



UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, ILLINOIS 60532-4352

December 11, 2018

EA-18-113

Mr. Chris Smith
VP, Corporate Compliance
Mistras Group, Inc.
4000 Underwood Road
LaPorte, TX 77571

SUBJECT: NRC INSPECTION REPORT NO. 03035114/2018002(DNMS), NOTICE OF VIOLATION, AND NRC INVESTIGATION REPORT NO. 3-2018-001 – MISTRAS GROUP, INC.

Dear Mr. Smith:

On October 2, 2017, the U.S. Nuclear Regulatory Commission (NRC) received written notification from your Director of Radiation Safety, Mr. Matthew Kim, that an industrial radiographer working in the State of Wyoming for Mistras Group, Inc. may have exceeded the annual occupational dose limit specified in Title 10 of the *Code of Federal Regulations* (CFR) 20.1201(a)(1)(i) as a result of an incident that occurred on September 8, 2017. Technical staff from NRC Region III reviewed this notification, and noted several items concerning NRC regulations for conducting radiographic operations at temporary jobsites that required further agency review. The NRC Office of Investigations began an investigation into these items on October 13, 2017, and completed the investigation on August 3, 2018. A factual summary of the NRC investigation is included in Enclosure 2.

In conjunction with this investigation, on October 24, 2017, staff from NRC Region III conducted a special inspection at your temporary jobsite on the premises of the Sinclair Oil Refinery in Sinclair, Wyoming, where the aforementioned incident occurred. The purpose of this inspection was to review the circumstances surrounding the incident and to assess its potential radiological significance. The results of this inspection are presented in Enclosure 3.

Based on the results of the NRC's review of this incident, two 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's website at <http://www.nrc.gov/about-nrc/regulatory/enforcement/enforce-pol.html>. The apparent violations involved: (1) an employee's deliberate use of radioactive material for unauthorized purposes, contrary to 10 CFR 30.34(c), and (2) an employee's deliberate conduct of radiography at a temporary jobsite with only one individual present, contrary to 10 CFR 34.41(a).

Because the NRC has not made a final determination in this matter, the NRC is not issuing a Notice of Violation for these inspection findings at this time. Mr. Ryan Craffey 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 you and Mr. Kim during an exit meeting by telephone on November 2, 2018.

Before the NRC makes its enforcement decision, we are providing you an opportunity to either: (1) respond in writing to the apparent violations addressed in this inspection report; (2) request a Predecisional Enforcement Conference (PEC); or (3) request Alternative Dispute Resolution (ADR). **Please contact Mr. Aaron T. McCraw, Chief of the Materials Inspection Branch, at 630-829-9650 or aaron.mccraw@nrc.gov within 10 days of the date of this letter to inform the NRC of your intended response.**

If you choose to provide a written response, it should be clearly marked as "Response to the Apparent Violations in Inspection Report No. 03035114/2018002(DNMS); EA-18-113," and should include, for the apparent violations: (1) the reason for the apparent violations, or, if contested, the basis for disputing the apparent violations; (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 violations. 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. Your response should be sent to the NRC's Document Control Desk, Washington, DC 20555-0001, with a copy mailed to the NRC Region III Office, 2443 Warrenville Road, Suite 210, Lisle, Illinois 60532, within 30 days of the date of this letter. 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 violations and any other information that you believe the NRC should take into consideration before making an enforcement decision. The topics discussed during the PEC 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, the NRC will issue a press release to announce the time and date of the conference; however the PEC will be closed to public observation since information related to an Office of Investigations report will be discussed and the report has not been made public.

In lieu of a PEC, 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 "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.**

Please be advised that the number and characterization of the apparent violations described in Enclosure 3 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.

As a result of the NRC's review of this incident, one violation of NRC requirements was identified in addition to the apparent violations previously identified. This violation was also evaluated in accordance with the NRC's Enforcement Policy and was categorized at Severity Level IV. The violation involved the failure to notify the NRC that Mistras Group was conducting radiographic operations and/or storing radioactive material at the Sinclair Oil Refinery, a location not listed on the license, for a period in excess of 180 days in a calendar year, as required by 10 CFR 34.101(c). The violation is cited in the enclosed Notice of Violation (Notice) (Enclosure 1). The NRC is citing the violation in the enclosed Notice because the inspector identified it.

The NRC has concluded that information regarding the reason for this violation, the corrective actions taken and planned to correct the violation and prevent recurrence, and the date when full compliance was or will be achieved is already adequately addressed on the docket in Enclosure 3. Therefore, you are not required to respond to this letter regarding the Severity Level IV violation unless the description therein 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.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and any response you provide 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 Mr. Craffey if you have any questions regarding this correspondence. Mr. Craffey can be reached at 630-829-9655.

Sincerely,

/RA/

John B. Giessner, Director
Division of Nuclear Materials Safety

Docket No. 030-35114
License No. 12-16559-02

Enclosures:

1. Notice of Violation
2. Factual Summary of NRC Investigation
3. IR 03035114/2018002(DNMS)

cc w/encl: Matthew Kim, Director of
Radiation Safety (RSO)
State of Texas
State of Wyoming

Letter to Chris Smith from John Giessner, dated December 11, 2018.

SUBJECT: NRC INSPECTION REPORT NO. 03035114/2018002(DNMS), NOTICE OF VIOLATION, AND NRC INVESTIGATION REPORT NO. 3-2018-001 – MISTRAS GROUP, INC.

DISTRIBUTION w/encls:

Steven West
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ADAMS Accession Number: ML18346A057

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DATE	11/13/2018		11/13/2018		12/6/2018		11/20/2018	
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NAME	KGamin*(via-e-mail)		*(via-e-mail)		JCameron		JGiessner	
DATE	12/4/2018		12/4/2018		12/10/2018		12/11/2018	

*LSreenivas (via-e-mail) these individuals concurred on the enclosed report; review and concurrence received via e-mail

OFFICIAL RECORD COPY

NOTICE OF VIOLATION

Mistras Group, Inc.
Burr Ridge, IL

License No. 12-16559-02
Docket No. 030-35114

During a U.S. Nuclear Regulatory Commission (NRC) inspection conducted on October 24, 2017, with continued review through November 2, 2018, one violation of NRC requirements was identified. In accordance with the NRC Enforcement Policy, the violation is listed below:

Title 10 of the *Code of Federal Regulations* (CFR) 34.101(c) states that any licensee conducting radiographic operations or storing radioactive material at any location not listed on the license for a period in excess of 180 days in a calendar year, shall notify the appropriate NRC regional office listed in §30.6(b)(2) of this chapter prior to exceeding the 180 days.

Contrary to the above, as of October 24, 2017, Mistras Group, Inc. conducted radiographic operations at a location not listed on the license for a period in excess of 180 days in a calendar year, and failed to notify the appropriate NRC regional office. Specifically, Mistras Group conducted radiographic operations at a temporary job site on the premises of the Sinclair Oil Refinery in Sinclair, Wyoming, a location not listed on NRC Materials License No. 12-16559-02, for a period in excess of 180 days in calendar year 2017, and failed to notify the appropriate NRC regional office prior to exceeding the 180 days.

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 NRC Inspection Report No. 03035114/2018002(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 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, IR 03035114/2018002(DNMS)" 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.

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.

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'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.

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

Dated this 11th of December 2018.

FACTUAL SUMMARY OF OFFICE OF INVESTIGATIONS REPORT 3-2018-001

On October 13, 2017, the U.S. Nuclear Regulatory Commission (NRC) Office of Investigations (OI), Region III Field Office, initiated an investigation to determine whether: (1) a radiographer willfully failed to use iridium-192 for industrial radiography as authorized by the NRC license issued to Mistras Group, Inc., (Mistras) while at the Sinclair Oil Refinery in Sinclair, Wyoming; (2) a radiographer willfully conducted radiographic operations without being accompanied by another qualified radiographer or an individual who has met the necessary training requirements; (3) Mistras willfully permitted an individual to act as a radiographer during radiographic operations without wearing on the body a personal dosimeter that is processed and evaluated by an accredited National Voluntary Laboratory Accreditation Program processor; (4) a radiographer willfully failed to conduct a survey of the radiographic device after each radiographic exposure to determine that the sealed source had been returned to its shielded position; and (5) Mistras willfully failed to control the annual occupational dose of an individual adult to 5 rem. The NRC completed its investigation on August 3, 2018.

On September 8, 2017, a Sinclair quality assurance department employee was reviewing production radiography film packets provided by a Mistras employee and identified a radiograph of a human hand. Sinclair staff notified Mistras of the radiograph who verified it was a radiograph of a hand. On the day the radiograph was submitted to Sinclair staff, only two Mistras employees were at the Sinclair facility. In a written report, dated October 2, 2017, the Mistras Director of Radiation Safety notified the NRC of a radiographer possibly exceeding the annual occupational dose limit in Title 10 of the *Code of Federal Regulations* 20.1201(a)(1)(i).

An investigator from Region III OI interviewed a number of individuals including Sinclair quality assurance staff, Mistras staff and management, and the Mistras radiographer and radiographer's assistant assigned to the Sinclair site at the time of the hand radiography.

During the OI investigation, the radiographer admitted to taking two radiographs of his own hand. The radiographer indicated that he took the radiographs of his hand by himself, without the knowledge of the assistant radiographer. The radiographer also indicated that he wore his personal dosimeter during the radiographs of his hand, and that he performed surveys of the guide tube and exposure device after taking the radiographs. The radiographer indicated that he did not intend to provide the radiographs to anyone. However, one of the radiographs was in a packet of radiographs provided to Sinclair quality assurance staff on September 8, 2017.

During the OI interview, the radiographer indicated that he wore his personal dosimeter and performed a survey of the exposure device after each radiographic exposure of his hand. The results of the OI investigation also indicated the licensee had originally calculated that the radiographer had received an occupational dose of 5.311 rem. However, after the licensee performed a recalculation of the radiographer's exposure using the actual strength of the source used for the hand radiographs, the licensee determined that the radiographer's occupational dose was 4.897 rem.

Based on a review of the OI report, training records, experience of the radiographer, and statements from Mistras personnel, it appears that on September 8, 2017, the radiographer deliberately radiographed his own hand, a use not authorized by Condition 9.A of Mistras' license and not in accordance with 10 CFR 30.34(c). Further, it appears the radiographer performed radiographic activities without another qualified individual present, as required by 10 CFR 34.41(a).

**U.S. Nuclear Regulatory Commission
Region III**

Docket No. 030-35114

License No. 12-16559-02

Report No. 03035114/2018002(DNMS)

EA No. EA-18-113

Licensee: Mistras Group, Inc.

Facility: Temporary Jobsite – Sinclair Oil Refinery,
100 Lincoln Avenue, Sinclair, Wyoming

Inspection Dates: October 24, 2017, with continued review
through November 2, 2018

Exit Meeting Date: November 2, 2018

Inspector: Ryan Craffey, Health Physicist

Approved By: Aaron T. McCraw, Chief
Materials Inspection Branch
Division of Nuclear Materials Safety

EXECUTIVE SUMMARY

Mistras Group, Inc. NRC Inspection Report 03035114/2018002(DNMS)

This was an announced special inspection of activities performed under U.S. Nuclear Regulatory Commission (NRC) Materials License No. 12-16559-02 at a temporary jobsite on the premises of the Sinclair Oil Refinery in Sinclair, Wyoming. The purpose of this inspection was to review the circumstances surrounding an incident that occurred on September 8, 2017, in which an industrial radiographer for Mistras Group, Inc. may have exceeded the annual occupational dose limit specified in Title 10 of the *Code of Federal Regulations* (CFR) 20.1201(a)(1)(i). A copy of the inspection charter will be available electronically for public inspection in the NRC's Public Document Room or from the NRC's Agencywide Documents Access and Management System (ADAMS) with Accession Number ML17306B193.

Mistras Group, Inc. concluded, following additional review, that the individual did not exceed any annual occupational dose limits. The NRC, after performing its own dose calculations, agreed with this conclusion.

Two apparent violations of NRC requirements were identified, involving: (1) use of radioactive material for unauthorized purposes, contrary to 10 CFR 30.34(c), and (2) radiography at a temporary jobsite with only one individual present, contrary to 10 CFR 34.41(a). One violation of 10 CFR 34.101(c) was identified, involving Mistras Group, Inc.'s failure to notify the agency that it was conducting radiographic operations and/or storing radioactive material at the Sinclair Oil Refinery, a location not listed on the license, for a period in excess of 180 days in 2017.

REPORT DETAILS

1 Program Overview and Inspection History

Mistras Group, Inc. (licensee), a nationwide non-destructive testing company, was authorized by NRC Materials License No. 12-16559-02 to use radioactive material for industrial radiography, materials analysis, and instrument calibration. The licensee had authorized locations in Alaska, Connecticut, Indiana, West Virginia, and Wyoming listed on the license and was authorized to work at temporary jobsites in NRC jurisdiction. The licensee's corporate radiation safety officer (RSO) was based in Ohio.

The licensee also maintained a continuous presence on the premises of the Sinclair Oil Refinery in Sinclair, Wyoming. The licensee stationed as many as 20 staff on site during refinery outages, but normally had between three and seven on site during normal business hours. Managers from the licensee's Longmont, Colorado office oversaw the conduct of licensed activities in Sinclair.

Since the last routine inspection of the licensee's radiation safety program in June-July 2017, the licensee has been inspected by the NRC at a temporary jobsite near Milne Point on the North Slope of Alaska (08/23/17), at a field station in Prudhoe Bay, Alaska (08/24/17), and at a temporary jobsite on the premises of the John. E. Amos Power Plant in Winfield, West Virginia (05/15/18). No violations were identified as a result of these inspections.

2 Sequence of Events and Licensee Response

2.1 Inspection Scope

The inspector toured the jobsite in Sinclair, interviewed licensee staff, and reviewed a selection of records to obtain the licensee's understanding of the circumstances surrounding the event, and to evaluate their response.

2.2 Observations and Findings

A. Sequence of Events

On September 8, 2017, two Mistras employees at the Sinclair Oil Refinery conducted radiographic operations in a designated area on the north end of the property. The area included a dedicated and barricaded one-story enclosure to shield against the elements and restrict access, as well as a mobile office for processing radiographic film. The radiographer and his assistant had taken three shots on one weld that morning, using a QSA 880D radiographic exposure device (s/n D11962) containing iridium-192 (Ir-192) in the form of a QSA Model A424-9 sealed source (s/n 58328G). Upon receiving the developed radiographs for this weld, the refinery's Quality Assurance (QA) personnel



Figure 1: Temporary Job Site

discovered that an unexpected fourth radiograph included with the three that they were expecting. This radiograph was of a human hand.

Title 10 CFR 30.34(c) states, in part, that each person licensed by the Commission pursuant to the regulations in this part and parts 31 through 36 and 39 shall confine his possession and use of the byproduct materials to the locations and purposes authorized in the license. NRC Materials License No. 12-16559-02, Amendment 37, dated April 21, 2016, and in effect on September 8, 2017, does not authorize the use of radioactive materials on humans. The radiographer's use of byproduct material contrary to the purposes authorized on the license, specifically the use of Ir-192 to radiograph his own hand on September 8, 2017, is an apparent violation of 10 CFR 30.34(c).

The Sinclair QA personnel immediately contacted Mistras regional management to inform them of the discovery. The licensee's General Manager of Operations and Regional Safety Manager for the US Mountain Region responded to the refinery, and confirmed it was a real radiograph of a human hand. After contacting Mistras corporate staff, the regional managers proceeded to interview the radiographer and his assistant separately about the radiograph. The radiographer admitted that he had radiographed his own hand twice, and had done so after obtaining the other radiographs, without the assistant present. During that time, the assistant had returned to the mobile office and was inside at the time that the radiographer created the additional radiographs.

Title 10 CFR 34.41(a) requires that whenever radiography is performed at a location other than a permanent radiographic installation, the radiographer must be accompanied by at least one other qualified radiographer or an individual who has at a minimum met the requirements of 10 CFR 34.43(c). The additional qualified individual shall observe the operations and be capable of providing immediate assistance to prevent unauthorized entry. Radiography may not be performed if only one qualified individual is present. The radiographer's conduct of radiography with only one qualified individual present (i.e., himself) is an apparent violation of 10 CFR 34.41(a).



Figure 2: Shooting area inside the enclosure

The managers were unable to obtain the reported second radiograph. However, they were able to gather from the interviews that the radiographer had obtained both using the aforementioned QSA camera connected to a seven-foot guide tube with a four half-value-layer tungsten collimator, and 25-foot drive cable. The end of this guide tube had been mounted approximately eight inches above a plate steel work bench using a magnetic stand. The radiographer

acknowledged cranking the source out to the end of this guide tube and placing his hand under the exposed source for approximately 8 seconds to obtain the first radiograph and approximately 15 seconds to obtain the second.

B. Licensee Response

The managers immediately and permanently revoked the radiographer's access to the site, and shortly thereafter terminated his employment with Mistras. The licensee

retrieved and immediately sent the radiographer's optically-stimulated luminescent (OSL) dosimeter, issued for the month of September 2017, for emergency processing. The vendor later reported that the dosimeter returned a deep-dose equivalent exposure of 2 millirem (mrem).

The managers also made their own estimate of whole-body and extremity dose to the radiographer based on information obtained from interviews with the individual. Because of the limited amount of detailed and reliable information they were able to obtain from the radiographer at the time, the managers made a number of assumptions based on their best attempts to reenact the radiographer's actions, including that:

- the source was uncollimated;
- the radiographer stood in front of the work bench, approximately 12 inches from the end of the guide tube, during the entire incident;
- the radiographer used a pipe stand to keep the handle steady at his side while he cranked out the source; and,
- the radiographer took approximately five seconds to crank the source out and five seconds to crank it back in, adding ten seconds of total exposure time to each radiograph.

Using a gamma constant of 5.2 rem per hour per curie at one foot, the licensee calculated initially that the radiographer had received approximately 9.4 rem extremity dose to the right hand, and 4.1 rem whole-body dose. The radiographer's year-to-date dose was already nearly 1.2 rem, therefore the licensee determined that the radiographer, in radiographing his own hand, appeared to have exceeded the regulatory limit in 10 CFR 20.1201(a)(1)(i) of 5 rem total effective dose equivalent by approximately 300 mrem.

C. Notification and Reporting

On October 2, 2017, the licensee submitted a written report of the incident to the NRC, in accordance with 10 CFR 20.2203(a)(2)(i). On October 10, 2017, the inspector reviewed the report. The inspector found that the report contained all required information; however, the inspector later identified through a review of utilization logs and sealed source inventory data that the licensee had inadvertently transposed two digits of the Ir-192 sealed source's activity and used a value 12 percent higher than the actual activity to determine the radiographer's doses.

The licensee subsequently revised the radiographer's extremity exposure down to 8.4 rem, and his whole-body exposure down to 3.7 rem. Incorporating the radiographer's year-to-date dose of 1.2 rem, the licensee determined that the radiographer had received approximately 4.9 rem of whole-body dose, and therefore did not exceed the regulatory limit in 10 CFR 20.1201(a)(1)(i).

On November 20, 2017, the licensee submitted a corrected written report of the incident to the NRC, incorporating the revised calculations. The technical staff from NRC Region III reviewed these revised calculations and did not identify any additional discrepancies.

2.3 Conclusions

The inspector had no concerns with the licensee's response to or reporting of the September 8, 2017 incident. The NRC identified apparent violations of 10 CFR 30.34(c) and 34.41(a).

3 **NRC Radiological Assessment of Incident**

3.1 Inspection Scope

The inspector toured the jobsite in Sinclair, interviewed licensee staff, reviewed a selection of records, and conducted independent dose assessments to evaluate the circumstances and consequences of the incident.

3.2 Observations and Findings

A. Estimation of Radiation Dose

The inspector calculated whole-body and extremity dose to the radiographer based on information obtained from the inspection and from other NRC interviews with the radiographer. Based on the information obtained, the inspector was able to calculate more realistic doses using parameters that differed from those originally used by the licensee, including the following:

- the source was collimated with four half-value layers of tungsten shielding, which limited direct exposure to a downward-facing 60-degree beam cone;
- the radiographer reused the setup that he and his assistant had used for the previous shots (see Figure 2, above);
- the radiographer first cranked out the source, then walked over and kneeled in front of the bench, exposed his hand the first time, remained kneeling while he swapped the film, exposed his hand a second time, and walked back to the cranks to retract the source;
- the radiographer took approximately two seconds to walk from the cranks to the spot at which he knelt;
- the radiographer knelt sideways in front of the work bench, rather than stand, in an attempt to utilize shielding provided by the half-inch thick steel bench top and an eighth-inch thick lead plate beneath the beam;
- the radiographer knelt down 12 inches from the front of the work bench, and was therefore 20 inches from the source while it was exposed; and,
- the radiographer remained kneeling for approximately five seconds between direct exposures to his hand while he swapped films.

The inspector used Table 1 of NRC Regulatory Guide 8.40, "Methods for Measuring Effective Dose Equivalent from External Exposure," to calculate whole-body dose for the

time the radiographer was kneeling using compartment factors and estimated dose at the center points of each compartment (see Figure 4).

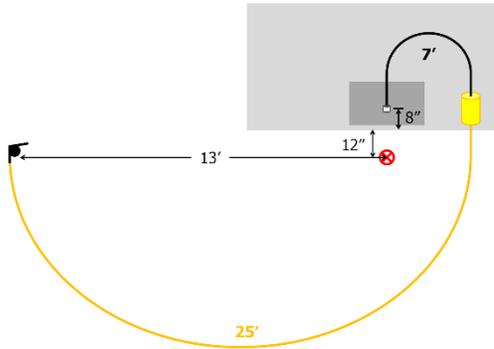


Figure 3: Equipment setup

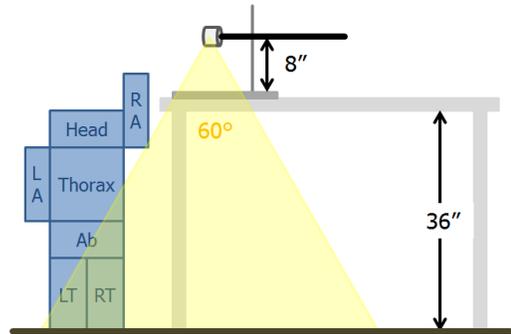


Figure 4: Dose compartments relative to beam

Using the same gamma constant as the licensee, the inspector calculated that the radiographer had received approximately 5.9 rem extremity dose to the right hand, and less than 0.1 rem whole-body dose (see Table 1).

Phase	Time <i>seconds</i>	Whole-Body <i>mrem</i>	Extremity <i>mrem</i>
1. Crank Out	5	0.14	0.14
2. Walk Over	2	0.91	0.91
3. First Radiograph	8	18.13	2,036.01
4. Swap Film	5	11.91	11.21
5. Second Radiograph	15	33.98	3,817.51
6. Walk Back	2	0.91	0.91
7. Crank In	5	0.14	0.14
TOTAL	42	66.12	5,866.83

Table 1: Dose estimate for each phase of the incident

Although there are assumptions and variables in this dose reconstruction, it is unlikely that the radiographer exceeded any regulatory limits for radiation exposure. Furthermore, the inspector concluded that neither the assistant radiographer nor any other member of the public likely received a dose in excess of applicable regulatory limits. The assistant, who was assumed to be the next closest person to the incident, was in the trailer approximately 40 feet from the collimated source. Conservatively assuming no other shielding was present, the assistant would have received, at most, around 0.2 mrem whole-body dose.

B. Comparison of Calculated Doses to Reported Readings

The inspector reviewed each utilization log prepared by the radiographer and the assistant completed in the five months leading up to the incident, in addition to monthly OSL dosimeter readings over the same time frame. The inspector noted that, in addition

to an OSL reading of 2 mrem for the month of September, the radiographer recorded 7 mrem of dose from daily reads of his pocket dosimeter, including 4 mrem on the day of the incident.

The inspector performed additional calculations using the assumptions described above and found that, depending on where exactly the radiographer wore his OSL dosimeter, it could have received anywhere from less than 10 percent to more than 150 percent of the whole-body dose calculated above. The inspector noted that the lower limit of this range nearly coincides with the dose actually recorded by the radiographer's OSL dosimeter.

Although the recorded dose varies by a factor of more than a thousand from the whole-body dose calculated by the licensee, it should be noted that the licensee made extremely conservative assumptions in doing so; primarily by assuming that no collimator was present. Controlling for this assumption and for the distance that the radiographer was from the source, the licensee's estimated whole-body dose would actually have been within about 15 percent of that estimated by the NRC (76 mrem vs. 66 mrem).

3.3 Conclusions

The inspector concluded that the radiographer likely did not exceed any regulatory limits for radiation exposure as a result of this incident.

4 **Other Areas Inspected**

4.1 Inspection Scope

The inspector toured the jobsite in Sinclair, interviewed licensee staff, and reviewed a selection of records to evaluate select aspects of the radiation safety program as implemented at the Sinclair Oil Refinery.

4.2 Observations and Findings

The inspector found that the licensee used adequate hazard communication measures at the temporary jobsite and had adequately secured all radioactive material on the premises from unauthorized removal. The licensee's personnel possessed calibrated and operable dosimetry and instrumentation, as well as properly labeled radiography equipment, which the inspector found to be in good condition. The inspector also reviewed a selection of radiographer audits and initial and refresher training material.

Title 10 CFR 34.101(c) requires, in part, that any licensee conducting radiographic operations or storing radioactive material at any location not listed on the license for a period in excess of 180 days in a calendar year, shall notify the appropriate NRC regional office prior to exceeding the 180 days. The inspector reviewed utilization logs and interviewed available staff and concluded that the licensee conducted radiographic operations or stored licensed material to the Sinclair Oil Refinery every weekday and occasionally on weekends, as well. As such, the licensee would have exceeded 180 days of use or storage no later than September 2017. As of October 24, 2017, the licensee had conducted radiographic operations or stored radioactive material at the Sinclair Oil Refinery, a location not listed on the license, for over 180 days in calendar

year 2017 and had not provided the required notification. The licensee's failure to provide that notification prior to exceeding 180 days of use or storage is a violation of 10 CFR 34.101(c).

The inspector determined that the root cause of the violation was a misunderstanding of regulatory requirements; the licensee did not realize that a day in which material was used on the premises (but not stored overnight) counted towards the 180-day threshold.

As corrective action, on November 2, 2018, the licensee provided the required notification to the NRC's Region III Materials Licensing Branch. The licensee confirmed that this was currently its only long-term temporary jobsite. The licensee also committed to send an email to site RSOs reminding them of the requirement in 10 CFR 34.101(c), and to revise the section of its Operating and Emergency procedures on field operations requirements to include an additional reminder.

4.3 Conclusions

The inspector identified a violation of 10 CFR 34.101(c).

5 **Exit Meeting Summary**

The NRC inspector presented preliminary inspection findings following the onsite inspection on November 2, 2018. The licensee acknowledged the findings presented.

LIST OF MANAGEMENT PERSONNEL CONTACTED

- Kelly Fulton – Safety Manager, U.S. Mountain Region
- Eric Hopkins – General Manager of Operations, U.S. Mountain Region
- # Matthew Kim – Director of Safety, RSO
- # Chris Smith – VP, Corporate Compliance

- # Attended exit meeting on November 2, 2018

INSPECTION PROCEDURES USED

- 87103: Materials Licensees Involved in an Incident or Bankruptcy Filing
- 87124: Fixed and Portable Gauge Programs