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Practical Matter

The advantages of creating a positive radiation safety culture in the higher education and research sectors*

T Coldwell[1], P Cole[2], C Edwards[3], J Makepeace[4], C Murdock[5], H Odams[6], R Whitcher[7], S Willis[8] and L Yates[9]

[1] Health & Safety Services, University of Hull, Cottingham Road, Hull, HU6 7RX, UK
[2] Radiation Protection Office, University of Liverpool, L69 3BX, UK
[3] Safety, Health & Environment, University of Central Lancashire, Preston, PR1 2HE, UK
[4] National Physical Laboratory, Teddington, Middlesex, TW11 0LW, UK
[5] Peak RPA Ltd, Buxton, Derbyshire, SK17 6WT, UK
[6] The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK
[7] CLEAPSS, Gardiner Building, Brunel Science Park, Uxbridge, UB8 3PQ, UK
[8] AURORA Health Physics Ltd, Library Avenue, Harwell, Didcot, Oxfordshire, OX11 0SG, UK
[9] Health & Safety Office, University of Cambridge, 16 Mill Lane, Cambridge, CB24 9XN, UK

E-mail: pcole@liv.ac.uk

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Abstract

The safety culture of any organisation plays a critical role in setting the tone for both effective delivery of service and high standards of performance. By embedding safety at a cultural level, organisations are able to influence the attitudes and behaviours of stakeholders. To achieve this requires the ongoing commitment of heads of organisations and also individuals to prioritise safety no less than other competing goals (e.g. in universities, recruitment and retention are key) to ensure the protection of both people and the environment.

The concept of culture is the same whatever the sector, e.g. medical, nuclear, industry, education, and research, but the higher education and research sectors within the UK are a unique challenge in developing a strong safety culture.

This report provides an overview of the challenges presented by the sector, the current status of radiation protection culture, case studies to demonstrate good and bad practice in the sector and the practical methods to influence change.

* A report from the Working Group on Culture in Research and Teaching.

Keywords: radiation, protection, safety, culture, education, research

(Some figures may appear in colour only in the online journal)

Introduction

The International Radiation Protection Association (IRPA) has recognised that there is potential to improve how radiological challenges are addressed through the development or enhancement of a strong Radiation Protection (RP) safety culture in all relevant sectors. As the international voice of radiation protection professionals, IRPA has initiated a process which has provided a medium for discussion on this topic throughout the world.

As part of this process, the UK professional radiation protection partner societies (see appendix A) have responded to the decision to enhance RP culture among RP professionals in all relevant sectors and as a key element of this, recognise the need for programmes and tools to assist with the development and improvement of radiation safety and protection at a cultural level within an organisation, as an effective mechanism for delivering aspirational performance.

What is safety culture?

The Chernobyl disaster of 1986 highlighted the importance that safety culture has on an organisation and in particular the impact that management and human factors have on safety performance. Since then there have been a number of widely-used definitions of safety culture.

The UK Health and Safety Commission provided one of the most commonly used definitions of safety culture:

> '*The product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's health and safety management.*
> *Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures*.'

Therefore, in simple terms, the safety culture of any organisation is a reflection of the attitudes, behaviours and actions of its stakeholders towards safety. In an educational/research setting, these stakeholders would include academic staff, students, managers, supervisors, technical support, administrators, contractors, visitors and members of the public.

Why have strong safety cultures?

A strong safety culture is essential to protect staff but it is equally important in protecting the high percentage of young and inexperienced persons (students) based in education and research establishments, and the reputation of academic/research institutions. Safety culture is rooted in ethical, moral and practical considerations, and a basic duty of care. It is less about legal and regulatory requirements although obviously elements of these can and are used to improve an organisation's safety culture.

Safety culture encompasses the entire organisation, from the top and needs to be integrated throughout the organisation which is why successful and sustained safety cultures take a comprehensive effort. These efforts will vary, and include: identifying problems with a safety management system; maintenance of rules and regulations; testing to make sure education is being consistently maintained; and promoting positive reinforcement. Audit, inspection and review must also fit the relevant industry.

When practised well, safety can engender a high level of ownership at all levels, it can increase performance and can also be successfully used as a tool in developing student skills and awareness.

Safety culture can be broken down into a number of key elements:

1. Leadership & Management

The management style of leaders within an organisation can have a substantial effect on the safety culture, positively or negatively (Health & Safety Executive 2005). To build a strong culture of safety, leaders need to:

- inspire others to value safety;
- build trust through open and transparent communication;
- lead by example;
- accept responsibility for safety; and
- hold others to account for their safety performance.

There needs to be a clear line of responsibility for safety, coming from the Senior Management Team, to individual staff members.

2. Learning Culture

To maintain and improve the safety culture within an organisation, there should be a continuous professional development of staff in safety knowledge. Staff should be encouraged to contribute ideas for improvements and develop an awareness of what good safety performance actually means in their own jobs. In universities, a strong safety ethic should be embedded into taught courses, so that students can develop their own safety skills.

3. Attitude & Awareness

As well as a positive approach to safety at an institutional level, it is important that individuals have the same attitude or 'safety ethic'; '*to value safety, work safely, prevent risky behaviour, promote safety and accept responsibility for safety*' (American Chemical Society 2012).

4. Taking Ownership–Responsibility & Accountability

The acceptance of safety responsibilities needs to be implemented from the top of the institution, to all employees. This usually follows the normal HR chain of line management. At each managerial tier, employees should set a positive example for others. If employees do not perform as expected regarding safety, there must be mechanisms in place to hold them accountable for their inadequate performance.

5. Learning from Our Mistakes

Much of the progress in improving safety has come from the desire to prevent repeat mistakes or incidents. It is important that when incidents occur, they are investigated to determine the direct, indirect and root causes. The findings (and corrective actions taken) should be publicised to the institution, or even across institutions, so that they can be used as case studies. Near-miss reporting also provides valuable input to inform this process.

6. Promoting and Communicating Safety

The best way to promote safety is through personal example. However, this only extends to those people close by. Wider promotion across the institution is needed to raise awareness of safety issues. A method to achieve this should be put in place, using electronic communications, printed materials, seminars or events and a recognition system for good safety performance.

7. Collaboration & Best Practice

Even if a department or service area has made excellent progress in changing its safety culture, if the rest of the institution does not follow suit then any benefits will have minimal impact.

The Health & Safety at Work etc. Act 1974 requires that in certain circumstances an institution-wide Safety Committee be set up to review the measures being taken to ensure the health and safety of employees.

It is good practice to include a representative cross-section of employees to participate in this committee. Under this main committee, a network of local committees can be set up (faculty, department etc.) to encourage collaboration and the sharing of best practice across the institution.

8. Funding & Resources

It is important that any safety management system is adequately funded. Each department or service area should allocate a budget for safety-related equipment and activities, rather than absorbing it into general budgets.

What are the RP cultural issues?

The higher education and research sectors within the UK represent a unique challenge for the establishing and improving of a strong safety culture. The reasons for this include:

- There will be a higher percentage of young and inexperienced persons involved when compared to a non-educational work environment.
- There is a higher 'turnover' of personnel involved in hazardous work, indeed most undergraduate student courses have a three year cycle duration, and short term contracts are becoming more common in research companies.
- Academic attitudes are often more focussed on recruitment and retention of students, research goals and outcomes than on safety and radiation protection.
- The research work carried out in these sectors is often very diverse.
- The research is often extremely novel in its nature, if not unique, and this leads to challenging hazards.
- There is chronic under-funding that leads to a process of 'grant optimisation' which may not place safety as a priority.

It is important though, that we do not consider the safety pressures of academia and research to differ from those of industry. The maintenance of a high level of productivity and safety applies to both. In industry a number of high profile major accidents have resulted from failures compounded by production demands e.g. Piper Alpha oil platform, the Challenger space shuttle (Cowing *et al* 2004). It seems that many senior managers perceive safety and productivity as competitors whereas in truth they go hand in hand.

A review of serious and fatal accidents in university labs, mainly from US, (Van Noorden 2011) concludes amongst other things that in some cases '… *academic freedom is more important than safety.*' A recent survey on laboratory safety (Evans 2014) revealed that academic researchers often engage in unsafe laboratory practices.

In the Guardian newspaper on 4th December 2014, the Science Editor, Ian Sample, reports on '*Revealed: 100 safety breaches at UK labs handling potentially deadly diseases.*' This report revealed failures in procedures, infrastructure, training and safety culture at some British laboratories.

Obviously, these references do not directly relate to radiation safety. However it is reasonable to assume that such lack of culture extends to all types of work in laboratories–including that involving sources of ionising radiation.

The ethical reasons for having a strong RP safety culture

Protecting the workforce (staff and students)

Whilst a strong safety culture is essential to protect employees, it is equally essential in protecting students and is a significant factor in the promotion of safety awareness and the development of safety skills.

Protecting the general public and the environment

The Public's perception of radiation risk can be greatly affected by the context in which the radiation is used and this perception can be skewed significantly by poor knowledge of benefit and detriment. Therefore it remains as important for us to communicate risk factors as it is the many benefits to society that can result from research using radioactivity.

To continue to increase public knowledge we must:

- define the concepts of risk in lay terms;
- use a simple vocabulary to explain radiation; and
- educate the public and the media about radiation and its benefits and risks.

However, increased public knowledge will not necessarily lead to an increase in public trust. Organisations and individuals can positively affect public perception by being seen to work closely with the regulators to strive for continual improvements in environmental and health and safety compliance. An example would be to improve the public's awareness of a research organisation's responsibilities to apply Best Available Techniques (BAT), legally required under environmentally protection legislation, but also ethically as a duty of care to external stakeholders. Academia, in particular, could benefit here by taking a lead from the nuclear industry that has worked to publish an industry code of practice for BAT compliance; additionally, they hold open days and stakeholder meetings around their permitted sites.

Doing safe and scientifically robust research

Many organisations depend on universities and R&D companies undertaking robust and trustworthy scientific research, publishing learned articles founded on good science, developing products, and enhancing humanity's knowledge.

Yet there are many ways in which the failure to follow good basic practices as part of a strong RP safety culture can lead to the ruination of scientific data and the knock-on effects can be significant. Examples of poor practice include:

- Failure to carry out suitable and sufficient monitoring for radioactive contamination in a laboratory area used for handling unsealed radioactive substances leading to contamination spreading onto liquid scintillation vials which when counted yield erroneous results.
- Failure to calibrate instruments causing an unnoticed measurement error of radiation outputs from x-ray generators.
- Failure to ensure regular servicing of equipment leading to unsafe operational conditions and subtle malfunctions that impact measurements.
- Failure of management to ensure that safety issues are addressed in project proposals and in project reports/papers submitted for publication.
- In-house maintenance carried out by persons unqualified to make such repairs leading to unsafe and incorrect equipment performance.

Many good practices can be viewed by academics and researchers as mundane and of low priority or simply interference in research productivity. As a result, they can be performed incompletely, incorrectly or just not at all. Frequently there is a lack of understanding of how crucial routine laboratory tasks can be to obtaining reliable measurement data. In addition, this lack of understanding can be promulgated amongst junior staff and students by the importance of such tasks being treated glibly, overlooked and missed during in-house training.

The risks of not having a strong RP safety culture

Business continuity

Business Continuity Management is about establishing and maintaining an organisation's capability to retain continuous critical business processes, regardless of what disruptive event may occur.

Continuity of activities (teaching, learning, research, support services and other business activities) is a priority in education and research. It is the responsibility of all component areas (University Councils/Research Boards, Committees, Directorates, Schools and Services) to take all reasonable steps to avoid any foreseeable incident that may require an emergency management or business continuity planning response. If such an incident does occur, component areas will need to minimise any impact on the organisation and its stakeholders.

The objectives of emergency management and business continuity planning are to ensure that an organisation:

- Understands its critical activities and maintains the capability to resume operations within agreed timeframes, following the deployment of a suitable response.
- Increases resilience by protecting critical assets and data (electronic and otherwise) through a co-ordinated approach to management and recovery.
- Minimises impacts using a focused, well-managed response.

The establishment of a radiation protection policy that includes a regularly-reviewed radiation risk register is a significant step towards a good radiation protection culture and will secure better contingency plans and thus business continuity.

Although policies, plans and registers may not cover every conceivable contingency in a crisis, responsible decision-making, good judgement and good communication are paramount in a crisis to protect the organisation's ability to meet its mission of teaching, research and public service.

Financial implications

In university and research organisations, crises can result not just in the loss of vital resources such as buildings, equipment, infrastructure, technology and personnel, but also in teaching downtime and loss of manpower due to injury or stress, not forgetting the cost of remediation and the potential for significant damage to institutional reputation (see the next section).

A poor radiation protection culture can lead to bad practices which may adversely affect the health of staff, students and members of the public. This can lead to costly civil litigations and negative media coverage.

Likewise, a poor radiation protection culture may result in non-compliances with the radiation legislation, notably the Ionising Radiations Regulations 1999 (Health & Safety Executive 2000) and the Environmental Permitting Regulations 2010, amongst others. This can lead to regulatory actions such as prohibition notices and prosecutions by the Health and Safety Executive (HSE) and the Environment Agency (EA). This might escalate to significant fines being levied against the organisation, the severity of which will reflect the level of transgression.

Reputational damage

Significant reputational damage may emanate from adverse media coverage, for example, from reporting of legal action and fines to compensation claims or clean-up costs—which can lead to loss of trust resulting in falling student numbers and loss of revenue. This can also result in an adverse change in the attitudes of potential collaborators and grant funding bodies leading to a lowering in research rating, smaller number of grant awards and the inability to attract the best academic staff. Bid documents for commercial contracts invariably ask for details of any such legal actions, in preceding years, across the whole organisation.

How to improve radiation safety culture?

Radiation safety culture is a subset of general safety culture which in turn is rooted in, and must integrate with, the wider aspects of culture within any organisation. It is therefore essential that this topic is not considered in isolation because much work has been done, and good practice identified, in other subsets e.g. chemical-safety culture.

There are at least four effective ways to impact radiation protection culture:

- by educating and training the people involved in RP applications;
- by creating positive and total awareness of RP in workplaces, establishing adequate and proper communication processes among all the stakeholders involved in RP applications; and

- by engendering the capacity to learn from accidents, near misses and safety performance indicators and bring about continual improvement.
- by learning from other sectors and industries

Expanding on these ways:

Training

Radiation Safety training as with other health and safety related training is an essential part of the University's commitment to achieving a safe and healthy workplace for staff, students and visitors.

Staff must be provided with sufficient information, instruction and training to ensure that they are aware of radiation hazards and know what safe working procedures to follow to reduce the risk of injury or work related ill health, to themselves and others. Training is also essential in raising the level of staff and students awareness of health and safety policies and procedures, such as Local Rules, and to ensure their effective implementation.

All new staff or those that have been redeployed or relocated must receive general health & safety induction from their line manager or other appointed person, and specific induction from the Radiation Protection Supervisor (RPS) in the area in which they will be working. This requirement also applies to those on temporary contracts and agency staff.

The importance of knowing what health and safety training is needed is key to the selection and design of workshops. These needs should be assessed on appointment, when members of staff take on a new role with increased safety responsibilities, or new equipment is introduced. Training needs should also be reviewed as part of staff appraisals, from reviews of radiation safety performance and risk assessments.

Communication

Communication is key to the promotion of good safety practice and in learning environments such as universities and research establishments, leading by example is especially important as students will follow examples set by academics and senior research staff. Communication can be in many forms from the traditional safety posters, newsletters and weekly bulletins to the modern day emails, texts and Twitter messages.

Learning from our mistakes

Much of what is known about safety has been learned from accidents, incidents and near-misses. By using a lessons-learned approach, educational and research organisations are able to engage with staff and students and provide a challenge to think about how safety measures could have prevented an accident or incident, or at least have minimised the consequences. It is important therefore to establish robust accident/incident reporting systems and investigation procedures to identify root causes and formulate plans to implement mitigating actions.

Learning from other sectors and industries

Safety cases were developed by the oil, nuclear and rail industries in response to high-profile accidents and disasters. In a strong safety culture, members of staff collect evidence from a range of sources to build a sound safety case, with supporting evidence that systems are safe and risks are controlled and monitored.

The core of the safety case is typically a risk-based argument and corresponding evidence to demonstrate that:

- all risks associated with a particular system have been identified;
- appropriate risk controls have been put in place; and
- there are appropriate processes in place to monitor the effectiveness of the risk controls and the safety performance of the system regularly.

By applying safety case methodology in the university and research settings, institutions would be able to:

- promote structured thinking about risk amongst academics and researchers;
- integrate evidence sources;
- aid communication among stakeholders; and
- make the implicit explicit.

The OTHEA database (http://relir.cepn.asso.fr) is provided by a network of radiation protection stakeholders who have a joint interest in sharing feedback and experience from radiological incidents, in order to improve the protection of persons working with similar radiation sources. More generally, the aim is to encourage good practice within different sectors including medical and veterinary, industrial, research and education sectors, etc.

Incidents and reports are selected on the basis of the value of sharing the lessons learned and therefore the database includes a wide variety of incidents: not just accidents and incidents, but also any situation, event, behaviour or anomaly with the potential to cause an unplanned radiation exposure, or a significant decrease in the existing standard of radiation protection. This could include 'near misses', contamination spills as well as more serious radiological incidents.

Learning from 'Bright Spots'

'Bright Spots' are those institutions which have made successful progress towards a goal and are worthy of being emulated (Heath & Heath 2010). With regard to radiation safety culture, institutions which are bright spots will most likely share the following traits:

- Established lines of authority for safety, via senior management, Radiation Protection Advisers (RPA), Radiation Protection Officers (RPO), and Radiation Protection Supervisors (RPS).
- Safety policies in place, covering the use of all ionising and non-ionising radiation (unsealed sources, sealed sources, x-rays, particle accelerators, lasers, ultraviolet, etc).
- Safety responsibilities defined in job descriptions and performance/appraisal plans. There will be a set of responsibilities and duties for the specialist radiation safety personnel (RPA, RPS, RWA, RPO).
- Senior management demonstrate a care for radiation safety in their actions and have a commitment to funding radiation safety programmes adequately.
- A strong, effective radiation safety management system is in place.
- Safety skills are integrated into taught courses and the skills are assessed.
- All those with radiation safety responsibility have received appropriate training and recognised safety qualifications (e.g. Strathclyde certificate in RP, NVQ Level 4 in Radiation Protection).
- Prior risk assessments include all phases of a research project including source procurement and disposal. Grant applications should be 'forward-looking' and incorporate funding, for example, to pay for any specialist radioactive waste contractor fees.

- The costs of radiation safety education and training are included in research grant proposals and contract bids.
- All accidents and near misses are investigated, recorded, communicated and acted upon.
- Established a series of safety committees from the highest level to the departmental level or lower. Each of these committees report on radiation safety to a committee which is higher in the institution's hierarchy.
- Specialist radiation protection members of staff have close working relationships with departments using ionising and non-ionising radiation, collaborating on implementing safety programmes.
- A system is in place to promote radiation safety within the institution. Information is published on their website, a regular bulletin is sent out to staff, regular training sessions and presentations on radiation topics take place.
- A reporting system for safety concerns is in place, allowing staff to feedback directly to senior management.
- A close relationship with local emergency providers has been developed (e.g. taking part in joint exercises, such as decontaminating personnel).
- Good working relationships with regulators.

The various RP Societies play an important role in the 'Learning from Bright Spots', in that their programmes of meetings facilitate the dissemination and discussion of good practice from across the sectors. Equally there is a need for the employers of RP professionals to support attendance, both for professional development and to ensure organisations are aware of practices that could impact on the organisations work.

Methods for assessing RP safety culture in higher education and R&D sectors

The assessment tools used to examine the radiation safety culture of an institution can be a mixture of quantitative and qualitative tools. This is so that in addition to measuring the culture against set criteria, the attitudes and beliefs of staff can be investigated. The assessment tools should be used over time to pick up any positive or negative drifts in radiation safety culture. Such methods might include:

Audit against the legal requirements in IRR99 and EPR2010

Within this audit there needs to be ongoing assessment of the radiation protection management structure. There must be a mechanism to identify and then encourage the removal of any disconnect that exists between: (a) the management of radiation protection at the 'coal face' and (b) senior site management (see management structure performance indicator below).

The engagement of an external auditor to examine periodically the current state of culture (and its development) against recognised standards may be expensive, but is no doubt beneficial in testing the culture, and it is impartial.

It should be noted that regulatory inspectors (e.g. from the HSE or EA) 'have a powerful opportunity to offer support and encouragement for developing an effective radiation protection culture' (Cole *et al* 2014). Indeed, annual inspection regimes conducted by the radiation regulator are important in ensuring a compliance culture and thereby act to promote a radiation safety culture. It is useful to have good working relationships with the regulators and local inspectors.

Review of key performance indicators

It is important to assess whether initiatives to develop and improve RP safety culture are making any difference. Only in this way can one evaluate strategies for improvement so that managers use the most effective methods.

As highlighted by Cole *et al* (Cole *et al* 2014) such indicators might include the:

- Annual collective dose of radiation workers.
- Annual number of radiation-related incidents or near-misses.
- Number of non-compliances with permit conditions (e.g. leading to prosecutions, notices, or RASCAR [Radioactive Substances Compliance Assessment Report] points) or in-house rules.
- Number of persons attending radiation safety training (including refresher training) as a percentage of those registered/intending to attend.
- Number of late and non-returned personal dose-meters.
- Number of outstanding actions identified from audits/inspections.

This data needs to be garnered from surveys of all staff and areas within the organisation, and students. Information needs to be recorded and databases interrogated to produce periodic reports on the organisation's website. Comparing trends in RP indicators against overall safety indicators for the organisation may also show up comparisons that could be helpful in identifying areas of relative success or failure.

Attitude surveys

Universities and research establishments are increasingly interested in retaining the right talents whilst targeting new talents; measuring attitude provides an indication of how successful they are in fostering a working environment which is conducive to nurturing a positive culture amongst both staff and students. The more that senior management know about their staff and student's feelings, the easier it is to manage their behaviour. Surveys can also be a powerful tool for management to demonstrate that they value staff and student input and that it will be integrated into decision making processes.

It may not be easy to illicit weaknesses in RP culture in an organisation, for example, fear of blame will suppress reporting near-misses, and fear of unfair disciplinary proceedings will inhibit staff expressing concerns on poor attitudes to safety by line managers. An attitude survey, if carried out so that staff are confident the data will be anonymised (such as through an independent external body), will provide senior managers with useful insight into the weaknesses of RP culture perceived by employees. Exit interviews can also give useful data.

Employee engagement

As a knowledge-driven sector, higher education is essentially people-driven and employee engagement levels are therefore very important. The quality of HE employees' contribution to teaching, research, enterprise and the various supporting activities are key to the success of individual institutions and the sector's reputation as a whole. Employee commitment is vital to meeting student and other HE stakeholder expectations and satisfaction, and without an engaged workforce, HE would not meet the significant challenges currently facing the sector. For this reason, the Universities and Colleges Employers Association (UCEA) and Universities Human Resources (UHR) have commissioned a joint web-based toolkit on employee engagement (www.ucea.ac.uk/en/publications/eetoolkit/index.cfm). This toolkit provides institutions with the essential advice and guidance on how to secure, maintain and develop employee engagement with their institutional visions and missions.

Plan, Do, Check, Act

Whatever the size or nature of the organisation, the key factors to manage for health and safety are:

- leadership and management (including appropriate business processes);
- a trained/skilled workforce; and
- an environment where people are trusted and involved.

The HSE guidance INDG417 (Health & Safety Executive 2013) sets out an agenda for the effective leadership of health and safety by all directors, governors, trustees, officers and their equivalents in the private, public and third sector. It applies to organisations of all sizes. The guidance is based on the HSE's approach to health and safety of 'Plan, Do, Check and Act'.

The safety climate tool

The Health and Safety Laboratory's Safety Climate Tool (www.hsl.gov.uk/products/safety-climate-tool) can be used to gauge corporate safety culture. It measures key areas of health and safety climate, giving a snapshot of the underlying safety culture. Using the Tool helps organisations benchmark their performance against similar organisations in the industry and shows where to target resources, providing a baseline to measure improvements in safety culture.

Corporate health & safety performance index tool (CHaSPI)

CHaSPI is a free web-based tool, available to all large organisations employing over 250 people–in public, business and charity/voluntary sectors. It is available at www.chaspi.info-exchange.com and can also be accessed via the HSE's website.

CHaSPI can be used internally by organisations to help them manage and track their health and safety performance and to bring about any necessary improvements over time. It can also help organisations to benchmark their performance against others within the same sector, using a recognisable set of indicators. The organisation's CHaSPI score is determined from this set of indicators. A rating between zero and 10 is calculated, where zero is the worst possible score and 10 is the best.

Practical methods to implement cultural change

It is proposed by the authors to design and produce a number of tools that can be used to develop a good RP culture, or to enhance an existing one, within higher education and research institutions. Such tools could be made available in a 'culture pack' of resources distributed via, for example, AURPO or USHA. The pack could reasonably include:

- A senior management briefing (or set of briefings) which would emphasize the contents of this practical matter article. This would include a set of standard slides and a short video to facilitate the briefing(s).
- Training resources such as slides, videos, suggestions for practical exercises, exam questions, and quizzes for use by RP workers and other RP trainers/coaches.

- 'Tools' to help promote a good culture e.g. templates for feedback questionnaires and suggestion forms, methods for establishing and running an RP discussion forum on the organisation's website, and instructions on how to use Twitter to garner RP comments from staff and students.
- Information about RP professional societies, the benefits of membership, and instructions on how to join (with membership application forms included).
- A newsletter of topical RP articles, links to further RP information, notices of forthcoming RP events, etc.
- Contact details for RP Culture 'mentors' in the UK.

The RP system already established at an organisation may benefit from compliance with an external Quality Management System such as that provided by ISO9000. This might seem onerous, but it is certainly comprehensive and robust. It would act to promote the implementation of an organisational RP Committee, the inclusion of RP as a standing agenda item in top level H&S committee meetings; the RPA (or RPO) could present a 'culture and compliance' report to senior management who are then more informed and better able to buy into radiation safety, and the incorporation of incident case studies (see appendix B) and lessons learned into both end-user and management training.

Conclusions

This practical matter article asserts that creating a good RP culture has good outcomes for research projects, finances and reputation in universities and research organisations. This assertion must be embraced by all stakeholders but in particular senior management who may not be RP conversant. Short-cuts in safety may seem attractive, but the 'benefits' at best are short-term. An immediate saving may be made, but the costs when things go wrong are orders of magnitude greater. Excellence in education does not go hand-in-hand with sub-standard safety attitudes. Poor RP culture and poor educational and research quality have a strong positive correlation.

Appendix A. UK Partner Societies

The Society for Radiological Protection (SRP)
The Association of University Radiation Protection Officers (AURPO)
The Institute of Physics and Engineering in Medicine (IPEM)
The Royal College of Radiologists (RCR)
The British Institute of Radiology (BIR)
The Society and College of Radiographers (SCoR)
The British Nuclear Medicine Society (BNMS)

Appendix B. Case studies

B.1. Overexposure of a worker using unsealed ^{131}I (From the IAEA News Channel–Nuclear & Radiological Events)

A laboratory worker was contaminated with ^{131}I in a radiopharmaceutical company in Finland on 28th February 2013. The worker was wearing two pairs of gloves and, when changing gloves, had noticed a break in the right inner glove, but not any obvious break in the outer latex glove.

Only 3–4 h later, routine monitoring revealed heavy contamination of the dorsal part of the right hand. Immediate actions to decontaminate the hand were undertaken on site. On the next day, besides persisting heavy contamination of the hand, activity was also found in the thyroid gland, and the Finnish Radiation and Nuclear Safety Authority (STUK) was notified. Stable iodine had not been administered. Based on original measurements on site and later follow-up at STUK, including surface contamination measurements and whole body counting, the original activity of the hand was estimated at 11 MBq and the equivalent skin dose at 25 Sv, affecting an area of about 10 cm^2. The estimated equivalent dose to the thyroid was 430 mGy and the estimated effective dose 22 mSv. On her first visit at STUK, the worker was advised to wear a glove and change it frequently in order to protect the surrounding and promote decontamination by sweating and washing. Three days later little activity was left in the hand but 11 d after the incident the skin was dry and slightly desquamating. After 15 d the skin was intact with no desquamation left. No further signs of skin damage have occurred.

This company develops and manufactures radiopharmaceutical for nuclear medicine applications. There are many similar companies worldwide carrying out similar unsealed radioactive work. It is probable that similar exposures of this type might go undetected. There seems to have been a PPE (double glove) failure, combined with a lack of monitoring so that the hand contamination went unnoticed (for up to four hours). It is not clear if the thyroid contamination is a result of transfer from the hand, or due to an inhalation intake at the workplace (during the initial contamination incident), but clearly there was a severe lack of radiological hygiene standards and failures to monitor for contamination which may have arisen from poor training.

B.2. Loss of a sealed brachytherapy source (anecdotal from an author's experience)

Within a large university veterinary teaching hospital, a senior academic surgeon felt that a 370 MBq ^{90}Sr brachytherapy sealed source 'plaque' required repairing. Without informing anybody within the hospital, he took the source home in his own private car to 'fix' it by manually gluing the source back onto its metallic rod mount. He was not wearing any form of dose monitor or using any PPE during the process.

A week later the RPS discovered that the source was missing when she was preparing for a multi-regulator inspection. She notified all the appropriate stakeholders and raised the alarm. The RPA immediately informed the EA and the HSE. The senior academic said nothing but he knew that the source was still at his house.

There ensued an extensive site search but the source could not be located. The senior academic continued to say nothing even though he was fully aware of the brouhaha caused by his actions.

The regulators investigated and eventually, believing the source to have been lost in an inappropriate and non-radioactive waste stream, they issued a prohibition notice to the hospital. ^{90}Sr sealed sources could no longer be used on this site. Eight weeks later, and in a clandestine fashion, the senior academic returned the source to the source store room where it was discovered.

This case illustrates that some academic attitudes to following safe procedures can lead to serious non-compliances with the legislation and the potential for fines, bad press coverage and even custodial sentences. It also highlights that inventory checks should be routinely and frequently carried out and not just in preparation for a regulatory inspection. The hospital and academic concerned were fortunate that this incident did not result in any more serious actions by the regulators and the police.

B.3. Accountancy of open sources of radioactivity (anecdotal from an author's experience)

A large research intensive university uses ^{32}P radiolabel for studies into DNA and RNA. To monitor control of the radiolabel, researchers were required to complete paper copies of stock and disposal documentation. Multiple sheets of paper were required to complete the record, including a primary stock record, solid waste records, and aqueous waste record, along with separate contamination records.

There were a number of multi-user laboratories with up to three research groups and fifteen individual researchers in each facility. All records for each facility were retained in a single folder holding the documentation. All stocks were held in a single central storage facility although each group had their own storage space in either a fridge or a freezer. The paper records were maintained at the same site as the storage.

Access to the central storage was controlled via a single key. Control of the key was from a separate office and had to be signed in and out with date and time.

There were a number of issues starting to build up:

- A degree of trust had built up regarding access to the key and therefore to the radioisotope storage facility.
- There was poor control over who can or who is completing the stock and disposal recording. There was evidence of records being completed at a later date based on spot checks made by the Radiation Protection Officer (RPO)
- It was not easy to identify how the holdings and use of radioactive materials related to the EA Permits.
- When errors had been made, then corrections were overwritten and it was not always clear as to what the original mistake had been.
- There was no decay correction being applied for the use of short half-life radioactive substances, leading to inaccuracies in disposal records.
- There was no notification to the RPS or RPO of how long waste had been accumulated on site other than a dated label.
- Due to the lack of any decay correction or accumulation times of activity, it was difficult to accurately audit stocks and waste.
- A culture had developed where it was easier to procure an activity for two or three assays based on a maximum activity that might be required rather than optimising the activity per assay. This is not using Best Available Techniques (BAT).

During a period of increased productivity in one lab a researcher believed they had enough reagent left for a final experiment. However, they discovered that the last 10 μl of ^{32}P reagent in their own stock vial had disappeared. It was determined that this could not be due to under filling of the initial stock or from evaporation of the stock. This was reported immediately to the RPS. The resulting investigation identified that another researcher had run out of reagent from their batch but had found some more in the central storage facility. They proceeded to use the newly found stock with the intention of notifying the original owner the following day when they had returned to work. Unfortunately, due to staff absences, increased pressure to get results and resulting stress, the stock records did not get completed and the original owner did not get informed. The error was not discovered until several days later when the reagent was needed again. The incident was reported to the appropriate regulators and corrections were made to the stock records. The regulator requested that a more robust method of regular audit was introduced and that refresher training of the individuals concerned was undertaken. As a result of this incident an in-house web-based radioactive stock accountancy programme was introduced within three months. Training was provided to over 150 researchers over 1 week on the new system. All researchers were told to only use the web based system.

There are a number of advantages with the web-based inventory:

- Staff wishing to use the system had to apply for a unique log-in. The inventory could only be accessed by approved users who had undertaken training.
- Recording of stock and disposal by an individual was easily identifiable, dated and timed.
- All recording is undertaken on a single web page and not on multiple sheets of paper.
- The RPS could undertake regular, easier and more effective auditing of the radioactive stock.
- The RPS and RPO was automatically notified if any of the EA Permit Schedules had been breached or were within 50% of the limit.
- All radioactive materials are decay-corrected automatically.
- There is no requirement for the researchers to undertake complex calculations to use the correct activity or volume. This in turn makes the creation of secondary stocks or retained sample activities more accurate.
- There is an accurate record of total accumulation of stocks and wastes both on site and in each storage facility available immediately.
- Monthly and annual records of waste returns and stock holdings takes 2–3 min to process for the entire University as opposed to days or weeks of checking spreadsheets.

Since the introduction of the web-based system the number of recording incidents has been significantly reduced. The researchers all use the same system and are familiar with it. This makes it more practical for research groups to interact, for staff movement between groups and for training to be undertaken by the RPS. The RPSs are able to give more time to supervision and to research, since less time and effort is required to effectively audit stocks. The system is easy and intuitive to use and the researchers are more proactive in completing the stock and disposal records. The culture and awareness of use of radioactive materials has significantly improved since the introduction of this web based system.

B.4. Laser installation (anecdotal from an author's experience)

A university chemistry department procured the use of a laser system for a transient absorption spectroscopy (TAS) research project for 12 months. The system is a complex one involving two Class 4 lasers, an Optical Parameter Amplifier (OPA) and the spectrometer. There were multiple stakeholders involved including the laser manufacturer, the laser installation engineers, the owner of the system, the 3rd party facility that ran the laser loan pool, and the university where the TAS project took place.

Once the system had been installed and 'handed over' to the university, the chemistry research group were aware that they were responsible for safety during its routine usage. With the assistance of the university's Laser Safety Officer (LSO), the research project leader had drawn up a risk assessment and a set of laser safety local rules for the routine use. All relevant members of university staff had received laser safety training and appropriate laser safety glasses for routine use had been purchased. The lab where the equipment was to be installed was assessed and deemed suitable by the university's LSO.

However, at the point when the installation phase was about to commence, once the engineers were on site, some problems were discovered. The installation engineers seemed unaware that they were responsible (or at least partly responsible) for laser safety during the installation process. They had asked the university to sign a declaration to accept this full responsibility. The university refused to sign it. In addition, it was unclear who the installation engineers, the laser manufacturer, and the laser loan pool had appointed as their LSO. Nobody from this group of three appeared able to provide any evidence of laser (safety) training; in fact the engineers were surprised that they were asked to provide any. There was no risk assessment or safety operating procedures made available. At one point one of the engineers asked if he can borrow a pair of the university's laser safety glasses as they didn't have enough pairs.

The installation lasted for approximately one week. It went ahead despite advice from the university's LSO that it should not until the question of responsibility was clarified and copies of the full safety documentation from the engineers or loan pool was forthcoming. For the installation week it was unclear as to which stakeholder had overall control of safety and compliance during the installation.

This is a case of miscommunication between the university's in-house personnel and external parties during the installation of a complex and hazardous piece of equipment. Also, there was little comprehension of the LSO's concerns or motivation to address them. Each of the parties thought that one of other parties was responsible, but no one took the crucial steps to find out for sure who was responsible for what parts of the project. As a result, during the installation week the university was potentially liable for any safety-related incidents with an installation process, about which they knew scarce details and had little practical involvement, which was carried out by persons who may not have been adequately trained.

No adverse incidents occurred during the installation which was completed successfully. Nevertheless, as a result of this installation, the university were instructed by their LSO and Safety Officer to review and recast their policy and procedures for the installation of any hazardous equipment by 3rd party engineers.

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