UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
2443 WARRENVILLE RD. SUITE 210
LISLE, IL 60532-4352

June 21, 2017

EA-17-082
EN 52520
NMED No. 170074 (Closed)

Mr. Bruce Backus
Assistant Vice Chancellor, Environmental
Health & Safety
Washington University in St. Louis
Campus Box 8053, 660 S. Euclid Avenue
St. Louis, MO 63110-1093

SUBJECT: NRC SPECIAL INSPECTION REPORT NO. 03002271/2017001(DNMS) – WASHINGTON UNIVERSITY IN ST. LOUIS

Dear Mr. Backus:

On February 1, 2017, through February 2, 2017, an inspector from the U.S. Nuclear Regulatory Commission (NRC) conducted a special inspection at your St. Louis, Missouri campus, with continued in-office review through May 25, 2017. The in-office review included a review of information that was unavailable during the onsite inspection, including documentation about training and experience for a physician that was approved by your staff to become an yttrium-90 (Y-90) Therasphere® authorized user, and receipt and review of the NRC medical consultant's report. The purpose of this inspection was to review the circumstances, root and contributing causes, and proposed corrective actions for a medical event that was identified by the inspector on January 30, 2017, based on a discussion with your radiation safety officer (RSO) on January 11, 2017. On January 30, 2017, the inspector informed your associate RSO that a medical event occurred and requested that Washington University in St. Louis (licensee) report the medical event to the NRC Operations Center by telephone. On January 31, 2017, your RSO reported the medical event to the NRC Headquarters Operations Center. The enclosed inspection report presents the results of the inspection.

During this inspection, the NRC staff examined activities conducted under your license related to public health and safety. Additionally, the staff examined your compliance with the Commission's rules and regulations as well as the conditions of your license. Within these areas, the inspection consisted of selected examination of procedures and representative records, observations of activities, and interviews with personnel.

Based on the results of this inspection, one apparent violation of NRC requirements was identified and is being considered for escalated enforcement action in accordance with the NRC Enforcement Policy. The current Enforcement Policy is included on the NRC's website at http://www.nrc.gov/about-nrc/regulatory/enforcement/enforce-pol.html. The apparent violation concerned the licensee's failure to notify the NRC Operations Center, by telephone, no later than April 17, 2016, the next calendar day after the licensee had necessary information to discover the medical event, as required by Title 10 of the *Code of Federal Regulations* (CFR) Part 35.3045(c).

The NRC understands that the licensee disputes the apparent violation because it determined that the incident was not a medical event because: (1) of speculation that the cause of the incident was unintentional patient intervention that shifted the catheter tip due to breathing, coughing, or other movement, when there was no indication of patient intervention; and (2) it interpreted "shunting" in the context of the NRC's current Y-90 Microspheres Guidance, dated February 12, 2016 (Microspheres Guidance), as *when the licensee's procedure for administering Therasphere® is complied with and the Therasphere® go to the wrong location in the patient's body*. In addition, the NRC understands that the licensee plans to determine if corrective steps will be taken to avoid further violations after it reviews this inspection report.

Based on discussions between NRC Headquarters and the NRC Region III office, the NRC has determined that the apparent violation is valid. Specifically, the licensee's speculation that patient intervention occurred without indication of it is not in accordance with the definition of "patient intervention" in 10 CFR 35.2 which states, "actions by the patient or human research subject, whether intentional or unintentional, such as dislodging or removing treatment devices or prematurely terminating the administration".

Although "shunting" is not defined in the Microspheres Guidance, it states, in part, "The licensee shall commit to report any event, except for an event that results from intervention of a patient or human research subject, in which the administration of byproduct material results in dose or activity to an organ or tissue other than the treatment site, as documented in the written directive, except for shunting when shunting was evaluated prior to the treatment in accordance with the manufacturer's procedures." The licensee conducted shunting tests prior to Therasphere® treatments involving intra-arterial injection of technetium-99m labeled macro-aggregated albumin into the patient's applicable liver arteries and conducted a single photon emission computed tomography scan and anterior and posterior planar images acquired by a gamma camera to determine the percent of liver to lung shunting in accordance with the medical definition of "shunt". In addition, previous versions of the Microspheres Guidance include verbiage consistent with the medical definition of "shunt". Finally, at least two applicable licensee physicians interpreted "shunting" in the context of the Microspheres Guidance as per the medical dictionary, rather than, *when the licensee's procedure for administering Therasphere® is complied with and the Therasphere® go to the wrong location in the patient's body*.

Because the NRC has not made a final determination in this matter, the NRC is not issuing a Notice of Violation for this inspection finding at this time. Mr. Robert Gattone of my staff discussed the circumstances surrounding this apparent violation, the significance of the issue, and the need for lasting and effective corrective action with Dr. Susan Langhorst, RSO, of your staff at the inspection exit meeting on May 25, 2017.

Before the NRC makes its enforcement decision, we are providing you an opportunity to either: (1) respond in writing to the apparent violation addressed in this inspection report within 30 days of the date of this letter; or (2) request a Predecisional Enforcement Conference (PEC). **Please contact Aaron T. McCraw at 630-829-9650 or aaron.mccraw@nrc.gov within 10 days of the date of this letter to notify the NRC of your intended response.**

If you choose to provide a written response, it should be clearly marked as "Response to the Apparent Violation in Inspection Report No. 03002271/2017001(DNMS); EA-17-082," and should include, for the apparent violation: (1) the reason for the apparent violation, or, if contested, the basis for disputing the apparent violation; (2) the corrective steps that have been taken and the results achieved; (3) the corrective steps that will be taken to avoid further violations; and (4) the date when full compliance was or will be achieved. In presenting your

corrective actions, you should be aware that the promptness and comprehensiveness of your actions will be considered in assessing any civil penalty for the apparent violation. The guidance in NRC Information Notice 96-28, "Suggested Guidance Relating to Development and Implementation of Corrective Action," may be useful in preparing your response. You can find the information notice on the NRC website at: http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/1996/in96028.html. Your response may reference or include previously docketed correspondence, if the correspondence adequately addresses the required response. If an adequate response is not received within the time specified or an extension of time has not been granted by the NRC, the NRC will proceed with its enforcement decision or schedule a PEC.

If you choose to request a PEC, it will afford you the opportunity to provide your perspective on the apparent violation and any other information that you believe the NRC should take into consideration before making an enforcement decision. The topics discussed during the conference may include the following: information to determine whether a violation occurred, information to determine the significance of a violation, information related to the identification of a violation, and information related to any corrective actions taken or planned to be taken. If a PEC is held, it will be open to public observation, and the NRC will issue a press release to announce the time and date of the PEC.

Please be advised that the number and characterization of the apparent violation described in the enclosed inspection report may change as a result of further NRC review. You will be advised by separate correspondence of the results of our deliberations on this matter.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, 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's 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.

Please feel free to contact Mr. Gattone of my staff if you have any questions regarding this inspection. Mr. Gattone can be reached at 630-829-9823.

Sincerely,

/RA/

John B. Giessner, Director
Division of Nuclear Materials Safety

Docket No. 030-02271
License No. 24-00167-11

Enclosure:
IR 03002271/2017001(DNMS)

cc w/encl: Susan Langhorst, Ph.D., RSO
Darryl Zuckerman, M.D.,
Referring Physician
Edward Silberstein, M.D.,
NRC Medical Consultant
State of Missouri

Letter to Bruce Backus from John Giessner dated June 21, 2017

SUBJECT: NRC SPECIAL INSPECTION REPORT NO. 03002271/2017001(DNMS) – WASHINGTON UNIVERSITY IN ST. LOUIS

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U.S. Nuclear Regulatory Commission
Region III

Docket No.	030-02271
License No.	24-00167-11
Report No.	03002271/2017001(DNMS)
EA No./NMED No.	EA-17-082 / 170074
Licensee:	Washington University in St. Louis
Facility:	Campus Box 8053, 660 S. Euclid Avenue St. Louis, MO 63110-1093
Inspection Dates:	February 1, 2017, through February 2, 2017, with continued in-office review through May 25, 2017
Exit Meeting Date:	May 25, 2017
Inspector:	Robert Gattone, Senior Health Physicist
Approved By:	Aaron T. McCraw, Chief Materials Inspection Branch Division of Nuclear Materials Safety

Enclosure

EXECUTIVE SUMMARY

Washington University in St. Louis
NRC Inspection Report 03002271/2017001(DNMS)

The U.S. Nuclear Regulatory Commission (NRC) conducted a special inspection on February 1, 2017, through February 2, 2017, with continued in-office review through May 25, 2017, to review the events and circumstances associated with a medical event that was identified by the inspector on January 30, 2017, based on a discussion with the licensee's radiation safety officer (RSO) on January 11, 2017.

The licensee planned to treat cancer in a patient's liver with yttrium-90 (Y-90) Therasphere® (Therasphere®) in two fractions. Fraction 1 involved treatment of the right lobe of the liver, and the Therasphere® were administered to the patient without incident on March 3, 2016.

Fraction 2 involved treatment of the left lobe of the patient's liver on April 8, 2016. After administering the Therasphere® to the patient, the licensee conducted a positron emission tomography/magnetic resonance imaging scan (PET-MRI) on the patient. The patient's PET-MRI was assessed by the licensee, and the licensee determined that approximately 95 percent of the Therasphere® were delivered to the right lobe of the patient's liver, and approximately 5 percent of the Therasphere® were delivered to the left lobe of the patient's liver. The dose to the right lobe of the liver from Fraction 1 was 11,800 rad. The dose to the right lobe of the liver from Fraction 2 was 9,380 rad. The cumulative dose to the right lobe of the liver for both fractions is 21,180 rad.

The NRC's medical consultant determined that the cumulative dose to the right lobe of the liver for both fractions was 21,200 rad. In addition, the NRC's medical consultant determined that the overall impact of the medical event on the patient was atrophy of the patient's right lobe of the liver and potential hypertrophy of the left lobe of the liver. In addition, the NRC's medical consultant stated that there was no lethal dose, and the patient did not suffer ill effects.

On April 16, 2016, the licensee had the necessary information to discover that the incident was a medical event per Title 10 of the *Code of Federal Regulations* (CFR) Section 35.3045(a)(3) and the information in the NRC's current Y-90 Microspheres Guidance dated February 12, 2016 (Microspheres Guidance); however, the licensee determined that the incident was not a medical event because it: (1) interpreted "shunting" in context with the Microspheres Guidance different from the NRC's interpretation; and (2) speculated that the cause of the incident was unintentional patient intervention that shifted the catheter tip due to breathing, coughing, or other movement, when there was no indication of patient intervention.

The inspector identified an apparent violation of 10 CFR 35.3045(c) for the licensee's apparent failure to notify by telephone the NRC Headquarters Operations Center no later than the next calendar day after discovery of the medical event. As corrective action, on January 31, 2017, the licensee notified the NRC Headquarters Operations Center by telephone about the medical event. In addition, the licensee submitted a written report of the medical event, dated February 14, 2017, to the NRC Region III Office per 10 CFR 35.3045(d). The licensee disputes the apparent violation of 10 CFR 35.3045(c) and plans to determine if additional corrective steps will be taken to help prevent future similar violations after it reviews this inspection report.

REPORT DETAILS

1 Program Overview and Inspection History

Washington University in St. Louis (licensee) is authorized under NRC Type A broad scope medical License No. 24-00167-11 for conducting medical diagnostic procedures, therapeutic procedures including Y-90 microspheres, human research, and non-human research and development. The license also authorizes the use of byproduct materials with Atomic Numbers 1-83 and transuranics (Atomic Numbers 84-103) for medical diagnosis, therapy and research in humans; and non-medical research and development (including animal studies), instrument calibration, student instruction, and in-vitro studies. In addition, the license authorized the use of: (1) two remote afterloader brachytherapy devices for physics quality assurance testing, dosimetry measurements, medical use (including research in humans) and irradiation of animals; (2) five self-shielded irradiators for the irradiation of various materials, including blood and blood products; (3) a Leksell Gamma Stereotactic Radiosurgery Unit (a.k.a. Gamma Knife Perfexion) for the treatment of humans, human research studies, and non-human research studies (including animal studies); (4) a ViewRay device for medical use, research and development (including animal studies), prototype testing, and calibration; and (5) a commercial nuclear pharmacy for PET radiopharmaceuticals.

The NRC conducted an inspection of the licensee on January 25-29, 2016. As a result, a Non-Cited Violation of 10 CFR 35.40 was identified involving incomplete written directives.

The previous, inspection was conducted on January 13, 2015. No violations of NRC regulatory requirements were identified.

2 Sequence of Events and Licensee Investigation

2.1 Inspection Scope

On January 11, 2017, the inspector telephoned the licensee's RSO to ask questions to obtain information about the licensee's radiation safety program. In response to one of those questions, the RSO stated that a Y-90 microspheres administration deviated from the written directive which stated the treatment site is the left lobe of the liver. One week after the administration, the licensee identified that most of the Y-90 microspheres went to the patient's right lobe of the liver instead. The licensee determined that there was no medical event based on new medical event criteria guidance. The inspector suspected that the incident was a medical event; therefore, the inspector obtained additional details of the incident and consulted NRC Headquarters to verify that the incident was a medical event. Once confirmed as a medical event, the NRC conducted a special inspection on February 1-2, 2017. The inspector interviewed the physician authorized user (AU) for the medical event, an authorized medical physicist (AMP), the RSO, the interventional radiologist (IR), a radiation oncologist (RO), a nuclear medicine authorized user, the assistant professor for radiation oncology, and other licensee personnel to determine the sequence of events that resulted in the medical event. In addition, the inspector reviewed selected licensee records, licensee procedures, and the licensee's compliance with regulatory requirements for Y-90 microspheres treatments.

2.2 Observations and Findings

a. Medical Event Details

The licensee planned to treat cancer in a patient's liver with Therasphere® in two fractions. As per the licensee's procedures, the licensee conducted a liver-to-lung shunt test on or about March 18, 2016. The test included intra-arterial injection of technetium-99m labeled macro-aggregated albumin (Tc-99m MAA) into the patient's applicable liver arteries and conducted a single photon emission computed tomography scan (SPECT) and anterior and posterior planar images acquired by a gamma camera. The licensee determined that the patient had 4.4 percent liver-to-lung shunting. As such, the licensee determined that the future administration of Therasphere® to the patient would result in 4.4 percent of the Therasphere® going to the patient's lungs instead of the intended liver lobe. Because the patient's liver-to-lung shunting test resulted in less than 15 percent, the licensee prepared to administer the Therasphere® to the patient, as per the licensee's procedure.

Fraction 1 involved treatment of the right lobe of the liver. On March 3, 2016, the AU signed and dated the Therasphere® written directive that prescribed 118 Gray (Gy) (11,800 rad) and 5.22 Gigabecquerel (GBq) (141 millicuries (mCi)) by route of intra-arterial injection to treat the right lobe of the patient's liver. On March 3, 2016, the Therasphere® were administered to the patient without incident.

The licensee complied with its procedures to provide high confidence that the Therasphere® were administered in accordance with the written directive and the applicable treatment plan, including, in part, measuring the radioactivity of the Therasphere® prior to administration and measuring the residual radioactivity after the Therasphere® administration as a means of determining the radioactivity that went into the patient.

Fraction 2 involved treatment of the left lobe of the patient's liver. On April 8, 2016, the AU signed and dated the Therasphere® written directive that prescribed 117 Gy (11,700 rad) and 4.15 GBq (112.16 mCi) by route of intra-arterial injection to treat the left lobe of the patient's liver. Based on the licensee's records, on April 8, 2016, at 8:58 a.m., the licensee conducted an angiogram using contrast media to verify that the catheter tip was positioned correctly. The catheter tip was positioned 0.5 to 1 centimeter beyond the left hepatic artery origin to ensure that the Therasphere® are delivered to the middle hepatic artery and the left hepatic artery. Just prior to Therasphere® administration, the licensee conducted a fluoroscopic image to verify that the catheter tip position was correct. At 9:30 a.m. the licensee administered the Therasphere® to the patient without incident (e.g., the individuals who observed the patient during the administration identified no problem with the administration, including no indication of patient intervention). All of the licensee's procedural checks and steps were done without error.

Subsequently on April 8, 2016, the licensee conducted a PET-MRI scan on the patient. The patient's PET-MRI was assessed by the licensee on April 16, 2016, and the licensee determined that approximately 95 percent of the Therasphere® were delivered to the right lobe of the patient's liver, and approximately 5 percent of the Therasphere® were delivered to the left lobe of the patient's liver. The IR who administered the Therasphere® was the patient's referring physician and he was

notified of the incident on April 16, 2016. The patient's referring physician spoke to the patient about the incident on April 20, 2016.

As previously stated, Fraction 1 involved treatment of the right lobe of the liver without incident. The dose to the right lobe of the liver from Fraction 1 was 11,800 rad. On April 8, 2016, Fraction 2 involved treatment of the left lobe of the liver; however, approximately 95 percent of the Therasphere® went to the right lobe of the liver, and the left lobe of the liver received approximately 5 percent of the prescribed dose. The dose to the right lobe of the liver from Fraction 2 was 9,380 rad. The cumulative dose to the right lobe of the liver from both fractions was 21,180 rad. Those estimated doses were determined by the licensee, and the inspector determined that the estimated doses were reasonable.

Subsequently, the licensee chose not to administer Therasphere® to the patient's left lobe of the liver to make up for the under dose from Fraction 2. Instead, the patient was treated with chemotherapy.

The licensee's process for patient followup after Therasphere® treatment included having the patients get a magnetic resonance imaging scan (MRI) or a computerized axial tomography scan (CAT) about 3 months after Therasphere® administrations. The licensee reviewed the results of those scans with a focus on anatomical changes to: (1) determine if the treatment met the objective; and (2) indicate that the Therasphere® were properly located in the patient's body. The medical event patient was scanned about 3 months after Therasphere® administration, and the licensee reviewed the results of the scan. The licensee determined that: (1) the patient was doing fine; (2) the tumor in the right lobe of the liver was necrotic; (3) the right lobe of the liver had atrophied, and it was accompanied by appropriate and expected compensatory hypertrophy of the left lobe of the liver; and (4) the left lobe of the liver compensated for any loss of liver function from the right lobe of the liver.

The patient was seen in the licensee's Radiation Oncology Department for followup on January 23, 2017. The patient presented no significant changes to liver function that were inconsistent with liver cancer. In addition, the patient had no abdominal pain.

b. Medical Event Assessment

The licensee's RSO was immediately notified about the incident and the licensee evaluated it. The licensee determined that the incident was not a medical event based on the NRC's Microspheres Guidance, regarding the exemption for patient intervention that results in administration of byproduct material in dose or activity to an organ or tissue other than the treatment site, as documented in the written directive, except for shunting when shunting was evaluated prior to the treatment in accordance with the manufacturer's procedures.

The licensee speculated that the cause of the incident was unintentional patient intervention that shifted the catheter tip due to breathing, coughing, or other movement; however, there was no indication of patient intervention to determine that patient intervention occurred.

In addition, the licensee's interpretation of "shunting" in the context of the Microspheres Guidance as *when the licensee's procedure for administering Therasphere® is complied with and the Therasphere® go to the wrong location in the patient's body* appears incorrect because "shunting" in the context of the Microspheres Guidance is as defined in the medical dictionary. For example, "The Farlex Medical Dictionary" defines "shunt" as "a condition in which blood, by going through an abnormal pathway or bypass, such as arteriovenous fistula forms or in congenital anomalies of the heart in which the blood passes from the right atrium or ventricle directly to the left atrium or ventricle respectively, through a defect in septum that normally separates the atria and ventricles." In addition, Edition 19 of "Taber's Cyclopedic Medical Dictionary" defines "shunt", in part, as, "A normal or abnormal direct connection between arterial and venous circulation."; "An abnormal connection between the cavities of the heart or between the systemic and pulmonary vessels."; and "The passage of blood from the left side of the heart to the right side through an abnormal opening."

Although "shunting" is not defined in the Microspheres Guidance, it states, in part, "The licensee shall commit to report any event, except for an event that results from intervention of a patient or human research subject, in which the administration of byproduct material results in dose or activity to an organ or tissue other than the treatment site, as documented in the written directive, except for shunting when shunting was evaluated prior to the treatment in accordance with the manufacturer's procedures." The licensee conducted shunting tests prior to Therasphere® treatments involving intra-arterial injection of technetium-99m labeled macro-aggregated albumin into the patient's applicable liver arteries and conducted a single photon emission computed tomography scan and anterior and posterior planar images acquired by a gamma camera to determine the percent of liver to lung shunting in accordance with the medical definition of "shunt". In addition, previous versions of the Microspheres Guidance include verbiage consistent with the medical definition of "shunt". Finally, at least two applicable licensee physicians interpreted "shunting" in the context of the Microspheres Guidance as per the medical dictionary, rather than, *when the licensee's procedure for administering Therasphere® is complied with and the Therasphere® go to the wrong location in the patient's body*.

Based on interviews with individuals that observed the patient during treatment administration, there was no indication of a problem (e.g., no indication of patient intervention) during the administration that resulted in the medical event. In fact, soon after the event, the licensee determined that it could not identify the cause of the event.

Based on the special inspection, the inspector also could not determine the cause of the medical event. Because there was no indication of the cause of the medical event such as patient intervention, shunting, or other causes, the licensee and the inspector could not determine the cause of the medical event. The inspector identified a contributing factor to the medical event as the amount of time between when the angiogram was done and the administration of the Therasphere® to the patient. Specifically, the 32-minute gap between the angiogram and the Therasphere® administration increases the potential for catheter tip movement away from the intended position. The licensee did conduct a fluoroscopic image without contrast in the interim as a means to verify that the catheter tip was still positioned in the intended location just before the administration of the Therasphere®.

Despite that the licensee could not determine the cause of the medical event, soon after identifying the incident, the licensee implemented generic, immediate corrective actions to prevent a similar incident. The focus was on communications between the team members if someone were to have a concern about catheter placement, including establishing standard language to voice a concern, reminding the team about safety culture to include stopping the line and speaking up if there is any concern, and requiring that all participating team members confirm that it is okay to administer the Therasphere® prior to administration. The inspector reviewed the licensee's applicable procedure that included the corrective action.

Title 10 CFR 35.3045(a)(3) requires that licensees shall report any event, except for an event that results from patient intervention, in which the administration of byproduct material or radiation from byproduct material results in a dose to the skin or an organ or tissue other than the treatment site that exceeds by 0.5 Sv (50 rem) to an organ or tissue and 50 percent or more of the dose expected from the administration defined in the written directive (excluding, for permanent implants, seeds that were implanted in the correct site but migrated outside the treatment site).

In the March 2016 timeframe, the licensee implemented the Microspheres Guidance. Pages 8 and 9 of that guidance states, in part, that the "licensee shall commit to report any event, except for an event that results from patient intervention of a patient or human research subject, in which the administration of byproduct material results in dose or activity to an organ or tissue other than the treatment site, as documented in the written directive, except for shunting when shunting was evaluated prior to treatment in accordance with the manufacturer's procedures."

Title 10 CFR 35.3045(c) requires that licensees shall notify by telephone the NRC Headquarters Operations Center no later than the next calendar day after discovery of the medical event. On April 16, 2016, the licensee had the necessary information to discover that the incident was a medical event per 10 CFR 35.3045(a)(3) and the aforementioned information on pages 8 and 9 of the Microspheres Guidance; however, due to the licensee's speculation that patient intervention occurred without indication of it and its apparent misinterpretation of shunting in the context of the Microspheres Guidance, the licensee did not discover that the incident was a medical event.

On January 30, 2017, the inspector notified the licensee that the incident was a medical event and requested the licensee to notify by telephone the NRC Headquarters Operations Center about the medical event. The inspector identified an apparent violation of 10 CFR 35.3045(c). The inspector determined that the root cause of the apparent violation of 10 CFR 35.3045(c) was the licensee's: (1) apparent misinterpretation of "shunting" in context with the Microspheres Guidance; and (2) speculation that the cause of the incident was unintentional patient intervention that shifted the catheter tip due to breathing, coughing, or other movement, when there was no indication of patient intervention.

On January 31, 2017, the licensee notified the NRC Headquarters Operations Center by telephone about the medical event. In addition, the licensee submitted a timely, written report of the medical event, dated February 14, 2017, to the NRC Region III Office as required by 10 CFR 35.3045(d).

The licensee disputes the apparent violation of 10 CFR 35.3045(c) and planned to determine if long-term corrective actions are necessary after it reviews this inspection report.

2.3 Conclusions

The licensee implemented its procedures for Therasphere® administrations without error. The inspector determined that the licensee's response to and assessment of the incident was inadequate because the licensee had the necessary information to determine that a medical event occurred, and it determined that there was no medical event. The inspector identified an apparent violation of 10 CFR 35.3045(c) for the licensee's failure to notify by telephone the NRC Headquarters Operations Center no later than the next calendar day after discovery of the medical event.

3 Review of Microspheres Administrations

3.1 Inspection Scope

The inspector interviewed applicable licensee staff and reviewed selected records of Y-90 microspheres administrations.

3.2 Observations and Findings

The licensee conducted about 150 Y-90 microspheres treatments per year. About 75 of those treatments involved Therasphere® and about 75 of those treatments involved SIR-Spheres®. The licensee conducted post treatment images of 40 of the 150 microspheres patients (about 27 percent) to verify where the microspheres went in the patients' body by detection of the Y-90 radiation emissions. Specifically, the licensee conducted PET-MRI scans to verify where the microspheres went in the patients' bodies. As such, the licensee did not conduct post treatment images of 110 of the 150 microspheres patients (about 73 percent) to verify where the microspheres went in the patients' body by detection of the Y-90 radiation emissions.

The inspector reviewed the licensee's Therasphere® procedure to provide high confidence that the patients' or human research subjects' identities are verified before each administration; and each administration is in accordance with the written directive, as required by 10 CFR 35.41(a). The inspector noted that the procedure was silent about conducting post treatment images of microspheres patients to verify where the microspheres went in the patients' body by detection of the Y-90 radiation emissions. In addition, the inspector noted that the licensee acknowledged that the incident that resulted in a medical event would most likely not have been identified if the patient did not get a PET-MRI scan to verify where the microspheres went in the patients' body.

The licensee determined that the medical event was the only treatment where the Y-90 microspheres went to the wrong location in the patient's body. The inspector reviewed selected records of the patients who had PET-MRI to verify where the microspheres went in the patients' bodies, and there was no indication of another example of where the Y-90 microspheres went to the wrong location in a patient's body. In addition, the

selected records indicated that the licensee implemented its Y-90 microspheres procedures without error.

3.3 Conclusions

Based on the information obtained by the licensee, including selected records of Y-90 microspheres, the inspector determined that the Y-90 microspheres administrations that were conducted did not result in an additional medical event.

4 Independent Patient Dose Assessment

4.1 Inspection Scope

The NRC contracted a medical consultant to assess probable deterministic effects of the radiation exposure to the patient as a result of the medical event. The inspector reviewed the medical consultant's report.

4.2 Observations and Findings

The NRC's medical consultant determined that the cumulative dose to the right lobe of the liver for both fractions is 21,200 rad. The NRC's medical consultant stated that the patient's right lobe of the liver will atrophy with focal fibrosis, and the left lobe of the liver may hypertrophy somewhat. In addition, the NRC's medical consultant stated that there was no lethal dose, and the patient did not suffer ill effects. A copy of the medical consultant's report can be found in the NRC's Agencywide Documents Access and Management System (ADAMS), under Accession Number ML17118A206.

4.3 Conclusions

The NRC's medical consultant determined that the overall impact of the medical event on the patient is atrophy of the patient's right lobe of the liver and potential hypertrophy of the left lobe of the liver.

5 Exit Meeting

At the completion of the onsite inspection, the inspector discussed the preliminary inspection findings in this report with licensee management during a preliminary exit meeting. The licensee did not identify any information reviewed during the inspection and proposed for inclusion in this report as proprietary in nature. A final telephonic exit meeting was conducted on May 25, 2017.

Attachment: Partial List of Persons Contacted

Partial List of Persons Contacted

Mike Altman, Assistant Professor for Radiation Oncology
+Keith Anderson, Radiation Safety Manager
+Bruce Backus, Assistant Vice Chancellor, Environmental Health and Safety
+Briana Davis, Health Physicist II
Perry Grigsby, M.D., Authorized User for Y-90 Theresphere®
^+Susan Langhorst, Ph.D., Radiation Safety Officer
Michael Lauer, Executive Director, Support Services & Public Safety
+David Luechtefeld, Health Physicist
Sasa Mutic, Medical Physicist
Parag Parikh, M.D., Radiation Oncologist
+Buck Rogers, Radiation Oncology Professor
Darryl Zuckerman, M.D., Assistant Professor of Radiology and Surgery

+ Attended the onsite exit meeting February 2, 2017
^ Participated in the telephone exit meeting on May 25, 2017

INSPECTION PROCEDURES (IP) USED

IP 87134: Medical Broad-Scope Programs