July 17, 2012

EN 47946
NMED No. 120316 (Closed)

Mr. Stephen K. Benedict, Director
Occupational Safety & Environmental Health
University of Michigan
Campus Safety Services Building
1239 Kipke Drive
Ann Arbor, Michigan 48109-1010

SUBJECT: NRC REACTIVE INSPECTION REPORT NO. 03001988/2012002(DNMS) AND NOTICE OF VIOLATION – REGENTS OF THE UNIVERSITY OF MICHIGAN

Dear Mr. Benedict:

On May 24, 2012, with continued U.S. Nuclear Regulatory Commission (NRC) in-office review through June 26, 2012, an NRC inspector conducted a reactive inspection at the University of Michigan in Ann Arbor, Michigan. The in-office review included review of the licensee's dose assessment, completion of a confirmatory dose assessment, and review of professional literature with relevance to the event. The purpose of this inspection was to review the circumstances, root and contributing causes, and proposed corrective actions for a medical event that your staff reported to the NRC on May 22, 2012. The findings of the inspection were discussed with selected University of Michigan personnel at a preliminary, onsite debrief meeting on May 24, 2012, and at a telephonic exit meeting with Mark Driscoll, Radiation Safety Officer (RSO), and other Radiation Safety Services staff on June 26, 2012. The enclosed report presents the results of this inspection.

Based on the results of this inspection, the NRC has determined that one Severity Level IV violation of NRC requirements occurred. The violation was evaluated in accordance with the NRC Enforcement Policy. The current NRC Enforcement Policy is included on the NRC's website at http://www.nrc.gov/about-nrc/regulatory/enforcement/enforce-pol.html. The violation involved the licensee's administration of a dosage of technetium-99m that differed from the prescribed dose by more than 20 percent, which was not in accordance with Title 10 of the Code of Federal Regulations (CFR) 35.63(d).

The violation is cited in the enclosed Notice of Violation (Enclosure 1), and the circumstances surrounding the violation are described in detail in the subject inspection report (Enclosure 2). The violation is being cited because the inspector identified it during the May 24, 2012, inspection.

The NRC has concluded that information regarding the reason for the Security Level IV violation, the corrective actions taken and planned to correct the violation and prevent recurrence, and the date that full compliance was achieved is already adequately addressed on the docket in Inspection Report 03001988/2012002(DNMS); therefore, you are not required to respond to the Notice of Violation unless the description in the enclosed inspection report does not accurately reflect your corrective actions or your position. In that case, or if you choose to

provide additional information, you should follow the instructions specified in the enclosed Notice of Violation.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosures, and your response, if you choose to provide one, will be made available electronically for public inspection in the NRC's Public Document Room or from the NRC's Agencywide Documents Access and Management System (ADAMS), accessible from the NRC website at http://www.nrc.gov/reading-rm/adams.html. To the extent possible, your response should not include any personal privacy, proprietary, or safeguards information so that it can be made publicly available without redaction.

If you have any questions regarding this correspondence, please contact Aaron McCraw of my staff at 630-829-9650 or Aaron.McCraw@nrc.gov.

Sincerely,

/RA/

Tamara E. Bloomer, Chief
Materials Inspection Branch
Division of Nuclear Materials Safety

Docket No. 030-01988
License No. 21-00215-04

Enclosures:
1. Notice of Violation
2. Inspection Report No. 03001988/2012002(DNMS)

cc w/encls: Mark Driscoll, Radiation Safety Officer
Kirk Frey, M.D., Chief of Nuclear Medicine
State of Michigan

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Docket No. 030-01988
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Enclosures:
1. Notice of Violation
2. Inspection Report No. 03001988/2012002(DNMS)

cc w/encls: Mark Driscoll, Radiation Safety Officer
Kirk Frey, M.D., Chief of Nuclear Medicine
State of Michigan

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NOTICE OF VIOLATION

Regents of the University of Michigan
Ann Arbor, Michigan

Docket No. 030-01988
License No. 21-00215-04

During a U.S. Nuclear Regulatory Commission (NRC) inspection conducted on May 24, 2012, with continued U.S. Nuclear Regulatory Commission (NRC) in-office review through June 26, 2012, the NRC inspector identified one violation of NRC requirements. In accordance with the NRC Enforcement Policy, the violation is listed below:

> Title 10 of the Code of Federal Regulations (CFR) 35.63(d) states that, unless otherwise directed by an authorized user, a licensee may not use a dosage if the dosage does not fall within the prescribed dosage range or if the dosage differs from the prescribed dosage by more than 20 percent.
>
> Contrary to the above, on May 17, 2012, the licensee used a dosage that differed from the prescribed dosage by more than 20 percent without approval from an authorized user. Specifically, the licensee administered a 25-millicurie (mCi) dosage of technetium-99m sulfur colloid when a 3-mCi dosage of technetium-99m methylene diphosphonate was prescribed, a difference of more than 20 percent of the radioactive material prescribed.

This is a Severity Level IV violation (Section 6.3).

The NRC has concluded that information regarding the reason for the violation, the corrective actions taken and planned to correct the violation and prevent recurrence, and the date when full compliance was achieved is already adequately addressed on the docket in Inspection Report 03001988/2012002(DNMS); however, you are required to submit a written statement or explanation pursuant to 10 CFR 2.201 if the description therein does not accurately reflect all of your corrective actions or your position. In that case, or if you choose to respond, clearly mark your response as a "Reply to a Notice of Violation" and send it to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001 with a copy to the Regional Administrator, Region III, within 30 days of the date of the letter transmitting this Notice of Violation.

If you choose to respond, your response will be made available electronically for public inspection in the NRC's Public Document Room or from the NRC's Agencywide Documents Access and Management System (ADAMS), accessible from the NRC website at http://www.nrc.gov/reading-rm/adams.html. To the extent possible, your response should not include any personal privacy, proprietary, or safeguards information so that it can be made publicly available without redaction.

If you contest this enforcement action, you should also provide a copy of your response, with the basis for your denial, to the Director, Office of Enforcement, U. S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

In accordance with 10 CFR 19.11, you may be required to post this Notice of Violation within two working days.

Dated this 17th day of July 2012.

NUCLEAR REGULATORY COMMISSION

REGION III

Docket No.:	030-01988
License No.:	21-00215-04
Report No.:	03001988/2012002(DNMS)
Licensee:	Regents of the University of Michigan
Location:	1239 Kipke Drive Ann Arbor, Michigan
Dates of Inspection:	May 24, 2012, with continued in-office review through June 26, 2012
Exit Meeting:	June 26, 2012
Inspector:	Aaron T. McCraw, Senior Health Physicist
Reviewed By:	Tamara E. Bloomer, Chief Materials Inspection Branch Division of Nuclear Materials Safety

EXECUTIVE SUMMARY

Regents of the University of Michigan
Ann Arbor, Michigan
Inspection Report 03001988/2012002(DNMS)

The U.S. Nuclear Regulatory Commission (NRC) conducted a reactive inspection on May 24, 2012, to review the circumstances associated with a medical event that the licensee reported to the NRC on May 22, 2012. The medical event occurred as a result of a wrong radiopharmaceutical being injected into a patient. The patient was prescribed 3 millicuries (mCi) of technetium-99m (Tc-99m) sulfur colloid for a lymphoscintigraphy procedure, but received a dose of 25 mCi of Tc-99m methylene diphosphonate (MDP) using the injection protocol for a lymphoscintigraphy procedure. The administration of a wrong radiopharmaceutical resulted in a dose that exceeded 50 rem to tissue and skin, which meets the medical event criteria in Title 10 of the Code of Federal Regulations (CFR) 35.3045(a)(2)(i). The licensee did not anticipate any long-term medical effects on the patient as a result of the medical event, because the injection sites were excised – as is standard for a lymphoscinitigraphy procedure – on May 22, 2012.

The root cause of the medical event was the failure to follow the licensee's procedure of verifying the dosage against the patient's prescription, in that the nuclear medicine technologist did not verify that the dosage administered matched the dosage that was prescribed. Contributing causes were a miscommunication at the pharmacy pass-through window and a distraction caused by the needle on the syringe. The nuclear medicine technologist thought he had heard someone in the pharmacy indicate that his dosage was coming next, while he waited at the pharmacy pass-through window for the dosage for his scheduled procedure. After obtaining the next dosage that came through the pass-through window and returning to the camera room where the patient was waiting, the nuclear medicine technologist recognized that the needle was not of the correct gauge for an intradermal injection and assumed that the nuclear pharmacy had put the wrong gauge needle on the syringe. The nuclear medicine technologist obtained a needle of the correct gauge for an intradermal injection, attached it to the syringe containing the wrong radiopharmaceutical and dosage, and proceeded with the injection.

The inspector identified a violation of 10 CFR 35.63(d), regarding the licensee's administration of a dosage that differed from the prescribed dosage by more than 20 percent.

The licensee implemented corrective actions to prevent a similar event and a similar violation that included: (1) reviewing the incident and the licensee's policy for administering radiopharmaceuticals with all nuclear medicine technologists during a weekly staff meeting on May 23, 2012, and periodically in the future; and (2) performing periodic spot checks to monitor adherence to the policy.

Report Details

1 Program Scope and Inspection History

This licensee was a broadscope license authorized for medical and research activities. The licensee was authorized by NRC License No. 21-00215-04 to use a variety of byproduct materials for diagnostic nuclear medicine, including Tc-99m sulfur colloid for lymphoscintigraphy procedures and Tc-99m MDP for bone imaging procedures.

During the NRC's last routine inspection conducted on February 6 through 10, 2012, two Severity Level IV violations of NRC requirements were identified. One violation pertained to incomplete information on a written directive for a high dose-rate remote afterloader brachytherapy treatment. The second violation concerned protection of sensitive information.

As a result of an NRC reactive inspection that was conducted on March 15 through 16, 2011, to review a medical event involving yttrium-90 labeled TheraSpheres®; the NRC cited the licensee for a Severity Level III violation of 10 CFR 35.41(a)(2), concerning the licensee's failure to develop written procedures to provide high confidence that each administration is in accordance with the written directive.

2 Sequence of Events

2.1 Inspection Scope

The inspector interviewed the nuclear medicine chief, the nuclear pharmacist, the medical physicist, a nuclear medicine technologist, the Radiation Safety Officer (RSO), and other licensee personnel to determine the sequence of events that resulted in the medical event. In addition, the inspector reviewed the licensee's policies and procedures for administering radiopharmaceuticals, the licensee's dose estimates to the patient, and the licensee's compliance with regulatory requirements for nuclear medicine administrations.

2.2 Observations and Findings

On May 17, 2012, the licensee was scheduled to perform a lymphoscintigraphy procedure on a patient that had a skin melanoma on the arm that was previously surgically removed. Lymphoscintigraphy procedures are typically performed at sites where cancerous lesions were surgically removed to identify any lymph nodes that may hold metastatic melanoma for surgical removal. As is standard in this procedure, the patient was prescribed 3 mCi of Tc-99m sulfur colloid to be injected intradermally. The Tc-99m sulfur colloid was to be injected in three separate areas in equal amounts of 1 mCi per injection site. The injection sites were to be approximately 2.5 centimeters apart and form a triangle around the lesion.

The licensee administered a dosage in the appropriate manner for a lymphoscintigraphy procedure; however, the licensee administered the wrong radiopharmaceutical. Instead of administering 3 mCi of Tc-99m sulfur colloid, as prescribed; the licensee administered a 25 mCi dosage of Tc-99m MDP to the patient. Tc-99m MDP is a radiopharmaceutical used for bone imaging studies.

Title 10 CFR Section 35.63(d) states that, unless otherwise directed by the authorized user, a licensee may not use a dosage if the dosage does not fall within the prescribed dosage range or if the dosage differs from the prescribed dosage by more than 20 percent. On May 17, 2012, the licensee administered a dosage of 25 mCi of Tc-99m MDP when a dosage of 3 mCi of Tc-99m sulfur colloid was prescribed. This was a violation of 10 CFR 35.63(d), as the administered dosage of Tc-99m differed from the prescribed dosage by more than 20 percent.

The inspector determined that the root cause of this violation was that the nuclear medicine technologist that administered the dosage did not verify, using the labels on the syringe, the syringe shield, or the syringe carrier, that the dosage administered matched the prescribed dosage for the patient. Corrective actions for this violation are described in Section 4.2 of this report.

The licensee became aware of the error approximately 20 minutes after the injection of the wrong radiopharmaceutical when another nuclear medicine technologist realized that the dosage for her intended study, a bone imaging study, was missing from the nuclear pharmacy pass-through window, but a 3 mCi dosage of Tc-99m sulfur colloid for a lymphoscintigraphy study was there. Imaging of the lymphoscintigraphy patient had proceeded at 5-minute intervals during this 20 minute span and indicated that the wrong radiopharmaceutical had been injected, because the images were not as expected for the intended procedure. Tc-99m sulfur colloid typically remains near the injection sites, with some of the radioactive material being transported through the lymph system. The images displayed following intradermal injection of the Tc-99m MDP showed the radioactive material being transported away from the injection sites fairly rapidly, as the MDP entered the lymph and circulatory systems.

The inspector determined that the administration of the wrong radiopharmaceutical was a series of errors and missed opportunities to correct the errors. After correctly identifying the patient and leading the patient to the appropriate camera room, the nuclear medicine technologist went to retrieve the dosage for the lymphoscintigraphy procedure from the nuclear pharmacy pass-through window. While waiting for the dosage, the nuclear medicine technologist heard someone in the pharmacy say a phrase similar to “yours is next.” The nuclear medicine technologist assumed that the person in the pharmacy was referring to his dosage and grabbed the next syringe carrier that came through the pass-through window, which happened to contain a dosage for a bone imaging study. The syringe carrier, the syringe shield, and the syringe were all appropriately labeled, as required by 10 CFR 35.69. The nuclear medicine technologist did not look at the label on the syringe carrier after grabbing the carrier and returned to the patient in the camera room. This was a missed opportunity to identify that the wrong dosage was obtained.

Continuing with the intended procedure, the nuclear medicine technologist removed the syringe, with the syringe shield intact, from the carrier and noticed that the needle was not of the correct gauge for an intradermal injection. The nuclear medicine technologist proceeded to obtain the correct gauge needle for an intradermal injection without verifying that he had obtained the correct dosage. This was another missed opportunity to identify that the wrong dosage was obtained. After obtaining a needle of the correct gauge and affixing it to the syringe, the nuclear medicine technologist injected intradermally 25 mCi of Tc-99m MDP.

The inspector concluded that the root cause of the event was human error in that the nuclear medicine technologist did not verify that the dosage administered was in accordance with what was prescribed for the patient. The inspector identified the miscommunication at the pass-through window and the wrong gauge needle as contributing causes of the event. The nuclear medicine technologist assumed he had obtained the correct dose based on what he heard at the pass-through window. The nuclear medicine technologist also assumed that the pharmacy had made an error in preparing the syringe by putting the wrong gauge needle on syringe. The nuclear medicine technologist deviated from the licensee's policy of verifying the dosage against the patient's prescription.

Based on the dose estimate information detailed in Section 5.2 of this report, the administration of the wrong radiopharmaceutical resulted in a medical event as defined in 10 CFR 35.2. Specifically, this administration met the medical event criteria in 10 CFR 35.3045(a)(2)(i): a dose that exceeds 0.5 Sievert (50 rem) to a tissue or the skin from an administration of a wrong radiopharmaceutical containing byproduct material.

The licensee's medical staff determined that the accidental administration of 25 mCi of Tc-99m MDP would not result in any adverse significant medical effect to the patient. The impacted tissue was excised per routine lymphoscintigraphy procedure on May 22, 2012, when the procedure was repeated. During the procedure on May 22, 2012, the licensee administered the correct radiopharmaceutical in the prescribed amount.

2.3 Conclusion

The inspector identified a violation of 10 CFR 35.63(d), because the licensee used a dosage that differed from the prescribed dosage by more than 20 percent. The licensee determined that the incorrect administration would not result in any adverse significant medical effect to the patient because the affected skin and tissue was excised on May 22, 2012.

3 Notifications and Reports

3.1 Inspection Scope

The inspector interviewed the nuclear medicine chief, the nuclear pharmacist, the medical physicist, and the radiation safety service staff to determine what event notifications had been made. The inspector reviewed the licensee's telephonic event notification to the NRC Operations Center made on May 22, 2012, and the licensee's written report dated June 5, 2012.

3.2 Observations and Findings

On May 17, 2012, the licensee notified the patient, the referring physician, and other clinical staff about the treatment error. The RSO was notified of the treatment error on May 21, 2012, after the medical physicist had completed his initial dose estimate. The RSO concluded that a medical event per the criteria in 10 CFR 35.3045 had occurred. After consulting with the Region III office, the RSO notified the NRC Headquarters Operations Center of the medical event by telephone on May 22, 2012. In addition, on

June 5, 2012, the RSO sent the written report of the event to the NRC in accordance with 10 CFR 35.3045(d), and it included all of the required information.

3.3 Conclusion

The inspector concluded that the licensee made all required notifications in a timely manner upon determination that a medical event had occurred.

4 Licensee Corrective Actions

4.1 Inspection Scope

The inspector reviewed the licensee's proposed corrective actions to prevent a similar event and a similar violation by interviewing selected staff and reviewing the licensee's written report dated June 5, 2012.

4.2 Observations and Findings

To prevent recurrence of a similar violation of 10 CFR 35.63(d) and a similar medical event, the licensee reviewed the event and the licensee's policy for administering radiopharmaceuticals with all nuclear medicine technologists during a weekly staff meeting on May 23, 2012. The licensee committed to reviewing its policy for administering radiopharmaceuticals with staff more frequently and to performing periodic spot checks to monitor performance.

4.3 Conclusion

The inspector determined that the licensee planned and implemented corrective actions to prevent similar violations and medical events.

5 Patient Dose Assessment

5.1 Inspection Scope

The inspector reviewed the licensee's dose assessment, scientific literature provided by the licensee, and information from a confirmatory dose assessment performed by a Certified Health Physicist on staff at NRC's Region III Office.

5.2 Observations and Findings

After reviewing the details of the event, the licensee constructed a dose assessment using the dose information for Tc-99m sulfur colloid injected intradermally from the radiopharmaceutical's drug fact sheet supplied by the manufacturer combined with data for the effective half-life of Tc-99m MDP injected intradermally, which was obtained from a professional journal article[1]. The effective half-life is a mathematical combination of the chemical's biological half-life – the rate at which the body eliminates a substance – and the radioactive material's radiological half-life – the rate at which the radioactive material decays. The licensee's dose assessment estimated that each injection site

[1] Castronovo F, McKusick K, and Strauss H. 1994. Dosimetric consequences of radiopharmaceutical infiltrations. Investigative Radiology 29: 59-64.

received a dose of approximately 40 rad. The licensee concluded, based on the images obtained following the injection of the wrong radiopharmaceutical, that the Tc-99m MDP quickly migrated from the injection sites; therefore, only a small volume of tissue and skin would have received the dose, and that each injection site should be treated individually.

The NRC conducted a confirmatory dose assessment and concluded that the licensee's assessment was reasonable based on the assumptions that the licensee made, but that the injection sites should not be treated individually. Because of the volume of affected tissue for a dosage of TC-99m sulfur colloid injected intradermally, as specified in a professional journal article[2] referenced in radiopharmaceutical's drug fact sheet supplied by the manufacturer, the NRC concluded that the doses from each of the injections sites would be superposed because of the proximity of the injection sites; therefore, the doses should not be treated individually and would have a cumulative effect in a small volume of tissue.

In further evaluation of the dose to the patient, the NRC identified that the professional journal article provided by the licensee (see Footnote 1) contained a direct conversion factor for absorbed dose per mCi of Tc-99m MDP injected intradermally (25.1 rad/mCi), which was calculated from experimental data. The NRC's Certified Health Physicist concluded that this direct conversion factor would be more appropriate for estimating the dose to the tissue and skin at the injection sites than the aforementioned derived dose estimate. Based on the direct conversion factor and assuming that the radioactive material was evenly distributed among the three injection sites (25 mCi/3 injection sites = 8.33 mCi per injection site), the tissue and skin received a dose of approximately 209 rad per injection site (25.1 rad/mCi x 8.33 mCi = 209 rad). The experimental data suggests that only a small volume (approximately 2 cubic centimeters (cc)) would have received that dose; therefore, the doses from each of the injection sites would not be superposed and could be treated individually. Using a 1-to-1 ratio of rad to rem, the tissue and skin received a dose of 209 rem, which meets the dose criteria for a medical event in 10 CFR 35.3045(a)(2).

5.3 Conclusions

The NRC concluded a small volume (approximately 2 cc each) of tissue and skin had received 209 rem at each of the injection sites; which meets the criteria to be classified as a medical event.

6 Exit Meeting

At the completion of the onsite inspection, the inspector discussed potential issues and findings with the licensee during a preliminary debrief meeting. The licensee did not identify any information reviewed during the inspection and proposed for inclusion in this report as proprietary in nature. A telephonic exit meeting was conducted on June 26, 2012.

[2] Bergqvist L, Strand S-E, Persson B, et al. 1982. Dosimetry in lymphoscintigraphy of Tc-99m antimony sulfide colloid. J Nucl Med 23: 698-705.

Partial List of Persons Contacted

+ Robert Ackerman, Nuclear Laboratory Technologist Supervisor
+^ Mark Driscoll, Radiation Safety Officer
^ Karl Fischer, Senior Health Physicist
+ Kirk Frey, M.D., Division Chief of Nuclear Medicine
+ David Hubers, Authorized Nuclear Pharmacist
+^ Dennis Palmieri, Senior Health Physicist
+ Justin Quinn, Health Physicist
+ Dave Raffel, Ph.D., Medical Physicist
Stan Wegrzyn, Nuclear Medicine Technologist

+ Attended the onsite preliminary debrief meeting on May 24, 2012
^ Participated in the telephone exit meeting on June 26, 2012