

U.S. NUCLEAR REGULATORY COMMISSION
REGION I

INSPECTION REPORT

Inspection No. 05000134/2013001

Docket No. 05000134

License No. R-61

Licensee: Worcester Polytechnic Institute (WPI)

Location: 100 Institute Road
Worcester, MA 01609

Inspection Date: August 22, 2013 (on-site) and January 16, 2014 (exit)

Additional Information Received: August 22, August 26, October 7, October 29, and December 6, 2013 (Analytical data and source disposal confirmation)

Inspectors: Mark C. Roberts
Senior Health Physicist
Decommissioning and Technical Support Branch
Division of Nuclear Materials Safety

Kathy Modes
Senior Health Physicist
Decommissioning and Technical Support Branch
Division of Nuclear Materials Safety

Approved By: Marc S. Ferdas, Chief
Decommissioning and Technical Support Branch
Division of Nuclear Materials Safety

EXECUTIVE SUMMARY

Worcester Polytechnic Institute (WPI)
NRC Inspection Report No. 05000134/2013001

An announced inspection was conducted on August 22, 2013, at WPI, in Worcester, Massachusetts. The inspectors reviewed WPI's final status survey activities associated with the decommissioning of their research and test reactor (RTR). The inspection consisted of observations by the inspectors, interviews with WPI and contractor personnel, a review of procedures and records, and acquisition of split samples. The Nuclear Regulatory Commission (NRC) contracted with Oak Ridge Associated Universities (ORAU) to perform analysis of samples obtained by the inspectors. ORAU provided the results of the sample analysis in a report, "Letter Report for Analytical Results for Two Concrete and Three Soil Samples Associated with the Worcester Polytechnic Institute, in Worcester, Massachusetts," dated October 7, 2013, (Agencywide Document Access and Management System (ADAMS) Accession No. ML13309B020). Additional information in documents provided by WPI dated August 22, August 26, October 29, and December 6, 2013, was also examined as part of the inspection. The NRC's program for overseeing the safe decommissioning of an RTR is described in Inspection Manual Chapter (IMC) 2545, "Research and Test Reactor Inspection Program."

Based on the results of this inspection, no health and safety concerns were identified. The NRC's analytical results from the soil and concrete samples split with WPI were comparable to the analytical results provided by WPI and confirmed that the residual radioactivity in the soil and concrete was below the Derived Concentration Guideline Levels (DCGLs) established in the decommissioning plan (DP).

REPORT DETAILS

1. Summary of Facility Status

The Leslie C. Wilbur Nuclear Reactor Facility (LCWNRFF) was constructed by the General Electric Company as a standard 1-kW (thermal) open-pool training reactor, and first achieved criticality on December 18, 1959. The reactor license was upgraded to 10-kW (thermal) non-power in 1967. In 1989, the reactor was converted from High Enriched Uranium (HEU) fuel to Low-Enriched Uranium fuel. The LCWNRFF is located in the Washburn Shops and Stoddard Laboratories Building, a centrally located academic facility on the WPI campus.

The WPI reactor was shut down at the end of June 2007. On March 29, 2011, the NRC approved the DP (ADAMS Accession No. ML103120034) for the WPI RTR. A decommissioning consultant/contractor, TLG Services, Inc., provided field management and industrial and radiological safety services for the decommissioning activities. Based on the DP, the remediation focused on components within the reactor pool, the biological shield surrounding the reactor, and reactor support systems (i.e., exhaust ventilation system, pool water treatment system and floor drains adjacent to the reactor pool). Characterization measurements performed by WPI indicated no contamination of soil or ground water. A small amount of activated concrete from beneath the reactor compartment and in the vicinity of the beam port was removed. The primary radionuclides of interest at the facility are Fe-55, Co-60, Ni-63, Zn-65, Cs-134, Cs-137, Eu-152, and Eu-154.

The fuel was removed in July 2011, the pool water drained in September 2011, and the reactor systems de-energized in November 2011. WPI conducted principal decommissioning activities during times when WPI was not in session in order to reduce the impact on the academic schedule. Dismantlement commenced in July 2012, and was completed in October 2012. The WPI staff made the primary shipment of radioactive waste from the decommissioning project in May 2013 and made a small supplemental shipment in December 2013. The WPI Final Status Survey Plan dated January 31, 2013 (ADAMS Accession No. ML13046A107) was approved by NRC on June 11, 2013 (ADAMS Accession No. ML13156A041).

2. Research and Test Reactor Decommissioning

a. Inspection Scope (Inspection Procedure (IP) 69013)

An announced inspection was conducted on August 22, 2013, at WPI, in Worcester, Massachusetts. The inspectors reviewed WPI's final status survey activities associated with the decommissioning of their RTR. The inspection consisted of observations by the inspectors, interviews with WPI and contractor personnel, acquisition and radiological analysis of soil and concrete samples that had been split with licensee, independent radiological survey measurements, and a review of procedures and records. The NRC contracted ORAU to perform analysis of samples obtained by the inspectors. ORAU provided the results of the sample analysis in a report, "Letter Report for Analytical Results for Two Concrete and Three Soil Samples Associated with the

Worcester Polytechnic Institute, in Worcester, Massachusetts,” dated October 7, 2013, (ADAMS Accession No. ML13309B020). Additional information in documents provided by WPI dated August 22, August 26, October 29, and December 6, 2013, were also examined as part of the inspection.

The inspectors compared the data from the analysis of the split samples with the data obtained from WPI’s analyses. The inspectors also reviewed WPI’s analyses of the two contaminated items found during the survey process (a contaminated piece of paper and a component that was labeled as a fuel plate containing HEU).

The NRC’s program for overseeing the safe decommissioning of an RTR is described in IMC 2545, “Research and Test Reactor Inspection Program.” The inspection was performed pursuant to IP 69013, “Research and Test Reactor Decommissioning.”

b. Observations and Findings

The inspectors verified that decommissioning activities and final status survey activities by WPI were being conducted safely and in accordance with regulatory requirements, licensee commitments, and the NRC-approved DP and the Final Status Survey Plan. The inspectors noted that WPI representatives adequately provided oversight and control of its contractors. The inspectors attended pre-job briefs and confirmed that the information provided included a review of work plans/instructions and radiological and industrial hazards in the work areas.

The inspectors verified that site radiation protection and As Low As Reasonably Achievable programs were being conducted in accordance with site procedures, DP, and NRC regulations. The inspectors observed contractor personnel performing radiation surveys, concrete core sampling, and a partial survey of an embedded pipe. The inspectors reviewed radiation work permits and associated radiological surveys and verified that areas were posted for the radiological conditions in accordance with 10 CFR Part 20 requirements.

Surface Radiological Surveys

As part of the final status survey, WPI surveyed the walls and floors of the fuel pool, and rooms and areas outside of the fuel pool. The inspectors observed WPI’s use of radiation detectors attached to long-handled tools in order to reach the entire surface of the walls of the pool. The inspectors noted that the survey instrument used was a Bicon LabTech ratemeter with a dual alpha/beta phosphor detector (calibrated 7/26/2013), and was operational and within calibration. The inspectors noted that a source check was performed and recorded at the beginning of each day that a survey instrument was used to verify that the equipment was operating within an acceptable range.

Embedded Pipe Survey

The inspectors noted that radiological contamination levels in the reactor pool and in the areas outside the pool were generally low or non-detectable; therefore, embedded pipes and conduit leading from the reactor pool were not removed. WPI staff flushed each

pipe and conduit and then ran a cleaning swab through each line. After flushing and cleaning, WPI performed surveys at each end of a pipe and took smear samples on the pipe interior. The inspectors observed the performance of a direct survey on the interior of one of the embedded pipes that ran from the reactor pool floor and exited outside the pool wall. The inspectors noted that WPI's contractor threaded a thin rope through the 2-inch diameter pipe and attached a small diameter sodium iodide scintillation detector (Ludlum model 44-62) to the rope. The detector was also attached to a calibrated Ludlum Model 2000 scalar. The detector was advanced at 10-centimeter increments through the pipe by pulling the rope. One-minute counts were recorded at each 10-centimeter increment until the probe became lodged and would not move any farther into the pipe. Recorded counts were comparable to the background measurement. During performance of this activity, WPI noted that an obstruction due to the presence of a small bend in the pipe would not allow the probe to be advanced beyond the exterior of the pool wall. After further evaluation, WPI determined that an elbow from the opposite end of the pipe had to be removed in order to complete the survey from the opposite direction. During the exit conference call, WPI confirmed that they completed the survey of the embedded pipe and will include the data in the Final Status Survey Report.

Concrete Core Sampling, Soil Sampling, and Sample Splitting

The inspectors observed concrete core sampling from the reactor pool walls and floor and noted that appropriate personal protective equipment was used during the core drilling process. The inspectors observed WPI acquiring concrete core samples from two areas in the fuel pool floor. One sample was obtained from the area under the thermal column and the second was obtained from the southeast corner of the pool. For each area, two side-by-side cores were removed; one was provided to the NRC and the other to WPI for laboratory analysis. Each core sample measured 30 centimeters (cm) in length and 6.5 cm in diameter. All samples were surveyed for dose rate and removable contamination, wrapped in plastic, and labeled. Measured dose rates were comparable to the background exposure rate. All samples were secured in a locked area. The NRC's samples were sent to ORAU for analysis.

Prior to the NRC inspection, WPI obtained soil samples from the area below the concrete reactor pool floor. The NRC inspectors selected three of these soil samples to be split with WPI and were provided with a homogenous aliquot of each sample for analysis by ORAU.

Sample Analysis and Data Comparison

To ensure comparable data from the sample analyses, the NRC and WPI agreed to general sample preparation protocols. Specifically, (1) soil samples would be ground and analyzed by gamma spectrometry, and (2) concrete core samples would be divided into upper and lower halves, pulverized, any observable pieces of aluminum or brick discarded, and analyzed by gamma spectrometry.

The results of NRC's and WPI's analyses for the four concrete core and three soil samples are presented in the two accompanying tables in this section to this report.

NRC Soil and Concrete Core Samples ¹ (results in picocuries (pCi)/gram)				
NRC Sample Designation (ORAU sample ID #)	Co-60 ²	Eu-152 ²	Eu-154 ²	Corresponding WPI Survey Units (SU)
NRC core sample #2 (5225M001)	0.11 ± 0.03	0.89 ± 0.09	< 0.31	Core 1 (SU 1.3 #1, 0 - 15 cm)
NRC core sample #2A (5225M002)	< 0.03	0.10 ± 0.04	< 0.20	Core 1 (SU 1.3 #1, 15 - 30 cm)
NRC core sample #4 (5225M003)	0.13 ± 0.03	0.46 ± 0.06	< 0.22	Core 2 (SU 1.3 #3, 0 - 15 cm)
NRC core sample #4A (5225M004)	< 0.06	0.16 ± 0.04	< 0.19	Core 2 (SU 1.3 #3, 15 - 30 cm)
NRC soil sample #1 (5225S001)	0.11 ± 0.03	0.45 ± 0.06	< 0.26	Soil 1 (SU 1.6 #1)
NRC soil sample #2 (5225S002)	0.09 ± 0.03	0.65 ± 0.08	< 0.38	Soil 2 (SU 1.6 #2)
NRC soil sample #3 (5225S003)	0.15 ± 0.03	0.81 ± 0.08	< 0.28	Soil 3 (SU 1.6 #3)

¹ Uncertainties represent the 95% confidence level, based on total propagated uncertainties

² DCGLs for Co-60, Eu-152, and Eu-154 are 3.8, 7.0, and 8.0 pCi/gram, respectively

WPI Soil and Concrete Core Samples ¹ (results in pCi/gram)				
WPI Survey Units (SU)	Co-60 ²	Eu-152 ²	Eu-154 ²	Corresponding NRC samples ² (ORAU Sample ID)
Core 1 (SU 1.3 #1, 0 - 15 cm)	0.12 ± 0.052	0.91 ± 0.18	< 0.24	NRC core sample #2 (5225M001)
Core 1 (SU 1.3 #1, 15 - 30 cm)	< 0.095	< 0.24	< 0.27	NRC core sample #2A (5225M002)
Core 2 (SU 1.3 #3, 0 - 15 cm)	0.17 ± 0.054	0.88 ± 0.15	< 0.19	NRC core sample #4 (5225M003)
Core 2 (SU 1.3 #3, 15 - 30 cm)	< 0.084	< 0.26	< 0.26	NRC core sample #4A (5225M004)
Soil 1 (SU 1.6 #1)	0.17 ± 0.073	0.55 ± 0.15	< 0.19	NRC soil sample #1 (5225S001)
Soil 2 (SU 1.6 #2)	0.11 ± 0.049	0.62 ± 0.12	< 0.17	NRC soil sample #2 (5225S002)
Soil 3 (SU 1.6 #3)	< 0.13	0.91 ± 0.20	< 0.26	NRC soil sample #3 (5225S003)

¹ Results are statistically positive at the 95 percent confidence levels (activity is greater than or equal to the two sigma uncertainty)

² DCGLs for Co-60, Eu-152, and Eu-154 are 3.8, 7.0, and 8.0 pCi/gram, respectively

The results from the NRC and WPI sample analyses show very good agreement. Data were only tabulated for the three most prominent gamma-emitting radionuclides (Co-60, Eu-152, and Eu-154, based on the characterization data for concrete). No other gamma-emitting radionuclides of interest were identified.

The activities identified in the samples are less than the DCGL for each radionuclide. The DCGLs for Co-60, Eu-152, and Eu-154 are 3.8, 7.0, and 8.0 pCi/gram, respectively. Because multiple radionuclides were identified in some of the samples, the inspectors calculated the sum of the fractions for the core and the soil samples and the results were less than unity (1.0), indicating that the weighted contribution from all of the radionuclides detected did not exceed the criteria in the DP.

Evaluation and Disposition of Miscellaneous Objects Identified During Final Status Survey

During the final status survey activities of the rooms, offices, and storage areas associated with the reactor facility, WPI measured elevated radiation levels on a metal plate and a piece of paper beneath the plate. The items were found in a locked filing cabinet in a lower level storage room. The metal plate was labeled as a uranium fuel plate containing HEU. However, based on the shiny appearance and relatively light mass, WPI and the inspectors believed the plate to be a “dummy” fuel plate, made of aluminum. Gamma spectrometry measurements on the metal plate by WPI demonstrated that the radioactive material was approximately 2.5 grams of depleted uranium and not HEU. The contaminated paper appeared to be a historical log for a Cs-137 solution and WPI’s gamma spectrometry measurement confirmed the presence of Cs-137. During the onsite inspection on August 22, 2013, WPI repeated the measurements on the two miscellaneous objects for the inspectors. The inspectors confirmed that these two items and a low-activity chlorine-36 check source were disposed in a supplemental radioactive waste shipment by WPI.

Neutron Source Disposition

During the review of documents related to the WPI RTR decommissioning, the inspectors identified that the NRC license authorized the possession of a plutonium-beryllium (PuBe) neutron source. The inspectors confirmed the removal of the PuBe source from WPI and the proper transfer of the source to the Department of Energy.

c. Conclusions

Based on the results of this inspection, no health and safety concerns were identified. The NRC’s analytical results from the soil and concrete samples split with WPI were comparable to the analytical results provided by WPI and confirmed that the residual radioactivity in the soil and concrete was below the DCGLs established in the DP.

3. Exit Meeting

The inspection results were discussed with Michael J. Curley, WPI Reactor Facility Director and University Compliance Officer, the campus Radiation Safety Officer (RSO), and decommissioning contractor staff on August 22, 2013, at the conclusion of onsite inspection activities. On January 16, 2014, the inspectors held a telephone conference call exit with Mr. Curley, the campus RSO, decommissioning contractor staff, and the NRC Division of Waste Management and Environmental Protection (DWMEP) project manager to discuss the results of the inspection.

SUPPLEMENTAL INFORMATION

PARTIAL LIST OF PERSONS CONTACTED

Licensee

Michael J. Curley, Reactor Facility Director and University Compliance Officer
David Adams, RSO
David Messier, Chairman Radiation Health & Safety Committee

TLG Services / Entergy Nuclear (decommissioning consultant/contractor)

Joseph J. Adler, Senior Manager
Tim Arnold, Decommissioning Engineer/Health Physics Technician

NRC DWMEP

Theodore Smith, Senior Project Manager

INSPECTION PROCEDURE USED

Inspection Procedure 69013, Research and Test Reactor Decommissioning
Inspection Manual Chapter 2545, Research and Test Reactor Inspection Program

ITEMS OPEN, CLOSED, AND DISCUSSED

None

LIST OF DOCUMENTS REVIEWED

Decommissioning Plan dated September 2009 (ADAMS Accession No. ML092880231)
Revision to Decommissioning Plan Table 2.3 dated September 25, 2012 (ADAMS Accession No. ML12279A049)
Decommissioning Plan Approval dated March 29, 2011 (ADAMS Accession No. ML103120034)
WPI letter dated January 18, 2013 (ADAMS Accession No. ML13046A106)
Final Status Survey Plan dated January 31, 2013 (ADAMS Accession No. ML13046A107)
NRC approval of Final Status Survey Plan dated June 11, 2013 (ADAMS Accession No. ML13156A041)
DWP-10, Rev. 1, Performance of Final Status Survey, dated August 28, 2013
Los Alamos National Laboratory Letter dated July 23, 2010 confirming receipt of WPI's PuBe source
Copy of WPI Massachusetts license, amendment 43, issued April 29, 2013
Uniform Low-level Waste Manifests for two radioactive waste shipments
ORISE Report for Analytical Results for Two Concrete and Three Soil Samples Associated with WPI, dated October 7, 2013 (ADAMS Accession No. ML13309B020)
GEL Laboratories report transmitting the results of the contractors sample results dated October 28, 2013 (rec'd October 29, 2013) (ADAMS Accession No. ML14028A453)
GEL Laboratories report transmitting the results of the contractors sample results dated December 6, 2013 (ADAMS Accession No. ML14028A450)

LIST OF ACRONYMS USED

ADAMS	Agencywide Document Access and Management System
cm	centimeters
DCGL	Derived Concentration Guideline Levels
DP	decommissioning plan
DWMEP	Division of Waste Management and Environmental Protection
HEU	High Enriched Uranium
IMC	Inspection Manual Chapter
IP	Inspection Procedure
LCWNRF	Leslie C. Wilbur Nuclear Reactor Facility
NRC	Nuclear Regulatory Commission
ORAU	Oak Ridge Associated Universities
pCi	picocuries
PuBe	Plutonium Beryllium
RSO	Radiological Safety Officer
RTR	research and test reactor
SU	survey unit
WPI	Worcester Polytechnic Institute