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Newsletter - November 2017

This newsletter primarily deals with XRF analysers, the employer's associated responsibilities, and the HSE's current stance on their use in practice. Also, a brief update on the forthcoming IRR17 legislation is included (page 5 onwards).

XRF Analysers

XRF analysers are non-destructive test instruments used to determine the identification and composition of various materials, such as stainless steels, precious metals and soil. Typically, they work by exposing a material to X-rays in the 35 to 50 kilovolt (kV) region, which causes the atoms in the material to emit a scattered X-ray photon ('fluorescent X-ray' in this context), which is subsequently reabsorbed by the analyser, measured and 'converted' to a material identification. Usefully, most materials exhibit a unique 'fingerprint' of fluorescent X-ray values which aids in this identification.

By virtue of the fact XRF analysers emit X-rays, they carry inherent risks, primarily the exposure to ionising radiation. Ionising radiation simply means the radiation can remove electrons from the 'parent' atom, unlike non-ionising radiations such as visible light and infra-red, which possess insufficient energy for this to occur (that's not to say all non-ionising radiations are safe, after all, you wouldn't want to stick your hand in a microwave oven!).

This ionising effect can produce many effects over time, such as skin 'burns' (erythema), or even cancer. Of course, X-rays have their benefits, which is why when their use is justified, they are used in various settings such as the medical and non-destructive testing industries.

Typically, during normal operations with the analyser energised in contact with a test sample, an analyser used in 'hand-held' (AKA 'open-shop') mode emits ~ 5 µSv/h at the surface of the tube housing and < 0.5 µSv/h at all other positions, such as around the trigger. Various manufacturers claim that the output from the surface of the open tube window is in the region of 0.5 - 1 Sv/h (500,000 - 1,000,000 µSv/h). To provide context, background radiation dose rate is typically quoted in the region of 0.1 – 0.3 µSv/h, equating to approximately 20 µSv cumulative dose per week. Under normal XRF operating conditions, it would take several years of continuous exposure before any noticeable health effects would occur, therefore, the risk is minimal when used responsibly.

What are my duties as a radiation employer?

As stated above, when XRF analysers are used responsibly, the risk is negligible, and the operator is exposed to no more radiation than they would receive from normal background radiation. To enforce this, statutory regulations are in place which the employer are bound by. Current legislation is the Ionising Radiation Regulations 1999 (IRR99), which came into force on 1st January 2000. These are due to be replaced in early 2018 by IRR17 (more on this later!).

Primarily, the employer undertaking XRF work should as a minimum:

- Notify the Regulator (HSE) of their intention to use an XRF analyser, usually 28 days before commencement of the work
- Conduct a thorough risk assessment which considers not only routine work, but also any reasonably foreseeable accidents, such as damage sustained from a drop etc.
- Consult an RPA who can advise on relevant areas of the regulations, such as content of the risk assessment, dosimetry needs etc
- Ensure all operators receive sufficient training to enable them to work in a safe manner.
- Appoint a number of radiation protection supervisors (RPS) who can ensure the requirements of the regulations are being adhered to
- Produce a system of work ('local rules') which outlines the instructions to be followed by all to ensure all exposures remain 'As Low As Reasonably Practicable' (ALARP)
- A means to ensure ALARP doses, which for XRF operators is usually by the wearing of a suitable cumulative electronic dose meter with all doses recorded
- Ensure the analyser is supplied with a 'certificate of conformance' (or equivalent) and is maintained in line with manufacturer's recommendations

So what is a suitable dose meter for XRF work?

A suitable dose meter is a device which is robust, sufficiently sensitive to the radiation in question and actively alerts the operator if any unusual doses are received. Historically, a 'SV Bleeper' was considered sufficient as there wasn't much else on the market, however these are no longer deemed sufficient by the Regulator. Currently, the instruments of choice are Tracerco's T414 'PED' family of instruments, such as the 'Blue', 'IS' or '+' series. These are deemed more suitable for the following reasons:

- They are sufficiently sensitive to the XRF energy spectrum as they work in the range of 33 keV to 1.3 MeV
- Are robust and easy to use
- Measures cumulative dose and dose rate
- Clear display panel
- User definable audible alarm which alerts the wearer when a pre-set dose or dose rate is breached. This is accompanied by a vibration of the instrument
- Can be configured for individual wearers
- Shock, vibration and drop resistant and can withstand immersion in water of up to 1 metre ('IP 67' rated)
- Type-approved under 2004/108/EC (EN 61526:2013)

In most cases, the '**PED Blue**' is suitable for most aspects of portable XRF work (see additional information under portable test stands below). The PED Blue also incorporates a compensated GM tube dose rate function which continuously surveys the environment whilst being worn by the operator. It also records the peak instantaneous dose rate received.

Why is it important to monitor at all?

This comes down to the need to ensure all doses remain ALARP. As X-rays are invisible and undetectable by human senses, it is imperative that some form of instrument is used. As well as the ALARP principle, the employer has a duty to ensure that the employee is not subjected to a dose of radiation which breaches statutory limits, so this can only be determined if doses

are monitored and recorded (the HSE are of the opinion that if the doses are not recorded, why monitor them in the first place?). Recording doses also facilitates the identification of trends; e.g., why have recorded doses suddenly increased?

Another point to consider is legal compliance where a **controlled** area has been designated. Typically for portable analysers, this is stated as being 3 metres in the forward direction and 1 metre to the sides. As a controlled area is effectively in place each time the analyser is energised, it is a requirement of IRR99 to monitor doses. Specifically, Regulation 18(3) states:

"*An employer who has designated an area as a controlled area shall not permit a person to enter or remain in such area in accordance with the written arrangements under paragraph (2)(c), unless he can demonstrate, by personal dose monitoring or other suitable measurements, that the doses are restricted in accordance with that sub-paragraph."* Subsequently, under 18(5) it is a requirement to keep a record of these doses for two years.

If nothing else, monitoring doses also provides some reassurance to the operator that they are not being exposed to dangerous levels of radiation, after all, how else could they determine this?

But what if I only use my analyser inside a portable stand?

A portable test stand (PTS) provides additional engineered control measures, such as a shielded inspection chamber, an interlocked lid which prevents an exposure if the chamber is open and auxiliary warning lights. PTS's are deemed especially important when analysing small articles (such as nuts and bolts) which do not sufficiently intercept the X-ray window during an exposure under 'open-shop' conditions. Whilst in theory a controlled area is not in place during PTS use, the Regulators are of the opinion that, as the stand is essentially a shielded enclosure, the shielding integrity must be confirmed periodically by the employer. This can be achieved by:

- Regular visual inspections with a record kept (for two years)
- Ensuring the stand is not subjected to any knocks etc. which could compromise its shielding integrity
- Inspections and tests in line with manufacturer's recommendations
- Periodic radiation surveys around the vicinity of the stand during XRF analysis. Periodic should be considered to mean at least once a year. In many cases, this can be conducted by the RPA and / or service agent during their respective checks
- As with cumulative dose recording under 18(5), records of periodic dose rates should also be retained for two years under 19(4)

If the analyser is also used outside the stand occasionally, it is recommended that a '**PED +**' (AKA 'PED Black') is used, as unlike the PED Blue, this instrument incorporates a suitable dose rate meter in what is termed by Tracerco as 'hand-held' mode, which is selected from the menu (when in this mode, the instrument temporarily stops acting as a cumulative meter until switched back).

To summarise, the PED Black can be used as a cumulative meter for hand-held use, and a dose rate meter for periodic checks around the stand. If the only work undertaken is outside a stand, a PED Blue is sufficient.

Is my XRF risk assessment thorough enough?

If the risk assessment (RA) has been conducted with due diligence and considers routine work and reasonably foreseeable accidents, then yes it most probably is. No one RA can encompass all employers undertaking XRF work, as what is considered 'reasonably foreseeable' by one employer, won't be by another.

Great emphasis is placed on RA's by the Regulator, as they are deemed to be the hub around which all associated practices are based. For example, if it states in the RA that the XRF analyser is always used with the wrist strap, then there should be supporting text in the local rules stating this and the wrist strap should indeed be used each time the analyser is operated (otherwise, why reference it in the RA?). The same applies to the wearing of dose meters, annual inspections etc. Paragraphs 44 & 45 of IRR99's ACOP outline what should be considered when conducting such an assessment. For XRF use, these include:

- Storage when not in use
- Training needs / RPS appointment
- Safety checks / recording
- Dosimetry / recording
- Maintenance
- How it's used (e.g. the article being tested must fully intercept the window – deemed very important by the HSE!)
- Test stand (i.e. are test samples sufficiently small?)
- Exposure times
- Restricting access to the controlled area
- SSoW

Good RA's are not overly complicated as it will be almost impossible to implement their findings in practice. The RPA will always advise on suitable content and implementation.

XRF Contingency Plans

A thorough RA would hopefully highlight potential accident scenarios with the aim to prevent them, or limit their severity, but of course, accidents can happen. The overriding aim here is as for RA's; what is deemed reasonably foreseeable? This is a scenario which in theory cannot be ruled out, even after conducting the RA, such as damage from fire, being dropped, theft / loss of the analyser, accidental exposure etc. Therefore, there is a requirement under Regulation 12 to have a written summary in the local rules of the course of action to follow, which must be reasonably straight forward (consider in such an event people may not think clearly if in a state of panic). In some cases, contingency plans should be rehearsed every year, or as a minimum, all affected persons should periodically review the content (a tool-box talk helps with this).

A contingency plan deemed especially important by the HSE is that for an analyser which has been damaged in some way. It is imperative that before the analyser re-enters routine service, it is thoroughly checked by a person of appropriate competence to ascertain that the safety system architecture and shielding have not been compromised in anyway. The only way to confirm the shielding is intact is with a suitable dose rate meter, which a competent person will be in possession of.

This is also the case for an analyser which has been dropped but appears undamaged; it should still be checked by a competent person to ensure the shielding is sufficient, and the warning lights, trigger and proximity sensor work as intended.

Update on IRR17

You may recall in February we sent out an advisory note outlining our understanding of the new regulations. Since then after various presentations by the Regulator we can update you on this matter (some aspects are still being determined by the HSE however). Guidance is now available on the HSE website regarding the main changes. A draft copy of the ACoP to IRR17 is also available at http://www.hse.gov.uk/radiation/ionising/index.htm.

By and large, the new regulations are evolutionary, not revolutionary so many aspects will remain unchanged, therefore this update primarily focuses on key points:

- Will come into force on 1st January 2018
- Defines 'industrial radiography' as the use of ionising radiation for non-destructive testing purposes where an image of the item under test is formed (but excluding any such testing which is carried out in a cabinet in which a person cannot enter)
- Defines 'non-classified outside worker' as a person who is not a classified person who carries out services in the supervised or, pursuant to regulation 19(2)(c)(i), controlled area of any employer (other than the supervised or controlled area of their own employer)
- Defines 'outside worker' as a classified outside worker and a non-classified outside worker
- Defines 'radiation generator' as a device capable of generating ionising radiation such as X-rays, neutrons or other charged particles

Another key change from IRR99 is what the HSE term a 'graded approach' which, for the practice in question is a system of:

1. Notification
2. Registration
3. Consent (not "licensing" as our February newsletter intimated)

In this context, 'practice' is defined as a human activity that can increase the exposure of individuals to radiation from a radiation source and is managed as a planned exposure situation.

Employer's will have until 6th February 2018 to notify, register and receive consent (as applicable). If these have not been completed by this date, then the practice cannot continue until the relevant areas are addressed.

1. **Notification** will likely be a simple electronic system, similar to the current system

2. **Registration** will be necessary for:

- the operation of radiation generators or accelerators or radioactive sources for medical exposures or for non-medical imaging purposes
- the operation of radiation generators or accelerators, except electron microscopes, or radioactive sources for purposes not covered by the above
- This will cover the majority of practices – approximately 26,000 duty holders

- Electronic system with a **£25 fee**
- Will be completed by answering 8 to 10 questions
- Confirmation that a suitable risk assessment has been performed
- Confirmation that means to ensure ALARP doses to individuals are in place
- Confirmation that suitable contingency plans are in place
- Confirmation of adequate training to relevant individuals
- Confirmation (where applicable) that controlled and supervised areas have been designated and demarcated
- Confirmation that the means to assess employee's doses are in place
- Confirmation that local rules and RPS's are in place
- Confirmation that an RPA has been consulted / appointed

3. Consent – <u>This obligation is still under development</u>; however, it is likely that:

- It will be necessary for users of HASS, industrial radiography, work with particle accelerators and industrial irradiation
- Electronic system with a **£25 fee**
- Confirmation that the overall management, planning, organising, controlling and reviewing of this radiation risk have been considered
- Confirmation that the employer has appointed and consulted with a suitable RPA
- Confirmation that those engaged in the practice have received appropriate training in radiological protection
- Confirmation that those engaged in the practice have been informed of the radiological risks to their health from the practice and the precautions that should be taken
- Confirmation that those engaged in the practice will receive regular updates/refresher training in radiological protection
- Confirmation that those employees not engaged in work with ionising radiation but who are likely to be affected by it have received appropriate training in radiological protection
- Confirmation that the design features; engineering controls; and safety features of the facility and the radiation sources are such that exposures to radiation will be as low as reasonably practicable (ALARP)
- The maximum anticipated total annual effective dose (in mSv) to an employee engaged in the practice
- The maximum anticipated total annual dose equivalent (in mSv) to an employee engaged in the practice for:
    - Lens of the eye
    - Extremities
    - Single organ or tissue
- The maximum anticipated total annual effective dose (in mSv) to an employee not directly engaged in the practice
- The maximum anticipated total annual effective dose (in mSv) to a member of the public
- Confirmation that a suitable risk assessment has been performed.
- Confirmation that contingency plans for all reasonably foreseeable radiation accident have been drawn up and that they are rehearsed at suitable intervals
- Confirmation that a maintenance, testing, inspection and servicing regime is in place which ensures that the radiation source and the facility continue to meet the design requirements, operational limits and conditions of operation throughout their lifetime

- Confirmation that the management of any radioactive waste will ensure that exposures to employees will be ALARP
- Confirmation that the management of any disused source or radiation generators will ensure that exposures to employees will be ALARP
- Confirmation that where appropriate suitable and sufficient quality assurance regimes are in place

Specifically, for users undertaking **Industrial Radiography**, additional conditions of consent are:

1. Notify HSE of any material changes to original application

2. Comply with the IRR17

3. Only carry out site radiography if 7 days' notice (in writing) has been received from client unless permission from HSE has been granted

4. If required notify HSE on each and every occasion work is carried out

Other expected changes, which won't affect all employers include:

- Eye dose limit being reduced to 20 mSv per year
- If there is reason to invoke one of the contingency plans in the local rules, to carry out an investigation to help prevent recurrence and to keep the report for two years
- After regulation 7 of IRR17, the regulations follow the regulation numbering pattern of IRR99 + 1. For example, for IRR99, risk assessments come under regulation 7, but will be under regulation 8 of IRR17, local rules will be under regulation 18 instead of 17 etc.

Despite all the above changes seeming very daunting, it is emphasised that the new regulations are evolutionary, not revolutionary.

Please do not hesitate to contact us should you have any further questions regarding the content of this news letter or matters regarding radiation safety in general.

S. A. Wright

Principal RPA