UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
2056 WESTINGS AVENUE, SUITE 400
NAPERVILLE, IL 60563-2657

December 6, 2024

EA-24-114
EN 57110
NMED No. 240165 (Closed)

Justin Davison
President and Chief Executive Officer
Saint Francis Medical Center
211 Saint Francis Dr.
Cape Girardeau, MO 63703

SUBJECT: NRC REACTIVE INSPECTION REPORT NO. 030-02269/2024001(DRSS) - SAINT FRANCIS MEDICAL CENTER

Dear Justin Davison:

On May 14-15, 2024, two inspectors from the U.S. Nuclear Regulatory Commission (NRC) conducted a reactive inspection at your Cape Girardeau, Missouri, institution with continued in-office review through November 7, 2024. The purpose of the inspection was to review the circumstances, root and contributing causes and proposed corrective actions for a medical event that occurred on May 6, 2024; your staff reported this medical event to the NRC on May 7, 2024. The medical event involved an overdose to the treatment site utilizing yttrium-90 microspheres within the TheraSphere™ brachytherapy system. A medical event occurred due to a lack of management oversight of the yttrium-90 program. The nuclear medicine staff placed the order of the microspheres with the device manufacturer based on their understanding of the information provided by the authorized user. Your staff ordered two dosages of yttrium-90 TheraSphere™ which were administered to the patient on May 6, 2024, resulting in a dose of 300 percent greater than the prescribed. This administration also resulted in an unintended dose to the patient's lungs of 232 percent greater than your staff initially planned from this treatment. Our in-office review included a review of your written report and proposed corrective actions taken in response to the reported medical event. The NRC also contracted a medical consultant, John F. Angle, M.D., to review the medical significance of the medical event. Dr. Angle's review is summarized in our enclosed inspection report.

This inspection examined activities conducted under your license as they relate to safety and compliance with the NRC's rules and regulations and with the conditions in your license. Within these areas, the inspection consisted of an examination of selected procedures and representative records, observations of activities, and interviews with personnel.

Based on the results of this inspection, four apparent violations of NRC requirements were identified and are being considered for escalated enforcement action in accordance with the NRC Enforcement Policy. The current Enforcement Policy is included on the NRC website at http://www.nrc.gov/about-nrc/regulatory/enforcement/enforce-pol.html. The apparent violations are directly related to the medical event and involve the failures to: (1) have written directives dated and signed by an authorized user before the administration of therapeutic doses of

radiation from byproduct material as required by Title 10 of the Code of Federal Regulations (CFR) 35.40(a); (2) develop, implement, and maintain written procedures to provide high confidence that each yttrium-90 administration is in accordance with the written directive as required by 10 CFR 35.41(a); (3) provide training in the licensee's procedures to all individuals involved in yttrium-90 microsphere use, commensurate with the individual's duties to be performed as required by Condition 14. of NRC License No. 24-00158-03; and (4) through the Radiation Safety Officer, ensure that the radiation safety activities were being performed in accordance with licensee-approved procedures and regulatory requirements as required by 10 CFR 35.24(b). Deborah Piskura, Laura Dresen, and Rhex Edwards, of my staff, discussed the circumstances surrounding the apparent violations, the significance of the issues, and the need for lasting and effective corrective action with Ms. Lisa Newcomer and members of your staff on November 7, 2024.

Before the NRC makes its enforcement decision, we are providing you an opportunity to: (1) request a Pre-decisional Enforcement Conference (PEC) or (2) request Alternative Dispute Resolution (ADR). If a PEC is held, it will open for public observation and the NRC will issue a press release to announce the time and date of the conference. **Please contact Rhex Edwards at 630-829-9722 or Rhex.Edwards@nrc.gov within 10 days of the date of this letter to notify the NRC of your intended response.** A PEC should be held within 30 days and an ADR session within 45 days of the date of this letter.

If you choose to request a PEC, the conference will afford you the opportunity to provide your perspective on these matters and any other information that you believe the NRC should take into consideration before making an enforcement decision. The decision to hold a pre-decisional enforcement conference does not mean that the NRC has determined that a violation has occurred or that enforcement action will be taken. This conference would be conducted to obtain information to assist the NRC in making an enforcement decision. The topics discussed during the conference may include 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. 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 violations. The guidance in NRC Information Notice 96-28, "Suggested Guidance Relating to Development and Implementation of Corrective Action," may be helpful in preparing your response. You can find the Information Notice on the NRC Web site at: http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/1996/in96028.html.

You may also request ADR with the NRC in an attempt to resolve this issue. ADR is a general term encompassing various techniques for resolving conflicts using a neutral third-party. The technique that the NRC has decided to employ is mediation. Mediation is a voluntary, informal process in which a trained neutral party (the "mediator") works with parties to help them reach resolution. If the parties agree to use ADR, they select a mutually agreeable neutral mediator who has no stake in the outcome and no power to make decisions. Mediation gives parties an opportunity to discuss issues, clear up misunderstandings, be creative, find areas of agreement, and reach a final resolution of the issues. Additional information concerning the NRC's program can be obtained at http://www.nrc.gov/about-nrc/regulatory/enforcement/adr.html. The Institute on Conflict Resolution (ICR) at Cornell University has agreed to facilitate the NRC's program as a neutral third party. **Please contact ICR at 877-733-9415 within 10 days of the date of this letter if you are interested in pursuing resolution of this issue through ADR. In addition, if you choose ADR, please also contact Rhex Edwards at the telephone number or email address listed above.**

In addition, please be advised that the number and characterization of the apparent violations 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 the NRC's "Agency Rules of Practice and Procedure" in 10 CFR 2.390, 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, any 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 Deborah Piskura or Laura Dresen of my staff if you have any questions regarding this inspection. Deborah can be reached at 630-829-9867 or deborah.piskura@nrc.gov. Laura can be reached at 630-829-9554 or laura.dresen@nrc.gov.

Sincerely,

Feibus, Jonathan signing on behalf
of Curtis, David
on 12/06/24

David Curtis, Director
Division of Radiological Safety and Security

Docket No. 030-02269
License No. 24-00158-03

Enclosure: Inspection Report No. 030-02269/2024001(DRSS)

cc w/encl: Ms. Lisa Newcomer, RRT, MBA, FACHE, Vice President, Regional Operations
Ms. Jamie C. Eisenberg, MHA, CNMT, Radiation Safety Officer
Michael J. Naughton, M.D., Oncologist
State of Missouri

Letter to J. Davison from D. Curtis dated, December 6, 2024.

SUBJECT: NRC REACTIVE INSPECTION REPORT NO. 030-02269/2024001(DRSS) – SAINT FRANCIS MEDICAL CENTER

DISTRIBUTION w/encl:
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NAME	DPiskura:brt		LDresen		REdwards		DBetancourt-Roldan:GNE1 concur on behalf of	
DATE	11/13/24		11/13/24		11/15/24		11/21/24 & 12/6/24	
OFFICE	NMSS		OE		OGC		OE	
NAME	MBurgess		JPeralta		RAugustus		SWoods	
DATE	12/6/24		12/3/24		12/6/24		12/3/24	
OFFICE	RIII-DRSS							
NAME	DCurtis:JFeibus concur on behalf of							
DATE	12/6/24							

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U.S. Nuclear Regulatory Commission
Region III

Docket No.	030-02269
License No.	24-00158-03
Report No.	030-02269/2024001(DNMS)
NMED No.	240165
Licensee:	Saint Francis Medical Center
Address:	211 Saint Francis Dr. Cape Girardeau, MO 63703
Location Inspected:	211 Saint Francis Dr. Cape Girardeau, MO 63703
Inspection Dates:	May 14-15, 2024, with continued in-office review through November 7, 2024
Exit Meeting Date:	November 7, 2024
Inspectors:	Laura M. Dresen, Health Physicist Deborah A. Piskura, Senior Health Physicist
Approved By:	Rhex A. Edwards, Chief Materials Inspection Branch Division of Radiological Safety and Security

Enclosure

EXECUTIVE SUMMARY

Saint Francis Medical Center
NRC Inspection Report 030-02269/2024001(DRSS)

The U.S. Nuclear Regulatory Commission (NRC) conducted a reactive inspection on May 14-15, 2024, to review the circumstances, causes, and licensee corrective actions regarding a medical event that occurred on May 6, 2024, at the Saint Francis Medical Center (the licensee). The licensee reported the medical event to the NRC on May 7, 2024. The medical event involved an overdose to the prescribed treatment site within a patient's liver utilizing yttrium-90 microspheres in the Boston Scientific Corporation TheraSphere™ brachytherapy system. The inspection included an in office review through November 7, 2024, to review the licensee's written report and its updated written report on the unintended dose to an organ or tissue other than the treatment site.

During a palliative treatment of a liver tumor on May 6, 2024, the licensee overdosed the treatment site by approximately 300 percent using yttrium-90 microspheres within the TheraSphere™ delivery set. The authorized user prescribed a palliative dose of 90 Gray to the tumor within the left lobe of the liver. The authorized user worked with a representative from the device manufacturer to plan this treatment. A medical event occurred due to a lack of management oversight of the yttrium-90 program. Contributing to this was unclear e-mail communications and instructions from the authorized user prior to nuclear medicine staff ordering the microspheres from the device manufacturer. The licensee's nuclear medicine staff ordered two dosages of yttrium-90 TheraSphere™ which were administered to the patient on May 6, 2024, resulting in a dose of 300 percent greater than prescribed. This administration also resulted in an unintended dose to the patient's lungs of 232 percent greater than initially planned from this treatment. The licensee concluded that the medical event would not result in adverse health consequences for the patient.

The NRC retained the services of a medical consultant. Based on the medical consultant's review, the delivered dose exceeded the threshold for possible effects to the liver including radiation induced liver disease. The medical consultant also provided there were concerns about potential liver failure. The medical consultant noted that the patient showed no signs of pulmonary disease such as shortness of breath and no other organs appear to be affected from this medical event.

Four apparent violations were identified regarding the licensee's failures to: (1) have written directives dated and signed by an authorized user before the administration of therapeutic doses of radiation from byproduct material; (2) develop, implement, and maintain written procedures to provide high confidence that each administration is in accordance with the written directive; (3) provide training in the licensee's procedures to individuals involved in yttrium-90 microspheres administrations, commensurate with the individual's duties to be performed; and (4) through the Radiation Safety Officer, ensure that the radiation safety activities were being performed in accordance with licensee-approved procedures and regulatory requirements (five examples).

The licensee implemented corrective actions which included suspending its use of yttrium-90 microspheres.

REPORT DETAILS

1 Program Overview and Inspection History

Saint Francis Medical Center (licensee) was a large medical institution that conducted licensed activities at its hospital in Cape Girardeau, Missouri, under NRC License Number 24-00158-03. The licensee operated a limited scope medical program with authorization to use licensed material as specified in Title 10 CFR Part 35, Sections 35.100, 35.200, and 35.300. The licensee's authorization included Section 35.1000, yttrium-90 microspheres treatments including the Boston Scientific Corporation TheraSphere™ brachytherapy system.

The licensee administered approximately ten yttrium-90 microsphere treatments annually using the TheraSphere™ brachytherapy system. Amendment No. 83 of the NRC license specifically authorized four interventional radiologists as authorized users for yttrium-90 microspheres; two of these physicians were considered active users of yttrium-90. The licensee developed protocols for the administration of TheraSphere™, based on patient anatomy, vasculature, tumor volume, and liver volume. The licensee instituted a multi-departmental approach for the use of yttrium-90 microspheres. The team consisted of an interventional radiologist/authorized user, a nurse, a nuclear medicine technologist, and a radiology technologist. The licensee received pre-calibrated unit doses of the yttrium-90 TheraSphere™ from the vendor from which it assayed and stored the prepared dosages within the nuclear medicine hot lab. The team administered all microspheres treatments within the interventional radiology suite. Following the TheraSphere™ administration, the licensee imaged the patient to verify the location of the microspheres within the treatment site to confirm that the treatment was performed in accordance with the written directive.

During the last routine inspection conducted on July 18, 2023, with continued in-office review through November 2, 2023, one violation of 10 CFR 20.1502(a)(1) was identified. The violation involved the licensee's failure to monitor exposures to radiation from licensed and unlicensed radiation sources under its control that were received by an interventional radiologist who was likely to receive, in one year from sources external to the body, a deep dose in excess of 10 percent of the limits in 10 CFR 20.1201(a) and was therefore required to use individual monitoring devices. The NRC conducted a prior routine inspection remotely on April 21, 2021, with no violations of NRC requirements identified. The remote inspection reviewed the licensee's corrective actions for a violation of 10 CFR 35.2075 involving the licensee's failure to retain a record of the basis for authorizing the release of individuals following administrations of iodine-131, identified during a prior routine inspection on May 14 through June 6, 2018.

2 Management Oversight

2.1 Inspection Scope

The inspector reviewed the licensee's organization and management controls for the radiation protection program, including the organizational structure, management, and Radiation Safety Committee (RSC) involvement and oversight, radiation safety office staffing, and the effectiveness of procedures and management practices in implementing the yttrium-90 program.

2.2 Observations and Findings

For several years, the radiation protection program was overseen by a contract physicist who served as the Radiation Safety Officer (RSO). A change in the contract physicist who served as the RSO occurred in Amendment No. 82, issued on August 23, 2023. By the terms of the contract, the RSO reported to the vice president of regional operations who, in turn, reported to the chief operating officer. The licensee's contract physicist/RSO audited the radiation protection program on a quarterly basis. The consultant presented their audit findings during the licensee's quarterly radiation safety committee meetings; no findings involving the yttrium-90 program were identified during these program audits.

The RSO did not conduct an independent assessment of the licensee's yttrium-90 program or take other steps to validate the information provided by the contract medical physicists. The RSO did not review the licensee's policies and procedures for administrations requiring a written directive to ensure that these procedures included yttrium-90. A review of these policies and procedures would have revealed that the licensee provided no guidance or instruction on how to identify a potential error or inconsistency in the treatment worksheet and prevent a medical event. The RSO's audits did not identify that the written directives for yttrium-90 administrations were not dated and signed by one authorized user until after the completion of the treatment. Audits of the radiation safety program did not identify the lack of training provided to the nuclear medicine staff on the duties commensurate with their role in the yttrium-90 program.

The licensee utilized a contracted radiology group who provided interventional radiology patient services to the hospital. Two of these contract interventional radiologists administered the yttrium-90 patient treatments. This contract was due to expire in July 2024, with another group set to resume these interventional services to the hospital. The licensee provided no medical physics support to the yttrium-90 program. Prior to placing the yttrium-90 order with the device manufacturer, the licensee did not complete a medical physics review and verification of the dosage with the authorized user's prescribed dose to the treatment site. This lack of a review, and verification of the dosage ordered against the prescribed dose, created a vulnerability which resulted in a medical event.

Title 10 of the Code of Federal Regulations Part 35.24(b) states, in part, that a licensee's management shall appoint a Radiation Safety Officer who agrees, in writing, to be responsible for implementing the radiation protection program. The licensee, through the Radiation Safety Officer, shall ensure that radiation safety activities are being performed in accordance with licensee-approved procedures and regulatory requirements.

Contrary to the above, prior to May 6, 2024, the licensee, through the Radiation Safety Officer, apparently failed to ensure that radiation safety activities were being performed in accordance with licensee-approved procedures and regulatory requirements. Specifically, the Radiation Safety Officer failed to identify that:

(1) the licensee's policies and procedures provide high confidence that: (a) The patient's or human research subject's identity is verified before each administration; and (b) Each administration is in accordance with the written directive (quality management program), including the use of yttrium-90, in accordance with regulatory requirements;

(2) the licensee had no policies and procedures specific to ytrrium-90 administrations that provided guidance or instruction on how to identify a potential error or inconsistency in the treatment worksheet and prevent a medical event;

(3) the licensee had a practice of not generating a written directive prior to the treatment which created a vulnerability and prevented the licensee from identifying that this combination of dosages (ordered for the medical event case) would result in an unintended overdose to the treatment site;

(4) the licensee's nuclear medicine staff were trained and proficient in interpreting the dose tables which would have provided information that the two dosages ordered for the medical event case, with their respective calibration dates, would have delivered a dose in excess of the prescribed dose to the treatment site; and

(5) the licensee's quality management program contained outdated references to 10 CFR Part 35, as well as medical event criteria which no longer applied.

The licensee's failure, through the RSO, to ensure that the radiation safety activities were being performed in accordance with licensee-approved procedures and regulatory requirements was an apparent violation of 10 CFR 35.24(b) and is being considered for escalated enforcement action in accordance with section 6.3.b.3. of the NRC's Enforcement Policy.

2.3 Conclusions

The licensee's lack of oversight for the yittrium-90 program contributed to the medical event described in Section 3 of this report. The inspectors identified one apparent violation of NRC requirements involving the licensee's failure, through the RSO, to ensure that the radiation safety activities were being performed in accordance with licensee-approved procedures and regulatory requirements as required by 10 CFR 35.24(b).

3 Sequence of Events and Licensee Investigation

3.1 Inspection Scope

The inspectors reviewed the licensee's investigation of the medical event. The inspectors also interviewed select licensee personnel, reviewed the licensee's written policies and procedures for yttrium-90 administrations, and observed equipment and facilities.

3.2 Observations and Findings

On Monday, May 6, 2024, the licensee prescribed a dose of 90 Gray using the TheraSphere™ yttrium-90 microspheres brachytherapy system to the left lobe of the liver to a patient for a palliative treatment of a liver tumor from metastatic colorectal cancer. The patient previously received a TheraSphere™ treatment to the right lobe of the liver on April 16, 2024, where the physician prescribed a total dose of 96 Gray to segments VI and VII of the liver. The authorized user planned the treatment with two dosages to administer, one dosage to each segment. This treatment was administered without incident.

Prior to administering the May 6, 2024, treatment, the authorized user prepared a treatment plan to deliver his intended prescribed dose of 90 Gray to a tumor within the left lobe of the liver. Working with a representative from the device manufacturer, the authorized user planned the case using two options for the dosage and calibration date, in order to deliver the prescribed dose of 90 Gray for the planned treatment date. The authorized user planned the treatment with one dosage of an activity of 7.0 gigabecquerels (GBq), calibration date for Sunday, April 28, 2024, and a second dosage option of 3.0 GBq, calibration date for Sunday, May 5, 2024. Either of these single dosages would have delivered the prescribed dose of 90 Gray (or within 20 percent, satisfying the requirements of 10 CFR 35.3045) to the treatment site. However, the authorized user and the device manufacturer provided unclear instruction in their emails to the nuclear medicine staff who interpreted that the intended order consisted of both dosages for this patient treatment. Since the patient's April 2024 yttrium-90 treatment consisted of two dosages, the nuclear medicine staff had no reason to question a second treatment also requiring two dosages. During the treatment planning, the authorized user worked with an "old" computerized version of the TheraSphere™ written directive and treatment worksheet, failing to recognize that these combined dosages would deliver a dose of 362.9 Gray to the patient's treatment site, rather than the prescribed dose of 90 Gray. For reasons unknown, the physician listed both treatment dosage options on the same worksheet, which the nuclear medicine staff interpreted it was their intent to order these 2 dosages indicated on the worksheet. The old version of computerized worksheet did not include any alert or prompt features to warn the user that these combined dosages would result in a dose to the treatment site exceeding the prescribed dose.

On May 6, 2024, the licensee administered both of these dosages to the patient, resulting in a total dose of 362.9 Gray to the tumor within the patient's left lobe of the liver. This delivered dose to the treatment site was four times greater than the intended prescribed dose of 90 Gray. Upon completion of the patient's SPECT post-imaging and surveys, the licensee generated the written directive and completed the treatment worksheet, noting that the delivered dose to the patient's liver exceeded the prescribed dose by four times and met the medical event reporting criteria.

The inspectors requested the licensee to evaluate the dose to the patient's lungs from the April 16th and May 6th yttrium-90 administrations. Based on authorized user's treatment planning, the April 16, 2024, yttrium-90 administration to the right lobe of the liver was expected to result in a dose of 0.90 Gray (90 rem) to the lungs. According to the treatment plan for the first dosage of the May 6, 2024, yttrium-90 administration, the dose to the patient's lungs was expected as 0.91 Gray (91 rem). The dose to the lungs from the second dosage was not planned or recorded on the treatment worksheet. In addition, the total lung dose from the combined treatment dates was not evaluated until questioned by the inspectors. The licensee subsequently estimated the lung dose as 3.29 Gray from the May 6, 2024, yttrium-90 administration. The patient's cumulative lung dose from the April 16 and May 6, 2024, treatments was 4.2 Gray (420 rem). The licensee estimated that the lung dose exceeded the intended dose by 2.39 Gray (240 rem), or approximately 165% greater than the intended lung dose. However, the inspectors calculated the total lung dose at approximately 232% over the planned lung dose. Therefore, the patient's lungs, an organ other than the treatment site, received a dose that exceeded the expected dose by 0.5 Sv (50 rem) and was approximately 232% more than the dose expected from the administration. On July 9, 2024, the licensee contacted the HOO and updated its event report to include the additional reporting criteria.

Interviews with the licensee staff revealed inconsistencies between the two active authorized users who were prescribers of yttrium-90 and the timing when a written directive was prepared and signed by the respective physician. The treating physician for the medical event case routinely failed to prepare and sign a written directive prior to the administration of the yttrium-90 treatment. This authorized user failed to prepare and sign a written directive before the May 6, 2024, medical event. Based on information provided by the licensee staff, four yttrium-90 microspheres treatments were administered by the hospital in 2024 without a properly prepared and signed written directive. In 2023, the licensee administered six yttrium-90 cases without a properly prepared and signed written directive prior to the treatment. It was this physician's practice that he would use the vendor's treatment worksheet (which was intended to fulfill the written directive requirements) to plan the treatment, the prescribed dose to the treatment site, and the yttrium-90 dosage needed to deliver the intended prescribed dose. After the treatment, the nuclear medicine staff filled in the remaining fields of the vendor's computerized treatment worksheet which generated the actual dose to the treatment site and the lungs. It was at this time, a few hours following the patient treatment, when the staff completed the computerized treatment worksheet, that they recognized a medical event occurred on May 6, 2024, and the physician signed the written directive.

Title 10 CFR 35.40(a) requires, in part, that a written directive must be dated and signed by an authorized user before the administration of any therapeutic dose of radiation from byproduct material.

Contrary to the above, between approximately 2023, and May 6, 2024, the licensee apparently failed to have written directives dated and signed by an authorized user before the administration of therapeutic doses of radiation from byproduct material. Specifically, the licensee failed to have written directives dated and signed by an authorized user before the administration of approximately ten therapeutic doses of radiation from byproduct material from yttrium-90 TheraSphere™ microspheres.

The licensee's failure to have a written directive dated and signed by an authorized user before the administration of a therapeutic dose of yttrium-90 was an apparent violation of 10 CFR 35.40(a) and is being considered for escalated enforcement action in accordance with section 6.3.b.3. of the NRC's Enforcement Policy.

3.3 Conclusions

The licensee reported the May 6, 2024, medical event to the NRC on May 7, 2024, because the event involved an overdose to the treatment site that differed from the prescribed dose by 50 rem to an organ or tissue, and the total dose differed by greater than 20 percent from the prescribed dose. The licensee delivered a dose to the patient's liver which exceeded the prescribed dose by 300 percent. The patient's lungs, an organ other than the treatment site, received a dose that exceeded the expected dose by 0.5 Sv (50 rem) and was approximately 232% more than the dose expected from the yttrium-90 administration. One apparent violation of 10 CFR 35.40(a) was identified involving the licensee's failure to have written directives dated and signed by an authorized user before the administration of yttrium-90 therapeutic doses of radiation from byproduct material.

4 Policies and Procedures for Yttrium-90 Microspheres Administrations

4.1 Inspection Scope

The inspectors reviewed selected licensee procedures and written directives for yttrium-90 microspheres administrations and evaluated their adequacy for routine and emergency conditions. The inspectors interviewed the RSO, an authorized user, the department manager, and a nuclear medicine technologist.

4.2 Observations and Findings

As part of the reactive inspection, the inspectors reviewed the licensee's policies and procedures that provide high confidence that radiopharmaceutical administrations, including yttrium-90, would be in accordance with the written directive. The licensee developed a policy entitled, "Quality Management Program" effective date May 2011, last revision date October 2022, with the intent to comply with the requirements in 10 CFR 35.41. The licensee's quality management program provided written procedures and policies for radiopharmaceutical therapies including iodine-125, iodine-131, as well as other radiopharmaceuticals. However, the licensee's policy and procedure provided no provisions for ytrrium-90 administrations. Therefore, the licensee's policy and procedure did not provide high confidence that the patient's identity is verified before each yttrium-90 administrations and each administration was in accordance with the written directive. The inspectors noted that the licensee's quality management program contained outdated references to Part 35, as well as medical event criteria which no longer applied. Therefore, the licensee failed to develop, implement, and maintain written procedures to provide high confidence that the patients identify is verified before each yttrium-90 administration and the administration was in accordance with the written directive. The root cause of the failure to develop, implement, and maintain written procedures to provide high confidence that the patients identify is verified before each yttrium-90 administration and that the administration is in accordance with the written directive was attributed to inadequate oversight of the yttrium-90 program. Previous reviews and revisions to the licensee's policy failed to identify that the scope of the policy specifically omitted yttrium-90 administrations since the inception of the program.

Title 10 CFR 35.41(a) states that, for any administration requiring a written directive, the licensee shall develop, implement, and maintain written procedures to provide high confidence that: (1) The patient's or human research subject's identity is verified before each administration; and (2) Each administration is in accordance with the written directive.

Contrary to the above, as of May 6, 2024, the licensee apparently did not develop, implement, or maintain written procedures to provide high confidence that: (1) The patient's or human research subject's identity is verified before each administration; and (2) Each administration is in accordance with the written directive. Specifically, the licensee did not develop, implement, or maintain written procedures for administering yttrium-90 microspheres.

The licensee's failure to develop, implement, and maintain written procedures to provide high confidence that each yttrium-90 administration was in accordance with the written directive was an apparent violation of 10 CFR 35.41(a) and is being considered for escalated enforcement action in accordance with section 6.3.b.3. of the NRC's Enforcement Policy.

4.3 Conclusions

The inspectors identified one apparent violation of NRC requirements involving the licensee's failure to develop, implement, and maintain policies and procedures for written directives, specifically for yttrium-90 administrations, as required by 10 CFR 35.41(a). The licensee's failure to establish such policies specific to yttrium-90 administrations contributed to the medical event.

5 Training and Experience of the Nuclear Medicine Staff

5.1 Inspection Scope

The inspectors reviewed the training and experience of the nuclear medicine staff involved in yttrium-90 administrations. The inspectors interviewed the RSO, selected nuclear medicine technologists, and selected licensee management. The inspectors also reviewed selected training records of the nuclear medicine staff.

5.2 Observations and Findings

The inspectors determined that the medical event occurred, in part, due to inadequate training of personnel involved with the yttrium-90 program. In its letter dated March 7, 2017, (referenced in NRC License Condition 14.C.), the licensee committed to provide training to all individuals involved in yttrium-90 microsphere use, commensurate with the individual's duties to be performed, and that the training would be provided to all individuals preparing, measuring, performing dosimetry calculations, or administering yttrium-90 microspheres. The licensee-maintained records for the initial training provided by the device manufacturer in 2017; this training focused on the assembly of the administration set and did not include instruction on properly interpreting the dose tables. Although the nuclear medicine staff were responsible for ordering TheraSphere™ dosages, in accordance with the authorized user's treatment plan, the staff had received no formal training in this process and did not demonstrate adequate knowledge of the yttrium-90 dosage and the resultant dose to the treatment site in comparison with the physician's prescribed dose to the treatment site. Prior to the medical event, the nuclear medicine staff did not understand how to read and interpret the dose tables based on the dosage, the calibration date for the dosage, and the resultant dose to the treatment site. The senior nuclear medicine staff, who were present for the initial training provided by the device manufacturer at the time the program started in approximately 2017-2018, passed down this information to new staff as they were hired.

The licensee's failure to provide instruction to the nuclear medicine staff who were involved in yttrium-90 procedures contributed to the cause of the medical event. The manufacturer provided initial training to the nuclear medicine staff when the program was set up years ago. This training was focused on ordering, conducting patient surveys, setting up the device administration set, and assaying the dosage. The staff could not recall specific instruction on the use of the computerized treatment worksheet and how to interpret and read the dose tables. As the licensee hired new nuclear medicine staff, the training provided during their onboarding was also limited to senior staff's recollection of their initial training from the device manufacturer.

Following the on-site inspection, the licensee committed to review and revise its quality management program in its entirety based on the initial inspection findings, as well as provided training to the nuclear medicine staff on the revisions. Although the licensee

halted its use of yttrium-90, the license authorization allowed the licensee to administer other radiopharmaceutical therapies which were not specified in its quality management program.

License Condition 14.C. of License No. 24-00158-03, Amendment No. 83 provides: "Except as specifically provided otherwise in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the Licensee's letter dated March 7, 2017."

The licensee's letter dated March 7, 2017, states, in part that "we [the licensee] commit to provide training to all individuals involved in Y-90 SIR-Spheres and TheraSpheres™ use, commensurate with the individual's duties to be performed. This training will be provided to all individuals preparing, measuring, performing dosimetry calculations, and administering microspheres."

Contrary to the above, prior to May 6, 2024, the licensee apparently failed to provide training to all individuals involved in yttrium-90 microsphere use, commensurate with the individual's duties to be performed. Specifically, the licensee apparently failed to provide training in the licensee's TheraSphere™ use that was commensurate with the duties to be performed by individuals, including the nuclear medicine staff, that were involved with ordering, preparing, measuring and performing dosimetry calculations for yttrium-90 microspheres administrations. The licensee's failure to provide training to all individuals involved in yttrium-90 microsphere use, commensurate with the individual's duties to be performed was an apparent violation of License Condition 14.C. of License No. 24-00158-03 and is being considered for escalated enforcement action in accordance with section 6.3.b.3. of the NRC's Enforcement Policy.

5.3 Conclusions

One apparent violation of NRC requirements was identified involving the licensee's failure to provide training to the nuclear medicine staff on its yttrium-90 program. The licensee's failure to provide training to the nuclear medicine staff contributed to the medical event.

6 Root Causes and Contributing Factors of the Medical Event

6.1 Inspection Scope

The inspectors reviewed the licensee's investigation of the medical event. The inspectors also interviewed selected representatives of the device manufacturer, and reviewed information from the manufacturer provided to the licensee.

6.2 Observations and Findings

The inspectors determined that the direct cause of the medical event was the administration of an incorrect total activity of yttrium-90 microspheres to the patient's left lobe of liver. The root cause of the apparent violations was attributed to a lack of management oversight of the yttrium-90 program.

The licensee utilized a contract provider for its interventional radiology services, which included physicians who prescribed yttrium-90. The current and former RSO role was also fulfilled by a contractor who routinely reviewed the radiation safety program quarterly during their audits; the previous consultant audits did not identify the omission of yttrium-90 in the licensee's quality management program.

The inspectors identified contributing causes of the medical event including: (1) unclear e-mail communications and instructions from the authorized user prior to nuclear medicine staff ordering the microspheres from the device manufacturer; (2) inadequate training; (3) inadequate policies and procedures; and (4) inconsistent use of a properly prepared, dated, and signed written directive prior to the administration of yttrium-90. The licensee staff were not trained nor proficient in interpreting the dose tables which would have provided information that the two dosages ordered for the medical event case, with their respective calibration dates, would have delivered a dose in excess of the prescribed dose to the treatment site. Additionally, the licensee had no policies and procedures specific to ytrrium-90 administrations that provided guidance/instruction on how to identify a potential error or inconsistency in the treatment worksheet and prevent a medical event. Finally, the licensee's practice of not generating a written directive prior to the treatment created a vulnerability, preventing the licensee from identifying that this combination of dosages (ordered for the medical event case) would result in an unintended overdose to the treatment site.

The inspectors determined that the medical event was not the result of the occurrence of a one-time error or circumstance. Although the inspectors identified no additional yttrium-90 medical events during the reactive inspection, the underlying conditions remained in place prior to the medical event for several years. These conditions were present in the licensee's yttrium-90 program (i.e. training inadequacies, deficiencies in policies and procedures, lack of properly prepared, signed, and dated written directives, and inadequate oversight) and undetected during program audits by the licensee and the previous consultant until this medical event, occurred.

6.3 Conclusions

The inspectors determined that the direct cause of the medical event was the administration of an incorrect total activity of yttrium-90 microspheres to the patient's left lobe of the liver. The root cause of the apparent violations was attributed to a lack of management oversight of the yttrium-90 program. Several other causes contributed to the medical event.

7 Licensee Corrective Actions for the Medical Event

7.1 Inspection Scope

The inspection included an assessment of the licensee's proposed corrective actions to prevent similar events. The inspectors reviewed the licensee's May 22, 2024, written report of the medical event and interviewed the RSO, selected radiology staff, and the authorized user.

7.2 Observations and Findings

At the conclusion of the on-site inspection, the licensee management committed to suspend its yttrium-90 program. The licensee reevaluated the need for the yttrium-90 program services based on a change of service contract with a new radiology group. The RSO subsequently contacted the senior inspector to inform them of the licensee's decision to permanently suspend the yttrium-90 program. The licensee committed to file a license amendment request limiting its authorization for storage only of the waste pending decay for disposal. The licensee submitted its amendment request in a letter dated July 8, 2024 (ML24190A107). On September 5, 2024, the NRC issued Amendment No. 84 authorizing the licensee's use of yttrium-90 for storage only.

7.3 Conclusions

The licensee implemented immediate actions to address the direct cause of the medical event to preclude similar events involving yttrium-90 administrations.

8 Notifications and Reports

8.1 Inspection Scope

The inspectors reviewed the licensee's notifications to the NRC Operations Center, the referring physician, and the patient. The inspectors reviewed the licensee's initial written report and addendum describing the medical event.

8.2 Observations and Findings

On May 7, 2024, the licensee notified the NRC Operations Center of the medical event (Event Number 57110). The licensee notified the patient and the patient's referring physician. The licensee provided its written report of the medical event to the NRC in a letter dated May 22, 2024 (ADAMS Accession No. ML24204A053), detailing its initial actions taken in response to the medical event. The report included the information required by 10 CFR 35.3045(d)(1). On July 9, 2024, the licensee provided an update to the NRC Operations Center to report an unintended dose to an organ (the patient's lungs) other than the treatment site. On July 18, 2024, the licensee provided an addendum to its report detailing the dose to the patient's lungs (ADAMS Accession No. ML24204A053).

8.3 Conclusions

The licensee made all the notifications and reports for the medical event as required by 10 CFR 35.3045 within the specified time period. The licensee's written report and its follow-up addendum for the medical event included all the required information.

9 Licensee's Follow up with the Patient and Medical Consultant's Evaluation of the Medical Event

9.1 Inspection Scope

The inspectors reviewed information and documents provided by the licensee related to the patient's medical status following the medical event. The inspectors reviewed the information provided by the NRC's physician consultant who reviewed the circumstances of the medical event. The inspectors also reviewed information related to the event to be further considered by the NRC for potential inclusion in its Abnormal Occurrence Report.

9.2 Observations and Findings

The licensee determined that the left lobe of the patient's liver received 362.9 Gray, equivalent to 362.9 Seivert (36,290 rem) rather than the authorized user's intended prescribed dose of 90 Gray, equivalent to 90 Seivert (9,000 rem). Based on the licensee's assessment, the patient's lungs received an unintended dose of 3.29 Gray, equivalent to 3.29 Seivert (329 rem) rather than 0.91 Gray, equivalent to 0.91 Seivert (91 rem) that was expected to be delivered to the lungs based on the licensee-determined lung shunt fraction. The lung shunt fraction value used by the licensee was 2.0 percent and was based on a determination made by the licensee prior to the patient's April 16, 2024, yttrium-90 TheraSphere™ treatment.

The licensee determined the cumulative dose to the patient's lungs from the April 16, and May 6, 2024, procedures as 4.2 Gray, equivalent to 4.2 Seivert (420 rem) rather than the expected dose of 2.39 Gray, equivalent to 2.39 Seivert (239 rem) to the patient's lungs. The licensee anticipated no adverse medical effects to the patient from the medical event and the unintended dose to the lungs. The licensee continued to provide follow-up medical care to the patient, including monitoring of the tumor response to the yttrium-90 treatment.

The NRC contracted with a physician consultant to assist the NRC's inspection activities related to the medical event. The medical consultant reviewed the patient's medical records provided by the licensee. According to the medical consultant's assessment, they noted that "no signs of liver failure such as jaundice, ascites or variceal hemorrhage. Although there was mild elevation of liver transaminase at 2 weeks, the bilirubin was stable at 0.4 at 2 months. The delivered dose still exceeds threshold for deterministic effects to the liver. There may be radiation induced liver disease. There may be some shrinkage of the treated lobe on follow-up imaging." The NRC medical consultant also noted in their report that the patient showed "no signs of pulmonary disease such as shortness of breath. The estimated lung dose is nearly 7 times less than the 30 Gy dose accepted as the dose required to induce deterministic effects. No other organs appear to be affected such as gallbladder, stomach, or colon." The medical consultant also provided that there were concerns about potential liver failure.

Section 208 of the Energy Reorganization Act of 1974, as amended, defines an Abnormal Occurrence (AO) as an unscheduled incident or event which the Commission considers significant from the standpoint of public health or safety. The NRC reports AOs to Congress annually. The AO criterion in effect at the time of the medical event, was published in the *Federal Register* on October 1, 2017 (82 FR 45907). For medical licensees, Criterion III.C.1.b and III.C.2.a provide, in part, that a medical event shall be considered for reporting as an AO if it results in a dose equal to or greater than 10 Gray (1,000 rad) to any organ or tissue (other than a major portion of the bone marrow, or the lens of the eye, or the gonads) and represents a dose or dosage that is at least 50 percent greater than that prescribed.

9.3 Conclusions

The licensee determined that the right lobe of the patient's liver received a dose of 360 Gray (equivalent to 360 Seivert or 36,000 rem) instead of the intended prescribed dose of 90 Gray (equivalent to 90 Seivert or 9,000 rem). The patient's lungs received a total dose of 4.2 Gray, equivalent to 4.2 Seivert or 420 rem) instead of the intended dose of 1.9 Gray, equivalent to 1.9 Seivert (190 rem). Medical follow up was performed of the patient following a medical event. According to the licensee's assessment, there was no anticipated significant liver or lung function decline; the patient's condition was characterized as stable. The NRC's physician consultant provided in their review concerns for potential radiation induced liver disease or potential liver failure; however, to date the patient remained stable. Based on the information provided by the licensee, the medical event meets the criterion used by the NRC for evaluating the reportability of this event as an Abnormal Occurrence to Congress.

10 Exit Meeting Summary

The NRC inspectors presented the preliminary inspection findings following the onsite inspection on May 15, 2024. The licensee did not identify any documents or processes reviewed by the inspectors as proprietary. The licensee acknowledged the findings presented. The final exit meeting was conducted via videoconference on November 7, 2024.

LIST OF PERSONNEL CONTACTED

Licensee:

#*Peter J. Batchelor, MBA, Director, Imaging Services
*Andrew Godbey, M.D., Chief Physician Executive
*Nicole Lewer-Holst, Esq., General Counsel & Compliance Officer
#*Gwendolyn Long, BHS, CNMT, RT (CT), Manger, Imaging Services
Venkatesh Arumugam Murugan, M.D., Interventional Radiologist/Authorized User
#*Lisa Newcomer RRT, MBA, FACHE, Vice President of Regional Operations
#*Meg Watson, RN, Manager, Accreditation and Compliance

The Medical Physics Group, Ltd.:

#*Ken Andrews, M.S., President, Consulting Physicist
#*Jamie C. Eisenberg, MHA, CNMT, Radiation Safety Officer for the licensee
*Robert Turco, Ph.D., DABR, Vice President

#Attended the on-site exit meeting on May 15, 2024
*Attended final exit videoconference on November 7, 2024

Representative of Boston Scientific Corporation contacted by videoconference on May 21, 2024
Aaron Bartoo, Ph.D., Director, Medical Affairs

INSPECTION PROCEDURES USED

IP 87103, “Inspection of Material Licensees Involved in an Incident or Bankruptcy Filing”
IP 87130, “Nuclear Medicine Programs”
IP 87132, “Brachytherapy Programs”

LIST OF ACRONYMS USED

ADAMS	Agencywide Documents Access and Management System
AO	Abnormal Occurrence
CFR	Code of Federal Regulations
NRC	Nuclear Regulatory Commission
QMP	Quality Management Program
Rad	Radiation absorbed dose
RSC	Radiation Safety Committee
Rem	Roentgen Equivalent Man
RSO	Radiation Safety Officer