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Title: The Role of Independent Inspections in Achieving ALARA

INTRODUCTION

In the UK, independent inspections by Radiation Protection Advisers (RPA) form an important part of any radiation protection programme (RPP). Organisations with a complex use of ionising radiations may employ their own RPA but more frequently, for the non-nuclear industry, the RPA service is provided by an external body. Within the context of UK legislation, the RPA is regarded as a qualified expert as defined within article 38 of the EU Basic Safety Standards (BSS), Council Directive 96/29/EURATOM of 13 May 1996. Article 47 of the same directive require qualified experts to be involved in the provision of radiation protection advice, for instance on commissioning new equipment that utilises ionising radiation.

Audit and review form an important part of RPPs. Three types of inspection may be undertaken on an organisation involved in work with ionising radiations;

1 Internal self audit/ review within the company, probably by their own Radiation Protection Supervisor,

2 Audit/ review by an independent specialist/ organisation as part of the RPA function

3 Inspection by a regulator.

The first two may be planned by the company and undertaken on a regular basis. The latter inspection will usually depend on the regulatory body's time and resources and not the company using ionising radiations unless there is a specific reason, for instance a reportable incident has occurred.

ALARA CONSIDERATIONS (1) – INSPECTIONS BY REGULATOR VS QUALIFIED EXPERT (RPA)

Article 38 (1) of the BSS requires each EU member state to establish a system of inspection and enforcement in compliance of the BSS. The focus of an inspection by a regulatory body will therefore be on compliance rather than the provision of advice. Further, the regulator may be reluctant to provide specific advice since several regulatory bodies may be involved in ensuring compliance with the BSS and a regulator would need to take care that advice would not conflict with the requirements of other regulatory organisations.

For instance in the UK, the environment agencies (separate agencies for England/Wales, Scotland and Northern Ireland) and the Health and Safety Executive (HSE) have key roles in regulating work with ionising radiations. Care would need to be taken to ensure that advice provided by one agency was consistent with others. It may also be

problematic if a regulator takes on the dual role of enforcing and advising – this might compromise one or other role.
In the UK, whilst a regulator might provide an opinion, advice is normally provided by the RPA, who is contracted by the company utilising ionising radiation. Ultimately it is a court of law that makes judgement on the interpretation of a regulation since much of UK health and safety law today is goal setting rather than prescriptive, i.e. developing good practice in various work sectors and health and safety through risk assessment is positively encouraged.

In summary, whilst a regulator may see a snapshot in time of a company's work with ionising radiation, a RPA, as an independent inspector, would normally have developed a closer relationship with the company and been involved in the development of that company's RPP.

ALARA CONSIDERATIONS (2) – GOOD DESIGN

With the exception of the nuclear industry, the regulator does not directly "approve" equipment designs that may incorporate a source of ionising radiation. The RPA would normally be involved in the design, commissioning, use , maintenance and decommissioning stages of the equipment/ facility. In each of these stages there may be ALARA implications, for instance consideration of a dose constraint in the design stage or additional radiological protection requirements during maintenance when safety features such as interlocks might be inoperative.

X-ray security equipment sales are flourishing and there is strong competition between the various companies who supply this equipment. One point of contention in the UK is the provision of extended tunnel guards at the feed/ discharge ends. Dose rates beyond the lead rubber curtain within the body of a conveyor type x-ray security unit may range between a Svh^{-1} in the primary beam at 1 m to a few μSvh^{-1} just beyond the lead rubber curtain within the cabinet. Whilst there is no specific regulation requiring the provision of extended guards at the feed/ discharge ends, in the UK, it is not regarded as ALARA for an operator/ security personnel to be able reach into the primary beam. Even at lower dose rates due to scattered x-radiation, the RPA would recommend the use of guards to prevent access to areas of dose rates above a few tens of microsieverts per hour to ensure that doses to loaders are kept as low as reasonably achievable. The RPA would also take account of the presence of staff untrained in radiological protection. It should be noted that it is not just ALARA considerations that have resulted in the provision of extended tunnel guards but also concern from security staff for their own safety.

In another practice, x-rays are used for imaging, e.g. molecular structures, in x-ray crystallography (XRC). Unlike a x-ray security operator, the technician involved in XRC work will normally have a detailed understanding of the work and equipment used in this work. Due to the high mA that this equipment may operate at, typically 100 mA at 50 kV, filament changes tend to be frequent and may require subsequent x-ray beam alignment. This may be undertaken manually with the interlocks defeated in "open beam" mode. It was found that the extremities of the operator, on certain equipment, were in close proximity to the x-ray beam during the alignment process. Whilst the published guidance at the time permitted trained, experienced operators to undertake open beam alignment work, the risk of inadvertent exposure was high. The customer and XRC equipment supplier together with the RPA developed a number of beam enclosures that could be used during alignment to prevent inadvertent exposure and thus reduce extremity dose.

There have been problems in the past where a UK supplier is the agent of a non-EU parent company. Equipment from outside the EU appear to rely on trained operators using the equipment and tend not to have the same engineered guards and other safety features seen in equipment manufactured within the EU. In the case of the XRC

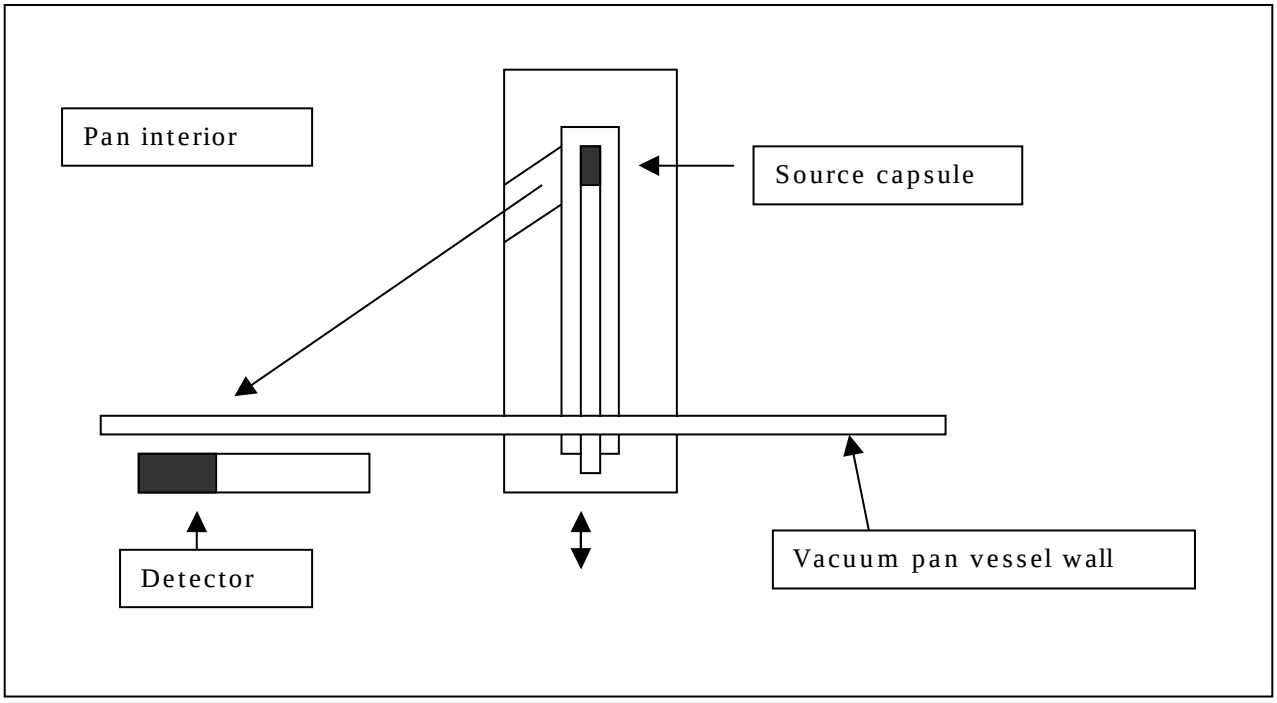
equipment referred to above, the parent company, located outside the EU, was convinced of the advantages of the beam enclosure jigs and now supply them as part of the system.

Both examples above demonstrate not only the influence of the RPA on design but the impact the customer can have. The supplier, if the equipment is to be accepted on the market, will need to satisfy the requirements of the customer, including any radiological safety considerations. Observations on customer equipment by the RPA may therefore influence the supplier's design, even if the supplier is located outside the UK.

ALARA CONSIDERATIONS (3) – NEW WORK/ EQUIPMENT

The RPA would normally be consulted before equipment containing a source of ionising radiation arrives at the company. By the time a regulator inspects the premises, the equipment could already have been installed and potential problems that might have been encountered on installation not identified. An example of this was the trial of a vacuum pan gauge in a sugar factory. This type of gauge is used in various countries such as Holland and Ireland and incorporated a 1.1 GBq caesium-137 source to measure the density of sugar as it forms within the pan. The gauge consists of a source on a rod within a lead shielded stainless steel sleeve. No shutter is provided but a small aperture through the lead shielding is provided such that when the source rod is pushed forward, there is an unshielded pathway back down to the wall of the vacuum pan vessel. The detector is located on the other side of the pan wall (see diagram below).

Sugar Vacuum Pan Gauge layout



Inspection of the drawings, which provided the 7.5 $\mu Sv h^{-1}$ contour and dimensions of the gauge and shielding indicated that whilst installed, it was unlikely that the dose rate above 7.5 $\mu Sv h^{-1}$ outside the pan would be accessible when the guards had been put in place. However, it was noted that close to the source position, the dose rates could be higher, up to 15 $mSv h^{-1}$ at the surface. With this information from the RPA, the company

made a shielded lead collar to be placed over the source rod prior to installation. Before installing the gauge, the company requested, on the RPA's advice, that the source was not installed in the gauge until company personnel had a chance to practice installation of the gauge and identify any delays that could increase exposure. Due to the additional shielding during movement of the gauge from the store to the pan and having been provided with the opportunity to practice installation, the gauge installation occurred with minimal dose received.

Another example of RPA input at an initial stage to reduce potential operator dose is the dispensing of liquid radioactive material from stock solutions in the life science sector. Radioactive stock solutions may be delivered in a variety of containers with different types of sealed tops. If a company changes supplier or there is a change in container, then time spent practising the removal of samples from an inactive or low activity stock might save dose and reduce the risk of contamination later on. This is similar to practising a new technique with inactive or low activity materials first to identify potential problems before commencing a study, i.e. to identify equipment that could potentially become contaminated and seek means to reduce this. A regulator would not normally be involved at this stage but might take some interest in the work if significant contamination had arisen as a result of poor work practices.

ALARA CONSIDERATIONS (4) – OTHER SOURCES OF EXPOSURE

The RPA is likely to be contracted by a company to cover a specific use of ionising radiation e.g. a liquid level device incorporating a radioactive source used in bottling plants. However, in the course of the visit, other sources of ionising radiation may become apparent. This may be another piece of equipment operated by the company but not identified as having a radioactive source, e.g. a gas chromatograph with an electron capture detector (nickel-63), or a source of ionising radiation brought onto site by a contractor, e.g. for non-destructive testing work, or a source of naturally occurring radioactive material (NORM).

The latter may present the greatest challenge in terms of achieving dose reduction and could possibly have significant impact on the company and its operations. Unless identified by a specific study, e.g. the NRPB UK study on radon affected areas, NORM issues are only likely to be raised due to the results of investigations elsewhere that the RPA has been made aware of or by accidental discovery. In the UK there has been significant focus on NORM in the oil and natural gas industry. However whilst the producer of materials incorporating NORM may be aware of the potential exposures and have systems in place to deal with these situations, despite regulations requiring co-operation between employers, their customers may not be aware. A RPA may advise several customers with a wide range of ionising radiation applications and be the first to identify a potential NORM problem. For instance, it is known that radon daughters, e.g. lead-210, can accumulate on filters within the natural gas supply network, especially close to the extraction points. However this might not be noted as an issue by the customer, for example, a gas fuelled power station. The RPA, aware of NORM issues in the gas industry might raise this with a major user, i.e. one who might use a high volume of gas, and seek to determine that radon daughter build up was not an issue on a power station's secondary gas filters (this has not found to be an issue in the UK).

ALARA CONSIDERATIONS (5) – "The same procedure as last year"

As previously mentioned, unless there was a statutory requirement for a regulatory body to undertake routine inspections of a premises, a radiation employer may only be inspected at infrequent intervals. However personnel changes may have a significant impact on a company's Radiation Protection Programme (RPP). A regulator might have

inspected and been satisfied with a company's RPP but personnel or other changes might have reduced the effectiveness of the RPP only a short time later.

The RPA would tend to visit at regular intervals or if there were any significant changes to personnel/ equipment. A company with an effective RPP usually welcomes the independent review by the RPA to indicate that high standards are maintained and keep up to date with legislative developments. The RPA will outline any likely changes to the law and how it might impact on the company. For a company that maintain a good standard of radiological protection, the RPA's visit may feel like "the same procedure as last year" but it is important under these circumstances for both the company and RPA not to become complacent.

However, changes in company personnel can have a negative impact on the RPP. The reduction in effectiveness of the RPP should be identified by the RPA who would recommend improvements. The reduced effectiveness of a RPP might be apparent in the quality of records maintained by the company or the loss of knowledge of legislative requirements leading to failure to comply with legal requirements, e.g. provision of transport documents for class 7 consignments or the failure to maintain radiation monitors.

The change from a satisfactory RPP to a poor RPP might be due to a change of equipment or other factors. The company might have coped well with a relatively simple use of ionising radiation but are more challenged when a more complex use of ionising radiation is encountered. An example of this might be a company that extracted and processed materials from natural sources and used some simple x-ray fluoroscopic equipment to determine the content of the products for quality assurance purposes. Several years later it is "discovered" that the extraction process has concentrated NORM in the equipment used for processing and now the company have a significant radioactive waste/ decontamination issue. Whilst staff might have been trained and confident in using the x-ray equipment, the additional work with NORM might prove too big a challenge. The RPA has a role in assisting the company to train up to meet the new challenge and identify potential exposures and means to reduce such exposures.

CONCLUSION

The independent, non-regulatory inspector has a significant role in assisting companies to keep dose as low as reasonably achievable and this role complements the statutory inspector's role. Whilst a company will seek to be compliant in the "eyes" of a statutory inspector, a company may be much more open with an independent inspector or consultant.

A company may seek an opinion on a point of law from a statutory inspector but day-to-day advice on all aspects of radiological safety would be sought from the independent inspector who may be requested to visit whenever any significant changes occurred or in the event of an incident. Hence the independent inspector will have a greater influence on a company's Radiation Protection Programme and the dose constraints/ investigation levels set.

REFERENCES

1 'Council Directive 96/29/EURATOM of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation', *Official Journal of the European Communities*, 1996 **39** (L159) 1-114

2 The Ionising Radiations Regulations 1999, Statutory Instrument 1999/3232, The Stationary Office Limited, London, 1999, ISBN 0-11-085614-7