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FILE

MEMO TO : Industrial Radiography Contractor Supervisors

FROM : Kenneth W. Wangler
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RE : Operational Topic: "Supervision of Site Radiography Contractors"

DATE : December 6, 2000

Enclosed is a copy of an article appearing in the November 2000 (Vol. 79, No. 5) edition of the Operational Radiation Safety Journal published by the Health Physics Society. The enclosed article entitled, "Supervision of Site Radiography Contractors" provides basic information needed to reduce the likelihood of unintentional exposures and ensure no radioactive materials are left at the site by the radiographers.

It is expected that you will review this information for applicability to your activities and consider actions, as appropriate, to ensure the safe and legal use of radioactive material in the State of North Dakota.

This notice is for your information only. No specific action nor written response is required. If you have any questions concerning this article, please contact the Radiation Control Program at 701.328.5188.

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Well-defined guidelines and appropriate assurances are necessary before allowing industrial radiography sources to be brought on site and placed into use there.

Supervision of Site Radiography Contractors

*Axel Macdonald**

Abstract: *Gamma radiography is used extensively under conditions of site radiography for non destructive testing of components where it is not reasonably practicable to check these components in a shielded enclosure. This is one of the few occasions when a high activity radioactive source is used outside a shielded enclosure and administrative controls are the principal means of restricting exposure. A company where site radiography is required should carry out certain checks themselves to ensure that other personnel not involved in the radiography are not exposed to ionizing radiation. Prior discussion with the radiography company on their safety systems and equipment and checks by the client before and during radiography will reduce the likelihood of unintentional exposures and ensure that no radioactive materials are left on the site. Health Phys. 79(Supplement 2): S61–S65; 2000*

Key words: *operational topic; gamma radiation; exposure, occupational; radiation, ionizing*

INTRODUCTION

Gamma radiography forms an important part of non destructive testing (NDT). Radiography is predominantly carried out to check the structural integrity of castings or integrity of welds on safety critical systems, e.g., pipes within a boiler at a power station. The ability to produce a photographic image of the weld to check for defects and to radiograph welds in relatively inaccessible areas are some of the advantages of gamma radiography. However, the use of high activity sources required for the radiography has the potential to cause injury to the radiographers and others not involved in the work. Safe working procedures need to be established to keep doses as low as reasonably achievable and prevent loss of the source.

BACKGROUND

One of the few occasions when a high activity source is used without any shielding is during site radiography. Gamma or x radiography is normally carried out in a purpose designed shielded enclosure; however, this is not always practicable, for instance if fixed pipes need to be examined. Gamma or x radiography outside of a shielded enclosure is known as site radiography.

During site radiography, the dose rates close to the source may be very high, on the order of Sieverts per hour, and the dose rate may not fall to less than 7.5 μSv h^{-1} (0.75 mrem h^{-1}) for several tens of meters. The main controls to prevent high personal exposures are administrative controls supporting various warning signs and signals. A number of nuclides may be used in gamma radiography, but the principal nuclide remains ^{192}Ir with activities typically ranging from 185 GBq to 3.7 TBq (5 Ci to 100 Ci).

The purpose of this article is to provide information to a client who will have gamma radiography carried out on their site on what safe procedures should be in place for the radiography to proceed and what checks should be carried out whilst the radiographers are on site. In the UK, the *Ionising Radiations Regulations 1999* cover the use of sources of ionizing radiation, and these regulations are enforced by the Health and Safety Executive. Similar regulations will be available in most countries to cover this work but their requirements and content will differ. This article focuses on the practical aspects of supervising site radiographers rather than specific regulatory guidance. For those whose regulations don't cover the topic of site radiography, the International Atomic Energy Agency has

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produced a practical radiation safety manual on gamma radiography (IAEA 1992). Although gamma radiography is dealt with in this article, many of the principles are also applicable to x radiography.

The objectives from the point of view of the client are

1. that staff and contractors, other than the radiographers, are kept away from the area where the work is to take place;
2. there are effective controls in place to prevent persons not involved in the radiography from entering the area; and
3. that the source is removed from the site at the end of the work.

Why the fuss? A look at any database on radiation accidents will reveal that incidents involving site radiography seem to dominate. The IAEA have published a safety report (1998) on industrial radiography accidents and lessons learned from these accidents. The use of untrained personnel, incorrect recovery procedures, and the failure to use a radiation monitor have resulted in high doses to radiographers and others leading to deterministic effects. Even worse, radiography sources have become detached and left behind. High individual doses have been received because a radiography source has been picked up and taken home (Fig. 1)!

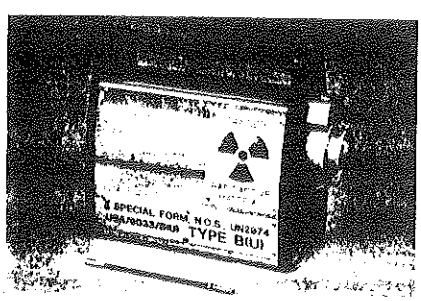

Figure 1. Amertest container with a radiography source.

SAFE WORKING PROCEDURES

Prior to work starting

Reference is made throughout the procedures to a Radiation Protection Adviser (RPA). In the UK this is a recognized individual or corporate body with a specialist knowledge of radiation protection and legislation. In other countries the government may have similar specialist advisers or qualified experts. Reference is also made to a coordinator. This is not a radiographer but an employee of the client company responsible for coordinating the work with the radiographers. The role of the coordinator is to check that the radiographers are following the correct safety procedures and ensure that no other staff or contractors are in the work area when radiography starts.

Before the radiographers arrive on site to carry out the work, there must be some consultation between the radiography company and the site where the work is to take place. The aim of the consultation is to

- Identify the personnel who will carry out the radiography and ensure that the radiographers who will carry out or supervise the work have been adequately trained. The training would have covered basic radiation protection standards and procedures for recovering a detached source. Normally at least three persons are required: the radiographer who will control the source, his/her assistant, and one extra person to patrol the barriers. If the radiography contractor cannot provide someone to patrol the barrier then the client may be able to provide someone but they must have received adequate instruction in their role. The barrier walker does not need to enter the designated work area but will require an effective means of communication with the radiographers.
- Check that the relevant regulatory body has been notified of the work, if appropriate.
- Discuss the area where the work is to be carried out and means of restricting access. This may mean disabling elevators and prevention of access to areas below and above the work area. If two radiography teams are to be used then their work areas must be distinct from each other and not overlap. Normally it is expected that rope/tape barriers will be used to demarcate the work area (referred to in UK legislation as the radiation controlled area). Physical boundaries, e.g., walls, may also be used.
- Discuss what safety systems are to be used (warning signs and signals) to check that they do not conflict with any similar signs and signals already in use. Normally a pre-exposure signal, klaxon/air horn, would be used to indicate that an exposure is imminent and a separate signal, red beacon, would indicate that a source is exposed. These signals must be clearly explained on warning notices at the barriers, and the signals must be able to be heard/seen from approach to the barrier. In the event that it is not practicable to use pre-exposure/exposure lights then some other method of indicating the source status must be used that meets the above criteria.
- Obtain a copy of the radiographer's operating procedures and check that they contain the names of any relevant persons who may be called upon in the event of an incident, the safety procedures for carrying out the work, and contingency plans to cover any reasonably foreseeable incidents. Furthermore, a check should be made on what emergency equipment the radiographers will bring onto the site with them, e.g., to deal with a source recovery. At least two appropriate radiation monitors, e.g., compensated

geiger muller dose rate monitor, must be brought on site—one for the barrier walker and one for the radiographer. In addition, all three persons should wear electronic personal alarm meters preferably with a digital display of the integrated dose and an alarm feature to warn the wearer if a pre-set dose rate is breached.

- Check that there are no hazardous conditions that could be caused by the work. An example of this could be if the radiography was carried out on a chemical plant where nucleonic level detectors were in use. The detector on the tank or hopper could respond to the gamma radiography source leading to the vessel overfilling. Some types of fire detection systems may also respond to the gamma radiography source.
- Request details of the nuclide and source activity that will be used. In the UK, some client companies impose a 370 GBq (10 Ci) activity limit for ^{192}Ir sources. Other radionuclides may be used subject to prior agreement with the Company's Radiation Protection Adviser. Also check what type of source container they will be using. Normally a shielded wind-out container would be used, but the client should consult a radiation protection adviser if another type of system is proposed.
- Check that there is no need for other contractors/staff to be in the area during radiography.

Arrival on site

The radiographers should either be met at the entrance to the site or directed to a specific area for the following checks to be made. They should not be permitted to remove any equipment from the vehicle until the coordinator is satisfied that the radiographers have all the necessary equipment with them. The vehicle should have a placard depicting the trefoil symbol on each side and the rear of the vehicle in compliance with the appropriate transport regulations. The source container should be securely fixed within the vehicle to stop movement during transport and in the event of a road traffic accident:

- Check the identity of the radiographer and that an assistant and a barrier walker are present. Ask to see their personal dosimeters (film or TLD). The radiographers should not be permitted to progress further if only the radiographer has turned up or if they do not have their personal dosimeters.
- Check that they have a copy of their safety procedures, including a contingency plan, with them and additionally a copy of the transport document—this should agree with the source details.
- Confirm the source details and check that they correlate with the actual source brought on site—compare against the transport document. The radiographers will normally have a decay chart pertinent to that source that can be used to confirm the activity and radionuclide (Fig. 2).
- Check that they have brought two radiation dose rate monitors with them and the batteries are satisfactory—use the battery check function (Fig. 3). In addition they should be requested to measure the dose rate from the surface of the source container. Many containers use depleted uranium shielding, and an empty container would give rise to a dose rate of approximately 25 μSv h^{-1} (2.5 mrem h^{-1}). This may rise to approximately 80–90 μSv h^{-1} if a 370 GBq (10 Ci) source was present within the container. Both radiation monitors should indicate similar dose rates. The dose rate reading should be recorded by the coordinator. This reading will

Figure 2. Client company's coordinator asking radiographer to check container on arrival.

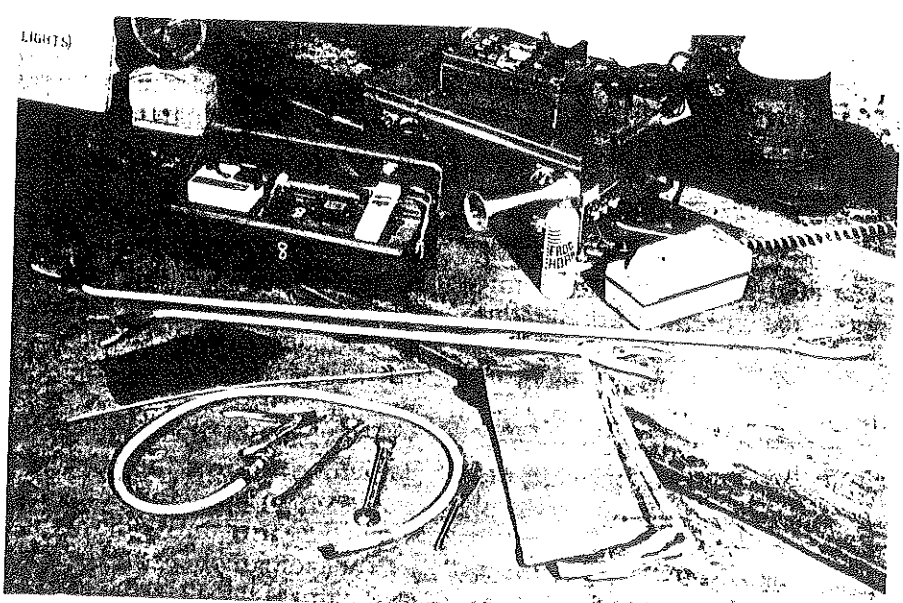

Figure 3. Typical ancillary equipment taken with container—note lack of lead shielding!

be compared against the dose rate reading from the container when the work has finished but before the radiographers have left the site. A much lower dose rate than on arrival would indicate that the source is no longer in the container! **The radiographers should not be permitted to progress further if one or both monitors are not operating correctly.**

- Other checks on the source container include confirmation that all covers and protective caps are locked/secured. This prevents the source becoming exposed during transport. The container itself should have two transport labels on it showing the trefoil symbol, nuclide/activity and transport index. Experience has shown that these labels tend to be missing or badly worn. Even if the labels are legible, the activity is likely to be incorrect since this will be the initial activity and not the current activity. If the container is unlocked or obviously damaged then the radiographers should not progress any further.
- Check that the radiographers have brought with them the emergency equipment as previously agreed and sufficient warning notices, signals and barriers for the work (Fig. 4).
- In addition to the above checks, the site radiography supervisor must ensure that all staff/contractors have left the work area. This may be achieved through the cancellation or suspension of permits.

Setting up the work area

Once the initial checks have been carried out and no one unconnected with the work is in the area then the radiographers may set up the work area, known in the UK as a controlled area. During this phase, the source container must remain locked in the vehicle. The radiographers will need to physically demarcate the work area using physical features, e.g., walls and tape or rope barriers. Pendants with the trefoil symbol should be attached at regular intervals to a rope barrier. The purpose of the barrier is to keep others away from the work area, and in the UK the barriers are set where the dose rates are 7.5 μSv h^{-1} or less. Where the barriers are to be placed should have already been discussed but the radiographers from their own experience will know approximately how far the barrier needs to be from the source for the dose rate to be less than 7.5 μSv h^{-1}. Usually the barriers are set further out than necessary to take advantage of physical features. A word of warning—the barriers should not be set so far out that the radiographers do not have control over them. Simply placing barriers at the entrance to a site is not satisfactory!

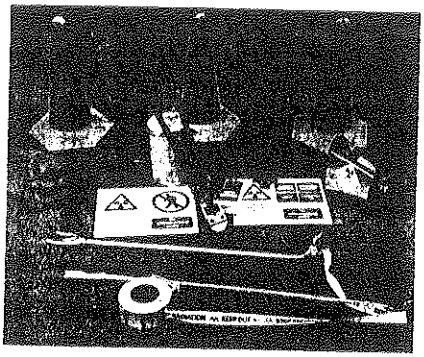

Figure 4. Selection of emergency equipment.

Once the barriers have been set up, warning notices explaining the significance of the pre-exposure/exposure signals should be displayed at the barrier. Separate warning notices warning of the presence of a radiation controlled area and prohibition of unauthorized personnel must be displayed at all points of access to the work area (Figs. 5 and 6).

Only once the barriers and warning notices have been erected should the source container be brought into the area. Some sites use a permit system to hand over the control of this area to the radiographers once the coordinator is satisfied that the barriers have been correctly erected.

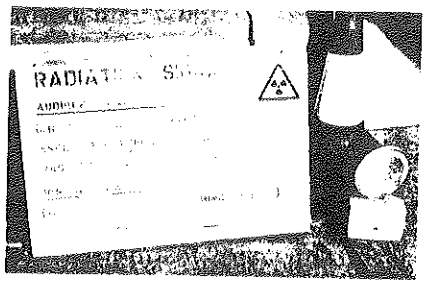

Figure 5. Typical warning notice at barrier explaining meaning of warning signals.

Radiography

When the container is taken into the work area, the pre-exposure/exposure warning signals can be tested. These warning signals should be visible from the position of the barrier and the radiographers' own working position. At this stage the functioning of the warning lights and a check on the dose rate at the barrier can be made together using a test exposure. The radiographers should not commence work at this stage since the test exposure may last several minutes. Normally the radiographers should use a collimator, but if possible the test shot should be made without collimation to check the barriers under worst case conditions. Only if a totally shielded system is used should the barrier checks be made with the collimation in place. This will then result in the barriers being correctly placed even in the event of a source becoming stuck in the exposed position. During the test exposure, one of the radiographers must remain close to the wind out point to control the source but far enough away to reduce his/her exposure. The barrier walker/second radiographer should accompany the coordinator around the barriers with a dose rate monitor to confirm that the barrier has been correctly set. If at any point a higher dose rate than agreed is recorded, the source must be retracted and barrier repositioned.

Figure 6. Barrier and warning notice. Radiographer's assistant preventing access to unauthorized staff.

A brief word on warning signals at this point. Most radiography companies manage to bring along and set up an adequate warning system to indicate when a source is about to be exposed and when the source is exposed. Most radiographers fail to bother with these signals. Experience has shown that a pre-exposure signal (klaxon or similar) is given before the session starts and then the exposure signal (red beacon or similar) is left on during the rest of the session. This is an incorrect use of the signals and can result in the signals being ignored.

Once dose rates at the barrier have been monitored and the coordinator is satisfied then radiography can start. The coordinator should return periodically to check that all is well.

End of radiography session

When radiography has finished and before the barriers are taken down, the source container, locked with no wind-outs attached, should be brought to the barrier for the coordinator to check. A dose rate measurement should be made at the surface of the container. This reading must be similar to the reading recorded when the radiographers first came on site. If the reading is lower, then the source may not be in the container but possibly still in the projection tube or elsewhere! Once the coordinator is satisfied that the source container is locked and source within, the container can be returned to the vehicle and barriers taken down.

Emergency procedures

In the event of an incident, the radiographers should implement their contingency plans. The coordinator must not get involved in the recovery procedure itself but be at hand to assist them, e.g., contact their employer or radiation protection adviser. One point worth remembering is that common sense can be forgotten in the heat of the moment. If radiography has been carried out several floors up, for instance in a boiler, then there may only be a metal grid surface rather than a solid floor. Tipping out the source onto such a surface will result in the source disappearing through the grid, ending up several floors below! A large board or similar item should be provided for the source to be tipped onto if that is required.

The principal duty of the coordinator in emergency situations is to alert security on site that there is a problem and to keep others away.

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