

ENCLOSURE

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Docket No.: 030-30691

License No.: 35-26953-01

Report No.: 030-30691/96-01

Licensee: Barnett Industrial X-Ray, Inc.

Facility: Barnett Industrial X-Ray, Inc.

Location: P.O. Box 1991
312 East Newman Avenue
Stillwater, Oklahoma

Dates: October 4 through December 9, 1996

Inspector: Richard A. Leonardi, Jr.
Radiation Specialist

Accompanied By: Charles L. Cain, Technical Assistant
Division of Nuclear Materials Safety

Approved By: Linda L. Howell, Chief
Nuclear Materials Inspection and
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Division of Nuclear Materials Safety

Attachments: 1. Supplemental Inspection Information
2. NRC Dose Calculations

EXECUTIVE SUMMARY

Barnett Industrial X-Ray, Inc., Stillwater, Oklahoma
NRC Inspection Report 030-30691/96-01

This inspection was conducted to review circumstances associated with an event that resulted in an unintended exposure of a radiographer's assistant (assistant) during radiographic operations at an oil refinery on October 3, 1996. The inspection also included a review of relevant aspects of the licensee's radiation protection program.

Purpose of Inspection and Licensee Program Overview (87100)

- On October 3, 1996, the licensee notified the NRC Region IV office of an event involving the unintended exposure of the assistant during radiographic operations at an oil refinery near Ponca City, Oklahoma. Region IV initiated a reactive inspection on October 4, 1996.

Causes of the Radiography Exposure Event (87100, 83822, 87103)

- The inspection determined that the direct causes of the event were a failure to fully retract an iridium-192 source to its shielded position at the conclusion of an exposure and failure to perform a survey of the exposure device after a radiographic exposure. The failure of radiography personnel to wear alarming ratemeters while performing radiography and the radiographer's failure to supervise an assistant while he was performing radiographic operations were identified as contributing causes of the event.

Review of Licensee Radiation Safety Program (87100)

- Both the radiographer and assistant had been trained in accordance with the conditions of the license and NRC requirements. Both individuals had been audited at prescribed intervals with no significant findings. The radiographic equipment in use on October 3 had been inspected and maintained in accordance with NRC requirements.

Event Reporting and Evaluation (87100, 83822)

- The licensee notified the NRC Region IV office by telephone promptly upon discovery of the unintended exposure. The radiation safety officer (RSO) reported to the temporary jobsite to investigate what had occurred and complete dose estimates.

Licensee Corrective Actions (87100)

- The RSO initiated immediate corrective measures upon notification of the exposure event. The RSO suspended both the radiographer and the assistant from work

activities for 3 days without pay and issued a "Notice of Safety Infraction" (written disciplinary action) to both individuals. The radiographer was subsequently terminated from employment with BIX. The RSO notified the remaining BIX employees of the event and provided additional instruction regarding the importance of using personal monitoring devices and performing required radiation surveys. The licensee also stated its intent to perform additional field audits of BIX employees to verify their compliance with NRC requirements and that additional disciplinary actions had been established to emphasize the importance of compliance.

Report Details

1 Purpose of Inspection and Licensee Program Overview (87100)

On October 3, 1996, at 11:45 a.m., the licensee notified the NRC Region IV office of an event involving an unintended exposure of a radiographer's assistant. The event occurred at approximately 9:30 a.m. while a radiographer and assistant were finishing two exposures at an oil refinery in Ponca City, Oklahoma. The RSO reported that the assistant attempted to remove the source guide tube from the exposure device after the second exposure was completed and discovered that the source had not been fully retracted into the device. Upon receiving notification from the radiographer and assistant, the RSO traveled to the refinery to begin an investigation of the incident. The RSO indicated that neither the radiographer nor the assistant were wearing personal monitoring devices during the event, and the assistant had not conducted a survey of the exposure device after the second exposure. Region IV initiated a reactive inspection to review the circumstances associated with the event and to review pertinent aspects of the licensee's radiation safety program.

BIX is authorized to possess iridium-192 and cobalt-60 sealed sources for use in radiographic devices under NRC License 35-26953-01. The license was recently renewed in March 1996, authorizing a new office/storage location and the addition of new source assembly model numbers. At the time of the inspection, the licensee possessed a total of five exposure devices, including four Amersham Model 660B exposure devices and one empty Gamma Century exposure device (this device was no longer in use). As of October 3, 1996, BIX employed four full-time radiographers and two assistants. Five mobile radiography units were in use in October 1996. Although the licensee is authorized to possess and use exposure devices with cobalt-60 sources, BIX did not have any exposure devices designed for use with cobalt-60 sources at the time of the inspection. BIX primarily performs radiography at refineries in northern Oklahoma and has worked at the Conoco refinery in Ponca City, Oklahoma, for several years.

2 Radiography Event Description (87103)

2.1 Inspection Scope

The inspector interviewed personnel involved with the event, observed a re-enactment of the assistant's actions, and reviewed pertinent records maintained by the licensee.

2.2 Observations and Findings

On October 3, 1996, the radiographer and assistant were tasked with radiographing two welds on refinery equipment. The equipment in use on October 3 was an Amersham Model 660B projector (Serial No. 2089) housing a 36.5 curie iridium-192 sealed source (Amersham Model A424-9, Serial No. A8632). The exposure device was fitted with a 7-foot guide tube with a shielded collimator and a 35-foot drive cable and associated pistol-grip crank assembly. All equipment used on October 3 met the standards specified in 10 CFR 34.20. The radiographer's daily equipment

check and BIX's last quarterly inspection of the equipment (performed on September 30, 1996) indicated that the equipment was operating properly.

Both the radiographer and assistant admitted that they were not wearing film badges, pocket dosimeters, and alarm rate meters on the morning of October 3, although they had their personal monitoring devices with them at the temporary jobsite. Two survey instruments were available at the jobsite; however, only one survey instrument was used by the radiographer and assistant on the morning of October 3, 1996.

The welds that the BIX crew was to radiograph were located on a nozzle that protruded from refinery equipment approximately 9 feet above the ground. A scaffold was constructed with a platform approximately 6 feet above the ground, and a second level platform was positioned approximately 3 feet above the surface of the first platform. The exposure device was placed on the second level platform, and the radiographer and assistant positioned the film and source guide tube while standing on the first platform. This placed the exposure device between knee and waist height of the operators.

The sequence of events involving the exposure event are described as follows:

- Both the radiographer and the assistant arrived at BIX's office at 7 a.m. on October 3. They departed BIX's office and arrived at the Conoco refinery at 8 a.m. and drove to the work location within the Conoco refinery. The assistant stated that prior to setting up the equipment, he and the radiographer contacted two Conoco employees to discuss upcoming radiography work. During this discussion, they realized that it was 9 a.m. and the scheduled window of time for the BIX employees to complete their work had been set for 9:00-9:15 a.m. The radiographer and assistant rushed back to the work location and started to set up the equipment sometime after 9 a.m. The assistant indicated that he set up the restricted area barricade tape and left the work location to obtain a work permit while the radiographer set up the radiography equipment.
- After the work permit was obtained and the equipment was set up, the radiographer and assistant worked together to complete the first exposure. As noted above, the exposure device was positioned on the second level of the scaffold, and the drive cable controls were positioned at ground level. After the first exposure was completed, both the radiographer and the assistant proceeded to remove the film and reposition the source guide tube for the second exposure. The radiographer carried the survey instrument with him as the two proceeded to prepare the equipment for the second exposure.
- For the second exposure, the radiographer cranked the source out, timed the exposure, and proceeded to hand the controls to the assistant. The radiographer instructed the assistant to crank the source in, remove the film and collimator, disconnect the source guide tube and drive cable from the

exposure device, and load the radiography equipment into the truck. The radiographer intended to remove the barricade established around the work area as the assistant was disassembling the equipment. The radiographer turned his back to assistant and proceeded to remove the restricted area barricade tape.

- The assistant cranked the source in (he did not remember hearing or feeling the source assembly lock in the exposure device) as instructed and proceeded to the first level of the scaffold. He did not take the survey instrument with him and later stated that he hadn't thought about it since he expected the radiographer to follow him with the instrument. He removed the two films and placed them in his pockets, removed the collimator from the source guide tube, and then turned to disconnect the source guide tube from the exposure device.
- The assistant grabbed the source guide tube with his right hand and proceeded to disconnect the source guide tube from the exposure device. Once he had disconnected the source guide tube, he pulled the source guide tube a few inches away from the exposure device intending to insert the safety plug into the source tube outlet. To his surprise, he observed the connector portion of the source pigtail protruding from the exposure device. The assistant realized that the source capsule was still outside the exposure device and immediately pushed the source guide tube back onto the exposure device. (The assistant did not take the time to fully reconnect the source guide tube to the exposure device.)
- The assistant immediately descended from the scaffold, yelling to the radiographer that the source was out of the exposure device. The radiographer picked up the drive cable controls and proceeded to retract the source into its fully shielded position within the exposure device.
- The radiographer and assistant re-erected the restricted area barricade tape, conducted a radiation survey of the area and a survey of the exposure device, and assured themselves that the source was in a fully shielded position. The radiographer and assistant then disconnected the radiography equipment and placed the equipment in the truck.
- Both the radiographer and assistant proceeded to Conoco's main fabrication shop and telephoned BIX's Stillwater office to report the incident. They discussed the incident with BIX's general manager who subsequently notified the RSO.

3 Causes of the Radiography Exposure Event (87103, 83822, 87100)

3.1 Inspection Scope

This portion of the inspection was focused on identifying possible causes of the exposure event. The inspector interviewed personnel and reviewed relevant records.

3.2 Observations and Findings

Based on interviews with licensee personnel and a review of the sequence of activities associated with the event, multiple causes of the event were identified. These probable causes are discussed below.

Failure to fully retract the source into the exposure device was identified as the most significant direct cause of the exposure event. Had the radiography source been fully retracted into the exposure device and locked into the fully shielded position, the unnecessary exposure of the assistant would not have occurred.

The Amersham Model 660B exposure device is designed and manufactured to automatically secure the source pigtail (source assembly) in a shielded position when the source assembly is fully retracted into the exposure device at the end of each radiographic exposure, as required by 10 CFR 34.20(c)(2). This function is accomplished by the locking mechanism which includes a safety slide bar (with color coded source position indicator) that engages the source assembly stop ball. When the source is fully retracted, the safety slide bar is designed to move to the lock position and a green dot is visible on the slide bar, just left of the selector ring, providing an indication to the user that the source is fully retracted.

During interviews with the assistant regarding his actions following the second exposure, he indicated that he retracted the source as he had many times previously; however, the assistant could not recall if he heard the safety slide bar "click" back into its locked position due to the high background noise level. Additionally, the assistant could not recall if he had applied a slight amount of forward pressure on the crank handle (as if to expose the source) to ensure that the positive locking mechanism had engaged the source assembly. This technique was described in the licensee's training program, as verified by the assistant and the RSO. In addition, Section 5.6 of the manufacturer's (Amersham) operating manual (MAN-006) describes the "click" sound that is made when the safety bar snaps into place and engages the stop ball on the source assembly. Also, this section emphasizes the technique of exerting forward pressure on the crank handle to ensure that the positive locking mechanism has engaged the source assembly. The inspection identified the assistant's potential failure to monitor the "clicking" sound of the safety bar and failure to test whether it had engaged the source assembly as a possible root cause of the event.

The failure to perform a survey after the second exposure to determine that the sealed source had been returned to its fully shielded position was identified as a

second direct cause of the event. Had the assistant used a survey instrument and observed the instrument as he approached the exposure device after the second exposure, it is likely that the assistant would have realized that the source was not in a fully shielded position. During interviews with the assistant regarding his failure to perform a post-exposure survey, he indicated that he assumed that the radiographer was following directly behind him as he approached the exposure device and that the radiographer had a survey instrument with him (as occurred after the first exposure). The assistant indicated that he did not realize that the radiographer had not accompanied him to the exposure device after the second exposure until after he removed the two films and turned around to place them in his pockets. The assistant disclosed that after realizing that he did not have a survey instrument with him, he decided to proceed and disassembled the exposure device without first obtaining a survey instrument.

The failure to use personal monitoring devices during radiographic operations on October 3, 1996, was identified as a contributing cause to the event. During interviews with the licensee's RSO and the radiographer and assistant, it was determined that neither the radiographer nor the assistant wore a film badge, pocket dosimeter, and alarm ratemeter while performing radiography on October 3. The inspector verified through discussions with the RSO, radiographer, and assistant that the individuals had film badges, pocket dosimeters, and alarm ratemeters present at the jobsite on October 3; however, they failed to wear them and instead left them in the truck.

Had the assistant worn his film badge, pocket dosimeter, and alarm ratemeter on the day of the event, the alarm ratemeter most probably would have sounded an alarm as he attempted to disassemble the exposure device. This would have alerted the assistant to the fact that the source was exposed. In addition, had the assistant worn his film badge, additional information would have been available to assist the RSO in determining the actual dose received by the assistant.

Both the radiographer and assistant stated that they simply forgot to wear personal monitoring devices while performing radiography on October 3, 1996. Both individuals indicated that they were "in a hurry to shoot" the two assigned films within the scheduled 15-minute break period. During separate interviews with the radiographer and the assistant, the assistant revealed that on at least one other occasion he had forgotten his personal monitoring devices while working with another radiographer. However, he noted that the radiographer reminded him to retrieve the devices and put them on before beginning work for the day. The radiographer indicated that he may have forgotten his pocket dosimeter on a few occasions in the past, but stated that he had never forgotten all three monitoring devices.

During interviews with the licensee's RSO regarding this issue, the RSO indicated that he had no concerns in the past regarding the safety practices of either of the two individuals involved in the event. The RSO disclosed that the radiographer had been audited in the field on four occasions prior to the event, and on all four occasions the radiographer was wearing all required personal monitoring devices.

The RSO also indicated that he had audited the assistant on three occasions prior to the event, and on all three occasions the assistant was wearing all required personal monitoring devices. The RSO stated that upon his arrival at the refinery, both individuals had in their possession all three required personal monitoring devices. However, both individuals admitted they had not worn the devices while completing the two exposures earlier that morning.

The failure of the radiographer to exercise close supervision of the assistant during radiographic operations on October 3, 1996, was identified as contributing cause of the event. Had the radiographer observed the assistant retract the source after the second exposure and noted that the assistant approached the exposure device without a survey instrument, he could have instructed the assistant to carry and use a survey instrument as he approached the device. The inspector verified through discussions with the radiographer and assistant that once the radiographer handed the assistant the drive cable controls and requested that he retract the source, the radiographer turned his back to the assistant and proceeded to remove the restricted area tape barricade.

The individuals' level of training and experience also appeared to be a contributing factor. Although the radiographer and assistant had been trained in accordance with the licensee's approved training program, both individuals were young in age, both had no previous training or experience in industrial radiography prior to working for BIX, and both had been performing radiography for a relatively short period of time prior to the event. Based on interviews with the RSO and a review of licensee training records, the inspector determined that the radiographer began work as an assistant with BIX in August 1995 and had been performing the duties of a radiographer since August 1996. The radiographer stated that he had worked as a radiographer on 15 jobs from August to October 1996. A review of the assistant's training records revealed that he began work with BIX in February 1996 and was designated as an assistant during April 1996. The assistant had worked with another experienced radiographer for the majority of the period from April to October 1996.

Time constraints and the radiography crew's rush to complete the two exposures was identified as another possible contributing cause of the event. During initial interviews with the radiographer and assistant, they indicated that they were in a hurry to complete the two exposures within the 15-minute break period (from 9:00-9:15 a.m.) because refinery personnel would not be in the area. Because the two exposures were fairly short and the welds were located on the same nozzle, this appeared to be an adequate period of time to complete the work. However, the radiographer and assistant spent some of this 15-minute period talking with refinery personnel in another area of the facility and as a result, they felt rushed to complete their work. This may have affected their performance in some respects, particularly with regard to locating and wearing their personal monitoring devices (neither had the devices on when they arrived at the refinery, although the devices were in the company vehicle) and the radiographer's actions following the second exposure. Specifically, the radiographer was attempting to remove the restricted area

barricade as the assistant disassembled the equipment so that they could leave the area before the end of the break. As a result, he was not watching the assistant.

However, during interviews with the RSO, the inspector determined that although the radiography crew was assigned to complete the two exposures during the 15-minute break period, it was not imperative that the exposures be completed at this specific time. The RSO indicated that he has a good working relationship with the refinery and that if for some reason assigned radiography could not be performed at the specified time, refinery personnel would provide other opportunities to complete assigned work. The radiographer subsequently stated that he was aware that he could stop radiographic operations anytime he was unable to perform radiography safely and that another opportunity would be provided to complete the work.

3.3 Conclusions

Based on interviews with licensee personnel and a review of the sequence of activities and facts associated with the event, the inspector determined that the exposure event had multiple direct causes, including the assistant's failure to perform a survey of the exposure device. The root cause of the event was appeared to be a failure to closely monitor the locking mechanism of the exposure device as the source was retracted and failure to test whether the locking mechanism had engaged the source as specified in the licensee's operating and emergency procedures. The radiographer's failure to supervise the assistant as he was completing the second exposure was identified as a contributing cause of the event.

4 **Review of Licensee Radiation Safety Program (83822, 87100, 86740)**

4.1 Inspection Scope

This portion of the inspection was focused on aspects of the licensee's radiation safety program that are relevant to the event. The inspector interviewed personnel and reviewed records relating to the radiation safety program.

4.2 Observations and Findings

A review of BIX's current training program revealed that the program had been implemented as outlined in the license application dated November 21, 1993. Training records for the radiographer and assistant involved in the event revealed that both individuals had been trained as specified in the license application. The assistant had received 8 hours of classroom training, a copy of the licensee's operating and emergency procedures, and had successfully completed Test No. 1 of the training qualification program. The assistant was audited in the field on three occasions prior to the exposure event with no negative findings identified. The radiographer's training records indicated that he had completed training as an assistant prior to beginning his radiographer training program. Records were available documenting his completion of the required 40-hour radiation safety

course and his successful completion of Test No. 2 of the training qualification program. The inspector noted that the radiographer had been audited on four occasions prior to the exposure event with no negative findings identified.

Quarterly inventory and inspection/maintenance records for radiographic equipment indicated that the inspections had been performed at quarterly intervals since the previous inspection of August 1995. The last quarterly maintenance inspection of the Amersham Model 660B exposure device used during the event was performed on September 30, 1996, just three days prior to the event. Records documenting this inspection indicated that no problems were identified and only routine maintenance was performed.

A review of personal safety equipment calibration records disclosed that the direct reading pocket dosimeters and alarm ratemeters used by the radiographer and assistant had been calibrated within the intervals specified in the licensee's procedures and in accordance with NRC requirements. The survey instrument used by the two individuals on October 3 had been calibrated within the previous 3 months.

Licensee dosimetry records indicated that the radiographer and assistant had received whole-body doses of 550 millirem (mrem) Total Effective Dose Equivalent (TEDE) and 265 mrem TEDE, respectively, from January through July 1996.

A selective review of licensee "Radiation Reports" (these are used to document activities performed at temporary jobsites) completed prior to the event indicated that surveys had been performed and recorded by the radiographer during work at other jobsites.

4.3 Conclusions

Based on a selective review of records and interviews of personnel, it appeared that with exception of the October 3 incident, the radiation safety program had been implemented as required. The RSO appeared to have maintained an appropriate level of program oversight.

5. **Event Reporting and Evaluation (83822, 87100)**

5.1 Inspection Scope

This portion of the inspection was focused the licensee's response to and evaluation of the event. The inspector conducted interviews with personnel and reviewed records documenting the licensee's dose assessment. A re-enactment of the actions taken by the assistant to disassemble the exposure device was also performed.

5.2 Observations and Findings

The licensee's RSO notified the NRC Region IV office of the suspected unintentional exposure of the assistant within three hours of the event. Telephone notification was made after the RSO visited the temporary jobsite to evaluate the situation with the radiographer and assistant. During initial discussions with the NRC, the RSO indicated that preliminary dose evaluations performed at the temporary jobsite and later at the licensee's office suggested that the event did not result in the assistant receiving a whole body dose in excess of regulatory limits. However, because he had not yet completed a full dose assessment and because of the significance of his initial findings, the RSO elected to notify the NRC Region IV office of the event by telephone.

The RSO conducted a re-enactment of the event at the jobsite with the assistant to determine the distances and exposure times required to estimate the dose received by the assistant. The RSO initially estimated that the assistant received a whole body dose of 2-5 rem (TEDE) and an extremity dose of 17.4 rem Shallow Dose Equivalent (SDE). The initial whole body dose estimate made by the RSO was later modified in accordance with a second re-enactment of the event. The RSO's final whole body dose estimate for the assistant was 1 rem. The RSO also examined the exposure device used on October 3 upon arrival at the jobsite and found no evidence of equipment defects or problems that could have contributed to the event. As noted in Section 4.2 of this report, the inspector's review of the maintenance history of this particular exposure device revealed that the device had been in good operating condition just prior to the event.

The inspector also performed dose calculations based on information obtained during interviews with the assistant and a re-enactment of actions taken by the assistant to disassemble and re-assemble the exposure device and source guide tube. The inspector estimated that the whole body dose received by the assistant was 0.9 rem and that the dose to the maximally exposed extremity was 16.7 rems. These dose estimates were based on a time and motion study conducted with the assistant and the source activity as verified by manufacturer's records. The inspector used the same gamma constant used by the licensee (which was considered conservative). The assistant's occupational dose through August 1996 was recorded as 0.265 rem. At the time of the initial site visit, the assistant's September 1996 film badge had not been processed, although the dose received by the assistant was estimated to be low. Thus, the sum of the reported cumulative dose through August 1996 (0.265 rem) and the highest dose estimate for October 3 (0.9 rem) was well below the annual occupational limit of 5.0 rems TEDE, and it appeared likely that the dose received by the assistant in September would be very low. Based on this review, the inspector concluded that the assistant had not received a dose in excess of occupational dose limits for calendar year 1996.

5.3 Conclusions

Based on the inspector's review of the event, it appeared that the licensee acted in a responsible manner and promptly reported the event to the NRC.

The initial dose estimate performed by the licensee indicated that the assistant had not received a whole body or extremity dose in excess of regulatory limits. Dose estimates performed by the inspector also indicated that the assistant had not received a dose in excess of regulatory limits based on information available during the inspection.

6 Regulatory Issues (87100, 87103)

6.1 Inspection Scope

This portion of the inspection included interviews of personnel and review of records relating to training, the radiation safety program, and the event.

6.2 Observations and Findings

The inspection findings generally appeared to indicate that the licensee's radiation safety program had been implemented as described in the license application and in accordance with NRC requirements. However, three apparent violations were identified as described below. The apparent violations are associated with the radiographer's and assistant's actions prior to and during the event on October 3, 1996.

As discussed in Section 3.2 of this report, both the radiographer and assistant failed to wear personal monitoring devices on October 3, 1996. Although the individuals acknowledged that they had film badges, pocket dosimeters, and alarm ratemeters with them, they stated that they forgot to wear the devices on October 3, and instead left them in the company vehicle while they completed the radiographs. The failure of the assistant to wear an alarm ratemeter was identified as a contributing cause of the event. Had he worn the device, he probably would have been alerted to the exposed source. The failure to wear a pocket dosimeter and film badge also complicated the licensee's efforts to determine the doses received by the assistant and radiographer.

10 CFR 34.33(a) requires, in part, that a licensee not permit an individual to act as a radiographer or an assistant unless, at all times during radiographic operations, each such individual wears a direct reading pocket dosimeter, an alarm ratemeter, and either a film badge or a thermoluminescent dosimeter. The failure of the radiographer and assistant to wear a film badge, pocket dosimeter, and an alarm ratemeter during radiographic operations was identified as an apparent violation of 10 CFR 34.33(a) (Apparent Violation 0303691/9601-01).

Also noted in Section 3.2, is the assistant's failure to perform a survey of the exposure device and source guide tube following the second exposure. Had the assistant used the survey instrument as he approached the exposure device and completed the survey, he would have been alerted to the exposed source and could have limited his exposure. 10 CFR 34.43(b) requires that a survey with a calibrated and operable radiation survey instrument be made after each exposure to determine that the sealed source has been returned to its shielded position. The survey must

include the entire circumference of the exposure device and the source guide tube, if one is in use. In addition, Paragraph 6.4, Section 6 of BIX's operating and emergency procedures manual, incorporated by reference in License Condition 18, specifies that survey meters are not to be left at the exposure device during radiographic exposures and that the meter will be "carried in hand" at all times to and from the exposure device whenever radiographic operations are being performed. Paragraph 10.2, Section 10 of the same procedure manual requires that the exposure device be surveyed after each exposure of the sealed source to determine that the source has been returned to a safe, shielded position.

The failure to use a radiation survey instrument as the assistant approached the exposure device and to perform a survey of the device after the second exposure on October 3 identified as an apparent violation of both 10 CFR 34.43(b) and Condition 18 of License 35-26953-01 (Apparent Violation 03030691/9601-02).

As described in Section 3.2 of this report, the inspector verified through discussions with the radiographer and assistant that once the radiographer handed the assistant the drive cable controls and requested that he retract the source, the radiographer turned his back to the assistant and proceeded to remove the restricted area tape barricade. 10 CFR 34.44 requires that an assistant be under the personal supervision of a radiographer whenever the assistant uses a radiographic exposure device, sealed source, or related source handling tools. Personal supervision as discussed in 10 CFR 34.44 includes the radiographer's personal presence at the site where sealed sources are being used, the ability of the radiographer to give immediate assistance if required, and the radiographer watching the assistant's performance of radiographic operations. The radiographer acknowledged that he had turned his back to the assistant and failed to watch him attempt to retract the source and retrieve the exposure device. As a result, the radiographer was unaware that the assistant failed to perform the required survey. The failure of the assistant to be under the personal supervision of a radiographer while he was using a radiographic exposure device on October 3, 1996, was identified as an apparent violation of 10 CFR 34.44 (Apparent Violation 03030691/9601-03).

7 Licensee Corrective Actions (87100)

7.1 Inspection Scope

Through interviews with licensee personnel and a review of licensee records, the inspector reviewed the licensee's proposed corrective measures.

7.2 Observations and Findings

The inspection determined that the licensee's RSO initiated immediate corrective measures after he was notified of the exposure event. The RSO gave instructions to the two radiography personnel while on location that they were not to perform further radiographic operations. The licensee's RSO performed two re-enactments of the event, completed a dose

assessment, and conducted interviews with the radiographer and radiographer assistant.

Other short-term measures identified during the inspection included: (1) relief of the radiographer and assistant from work duties until an investigation of the event was completed by the NRC, (2) the radiographer was subsequently terminated from employment with BIX, and (3) a mandatory safety meeting was conducted with all BIX employees to discuss the event and the job responsibilities of radiographers and radiographer's assistants. In addition, as noted in a letter dated October 16, 1996, the licensee provided additional training to the assistant prior to allowing him to resume work activities involving radiographic operations.

The RSO indicated that he had initiated long-term corrective actions that included development of a disciplinary program with monetary penalties for individuals who failed to observe the licensee's procedures and NRC requirements to emphasize the importance of compliance. Additionally, the RSO indicated that BIX planned on increasing the number of field audits conducted for radiographers and assistants to verify employees' compliance with NRC requirements while performing radiography in the field.

7.3 Conclusions

The licensee promptly initiated short-term corrective actions to emphasize regulatory requirements and provided additional training to BIX employees. The RSO also proposed long-term corrective actions to verify compliance with NRC requirements. Based on the inspector's review, it appeared that the licensee initiated corrective actions in a timely manner.

Exit Meeting Summary

The inspector presented the inspection findings to licensee management via telephone on December 9, 1996, including those apparent violations being considered for escalated enforcement action. In addition, the NRC Enforcement Policy was discussed with the RSO during the telephonic exit briefing. The RSO acknowledged the inspection findings and a predecisional enforcement conference was scheduled for January 6, 1997, to discuss the apparent violations.

Licensee representatives confirmed during the exit briefing that no proprietary information was reviewed by the inspector.

ATTACHMENT 1

PARTIAL LIST OF PERSONS CONTACTED

Licensee

L. Barnett, Owner/President/RSO
T. Barnett, Vice President/General Manager
T. Croteau,
D. Stephens, Radiographer
K. Herrmann, Radiographer Assistant

INSPECTION PROCEDURES USED

87100	Licensed Materials Programs
83822	Radiation Protection
86740	Inspection of Transportation Activities
87103	Inspection of Incidents At Nuclear Materials Facilities

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

030-30691/9601-01	APV	Failure to wear personal monitoring devices as required by 10 CFR 34.33(a).
030-30691/9601-02	APV	Failure to perform a post-exposure survey as required by 10 CFR 34.43(b).
030-30691/9601-03	APV	Failure of a radiographer to provide personal supervision of and during radiographic operations as required by 10 CFR 34.44.

Closed

None

Discussed

None

ATTACHMENT 2

NRC DOSE CALCULATIONS

Since no dosimetry equipment was available to record the radiation exposure received by the assistant, an estimate was derived from data obtained through interviews of the radiographer and assistant. The location of the radiographer is assumed to be near the restricted area boundary and therefore negligible for the short exposure intervals. The following estimate is provided for the assistant:

For iridium-192, the gamma constant used by the licensee (and considered conservative by the NRC) is 5.9 rems/hour-Curie at 1 foot. For the 36.5-curie source the dose rate would be

$$\frac{5.9 \text{ rems}}{\text{hour-Curie}} \cdot 36.5 \text{ Curie} \cdot \frac{\text{hour}}{60 \text{ minute}} = \sim 3.6 \text{ rems/minute at 1 foot}$$

Dose to the hand

While unscrewing the guide tube coupling, the back of the assistant's hand is estimated to have been no closer than 4 inches from the source for no more than 30 seconds. Additionally, the hand may have been as close as 2 feet from the source during the 30 seconds assumed to be required to remove the film and the collimator.

$$\begin{aligned} \frac{3.6 \text{ rems}}{\text{minute}} \cdot 0.5 \text{ minute} \cdot \frac{(12 \text{ inch})^2}{(4 \text{ inch})^2} + \frac{3.6 \text{ rems}}{\text{minute}} \cdot 0.5 \text{ minute} \cdot \frac{(1 \text{ foot})^2}{(2 \text{ foot})^2} \\ = 16.2 \text{ rems} + 0.5 \text{ rems} = 16.7 \text{ rems} \end{aligned}$$

Dose to the whole body

The whole body dose is estimated as a result of the assistant standing 2 feet from the source for one minute.

$$\frac{3.6 \text{ rems}}{\text{minute}} \cdot \frac{(1 \text{ foot})^2}{(2 \text{ foot})^2} = 0.9 \text{ rems}$$