HUMAN RESOURCE DEVELOPMENT IN RADIOLOGICAL SECURITY FOR AN INTERNATIONAL AUDIENCE: Lessons from the UK's experience

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Abstract

This paper explores the development of radiological security workshops delivered by an industry-academia partnership led by King's College London and funded by the British government. Training and development courses on radiological security have seen substantial growth in recent years, reflecting an increasing recognition by the international community that radiological materials falling outside regulatory control pose significant safety and security risks. To support human resource development across the nuclear security field, the UK's Global Threat Reduction Programme (GTRP) has facilitated a series of workshops and other educational activities – bringing together a range of operators, regulators and government agencies. Revisiting workshops held in the UK and Indonesia, this paper discusses the development of a radiological security curriculum and its impact on audiences of diverse organisational and cultural backgrounds. Here it is argued that the theoretical concepts outlined in the IAEA Nuclear Security Series can be most effectively disseminated using pedagogical tools that encourage interaction between instructors and participants to facilitate learning. This has particular resonance when discussing less tangible topics such as security culture. Nevertheless, there remain obstacles in ensuring that radiological security education has a sustainable impact on its target audience. There are also difficulties in convincing stakeholders of the salience of radiological security when national priorities tend to focus on nuclear security. This paper will argue, in view of limited funding available for radiological security education and training, the objective should be to ensure sustainable outcomes through equipping practitioners with sufficient resources to disseminate their own tailored education and training activities over the longer term.

1. INTRODUCTION

The UK has delivered professional development courses on radiological security for over two years. Entitled 'The Fundamentals of Radiological Security', these workshops form part of the British government's Global Threat Reduction Programme (GTRP).[1] The objective of the GTRP is to improve the security of fissile and other nuclear and radiological materials around the world, in line with the standards of the IAEA [1]. The British government has been working with international stakeholders since the early 1990s to develop civilian nuclear security in Russia and former Soviet Union republics, later expanding the geographical focus to include countries from around the world. With the launch of the Global Partnership in 2002,[2] the UK has employed the GTRP framework to support a range of international initiatives, including strengthening physical protection infrastructure, combating illicit trafficking, replacing high-risk radioactive sources with alternative technologies and supporting the IAEA Division of Nuclear Security.

[1] 'UK International Chemical, Biological, Radiological and Nuclear Security Assistance Programmes and their Contribution to the Global Partnership Against the Spread of Weapons and Materials of Mass Destruction, Report 2013-2015, HM Government: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/473876/FCO859_CBRN_Security_Report_-_PRINT__1_.pdf

[2] Global Partnership Against the Spread of Weapons and Materials: www.gpwmd.com

From an early stage, it was recognised that threat reduction efforts would only be effective and sustainable if those implementing security measures understood the broader issues at stake – namely, the nature of the threat, the maintenance and testing of security systems, the critical importance of a strong security culture and the range of potential adversaries, especially the threats posed by 'insiders'. To this end, the work was formalised in a new Nuclear Security Culture Programme, launched under the GTRP in 2014 and delivered by a consortium of academia and industry led by King's College London.[3]

The Nuclear Security Culture Programme is aimed at strengthening the human factor within different security systems – with a focus on education, training and activities that support the assessment and enhancement of security culture. A core component of the programme from its inception has been a workshop on the physical protection of nuclear material [2]. This is designed to complement states' existing efforts to improve the protection of nuclear materials and facilities – by showcasing IAEA guidance, sharing experiences in implementing security-related programmes and considering lessons learnt from the UK's approach to nuclear security. The workshop format employs subject matter experts (SMEs) disseminating information in a focused, educational environment to an international audience working with nuclear and radiological materials.

The development of a workshop on radiological security is a relatively new addition to GTRP activities,[4] reflecting a growing recognition of the need to protect radiological materials from potential adversaries throughout their lifecycle. Developing radiological security education and training for an international audience is not a simple endeavour, however. There exists significant complexities in terms of stakeholders, national contexts, regulatory systems, and the operating environments where radiological sources are employed. There are also challenges in conveying the criticality of this undertaking to governments and other key stakeholders when historically nuclear security – not radiological security – has been perceived as more salient. This paper seeks to provide insights about how the KCL-led consortium has developed radiological security education. As well as outlining the approach taken, it will discuss the challenges encountered and lessons learnt with a focus on ensuring that future activities are meaningful and sustainable.

2. DEVELOPMENT AND DELIVERY OF RADIOLOGICAL SECURITY WORKSHOPS

The curriculum for the radiological source workshop was developed by a team of SMEs with academic, industry and regulatory experience. The workshop agenda sought to provide a comprehensive overview of radiological security – both in conceptual and practical terms. It was also designed with recognition that the participants would be drawn from a wide variety of backgrounds – national, academic, and vocational. For example, where possible, the material should be relevant and applicable to a worker from an oil company operating in Nigeria, a cancer nurse in Thailand, or a university-based user of radiological sources in India. Consequently, a key strength of the curriculum is the interdisciplinary approach, with wide-ranging contexts covered. It is also shaped by the IAEA Nuclear Security Series, ensuring that the materials disseminated are aligned with IAEA guidance and international best practice.

The workshop agenda begins by considering radiological threats and providing a scientific and technical background to radiation. It then moves on to explore more in-depth topics such as regulatory frameworks, physical protection technologies, and the implementation of radiological security in a various operating environments and activities, such as hospitals, universities and transportation. A significant section of the workshop agenda includes sessions on building and enhancing security culture in organisations hosting radiological materials.

The importance of security culture in the radiological context cannot be underestimated given that radioactive sources are frequently used either in environments that are 'customer-facing' (such as universities and hospitals) or in industries where sources are mobile. As a result, the physical security of radiological sources is often limited for operational or practical reasons. A strong security culture – whether through the development of human resources or employees' actions – is essential in ensuring the security of radiological materials.

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[3] Consortium partners, 2014-2018: King's College London, Imperial College, University of Central Lancashire and National Nuclear Laboratory; 2018+: King's College London, Arup Group and Amport Risk Ltd.

[4] By contrast, the workshop 'Fundamentals of Physical Protection at Facilities Holding Nuclear and Radioactive Materials' has been delivered as part of the GTRP since the early 1990s.

In its delivery, the workshops draw on SMEs from academia, industry, the regulator and government. This includes those with recent experience from the UK's regulatory body[5] as well as from source-holding organisations, including licensees from a university and a hospital. The IAEA Nuclear Security Series are referred to throughout the workshops, with the materials presented being consistent with IAEA technical terminology and nomenclature. The workshops also utilise case studies, a tailored table-top exercise and other interactive teaching methods, as outlined in the following section.

3. PROMOTING LEARNING AND ACTIVE PARTICIPATION

The past few decades have seen a shift in approach to higher education and professional training, from that of passive instruction to active learning [3]. Here, studies from a wide variety of fields have demonstrated the benefits of flexible learning where students are placed at the centre of the teaching environment. This approach provides students with the freedom to engage deeply with a subject, develop their own critical thinking skills and apply these to complex problems. It also recognises that students will have different preferred learning styles [4]. Consequently, applying a variety of teaching methods and catering to the different learning styles within a group can serve to motivate students and encourage deeper learning.

A learning-centred approach strongly influenced the development of the radiological security workshops discussed in this paper. Such an approach was deemed appropriate due to both the technical subject matter and the diverse backgrounds of the audience. Although radiological security principles and approaches are relatively straightforward to outline and articulate, achieving effective security is a complex endeavour.[6] It is also one that varies from country to country as a result of differences in legal and regulatory structures, the threat environment and resource constraints. In order to explore the practical implementation of radiological security across different national and organisational environments, the pedagogical methods employed were designed to engender active participation and the sharing of experiences. This was especially effective for the workshop audience which consisted largely of practitioners from government, regulatory bodies and radioactive source operators; participants offered unique viewpoints as well as considerable practical experience.

Despite the obvious benefits of flexible learning, the more traditional lecture format remained relevant to some aspects of the workshops. This format – involving an expert speaking to a group in a unilateral exchange – is a highly effective method for transmitting a significant amount of information in a short period of time. Here, lectures were used largely to convey key security concepts rather than to focus on their implementation. Lectures were delivered in a semi-interactive format, through the use of questions, short discussions and an electronic voting system – allowing participants to express their views on issues of importance. This was found to be a useful tool in increasing participant engagement in what has traditionally been a passive learning format. It also provided instructors with real-time information on participant understanding so any areas of confusion could be clarified.

The workshops also made significant use of real-life case studies and a table-top exercise based on a hypothetical radiological source facility. Case studies are widely recognised as an effective way to link theory with practice, as well as to develop critical thinking skills [5]. Here, real-life case studies involving the theft of nuclear and radiological materials were presented in a 'retrospective' manner with the participants tasked with assessing motivations and actions of the 'adversary', before identifying the facility's security failings.[7] Participants were also encouraged to consider broader lessons from particular cases and transpose them into their own organisational contexts.

The table-top exercise involved a hypothetical medical facility containing several high-activity radioactive sources, with information provided to participants on the perceived threat and current security system and practices in place. Participants, working in small groups, were initially asked to put themselves in the mind of the adversary and consider how successful attacks against the facility might be perpetrated. This is a commonly

[5] The UK's regulatory system for radiological sources is relatively fragmented: the workshops drew expertise from the Environment Agency which regulates radiological sources in England.

[6] The IAEA's Nuclear Security Series provides a comprehensive overview of security principles and approaches across a variety of nuclear security domains: www-ns.iaea.org/security/nss-publications.asp

[7] King's College London has developed a number of nuclear security case study handbooks for integration into education and training programmes: www.kcl.ac.uk/sspp/departments/warstudies/research/groups/csss/teached/resources.aspx

utilised approach known as 'red teaming'.[8] In this context, participants were asked to construct realistic attack pathways as a means of highlighting the weaknesses within the facility security system. The task then evolved to an assessment of cost-effective security solutions. At all times, participants were encouraged to consider an intelligent adversary that represented a dynamic and ever-changing threat – requiring an approach capable of being modified in response to changes in security [6].

This simulation format – utilised in both the case studies and table-top exercise – enabled the participants to engage with the subject matter in a more focused way than might be the case with traditional teaching formats and techniques such as lectures. In particular, the simulation format 'brought to life' the complexities of real world problems and encouraged new thinking and creativity on radiological security [7]. This was especially relevant for participants engaging with the topic of nuclear security culture, an intangible concept but one that is critically important for the comprehensive protection of radiological sources in real-life settings. Indeed, learning-centred approaches such as the simulation format are particularly relevant to radiological sources where security rests far less with 'guns, guards and gates' but with the personnel responsible for their protection. As confirmed by participants' feedback,[9] this approach ultimately helped reinforce the learnings from the workshops – in essence, they induced 'deep learning'.

4. DELIVERING RADIOLOGICAL SECURITY WORKSHOPS

The KCL-led consortium has held radiological security workshops in two locations to date – the UK and Indonesia. This section compares the experience of delivering workshops in these different contexts.

4.1 London, UK

To date, the radiological security workshops have been held three times[10] in London with an international audience travelling to the UK from around the world. Participants who attended included those working with radiological sources – often in universities, the healthcare industry, and oil and gas companies – as well as regulators, government bodies, emergency services or nuclear operators that handled or produced radiological sources. The selection criteria placed priority on practitioners with some degree of accountability for the protection of radiological materials; such stakeholders were likely to be particularly motivated to disseminate the learnings from the workshops across their home organisation and beyond.

As discussed previously, the London workshops were delivered by SMEs from academia, industry, the regulator and government. They also drew on expertise from local licensees, including a radiation protection officer working at a London hospital; this provided insight into the challenges of securing radiological sources within a medical facility. KCL was also able to draw upon its own expertise, with the university's radiation protection officer discussing the security of radiological sources in a university environment. While having to overcome the usual visa-related challenges of bringing a diverse audience to the UK for the workshops, the rich discussion permitted by the variety of national and organisational contexts of the participants facilitated a stimulating learning environment.

4.2 Jakarta, Indonesia

In 2017, the radiological security workshop model was held overseas for the first time – in Indonesia. The workshop participants included licensees and regulators from Indonesia, as well as Malaysia, Vietnam and other countries in the region. Prior to the workshop taking place, the KCL-led consortium had already held three workshops on nuclear security in Indonesia which helped ensure the activity was successful in targeting the relevant regional practitioners. The curriculum was based on the London format – illustrating how agendas and teaching materials, once developed and successfully utilised, can be adapted to new contexts to maximise capacity-building.

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[8] 'Definition of red team', *Financial Times* http://lexicon.ft.com/Term?term=red-team

[9] In order to drive continuous progress and improvement, formal and informal feedback is collected throughout the workshop.

[10] March 2016, November 2016 and November 2017.

For the Indonesia workshop, materials were translated into the Bahasa Indonesia local language. This proved useful in enabling the Indonesian participants to play an active role in the table-top and other exercises – ensuring the key messages of the workshop sessions were delivered to the Indonesian participants. The workshop also drew on local expertise, with several presentations given by Indonesian SMEs, allowing them to showcase local best practices.

5. ENSURING SUSTAINABLE OUTCOMES

The issue of sustainability and long-term impact is critical in any educational and training activity. Given the technical nature of this particular workshop, especially its broad international focus, there is an intrinsic challenge in ensuring that participant knowledge and experiences gained from workshop attendance are translated into improved radiological security practice. Consequently, a number of steps were put in place to facilitate this, including the production of a course handbook with session summaries and further reading so that participants could continue to expand their learning beyond the workshop. Participants were also encouraged to run internal training courses that utilised, tailored and expanded on the materials presented, including in ways to suit their own organisational contexts. In addition, participants were provided with information on IAEA training and other opportunities available that might further grow their knowledge.

In the broader nuclear security arena there has been an upsurge in education and training programmes in the past few years, driven to a certain extent by the Nuclear Security Summit process. In addition to the Nuclear Security Support Centres, supported by the IAEA, there are a number of national and regional nuclear security Centres of Excellence that offer professional development and other opportunities [8]. There are also international organisations and networks that provide accredited programmes and access to education and training materials, such as the World Institute for Nuclear Security (WINS) Academy and the International Nuclear Security Education Network (INSEN). And in the past few years, there has also been an upsurge in academic programmes, with universities offering short courses and post-graduate programmes in nuclear security. Meanwhile, professional societies offer opportunities for networking and the sharing of experiences.[11]

More recently, online tools such as the IAEA's nuclear security e-learning platform[12] have represented valuable resources for disseminating information to individuals working with radiological sources around the world. This is particularly important in fostering a 'train the trainer' mindset amongst former workshop participants. In the workshops, participants were strongly encouraged to take advantage of these new opportunities to expand their knowledge and inform their organisational practice. Indeed, a KCL-led study has charted a recent shift from an academic 'community of interest' to a 'community of practice' [9].

The KCL-led consortium has also focused on continued engagement with workshop participants – proactively following up with them on their security improvement plans and inviting their colleagues to attend future iterations of the workshop. Other GTRP activities have included the mentoring of academics and trainers looking to establish new nuclear security components in their courses. There is now scope under the GTRP to partner with former participants to directly improve the implementation of security at their organisations, for example, by supporting an assessment of security culture. Future topics to be explored include 'alternative technologies'; these provide a substitute to radioactive sources, thereby expunging the security risks.

6. CHALLENGES FACED AND LESSONS LEARNT

Perhaps inevitable with the development of an entirely new curriculum, the radiological security workshops encountered various challenges in both design and implementation. Nevertheless, a structured post-workshop evaluation process and emphasis on 'lessons learnt' have served to enhance future iterations of the workshops. One technical challenge that has needed to be overcome was the provision for onsite training. The nature of radiological sources is that they tend to be somewhat inaccessible; for instance, there are patient confidentiality issues in hospitals and it is difficult logistically to visit oil and gas drilling rigs. As such, the

[11] For example in the UK, The Society for Radiological Protection: https://srp-uk.org

[12] Under its Nuclear Security Plan 2018-21, the IAEA has developed e-learning courses on a broad range of nuclear security topics (in all official languages), with the objective to develop human resources around the world: http://elearning.iaea.org

development of alternative learning tools for the workshops – particularly the simulation format – have taken on even greater relevance. The KCL-led consortium is also currently exploring the provision of a video walk-through of a radiological facility.

A broader challenge for human resource development in the area of radiological security relates to ensuring sufficient resources are devoted to the endeavour. In recent years, education and training specifically in the area of radiological security has been recognised by the IAEA and national governments alike as vitally important in view of the vast numbers of orphan and unsecured sources around the world, especially in the context of often lax and uneven regulatory frameworks. Under the GTRP, the British government has taken a leading role alongside several international partners, most notably the US, in funding, facilitating and promoting nuclear security initiatives for over two decades. However, one of the perennial challenges is that funding in this area cannot keep pace with growing global demand.

A related issue is that much of the funding available for nuclear security education and training tends to support activities related to nuclear materials (often civil nuclear sites), based on the belief that these represent a more attractive target than radiological materials for a potential adversary. Faced with scarce resources, ensuring that the radiological security workshops induce sustainable outcomes in participants' countries is a priority and requires support from governments, corporations and other key stakeholders around the world.

However, this raises another question in how to measure these sustainable outcomes. Whilst feedback collected during the workshops has been resoundingly positive, it is more difficult to assess the tangible impacts of the workshops over the longer term. Faced with this challenge, the KCL-led consortium has recently developed a formal impact assessment with the aim to produce evidence-based data on workshop impact. The assessment process involves semi-structured interviews with participants, conducted at set intervals following the completion of workshops. Ultimately, the aim is to ensure that the workshops provide participants with the appropriate educational resources to foster their own 'communities of practice' on radiological security, which are both sustainable and suited to the specific cultural, national and organisational contexts. It might be argued that a successful 'train the trainer' programme will eventually become obsolete because the learnings are diffused sufficiently amongst the relevant communities of practice.

7. CONCLUSIONS

Despite ongoing focus on the security of nuclear materials and facilities, the past few years have seen increased efforts to mitigate the risks posed by radiological sources and other radioactive materials. The development of the radiological workshop outlined in this paper is one such as activity, aimed at strengthening security culture within a diverse range of operating environments. As evidenced by formal and informal feedback, the learning-centred approach with a focus on active participant engagement has been effective in fostering deep learning on the different aspects of radiological security. Interactive teaching methods in particular – including case studies, group discussions, table-top exercises and electronic voting – have helped disseminate the key conceptual concepts of the IAEA's Nuclear Security Series and have supported the sharing of international best practice.

Nonetheless, there remains much work to be done to support human resource development across the field of radiological security. This involves more concerted efforts by national governments, corporations and other key stakeholders to promote radiological security – not only nuclear security – as well as provide the associated funding. Organisations such as universities, professional societies and online networks constitute instrumental actors in these endeavours – directing bottom-up pressures on governments and agencies, as well as diffusing information and educational resources within their circles of influence. There are already signs that informal communities of interest in the radiological security field are evolving into more structured communities of practice.

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