

MAINTAINING EXPLOSIVES SAFETY COMPETENCE IN THE UK AND EUROPEAN EXPLOSIVES SECTOR

Presenter: Professor I G Wallace, Department of Environmental Ordnance Systems, Cranfield University, Defence College of Management Technology, Shrivenham, Swindon, SN6 8LA, UK Tel: +44 (0)1793 785681, Fax: +44 (0)1793 785772 Email: i.g.wallace@cranfield.ac.uk

Co-Authors, Dr J Akhavan, Department of Environmental & Ordnance Systems, Cranfield University University, Defence College of Management Technology, Shrivenham Campus, Swindon, Wiltshire SN6 8LA UK Tel: +44 (0)1793 785324, Fax: +44 (0)1793 785772, Email: J.Akhavan@cranfield.ac.uk

R Parry, DOSG BM1b, Defence Ordnance Safety Group, Ash 2b #3212, MoD Abbey Wood, Bristol BS34 8JH UK Tel: +44 (0)117 9135547, Fax: +44 (0)117 9135903, Email: DOSGBM1@dpa.mod.uk

D Clarke, Denise Clarke Ltd, 52 Ickburgh Road, London E5 8AD Tel: +44 (0)208 806 4910, Email: denise.clarke@atlas.co.uk

Maj C N D Capel, Director ESA Standards Project, Room 16, Building 29, Brompton Barracks, Chatham, Kent, ME4 4UG, Tel: +44 (0)1634 822455, Email: Nigel.capel@re-cpd.org.uk

Abstract

Explosives accidents have claimed the lives of more than a thousand people around the world since the turn of the Millennium. Added to the loss of life has been the significant loss of defence capability and infrastructure. Many of the accidents have been caused not by failure of design, but by human failure. Much of the human failure can be attributed to the lack of competencies, skills and adequate training of the people concerned.

The presentation will describe some of the initiatives being taken in the UK and in the European Union to ensure that workers in the explosives community have the skills and competencies required to safely sustain activities involving explosives. It will describe the development and evolution of a range of National Occupational Standards for all personnel employed in explosives occupations. It will outline the qualifications framework being developed to generate and maintain the standards and finally, the presentation will refer to some of the novel training approaches which are being developed.

Professor Ian G Wallace, BSc, PhD, FRSC – Is Head of Department of Environmental and Ordnance Systems at Cranfield University, Defence College of Management and Technology, the Defence Academy of the UK. He was formerly Director of Ordnance Safety and Vice President of the Ordnance Board, Chief Inspector of Explosives for MOD, previous senior posts include Director of Safety Policy and Director of Standardisation in the PE, Ordnance Scientific Advisor in the

Naval Support Command, Director of Information Systems for Controller Air, Project Manager for Air Launched Weapons in the Directorate of Air Armament. Prior to this he spent 9 years at ERDE & PERME at Waltham Abbey engaged on studies into the ageing of rocket propellants and energetic materials. Particular interests include ageing, IM and environmental assessment.

Introduction

At PARARI 2003¹ and 2005² and at the DoD Explosives Safety Seminar of 2004³ the authors reported on the commencement and progress of an initiative to improve the skills and competence of workers in the explosives sector in the UK and European Union. This initiative is in response to growing concerns that, as a result of demographic trends and significant restructuring and downsizing of the explosives industrial sector, the UK and other nations were losing critical expertise from the explosives sector. Given that many explosives accidents can be attributed to human failure there is a real risk that the frequency of such accidents could increase. Furthermore the loss in expertise could compromise the ability of the UK and EU to maintain the high level of competence required to develop, manufacture and operate high quality high technology ordnance and munition products. Since the publication of these papers significant progress has been made in both the UK and in Europe.

UK National Occupational Standards

The UK's department of Education and Skills recognised that competitive advantage could only be achieved through having a workforce with the necessary skills for the 21st century. It established the Sector Skills Development Agency (SSDA) to sponsor the creation of Sector Skills Councils responsible for different sectors of the UK economy. There are 25 such SSCs covering 80% of the UK workforce. They are employer-led, independent organisation that covers a specific sector across the UK. Their four key goals are:

- to reduce skills gaps and shortages
- improve productivity, business and public service performance
- increase opportunities to boost the skills and productivity of everyone in the sector's workforce.
- improve learning supply including apprenticeships, higher education and National Occupational Standards (NOS).

There are, for example, SSCs covering the Automotive industries, information technologies, the chemical and nuclear industries. The British Army approached one of these councils which represents Science, Engineering and Manufacturing Technologies (SEMTA) in order to develop National Occupational Standards (NOS) for military personnel engaged in explosives search and clearance activities. The council established a Standards Setting Body (SSB) to develop occupational standards for six different search and clearance occupations. The standards define the knowledge and skills required to be competent in any one of the occupations. National Vocational Qualifications (NVQs) were introduced for each of the occupations. These

were launched in 2003 and they are now being used to recognize the skills and knowledge acquired during military training.

The launch of the search and clearance occupations NVQs occurred at a time when many organisations in the UK explosives sector were coming to terms with an approaching skills deficit. The approach used for the British Army for search and clearance occupations provided a useful model for the rest of the sector. It was decided to expand the scope of the SSB to cover all explosives related occupations and to seek to develop occupational standards for all workers, both military and civilian, working with explosives. Stakeholders representing major employer groups were invited to join the SSB to help develop occupational standards. The title of the SSB was changed to reflect this expanded role for developing occupational standards for Explosives Substances and Articles (ESA).

The first task for the SSB was to establish an Occupational Map for the sector. This provides a concise overview of the explosives sector. It describes the main employers and stakeholders, the numbers employed in the various sub-sectors, career progression and development for selected job roles, key trends and drivers for change within the sector and key characteristics of employment in the sector. The occupational map provided for the first time in the UK an estimate of the numbers employed in the sector. Table 1 shows the principal employing organisations.

Commercial Industries	Public Organisations	Military
Special effects & fireworks	Transport & logistics	Royal Air Force
Quarrying, mining, demolition & construction	Police	
Oil & gas escape mechanisms	Fire prevention & firefighting	Royal Navy
Seismology	MoD	
Motor industry	Training & education	Army
Research, testing & disposal		
Defence manufacturing		

Table 1 Types of explosives substances and articles (ESA) organisations in the UK

Sector	Managerial	Supervisor	Technician	Operator	Other	Total
Armed forces	4841	5410	2921	27,884	2	41,058
MoD	412	274	358	548		1592
¹ DSTL	17	46	15	152	16	246
² QinetiQ	138	120	178	237	65	738
³ Others	N/A	N/A	N/A	N/A	N/A	632,508

Table 2 Population of workers involved in explosives substances and articles for the U.K.

¹DSTL is the Defence Science and Technology Laboratories and is a part of the MOD

²QinetiQ is a commercial company involved in defence research and testing

³these include all the commercial industries from Table 1 plus police, fire prevention & firefighting, transport & logistics, and training & education.

Once the occupational mapping was complete a Functional Map developed. This describes the functions, or activities, that are carried out across the sector, and aims to identify functions that are common to two or more sub-sectors and those that are specialist. The occupational mapping revealed the wide scope of the explosives business and the diversity of activity. To make subsequent development more manageable it was decided to break the business down into the Key Roles undertaken within the sector. Table 3 shows the key roles undertaken by explosives workers in the UK.

Key Roles	Description
1	Research and develop explosive substances and articles
2	Develop and manage explosives safety
3	Test and evaluate explosive substances and articles in field trials
4	Manufacture explosive substances and articles
5	Maintain and repair explosive substances and articles
6	Procure explosive substances and articles
7	Store and move explosive substances and articles
8	Transport explosive substances and articles
9	Manage explosives facilities
10	Prepare and use explosive substances and articles for engineering and entertainment purposes
11	Dispose of explosive substances and articles
12	Enable the public and armed services to continue their regular activities in peace and war by controlling and removing munition threats
13	Support the explosive substances and articles function

Table 3 The main functions of explosives substances and articles occupations

Having established the key roles further workshops were conducted with employers engaged in undertaking these roles. These occupational working groups conducted functional analysis workshops, which were lively and sometimes contentious, attempted to derive all of the activities necessary to conduct a key role. Different organisations used different vocabulary to describe an activity and often expected different things from their workers. Consensus was finally achieved in all but a few areas. The analysis breaks down each key role into a series of activities some of which can be further sub-divided. The first example in figure 1 shows the results of part of the functional analysis for a worker undertaking research into explosives.

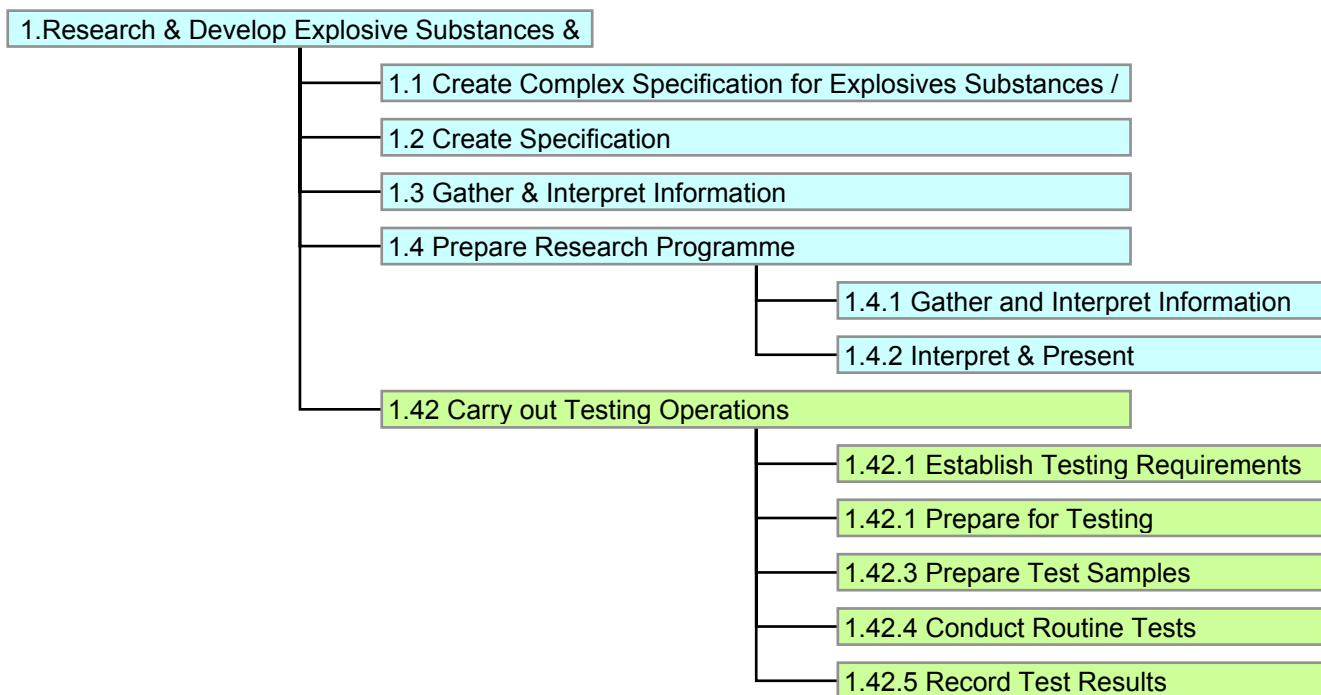


Figure 1 – Part of Functional Analysis of Explosives research Worker

In total some 60 principal activities were identified for this key role many of which can be further subdivided to give a total of 124 activities which might be performed to undertake research and development work on explosives substances and articles. Many of these activities are specific to explosives research whilst others are generic in nature and would typically be undertaken to support any research activities. Thus activities 1.26 to 1.60 are occupational standards drawn from other occupational standards appropriate for laboratory workers.

For each of the key roles specific explosives standards are augmented by more generic occupational standards. Each of these activities is known as a unit of competence. For all of the 13 key roles a total of more than 400 units of competence were identified by the occupational working groups. For each unit of competence there is a statement regarding context and describing the knowledge required to undertake that activity and a description of what the person must be able to do. For the 124 units of competence relating to research and development there are statements of context, criteria and knowledge. Table 2 shows the competency statement for key role 1.1 which is a description of what someone needs to know and be able to "create the complex specification for explosive substances and/or articles".

<p>Contexts</p> <p>Customer requirements: where a complex detailed technical requirement is provided; where a general description of requirements is provided</p> <p>Constraints: resource limitations; possible conflicts of interest</p> <p>Solutions for addressing customer needs: existing; adaptations to existing solutions; novel</p>	
<p>Criteria – You need to:</p> <p>work safely at all times, complying with health and safety, environmental and other relevant regulations and guidelines</p> <p>wear appropriate PPE</p> <p>identify or confirm accurately the customer’s underlying needs</p> <p>assess objectively the feasibility of the customer’s requirement</p> <p>determine objectively the best methods by which these needs can be addressed</p> <p>explain fully and clearly to the customer and any other relevant people the basis for any decisions</p> <p>identify accurately any operational constraints that could affect the research and development of the explosive substance and/or article</p> <p>provide relevant and timely advice to the customer, expressed in a way that meets their requirements</p> <p>alert the customer promptly to any additional information or implications that may be in their best interests</p> <p>consult others who may be affected and build their feedback into your specification</p> <p>create a specification that clearly addresses all the customer’s requirements and your success criteria</p> <p>create a clear and concise specification that contains sufficient detail to enable research planning to take place</p> <p>confirm the customer’s level of satisfaction and use the information to make further improvements</p> <p>maintain the requirements of confidentiality at all times</p>	<p>Knowledge – You need to know and understand:</p> <p>health, safety and environmental and other statutory legislation, regulations and safe working practices and procedures governing explosives and their implications for your area of work</p> <p>the relevance of PPE</p> <p>your organization’s strategic and operational policies and objectives</p> <p>how to carry out a feasibility study</p> <p>how to establish appropriate success criteria</p> <p>alternative options for meeting the customer’s needs</p> <p>the underlying needs of the customer’s requirements</p> <p>when and how to challenge a customer’s brief</p> <p>when and how to advise a customer to pursue a different course of action</p> <p>the constraints that may affect your decisions and plans</p> <p>your own level of authority and those of others with whom you work</p> <p>the requirements of confidentiality</p>

Table 4 – Competency 1.1 for “Create the complex specification for explosive substances and/or articles”

The National Occupational Standards (NOS) for each key role therefore consist of collection of these units or statements of competence which in the case of research and development runs 124 such statements. For key role 11 (ESA disposal) there are 27 units of competence.

The National Occupational Standards have now been approved by the UK National Qualifications and Curriculum Authority (QCA) and are in the public domain.

Qualifications

Higher Education

Once the NOSs have been approved qualifications based on these standards can then be developed. For Universities and higher education establishments the NOS will help to guide the curriculum and content of many of their courses. The emphasis in universities is however imparting knowledge and understanding rather than practical skills to undertake a particular job. For many courses the knowledge will be much wider than that required for a single key role. For postgraduate awards especially research based degrees the universities will not just be assessing knowledge but also the students ability to apply that knowledge to conduct research. For the student possession of a higher degree informed by National Occupational Standards will help provide evidence that they can meet the occupational standard should they subsequently wish to acquire a vocational award.

Professional Bodies

Professional bodies and institutions also have a considerable interest in the development of occupational standards. Many are responsible for awarding chartered status to their members to enable them to operate as professional engineers or scientists. Again occupational standards, which define both the knowledge and skills necessary to perform competently in a work environment can be used in assessing whether a candidate is worthy of chartered status.

Vocational Qualifications

Arguably the greatest value of occupational standards is for the award of vocational qualifications. National Vocational Qualifications (NVQs) and Scottish Vocational Qualifications (SVQs) are based on NOS. The occupational working groups and the SSB have therefore used the occupational standards to derive a qualifications framework for all explosives workers. In doing so the working groups had to consider for each key role the different levels of activity required to accomplish a key role. It distinguishes between those with responsibility for managing an activity, those who supervise those who undertake and those who support. Table 5 shows the proposed qualifications framework for explosives occupations.

	Key role	NVQ Level 2	NVQ Level 3	NVQ Level 4
1.	Research, Design and Development		X	X
2.	Safety Management			X
3.	Test & Evaluation	X	X	X
4.	Manufacture	X	X	X
5.	Maintenance	X	X	X
6	Procurement		X	X
7	Storage	X	X	X
8	Transport	X	X	
9	Facilities management		X	X
11	Disposal	X	X	X
	Hybrid	X		

Table 5 – Qualifications Framework for Explosives Workers

Each qualification has a set of associated units of competence depending on the level of the vocational qualification and the key role. So for someone undertaking a research management role the relevant key role is key role 1. Some of the units of competence are deemed mandatory whilst others are optional. To acquire the qualification candidates will need to demonstrate that they have both the knowledge and skills associated with each unit of competence. The NVQs were formally launched in June 2006.

The units appropriate to someone operating at level 4 in research are shown in table 6.

Unit No.	Unit of Competence	Mandatory	Optional
1.2	Create a specification for an explosive substance or article	X	
1.3	Assimilate & evaluate information on ESA	X	
1.4	Gather and interpret information on ESA	X	
1.7	Prepare a research programme for ESA	X	
1.8	Submit proposals for research work on ESA		X
1.9	Plan the research on ESA	X	
1.11	Carry out investigations and analyse the information collected on ESA	X	
1.14	Assess and document research findings into ESA	X	
1.15	Develop a dissemination plan for ESA		X
1.17	Design the scale-up process for ESA		X
3.1	Establish the performance criteria for ESA		X
3.7	Validate trial or test procedure for ESA		X
3.17	Evaluate the results of trials of ESA		X

11.1	Assess the ESA for disposal		
13.3	Manage own resources and professional development		X
13.7	Provide leadership in your area of responsibility		X
13.9	Provide explosives technical or safety advice and/or guidance to others		X
13.10	Make presentations on explosives matters		X
13.16	Manage explosive safety	X	

Candidates must achieve all nine mandatory units and 3 further optional units including 1 from each key role

Table 6 – Level 4 N/SVQ in Research, Design and Development of Explosive Substances and Articles

Candidates are normally assessed at their place of work by qualified assessors who may be employed by an assessment organisation such as a further education college or, for large employers, by an in-house assessor. The choice of optional modules will be driven by the precise nature of the job.

Training & Education

Having developed the NOS and vocational qualification it is important to ensure that there is adequate training provision to support this initiative. In the UK availability of such training and education is patchy. The armed services have comprehensive programmes for their service personnel who work with explosives but only rarely does this lead to the award of a qualification which is recognised externally. Some commercial companies also have effective in-house training but again few workers are awarded a recognised qualification. There are a number of colleges and universities offering explosives related courses some of which lead to formal qualifications but these are not necessarily linked to the occupational standards. Overall there is little consistency of approach and there are whole areas where there is little or no training provision. For colleges and training organisation to invest in the development of courses and training materials there needs to be an adequate level of demand which will require “buy in” by major employing organisations in both the military and civil sectors. So far these major stakeholders have already shown considerable commitment by resourcing the development of the standards the occupational working groups. What is now required is for them to embrace the qualifications and for their employees to have their skills and knowledge assessed.

Next Steps

To achieve “buy in” in the UK the chairman of the MOD’s Defence Ordnance Safety Board (DOSB) has convened a meeting of the major UK employing organisations to agree the way forward. All major stakeholders have indicated their support for the initiative. A number of steps have been agreed including:

- engagement with professional bodies with a view to them adopting NOS as a basis for professional accreditation
- establishing or identifying an organisation as custodian of the standards
- developing educational and training materials to support qualifications based on the NOS

- selecting one of the NVQs as a pilot for others
- continued liaison between major stakeholders to generate “critical mass” of UK explosives specialists to support
- Continue links with the EuExcert programme on European wide standards and qualifications for explosive workers.

References

1. Wallace I G, “Educating the Next Generation of Explosives Specialists”, 6th Australian Explosives Ordnance Seminar, PARARI, Canberra, 29-31 October, 2003
2. Wallace, I G, et al “Developing and Maintaining Skills in the UK and European Explosives Sector”, 7th Australian Explosives Ordnance Seminar, PARARI, Melbourne, 7-11th November, 2005
3. Parry R ,Wallace I G, "UK Explosives Competence – Setting the Standards”, 31st Department of Defence Explosives Safety Seminar, San Antonio, Texas, 24-26 August 2004.