UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
WASHINGTON, D.C. 20555-0001

March 1, 1999

NRC INFORMATION NOTICE 99-04: UNPLANNED RADIATION EXPOSURES TO RADIOGRAPHERS, RESULTING FROM FAILURES TO FOLLOW PROPER RADIATION SAFETY PROCEDURES

Addressees:

All radiography licensees.

Purpose:

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to remind addressees of the risk of unplanned high radiation exposures from radiography equipment, and the need for proper radiation safety practices to prevent such exposures. The notice was prompted by a series of incidents that have occurred recently and that resulted in unplanned exposures, all of which involved failures to follow proper radiation safety procedures. These incidents did not result in radiation exposures that are expected to lead to serious health effects to the exposed individuals. However, there was the potential, in all cases, for high exposures that could have led to serious health consequences. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action nor written response is required.

Description of Circumstances:

1. Pipe welds were being radiographed at a temporary job site in Indiana on August 21, 1998. A Source Production and Equipment (Spec) 150 camera, with a 3.9 terabecquerel (TBq) [105 curies (Ci)] iridium-192 (Ir-192) source and a collimator, was being used. A controlled area had been set up around the work site to keep unauthorized people out of the area. A radiographer inadvertently walked into the controlled area during one of the shots, when the source was out of its shield. He was wearing a film badge, but not an alarming ratemeter, and did not carry a survey meter with him. The dose he received from that incident was estimated to be 3.5 millisievert (mSv) [350 millirem (mrem)] to the whole body and 70 mSv (7 rem) to the right hand.

2. A radiographer and a radiographer's assistant were making radiographs on a large-diameter pipe at a temporary job site in Oklahoma on November 7, 1998. They were using a Spec camera with an 3.2 TBq (87 Ci) Ir-192 source. The camera was placed inside the pipe during this work to obtain panoramic views of some welds. At the end of one of the shots, the radiographer's assistant crawled into the pipe to reposition the equipment and prepare for the next shot. When it was time for the shot, the assistant crawled back into the pipe to deactivate the automatic locking mechanism, but discovered that the source was not in the locked position. She alerted the radiographer, who was able to retract the source to the locked position with about two turns of the drive cable crank. A review of the incident showed that the assistant had not made a survey before approaching the source in the pipe, nor was she wearing an alarming ratemeter. She was estimated to have received a dose of about 110 mSv (11 rem) to the whole body.

3. Two radiographers were using an Amersham-660B camera with a 2.7 TBq (72 Ci) Ir-192 source at a temporary job site at a refinery in Montana on November 20, 1998. They had just finished one shot and were preparing for a second. They then noticed that the source was not in the locked position. One of the radiographers was able to put the source back in the locked position with a half turn of the drive cable handle. A check of the self-reading dosimeters on the two radiographers showed that they were both off-scale. It was later estimated that they were exposed to the unshielded source for about 6 minutes. Film badge results showed a whole-body dose of 40 mSv (4 rem) to one of the radiographers and 120 mSv (12 rem) to the other. Although both radiographers had their alarming ratemeters on them, one of the meters did not alarm, and the other was turned off. Surveys had not been done after the first shot to confirm that the source was in the shielded position.

4. A radiographer and a radiography trainee were conducting radiography operations at a temporary job site in Texas on December 31, 1998. The radiographer, who had been with the company for only two weeks, had not met his partner before that day, and did not know that he was a trainee, but had assumed that he was a qualified radiographer. The trainee had assumed that the radiographer knew he was a trainee, and had not said anything about his position with the company. As a result, the radiographer had asked the trainee to do most of the shots that day, using a camera with a 4.6 TBq (123 Ci) Ir-192 source, and he had himself spent most of the time in the dark room. At the end of the day, the trainee thought they had finished shooting, and had removed his belt and put it in his truck. The belt has his TLD and alarming dosimeter on it, but his pocket ionization chamber was in his trousers' pocket. Before he could leave, however, the radiographer told him that they had to reshoot a 5 cm (2") and a 7.6 cm (3") pipe. They both set up for the 5 cm (2") pipe shot and the radiographer then went to the dark room and left the trainee to complete the shot. After shooting the 5 cm (2") pipe, the trainee set up for the 7.6 cm (3") pipe shot. When he went to the camera to extend the source for the shot, he found that he had forgotten to retract it into the camera after the previous shot. He immediately retracted the source and reported the incident to the radiographer. Investigation of the incident showed that, although the trainee had a survey meter with him at the time of the shots, he had not used it. The investigation also concluded that the trainee received a whole body dose of about 100 mSv (10 rem), and a dose to the index finger of about 30 - 50 Sv (3,000 - 5,000 rem). The dose to the

index finger was high because the shots were being made without a collimator, and the trainee had therefore handled the end of the guide tube, with the source in it, without any significant shielding. Ten days after the incident, signs of radiation injury had started to appear on his index finger.

Discussion:

An obvious fact about which radiographers should be repeatedly reminded is that, without a suitable instrument such as a survey meter or an alarming rate meter, both of which are required equipment for radiography work, there is no way for them to be sure that the source in a radiography camera is not out of its shield when it should have been shielded. Another fact, maybe not as obvious, that radiographers should be reminded of is that, with a typical radiography source such as 3.7 TBq (100 Ci) of Ir-192, the dose rate at 30.5 cm (1 foot) from the unshielded source is about 4.5 Sv/hr (450 rem/hr). Exposure at a foot from such a source will result in exceeding NRC's annual whole body-dose limit in about 40 seconds. A dose to the whole body of about 2.5 Sv (250 rem) would have a 50 percent chance of being fatal, and could be delivered by a 3.7 TBq (100 Ci) Iridium source a foot away in about half an hour. Such an exposure scenario is unlikely, but it is possible, as for example in a situation where extended preparation work is being done close to a camera with an unshielded source. Another type of severe injury that can result from exposure to such a source is that resulting from localized exposures, such as to the hands. For example, handling the guide tube with the source in it could result in dose rates, to the hand, on the order of 10 gray (Gy) [1,000 rads] per minute. Such dose rates could quickly lead to very serious injury to the skin and underlying tissues.

To avoid serious radiation injury, it is necessary to ensure that people are never close to an unshielded radiography source. Radiography cameras are designed to keep the sources locked in their shields when not in use, but the mechanisms used to accomplish this occasionally fail, either because of mechanical problems or because of improper use. The source may also have been cranked out by one person, without knowledge of another person who may later walk into the work area. In all these cases, there is usually no obvious indication that the source is unshielded. Without the proper instruments, a person would not know that a high radiation field exists in the area, and for this reason good radiation safety practices, as well as NRC's regulations, require the use of radiation detection instruments to ensure that the source is securely in the shielded position after use, or that it is safe to approach a radiography camera or a radiography work area.

The instruments needed for that purpose are ones that give a quick indication that a high radiation field exists. Dosimeters issued to radiographers, such as thermoluminescence dosimeters (TLD), film badges, and pocket dosimeters, do not serve this purpose. TLD and film must be sent away for processing before they can indicate a dose. Pocket dosimeters, although they can be read out in the field, are not suitable because they do not give a sufficiently quick indication of a high radiation field, and also because they are meant to be checked only occasionally during work. The only practical options available to the radiographer in the field are survey instruments and alarming rate meters. A radiation survey instrument is carried by the worker and has a meter that shows the dose rate all the time it is in use. It is the instrument of choice when making sure it is safe to enter an area and to verify that the source is in the shield. At times, however, it may be necessary to set the survey instrument aside to prepare for the next shot, or reposition equipment or barriers. Even though the camera may not

be in use at such times, it is still necessary to have an instrument that will continue to monitor for possible high radiation fields without the need to continuously look at a meter. The instrument for this purpose is the alarming ratemeter, usually worn on the worker's belt. It does not require the worker to look at a meter, because it is equipped with an alarm that goes off when the radiation field exceeds a preset level. This alerts the worker to a possible problem.

Survey instruments and alarming ratemeters can fail to work for a variety of reasons, or the meter may appear to be working but may be showing an incorrect dose rate reading. Because of this, and because of the serious dangers involved in using radiography sources, both instruments are required to be used during radiography. They serve different functions, but they also act as backups to each other. Note also that, because these instruments are fairly delicate, they must be checked regularly in the field to make sure they are still working properly. A survey instrument is checked by making sure the batteries have sufficient remaining charge, and also by holding the instrument next to a check source and making sure it reads roughly the dose rate it should read in that position. The user must also be sure the instrument is set to the proper scale. Alarming rate meters are checked by ensuring that the batteries are in good condition, the alarm is set at the proper alarm set point, and the alarm actually sounds when the meter is placed in a sufficiently high test radiation field.

In addition to using ratemeters and alarming dosimeters, radiographers should be reminded to follow proper safety procedures when using radiography equipment. These include, as examples: procedures for properly posting and roping off work area; controlling access to the radiography area during radiography; properly ensuring that the source is actually locked when it is retracted into the camera; periodically checking the camera to make sure that there is no apparent damage, and that moving parts do not show undue wear; and similar actions that ensure that the equipment is in good mechanical condition and that it is operated properly.

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Donald A. Cool, Director
Division of Industrial and
Medical Nuclear Safety
Office of Nuclear Material Safety
and Safeguards

Technical Contact: Bruce Carrico, NMSS
301-415-7826
E-mail: jbc@nrc.gov

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LIST OF RECENTLY ISSUED NMSS INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
99-03	Exothermic Reactions Involving Dried Uranium Oxide Powder (Yellowcake)	1/29/99	All operating uranium recovery facilities that produce oxide powder (U_3O_8) (yellowcake)
99-02	Guidance to Users on the Implementation of a New Single-Source Dose-Calculation Formalism and Revised Air-Kerma Strength Standard for Iodine-125 Sealed Sources	1/21/99	All medical licensees authorized to conduct brachytherapy treatments.
99-01	Deterioration of High-Efficiency Particulate Air Filters in a Pressurized Water Reactor Containment Fan Cooler Unit	1/20/99	All holders of licences for nuclear power, research and test reactors; and fuel cycle facilities.
98-33	NRC Regulations Prohibit Agreements that Restrict or Discourage an Employee from Participating in Protected Activities	8/28/98	All holders of a Nuclear Regulatory Commission license
98-30	Effect of the Year 2000 Computer Problem on NRC Licensees and Certificate Holders	8/12/98	All material and fuel cycle licensees and certificate holders
97-91 Supp. 1	Recent Failure of Control Cables Used on Amersham Model 660 Posilock Radiography Systems	8/10/98	All industrial radiography licensees.
98-20	Problems With Emergency Preparedness Respiratory Protection Programs	6/3/98	All holders of operating licenses for nuclear power reactors; non-power reactors; all fuel cycle and material licensees required to have an NRC-approved emergency plan.
98-18	Recent Contamination Incidences Resulting from Failure to Perform Adequate Surveys	5/13/98	Part 35 Medical Licensees

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98-45	Cavitation Erosion of Letdown Line Orifices Resulstin in Fatigue Cracking of Pipe Welds	12/15/98	All holders of operating licenses for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.
98-44	Ten-year Inservice Inspection (ISI) Program Update for Licensees that Intend to Implement Risk-Informed ISI of Piping	12/10/98	All holder of operating licenses for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor

OL = Operating License
CP = Construction Permit

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Survey instruments and alarming ratemeters can fail to work for a variety of reasons, or the meter may appear to be working but may be showing an incorrect dose rate reading. Because of this, and because of the serious dangers involved in using radiography sources, both instruments are required to be used during radiography. They serve different functions, but they also act as backups to each other. Note also that, because these instruments are fairly delicate, they must be checked regularly in the field to make sure they are still working properly. A survey instrument is checked by making sure the batteries have sufficient remaining charge, and also by holding the instrument next to a check source and making sure it reads roughly the dose rate it should read in that position. The user must also be sure the instrument is set to the proper scale. Alarming rate meters are checked by ensuring that the batteries are in good condition, the alarm is set at the proper alarm set point, and the alarm actually sounds when the meter is placed in a sufficiently high test radiation field.

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