HSE information sheet

Industrial radiography - managing radiation risks

Ionising Radiation Protection Series No. 1(rev 2 - 2018)

Introduction

This information sheet is for clients and principal contractors who engage specialist non-destructive testing (NDT) contractors to carry out a radiographic inspection. This includes inspection of products, operating plant, civil engineered structures or pipeline installations. The information sheet will also be relevant to managers of these NDT companies, self-employed contractors and companies who carry out in-house radiography. It does not give the full requirements of the Ionising Radiations Regulations 2017 (IRR17), as these can be obtained in the Approved Code of Practice and guidance supporting the Regulations, available from HSE Books [1].

The purpose of this information sheet is to focus on the management of health and safety risks arising from industrial radiography work by summarising precautions which, if followed, should help ensure compliance with IRR17's main health and safety requirements. Clients, principal contractors and contractors all have clear responsibilities under health and safety legislation. Contractors using sealed sources must also consider the requirements of the relevant environmental legislation, which are regulated by the Environment Agency, the Scottish Environment Protection Agency, Natural Resources Wales and Northern Ireland Protection Agency.

What is the problem?

Industrial radiography usually involves using intense radiation sources which can expose people at work to significant amounts of radiation. Over the years several serious incidents have been caused by the failure to maintain equipment, to carry out routine monitoring or to employ proper emergency procedures. HSE inspectors have also found that a significant number of NDT contractors fail to adopt routine working practices capable of keeping radiation exposures of employees as low as reasonably practicable: this is the main requirement of IRR17. Incidents occur because of poor job planning (most notably with site radiography), failure to use adequate local source shielding, or inadequate systems of work. Generally, people working in industrial radiography have received higher doses than those working in other sectors using ionising radiation.

Too often, clients (or principal contractors) can cause difficulties for their contractor by not allowing sufficient time or ensuring effective communication to plan work properly. There is rarely a valid reason for calling in an NDT contractor at the last minute. This work is normally a vital part of a quality assurance process and should be carried out in a carefully planned way.

Enclosure radiography v site radiography

If the work involves routine radiography of readily moveable articles it is nearly always reasonably practicable to carry it out in an adequately shielded enclosure or cabinet with the necessary safety system installed. Where practicable, using a suitable shielded enclosure must always be the first choice for radiography work. The client can either construct an enclosure on site or arrange for articles to be transported to an enclosure at the contractor's yard. In some cases it may be practicable to build a temporary enclosure on site if the contract is of sufficient duration. Enclosures can make it far easier to restrict exposure and prevent accidental exposures (see regulation 9 IRR17). This has a number of advantages over undertaking the work out of hours under 'open shop' conditions. It will make work safer and the client will also have much more flexibility about the timing of the work. Where a test item fits inside an enclosure, the enclosure must have the necessary safety system installed and in full working

order. Where any part of an enclosure safety system is not working it needs to be repaired before the enclosure can be used – it is not acceptable to use the enclosure under site radiography conditions whilst the safety system is not working and awaiting repair.

When site radiography is considered the only practicable option, personal exposure restriction and risks should still be controlled, so far as practicable, by using local shielding and through appropriate administrative arrangements such as systems of work and radiation controlled area designation. Site radiography contractors need to receive 7 days advance notification in writing from their client for each job (a condition of the industrial radiography consent required by regulation 7 IRR17), unless it is carried out in an adequately shielded enclosure or the work is a genuine emergency and HSE agrees a shorter period by granting a waiver.

In fact, material is often required to be moved off site, for example for stress relief or pressure testing, and a suitable stop off for radiography can often be organised during the shipment of the finished article.

Assessing the risks

All employers have to carry out a risk assessment to satisfy regulation 3 of the Management of Health and Safety at Work Regulations 1999. Employers should review this risk assessment periodically to ensure that it remains valid. When product or plant requires radiographing, whether in-house or by contractors, the employers should assess as part of the general risk assessment how this can be done safely. This cannot be ignored in the case of subcontracted NDT work: the responsibility for providing a safe working environment rests on clients as well as contractors (see *Planning for the job*).

In some cases, it may be appropriate to use NDT techniques that do not involve ionising radiation. It is advisable for clients to review their NDT requirements periodically with insurers and NDT contractors. This will help identify cases where ultrasonic testing and other non-radiographic NDT techniques can be used, which would eliminate the risk from ionising radiation.

Before they start any new work activities, radiography contractors have to make sure that their risk assessments are sufficient to cover the radiation protection aspects of that work (regulation 8 IRR17). They also have to consider the possibility of a radiation accident occurring and take reasonable steps to prevent this or to mitigate its consequences by drawing up emergency procedures and appointing a responsible person for administering them.

For site radiography work, the risk assessment made by the client (or principal contractor) in control of the site should take into account any special features of the site. This might be problems of access or lighting; manual handling or lifting equipment difficulties; or the need to isolate vessels or pipelines carrying dangerous materials or atmospheres.

Planning for the job

For engineering construction and maintenance work, the client and principal contractor will have explicit duties under the Construction (Design and Management) Regulations 2015 [2] for the management of the entire project. Where the project includes radiographic inspection of plant, they should develop safe procedures, with the co-operation of the NDT contractor, at the planning stage. These details should be incorporated into the pre-construction information by the principal designer and subsequently by the principal contractor for the construction phase health and safety plan.

On a nuclear licensed site, the licensee will generally oversee all work with ionising radiation, including radiography done by a specialist contractor (regulation 4(3) IRR99). The licensee will usually wish to check that people carrying out radiography on their site are suitably qualified (the British Institute of Non-Destructive Testing [3] holds details of suitable certification schemes) and experienced. They will also ensure that the people carrying out radiography follow the site's local rules and access arrangements, and receive information, instruction and training to enable them to carry out their work safely.

All clients and principal contractors have general duties under the Health and Safety at Work etc Act 1974 to make sure, so far as reasonably practicable, that the site is safe and without risks to health. Clients also have responsibilities under the Management of Health and Safety at Work Regulations 1999 to co-operate with the contractor. They must provide information about risks on site and the precautions for dealing with these (including information on appointed people responsible for emergency procedures). This information will help the contractor to ensure that the work is properly planned and carried out.

Remember, **site radiography** contractors need to receive written notification of the radiography work from their client at least seven days in advance of the work taking place.This is a condition of the radiography contractor's consent (as required by Regulation 7 of IRR17).
This period of time is deemed necessary to enable consultations between client and contractor to take place, to review risk assessments and to allow any necessary variations to be incorporated into the local rules. These processes must be built into the planning of the job.

Enclosure radiography

Manufacturers who need radiographic inspections of their products will often find that it is cost effective to provide an enclosure for the work, whether they do the work themselves or engage contractors. A well designed and constructed enclosure or cabinet for routine radiography will generally have walls (and roof, if appropriate) sufficient to restrict the dose rate outside to below 7.5 microsieverts per hour. Remember, however that even this low dose rate should never occur outside areas the employer carrying out the radiography has control over. HSE inspectors have found badly designed enclosures with inadequate shielding, for example light industrial units.

When assessing shielding requirements, the three dimensional space surrounding the source needs to be considered, as people working near, above or below the enclosure may also be at risk. Scattered radiation (sky-shine) outside large open-top enclosures can often be controlled by adequate collimation. During typical radiographic set-ups, it is very important to monitor levels of radiation around the enclosure to ensure that levels of radiation are as low as reasonably practicable (and below 7.5 microsieverts per hour). Monitoring should include measurements away from the enclosure walls to detect the presence of sky shine.

An enclosure designed for one type of source may not be suitable for a more powerful source without upgrading the shielding. Some employers in the general engineering and fabrication sector have achieved significant improvements in their productivity by using purpose-built enclosures (or shielded radiography cabinets for small items). Clients who believe that a conventional radiography enclosure will not be sufficiently flexible for their needs are advised to investigate other shielding options.

For X-ray sets it should always be reasonably practicable to install effective devices, such as reliable electrical or mechanical interlocks, which prevent or terminate an exposure if the door of the enclosure is opened. It may not always be possible to achieve this level of protection for sealed sources. These devices should be installed so that they are fail-safe, but they can deteriorate and require periodic checks. Clear warning signals will also be needed (regulations 9 and 11 IRR17).

At major petrochemical plants ongoing radiography is likely to be needed during the entire working life of the plant, so it is sensible for the client to construct a permanent radiography enclosure. This will then be available for continuing use during all subsequent maintenance and refurbishment operations.

In the chemical and offshore sectors, during construction projects or in the course of major refurbishment of existing plant, a significant amount of radiography will often be needed for loose pipe work before it is installed. If pipe work is prefabricated at another location, it should normally be possible for this to be radiographed before its arrival on site. When the fabrication is being done on the construction site and no permanent enclosure is available, it may be possible to provide a temporary enclosure or additional local shielding for examining material fabricated there.

Managing site radiography

Site radiography is only acceptable when it is not reasonably practicable to provide a shielded enclosure for radiographing articles (regulation 9 IRR17). However, there are clearly situations in which site radiography is the only option, for example on in situ pipe work which is an integral part of process plant.

Contractors (including temporary workers and the self-employed) need to be given sufficient information on the work to be done as far in advance as possible. For example, the contractor will often need to inspect the plant in advance to plan for any particular difficulties which might arise. If access is difficult (e.g. if a weld is inside a vessel or the pipe work is in a rack at height) radiographers will need a pre-determined safe location to control the exposure from. Localised shielding, barriers, warning notices and signals, site lighting and access routes may also need to be agreed or arranged well in advance of work starting.

Careful planning is particularly critical for complex site radiography work. This could be in a structure which can be accessed by several people on site to areas irradiated by the radiation source at different levels; where more than one radiography team is working simultaneously; or where the person changing films is not clearly visible from the control position. An effective communication system between the radiographer and assistants will be necessary to prevent misunderstandings.

Site radiography requires people to be excluded from the work area (the controlled area: regulation 17 IRR17). Exposures must be kept as low as reasonably practicable by using temporary enclosures or localised shielding e.g. appropriate collimation, moveable panels, pre-formed shields, lead mats, bags of lead shot (regulation 9 IRR17). Even earth mounds or a careful array of large drums filled with water can provide effective shielding. The size of the controlled area can be a major decision for both the client and contractor (regulations 17 & 19 IRR17). It should not be so large that it is difficult to control. The boundary of the area must be supervised, to ensure that only authorised people may enter. In all cases, employers must have management control of any area in which their radiography work causes radiation controlled area conditions (regulation 17(2) IRR17).

A number of special systems are available which use purpose-made localised shielding around exposed sources to significantly reduce the size of the controlled area. Boundaries to the radiographic area must be continuous. Suitable warning signs are required for each designated controlled area and may be appropriate for some supervised areas. All warning signs must comply with the Health and Safety (Safety Signs and Signals) Regulations 1996, be suitably positioned and give sufficient information to alert employees to the risks arising from the radiation source.

Use and maintenance of equipment for radiography

The use of torch-type containers in the past has caused serious overexposures and this equipment has not been acceptable in Great Britain for many years. It should always be reasonably practicable to use sealed source exposure containers that at least conform to ISO 3999.

If critical components of radiography equipment such as the control cable, pigtail connector and guide tube of projection type containers fail, this is likely to leave the source exposed. Therefore, it is essential that NDT contractors have a suitable programme of inspection and maintenance of their radiography equipment and keep adequate records (regulation 11 IRR17). Source exchanges should be carried out by specialist contractors unless the NDT company has the correct equipment and trained staff capable of carrying out this work safely and it is suitably risk assessed.

Local rules and contingency plans

The contractor (or main employer if in-house) will need written local rules outlining the systems of work required for radiography and other key information such as the size of the controlled area. It is advisable for the client to check that these cover the planned work. These local rules must be available to

employees doing the work and should reflect any special arrangements for the particular job (regulation 18 IRR17). A suitable radiation protection supervisor must be appointed with the duty to ensure that the local rules are followed (regulation 18 IRR17). See HSE information sheet *Radiation protection supervisors*.[4]

The local rules must summarise, or make reference to, the key aspects of the contractor's contingency plan which detail the procedures to deal with reasonably foreseeable 'emergencies' such as a stuck or detached radiography source (regulation 13 IRR17). A typical 'emergency' kit to be taken to the site and used as part of the plan would normally include bags of lead shot, a shielded pot, cutting equipment for the guidetube and long-handled tools. It is a regulatory requirement to rehearse the operation of the contingency plans periodically (regulation 13(2) IRR17). It is good practice to use dummy sources during these rehearsals and practise cutting an old guidetube.

Monitoring arrangements

Normally, radiographers will be designated as 'classified persons' (regulation 21 IRR17). The contractor (or main employer if in-house) will need to arrange for an approved dosimetry service to make routine dose assessments (1 month wear period for personal dosimetry) and keep dose records (regulation 22 IRR17). The HSE website gives further advice on the assessment and recording of doses[5].

Dose rate monitoring instruments enable radiographers to check that sealed sources have fully retracted into containers, or X-ray sets have stopped emitting radiation. Many radiographers have received inadvertent exposures to radiation because they failed, or were unable, to make checks with monitoring equipment that the source had returned to its shielded container, or that the X-ray set was de-energised. It is therefore essential that dose rate monitoring instruments are in working order; have been type tested; have a valid test certificate and are within their calibration date.

In addition, personal electronic alarming dosemeters give immediate warning of high dose rates, so wearing these may be particularly useful to radiographers. However, this should not replace the use of portable dose rate monitors. It is HSE's expectation that radiographers should be provided with and use personal electronic alarming dosemeters during site radiography work and during gamma source recovery incidents to give a real time assessment of radiation dose.

Radiation protection adviser (RPA)

Contractors (or the main employer if in-house) will almost certainly need to appoint a suitable radiation protection adviser with up-to-date knowledge of the requirements of IRR17 and radiation protection for industrial radiography (regulation 14 IRR17). The individual or organisation acting as the RPA must satisfy HSE's criteria of competence. The contractor must consult the RPA about compliance with IRR17, and in particular on a range of specified matters (see regulation 14(1) and schedule 4 IRR17).

References

Work with ionising radiation: Ionising Radiations Regulations 2017: Approved Code of Practice and guidance L121 ISBN 978-0-7176-6662-1

Managing health and safety in construction: Construction (Design and Management) Regulations 2015: Guidance on Regulations L153 ISBN 978-0-7176-6626-3

Dose monitoring, assessment and recording