016
16-27	Four CFD, HIC, & Boxes	July 13, 2016
16-14	SFPCU Control Rod Blades & LPRMs	April 16, 2016
15-49	RWCU Chem Decon Resins	June 17, 2015
15-23	RWCU Resins in 8-120 B Cask	April 29, 2015

Miscellaneous Documents

Babcock Loading Waste Containers on RFF Using the In-Air Transfer

2016 US Ecology Site Use Permit

DAC-0405 Rev 0 Columbia Generating Station Liner 16-059-OT

DAC-0382 Rev 1 Columbia Generating Station Filter Liner Characterization

DAC-0381 Rev 1 Columbia Generating Station Velocity Limiter Characterization

DAC-0378 Rev 1 Columbia Generating Station Cartridge Filter Report

DAC-0337 Rev 1 Characterization of Irradiated Hardware at Columbia Generating Station - February 2016

## LIST OF ACRONYMS

<b>Acronym</b>	<b>Full Acronym Description</b>
ACE	apparent cause evaluation
ALARA	as low as is reasonably achievable
AR	action request
AV	apparent violation
CAQ	condition adverse to quality
CFR	Code of Federal Regulations
CGS	Columbia Generating Station
CRG	Condition Review Group
DAW	dry active waste
DOT	Department of Transportation
DWJ	DW James Services
FIN	finding
ISIP	Integrated Shipping Inventory Program
LLRW	low-level radioactive waste
LPRM	low power range monitors
LSA	low specific activity
mCi	millicurie
mrem	millirem
NCV	non-cited violation
OQAPD	Operational Quality Assurance Program Description
PCP	process control program
PHIC	polyethylene high integrity container
QA	quality assurance
QC	quality control
radwaste	radioactive waste
RCE	root cause evaluation
RP	radiation protection
RPM	Radiation Protection Manager
RWCU	reactor water cleanup
RWTS	Radwaste Transportation Specialist
RxM	reactor maintenance
rem/hr	rem per hour
SDP	significance determination process
SFP	spent fuel pool
SFPCU	spent fuel pool cleanup
SWP	site-wide procedure
TEDE	total effective dose equivalent
FSAR	Final Safety Analysis Report
WSDOH	Washington State Department of Health

**Appendix M Assessment  
Columbia Generating Station  
EA-17-028**

Performance Deficiency: Failure to ensure that the radioactive contents of a radwaste container of low specific activity material did not exceed the requirements for shipping.

Degraded Condition: As a result of the performance deficiency, the licensee shipped a Type B quantity of radioactive material (5.5 times the allowed activity in curies) in a less robust Type A cask, rather than the required Type B package. Specifically, the licensee shipped material as low specific activity material, in a Type A package, even though the external radiation level was 2.1 rem/hr at 3 meters from the unshielded material.

Regulatory Requirement Not Met: 49 CFR 173.427(a)(1) requires, in part, that low specific activity material must be transported in accordance with the condition that the external dose rate may not exceed an external radiation level of 10 mSv/h (1 rem/h) at 3 meters (10 feet) from the unshielded material.

#### 4.1 Initial Bounding Evaluation

To the extent possible, given the circumstances of the finding, quantitative tools should be used to frame the risk impact of the finding. If a quantitative bounding evaluation is not possible, then an appropriate qualitative bounding evaluation can be used.

- Using Radiation Levels leg of Transportation branch of Public Radiation Safety Cornerstone SDP yields WHITE. Specifically, an external radiation level was exceeded (i.e. 1 rem/hr at 3 meters from the unshielded material), it was not accessible by the public, it was greater than two times the limit, but it was not greater than five times the limit.
- Enforcement Policy Section 6.8.c, Transportation, states SL-III violations involve, for example:
  2. External radiation exceeds 1 times, but not more than 5 times, the NRC limit
  3. A violation involves labeling, placarding, shipping paper, packaging, loading, or other requirements that could reasonably result in any of the following:
    - (a) a significant failure to identify the type, quantity, or form of material
    - (b) a failure of the carrier or recipient to exercise adequate controls
    - (c) a substantial potential for either personnel exposure or contamination above regulatory limits or improper transfer of material

Thus we have a bounding evaluation of White/SL-III.

#### 4.2 Attributes

1. Effectiveness of one or more Defense-in-Depth elements

The defense-in-depth philosophy has traditionally been applied in reactor design and operation to provide multiple means to accomplish safety functions and prevent the release of radioactive material. However, we can assess at the potential defense-in-

depth elements that would have protected the public/emergency responders during an event.

The intent of the dose rate limit is to restrict the LSA material contents allowed in non-accident resistant packages such that the post-accident external radiation hazard from the material would be comparable to that amount of non-LSA radioactive material allowed in a non-accident resistant package. This limit helps to ensure that any such releases of LSA material would not present a significant radiation hazard to nearby members of the public or to emergency response personnel who are first to arrive at the accident scene.

In this event, there were no defense-in-depth elements that would have effectively reduced the risk of exposure to members of the public or emergency responders. In addition to the radioactive material being improperly transported in a non-accident resistant package, the defense-in-depth element of shipping paperwork provided inaccurate information regarding the contents, dose rates, activity level, and emergency response instructions. Further, LSA packages are exempt from the DOT marking and labelling requirements, eliminating another potential defense-in-depth element.

2. A reduction in Safety Margin can be quantified.

N/A.

3. Extent to which the condition of the performance deficiency affects other equipment.

N/A

4. Degree of degradation of failed or unavailable components (assess in terms of functionality, if mission time can be met).

The activity in the Type A cask exceeded the allowed activity by a factor of 5.5. This could be considered a significant degree of degradation relative to the acceptable level of risk associated with the breach of a Type A package and release of its contents.

5. Period of time the performance deficiency existed (exposure time); and if opportunity to identify the finding during such period was missed.

Although the characterization surveys for the package began in 2015, it is more reasonable to consider activities beginning with the loading of the liner to consider "exposure period" for the performance deficiency. Note that the performance deficiency was the failure to ensure that the radioactive contents of a radwaste container of low specific activity material did not exceed the requirements for shipping.

The licensee began loading the radwaste liner on October 13, 2016, with the final items being loaded on November 5, 2016. Note that some radiation surveys were performed during the loading evolution, in addition to an event on October 13 during which several radiation monitors alarmed. Of the six filters that caused the alarms, only four were returned to the SFP and not included in the shipment. On November 5, initial surveys of the loaded cask indicated contact dose rates of 386 mrem/hr, in excess of the DOT limits for an open transport vehicle. The licensee rearranged items in the cask, and the new maximum contact dose rate was 250 mrem/hr. This was still in excess of the

200 mrem/hr limit, so the licensee constructed an enclosure around the cask to meet the DOT requirement. The surveys taken during the loading of the liner and the pre-shipment surveys of the cask both provided opportunities to identify the finding.

The licensee states that the improper package was only in transit on public roadways for 3 miles, on a roadway that is not highly used and had no railroads. Using Google Maps, the team determined the distance from Columbia Generating Station to US Ecology's facility was approximately 14 miles, approximately 12 miles which are denoted "partial restricted usage road". Note also that the incorrectly packaged material was also returned to CGS, thus doubling the "exposure time" with respect to distance travelled.

10 CFR 71.0(c), Purpose and Scope, states, in part, the regulations in this part apply to any licensee authorized by specific or general license issued by the Commission to receive, possess, use, or transfer licensed material, if the licensee delivers that material to a carrier for transport, transports the material outside the site of usage as specified in the NRC license, or transports that material on public highways. Thus the requirement to properly package the radioactive material applies from the point at which it left CGS' Owner Controlled Area and the fact that part of the journey was not on "public highways" is not a basis to reduce the exposure time.

6. The likelihood the licensee's recovery actions would successfully mitigate the performance deficiency.

N/A

7. Additional Qualitative Circumstances for Management Consideration

- Guidance in RIS 2013-04 and NUREG 1608
- Vogtle precedent
- Programmatic aspects of finding – inadequate surveys, inadequate inventory/labelling of items in SFP, incorrect manifest, failure of QA program to ensure compliance with 10 CFR 61, failure to meet QA requirement of 49 CFR 173.475(a) to ensure packaging proper for the contents.

M. Reddemann

COLUMBIA GENERATING STATION – REVISED NRC SPECIAL INSPECTION  
REPORT 05000397/2016009; PRELIMINARY WHITE FINDING – AUGUST 7, 2017

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By: LCC  Yes  No  Publicly Available  Sensitive

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