

*2. EU directives and  
harmonisation work*



# Standard system promotes the development of civil explosives

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**ABSTRACT:** Different kinds of explosives in China together with their characteristics, effects and meanings will be discussed in this paper. Standards play an important role in various aspects of the explosives namely the research, experimentation, production, testing, transport, storage and destruction. They also serve as the guideline to select the facility and the equipment concerning the production safety. Standards help to supervise the product quality, and to set thresholds for market entrance. They are also significant references for agencies to evaluate their security. The need for the standards is increasing in the areas of production and management of explosives. Standards are badly needed in the field for production safety promotion, environment protection, technique improvement, scientific management, and product quality improvement. A new system framework for the explosive industry is worked out in a systematic, comprehensive and scientific way. It comprises four sub-systems namely general foundation standards, management standards, technique standards and operation standards. The general foundation standards at the top level are universal to diverse areas. The management standards are employed to administrate management and promote safe production. The technique standards give the detailed requirement for production, equipment, facility, experiment and test method. The operation standards define the operation criteria for the manager, producer and seller. The four sub-systems depend on each other. The main contents of the classic standards in each sub-system will also be discussed.

## 1. FOREWORD

The civil explosives industry is an important composing part of Chinese industry. As the foundational industry of China, it has evolved to be an industrial system with completed products through over five decades of development. The main products include: industrial explosives, industrial detonator, industrial primer, industrial detonating cord, non-electric detonating system, percussion, blasting agent, hypocenter facilities, oil & gas well used blasting facilities and booster pellet, etc. These products have been widely

employed in industrial departments such as metallurgy, coal, water and electricity, civil construction, railway, traffic, shipping, petroleum, natural gas and mechanism manufacture. In the meantime, civil explosives belong to the high danger industry. It is greatly related with social public security and people's lives and properties. The code of conduct in civil explosives industry is the basis of its development which exerts important function in researching, manufacturing and managing. Every aspect, from researching, manufacturing, testing, inspecting, transporting, storing to destroying; from the scheme and

construction of enterprise to acceptance and put into production; from enterprise's safety production, product quality assurance, technique operation rules, facility management, site management to safety assessment of agencies; from the implementation of safety inspection, qualification approval, project audit to market admittance, must be based on the code of conduct and needs relative regulations and guidelines. This code of conduct plays a very important role in assuring production safety, enhancing product quality, boosting technology progress and guaranteeing a healthy, orderly and scientifically developed industry.

## 2. THE BASIC CONCEPT AND STANDARD SYSTEM OF THE CIVIL EXPLOSIVES INDUSTRY

In GB/T13016-1991 *The Fracture Principle and Requirement of Standard System*, it defines 'Standard System' as a scientific and organic whole based on its interior connection within certain scope of standard.

The composing unit of standard system form is standard. It consists of all criteria a standard system should have within certain time and certain scope, which includes current effective standard and standards need to constitute, modify and castigate. The criteria in the system affect and rely on one another. This system has a lot in common with average systems, which are integrity, congregation, objectivity, resolvability, relativity and environmental suitability.

The standard system of the civil explosives industry is an organic system based on interior connections of certain criteria in researching, manufacturing and managing, which relates and relies on one another. It is an integrated reflection on the system and regulation of the civil explosives industry, industrial structure, technology, manufacture and management level.

## 3. THE PURPOSE, FUNCTION AND CHARACTERISTICS OF THE CIVIL EXPLOSIVES INDUSTRY STANDARD SYSTEM

### 3.1 *The purpose of constructing civil explosives standard system*

It starts at adapting the development demand of civil explosives industry, centers on boosting overall product quality and safety production, aims

at optimizing industrial structure, upgrading the overall level and adaptability of civil explosives industry standards, establishing a system covering whole researching and manufacturing procedure of civil explosives industry and leading the industry to develop a scientific, pragmatic and completed standard system.

### 3.2 *The function of standard system in the civil explosives industry*

#### 3.2.1 *To depict a blueprint of standard activity and clear working direction and stress*

#### 3.2.2 *To systematically know international and overseas standards and to provide completed intelligence for adapting international standard and advanced foreign standards*

#### 3.2.3 *To guide the fracture of the standard system and modification plan*

With overall reflection of standard system table, we found the gas with international standard and advanced foreign standards as well as the blank in our system. Therefore, we can control direction and find priority to accelerate the speed of making system so we can avoid blindness in plan and repetition at work to save manpower, material resources, and financial resources.

#### 3.2.4 *To reform and improve current standard system to make a systematic, normative and scientific system*

#### 3.2.5 *To help with the expansion of scientific research work*

Standard system listed not only current criteria, but also corresponding future international criteria and advanced foreign criteria. It is very helpful for scientific personnel to take advantage of those advanced standards.

#### 3.2.6 *To help with the construction of enterprise standards*

### 3.3 *The basic principle of system*

#### 3.3.1 *Plan as a whole and serve the industry*

The construction of civil explosives industry standards should conform with and serve the demand of civil explosives industry. It is better to

plan as a whole and construct completed technical criteria, management criteria and work criteria to regulate management with standards, boost technical progress with standards, to assure safety production with standards and enhance product quality level with standards.

### 3.3.2 *Based entirely and strengthen foundation*

The standard should try its best to cover every aspect of this industry which requires us to take the altitude of overall industry and plot the content of every level. Meanwhile, the foundational scientific research of standards and standardization of civil explosives industry should be strengthened in order to provide solid support to the construction of a scientific and pragmatic standard system.

### 3.3.3 *Combine with national situation and connect with international*

The construction of standard system of civil explosives industry can't be divorced from actual national situation. It should try to connect with international general rules in the mean time. Therefore, we should analyze widely and profoundly international standards and foreign advanced standards to take advantage of them based on our national situation, accelerate the speed of our standard to connect with international and to boost our national competitive force in civil explosives industry.

### 3.3.4 *Pop out pivot and plot levels*

There are many standard items in a standard system. It takes a long time to build all criteria. Thus, we need to gather limited resources, pop out pivot area and pivot technology, select representative, progressing and mature project, start our work on pivot system, modification and research so to solve key and common problems pressing in the development of civil explosives facilities.

### 3.3.5 *Rely on enterprise and materialize demand*

The construction of standard system affects ultimately the development of enterprise, so it needs mass participation of enterprises to build a healthy and pragmatic system. Through wide suggestion adoption of enterprise and reflect enterprise's demand into system can pragmatize the system and solve enterprise problems.

## 3.4 *Characteristics of standard system*

The standard system of civil explosives is of objectivity, compatibility, level, matching, continuity and open.

**Objectivity:** to gain best order and interest for civil explosives industry, to promote technology advance of the industry, boost industrial structure and product quality level, to serve for the protection of safety production, staff health and environment.

**Compatibility:** every relative criterion in the system keeps consistency and connection to get unification and harmony.

**Level nature:** It refers to level connections of civil explosives standard including national standard and industrial standard.

**Matching nature:** refers to all kinds of civil explosives standards rely on and supplement one another to construct a completed organic system.

**Continuity nature:** refers to civil explosives standards should based on the old system and make modification, supplementation and improvement.

**Open nature:** refers to the level of civil explosives standards, structure plot and standard formation will evolve with the development and change of social economy, technology and trade.

## 4. THE DEMAND TO STANDARDS OF THE CIVIL EXPLOSIVES INDUSTRY

Since the implementation of Safety Management Regulation of Civil Explosives, civil explosives industry has had tremendous change. The construction of civil explosives standards should emphasize on new change and development to provide technical support and assurance for industrial regroup, product's structure adjustment, safety production, technology progress and product quality.

### 4.1 *The demand to safety standard*

Accidents have happened frequently during production of civil explosives facilities in recent years. The reasons for those lessons are not exceptionally connected with the execution of safety management system, the aging of equipment and facilities, the lag of techniques, the unreliable safety protection, untrained personnel and misplay

of operation. To guarantee safety production of civil explosives facilities and reduce accidents and production risk, a scientific and pragmatic standard system of safety management and safety technology involving every aspect of safety should be established to solve safety production problems systematically.

#### *4.2 The demand to standards of enterprise admittance*

Civil explosives enterprises have the characteristics of large in number, small in scale and relatively low in the overall level of safety production. Besides, those enterprises are not reasonable in overall arrangement, not intensive and dimensional in production and low in economic interest. Compared with those big groups and corporations of foreign civil explosives industry, our counterpart competition is weak. Strict standards for enterprise admittance should be established in order to promote overall level of this industry. Admittance standards should be enhanced and enterprise combination should be promoted to form a structure of dimensional and intensive production.

#### *4.3 Regulate the demand for industrial management standard*

With the adjustment and regroup of civil explosives industry and the progress of technology, the socialization and intensive production is getting higher and higher. The demand for every manufacture enterprise to consolidate and coordinate in technology and requirement through the creation and implementation of all kinds of management standards can make management concise, scientific and normative. Therefore, it is urgent to create industry standards to consolidate management standards like technical parameter, requirement, regulation and procedure to provide normative management for industry and technical assurance for information transmission.

#### *4.4 The demand of product quality assurance for standard*

The standards regulates inspection procedure, rules and methods of all kinds of products from raw material, equipment, system to capability target, technical requirement as well as inspection fits prescribed target and requirement or not. Therefore, standard is the precondition to assure the quality of civil explosives products. But many

new environmental protection and safety products have not created corresponding regulations so far. What's more, there are not many inspection methods standards of civil explosives products. It is necessary to make corresponding new methods to new products in order to provide technical support for measuring products quality.

### **5. THE FORMATION OF STANDARD SYSTEM OF CIVIL EXPLOSIVES INDUSTRY**

Through several decades of development, the standardization work of our civil explosives industry had basically formed a completed standard system.

#### *5.1 The scope of standard system*

Products like industrial explosives, industrial detonator, industrial primer, industrial detonating cord, non-electric detonating system, percussion, blasting agent, hypocenter facilities, oil & gas well used blasting facilities and booster pellet, etc belong to standard system of civil explosives industry.

#### *5.2 Standard stratum*

The stratum are divided into national standard, trade standard and enterprise standard.

#### *5.3 Standard kind*

According to its content, standards could be divided into foundation standard, method standard, product standard, engineer standard, service standard, safety sanitation standard and environment protection standard. Standard system should coordinate and match between criteria and based on principle of foundation first the rest later, synthesis first profession later and universe first professional later to make an organic whole of the system.

#### *5.4 Standard quantity*

The current national standard and trade standard totalled 120, 70 for the former and 50 for the latter.

#### *5.5 The structure of standard system*

Below is the basic frame of standard system of civil explosives: The structure of standard system consists of basic standard, management standard, technical standard and working standard.

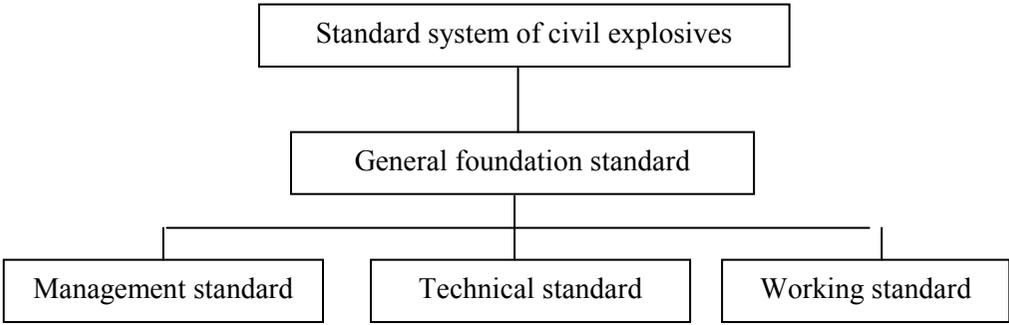


Figure 1. The structure of standard system.

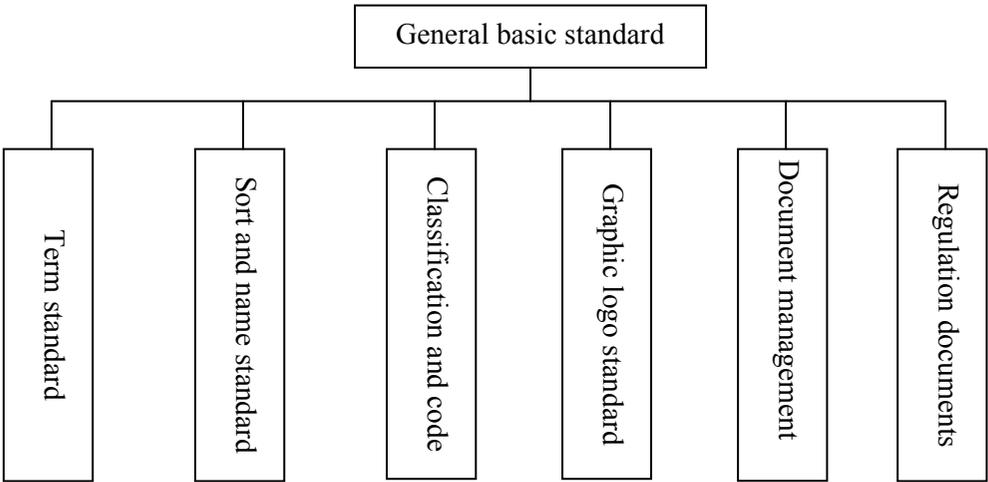


Figure 2. Subsystem of general foundation standard.

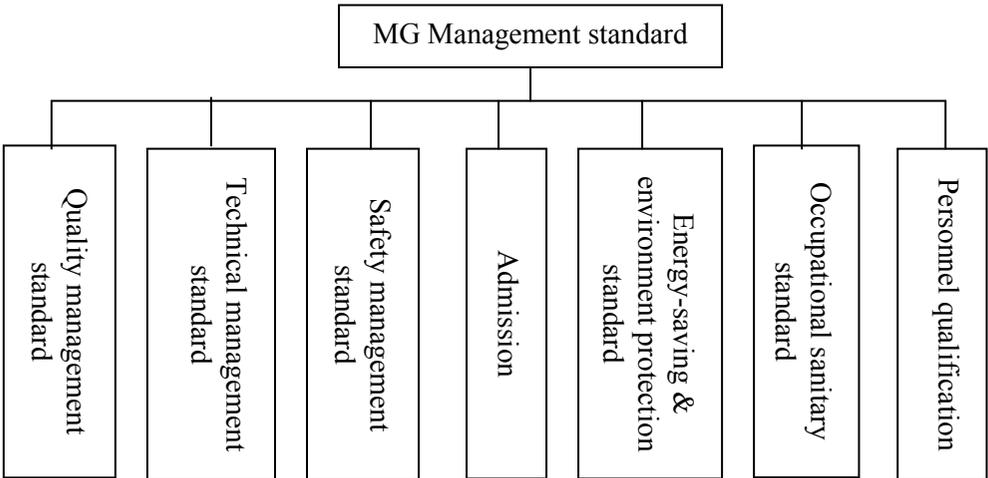


Figure 3. Subsystem of quality management.

### 5.5.1 General foundation standard

General foundation standard is the top standard of civil explosives standards and the standard the whole trade comply, including term standard of civil explosives industry, sort and name standard of civil explosives facilities, classification and code standard, graphic logo standard, document management standard and relative regulation documents (see Figure 2.). Creating general foundation standard could regulate enterprise behaviour within industry and assure the conformity and coordination of next level.

Currently, Chinese general foundation standards include GB/T14659-2003 *Terminology of Civil Explosives Facility*, GB 12268-2005 *Name of Danger Goods List*, GB/T7694-1987 *Name principle of Danger Goods*, GB6944-2005 *The Classification and Name Serial Number of Danger Goods*, WJ/T9041-2004 *The Classification and Code of Civil Explosives Facilities*, GB 20576-2006 *Chemical Goods Classification, Safety Regulation of Warning Label and Introduction Explosives*.

### 5.5.2 Management standard

Management standard of civil explosives industry consists of quality management, technical management, safety management, admission management, energy-saving & environment protection management, occupational sanitary standard and personnel qualification management (see Figure 3.). By making trade management standard, enterprise management standard and executing standards to fully exert the function of government in promoting optimization of industry layout, system mechanism reform, enhancement of technology level and strengthening of safety guarantee in order to realize standardized management of the enterprise.

The existent management standards are: GB 19455-2004 *Danger Characteristics Inspection Safety Rules of Civil Explosives Goods*, GB 18218-2000 *Identification Standard of Major Danger Source*, WJ 2531-1999 *The Safety Disposal Requirement of powder, explosives, fire related crap equipment, pipeline and accessories*, GB 6721-1986 *The Economic Loss Statistics standard of Enterprise Employee Casualty* and SY/T 5857-2006 *Management Rules of Civil Explosives Facilities for Petroleum Exploration and Earthquake Operation*.

### 5.5.3 Technical standard

Technical standard includes industrial explosives standard, industrial blasting composition standard, industrial detonator standard, industrial cord blasting standard, special explosives facility standard, test method standard, typical craftwork standard, metric technical standard, professional equipment standard, construction facility standard, storing, packaging and its material, raw material and supplement material, etc.(see Figure 4.). These standards could be divided into five categories: product standard, equipment standard, method standard, manufacture standard and construction standard.

**Product standard:** It emphasizes on researching and manufacturing new products with high techniques, good safety capability and environmental protection. Such as the creation and modification of industrial explosives standard, blasting facility standard, detonating facility standard and special blasting facility standard, etc. For example: GB12437-2000 *Industrial powder AN-TNT Explosive*, WJ/T9040-2004 *GTG Grain Percussion*, GB/T 8031-2005 *Industrial electric detonator*, WJ 9035-2002 *Oil & gas well used detonating cord*, WJ/T9036-2002 *Oil & gas well used casing blasting bomb*.

**Equipment standard:** starting from boost the researching, developing and designing level of civil explosives industry, we should emphasize on making designing regulation of special equipment, designing standard of product line, designing standard for function, safety and capability of key piece and facilities. For example: GB 2702-1990 *Explosives Safe*.

**Method standard:** It should make overall analysis research to the inspection standard of product, product line, key equipment, key piece and material, bring forward standard system and project modification and start to execute them, such as inspection and trial standard, examining and standard material. For example: GB 12440-1990 *Grade test of explosive Compression Method of Lead Column*, WJ9004-1992 *Burst and Heat Measurement of Industrial Explosive*, WJ/T 9054-2006 *Heat Stability Test Method of Industrial Explosive Differential scanning calorimetry*.

**Manufacturing standard:** Starting from enhancing manufacture level and product quality as well as reducing production cost to begin the creation and modification work of standard, such as special raw material, supplement material standard,

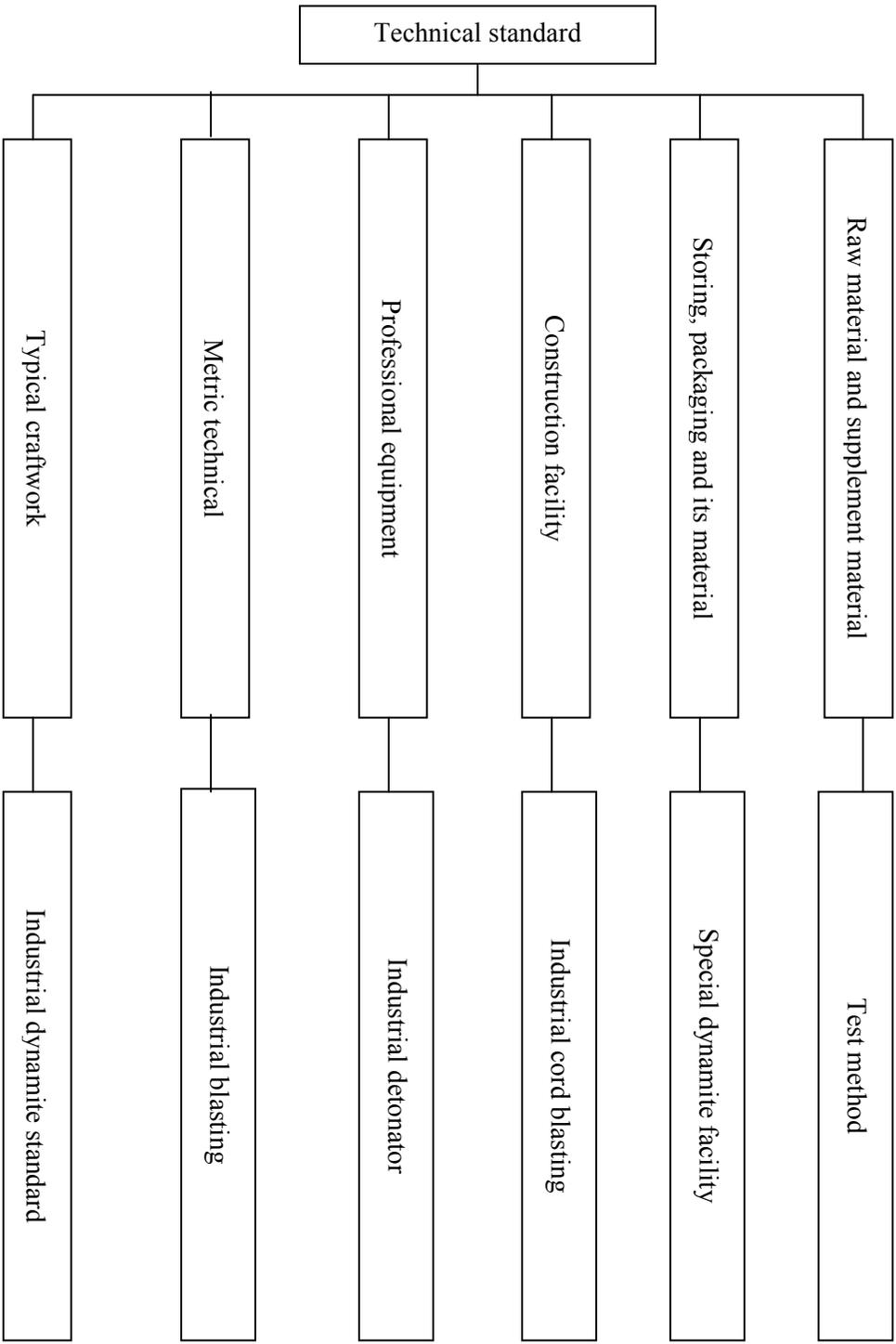


Figure 4. Subsystem of technical standard.

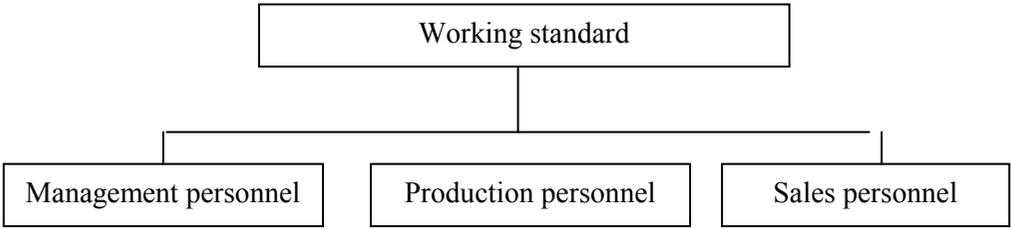


Figure 5. Subsystem of working standard.

typical technique standard and packaging standard. For example: GB18014-1999 *PVC Insulated cable for Electric detonator*, MT377-1995 *Insulated cable for Electric detonator*.

Construction standard: To standardize factory facilities of manufacturing civil explosives factories and promote overall safety of manufacturers. For example: GB50089-2007 *Safety Regulation of Engineer Design for Civil Explosives Facilities*, GB 50057-1994 *Designing Regulation of Lightning Conduction of Buildings*.

#### 5.5.4 Working standard

Working standard is to make corresponding standard for operation procedure of pivot craftwork segment, employee behaviour rule and work assessment, including standards for management personnel, production personnel and sales personnel (see Figure 5).

## 6. CONCLUSION

A scientific and pragmatic standard system can guide and promote the development of our national civil explosives industry. It should be based on wide research and analysis. Thus, we should fully realize the importance and necessity of establishing standard system, analyze our standard system and industrial system, combine with our national situation, introduce actively into international standard and advanced foreign standard, construct scientific form of standard system, improve constantly standard system of civil explosives to exert assuring and pulsive function for the technology development and production safety of our national civil explosives industry.

Since the new standard system for civil explosives industry is established, corresponding effective and reasonable management mechanism and operation mechanism should bring into being

to assure and promote the construction of standard system of civil explosives industry. Meanwhile, only adopting feasible measures can truly promote trade development of standard system for civil explosives industry.

## Developments in EUExcert project

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**ABSTRACT:** The paper will describe the work undertaken and the results achieved from phase 1 and phase 2 of the EUExcert project. In phase 1 a number of EU nations examined the explosives competencies developed in the UK by the Standard Setting Body (SSB) for Explosive Substances and Articles for all explosives occupations in both the civil and defence sectors. These competencies in the form of National Occupational Standards (NOS) were approved in the UK and are accompanied by a range of 24 new National Vocational Qualifications. They potentially provide the foundation for both UK and European qualifications for explosive workers. Phase 2 saw the validation of the UK NOS by the European partners of EUExcert and the development of an EU qualifications framework. To support the NOS and qualifications work a series of workplace learning initiatives were developed as well as internet learning packages. A European network of industries and institutions in the explosives sector was established and a basis for setting up a European centre of excellence with the ability to award European certificates was investigated.

### 1. INTRODUCTION

Since the turn of the Millennium there have been a number of well publicized explosives accidents around the world. One of the characteristics of these accidents is that they frequently have catastrophic consequences. In Lagos, Nigeria an ammunition dump exploded, the explosion created mass panic which subsequently led to the death of nearly 1000 people, most of whom were children. Another explosives accident aboard the Russian submarine led to the loss of 118 sailors, a loss of significant defence capability and serious political destabilization of the Putin Government. In Holland an explosion involving fireworks

destroyed 200 houses and killed 22 people, whilst in France an explosion involving ammonium nitrate destroyed a major industrial facility, killed 30 people and injured around 2000. The consequence of explosives accidents is frequently serious in human, economic and political terms.

Examining the cause of explosives accidents invariably reveals that human error or failure is a major contributory factor. The Enschede incident in Holland was initiated by a deliberate act by a malcontent. However the catastrophic consequences were also a result of management failure, breaches of the explosives regulations and a failure to understand that storing fireworks inside steel iso-containers generates sufficient

confinement to maximize the violence of the event.

One of the torpedoes loaded on the Kursk is known to have been dropped prior to embarkation and this may be linked to the torpedo explosion which, the official report suggests, led to the loss of the submarine and its crew. In both cases it was the actions of individuals or the failure to act in an appropriate way which contributed to the accident. Effective explosives safety depends on people making the right decisions at the right time. It depends upon people having the necessary competence to carry out their jobs properly. The concept of competence is well recognized in UK safety management. Much of UK safety legislation calls for “competent people” in roles that affect safety. In the case of explosives, this will be in all stages of life, from the formulation of new explosives in the laboratory, through manufacture, storage, transportation, use and disposal.

Whilst the stove piping of organizations in the European and UK explosives business has had an impact on the breadth of experience, the general contraction of the explosives business in Europe and the UK has had a major impact on the numbers of skilled specialists. Added to this many of the specialists were recruited in during a growth period in defence science and technology in the 1970s and are approaching retirement.

A lack of recruitment in the late 1970s and 1980s has left a demographic trough, wherein there are insufficient skilled explosives specialists to replace those who will be leaving government service in the next few years. Figure 1 illustrates the typical problems faced by the European countries with respect to the loss of expertise, if you assume that the ‘experts’ are those who are of the age 50+.

2. EUEXCERT PHASE 1

In 2003 Cranfield University together with KCEM, a Scandinavian explosives competence organisation, joined with other EU partners in a project funded by the European Union Leonardo da Vinci programme. This programme of work (called EUExcert) was aimed at replenishing explosives expertise, through vocational training and education across the EU with a view to setting up a European qualifications framework in order to award European certificates for workers in the explosives sector. The purpose was not only to ensure the supply of specialists in key explosives safety functions, but also to maintain European competitiveness in the ordnance and explosives industrial sector.

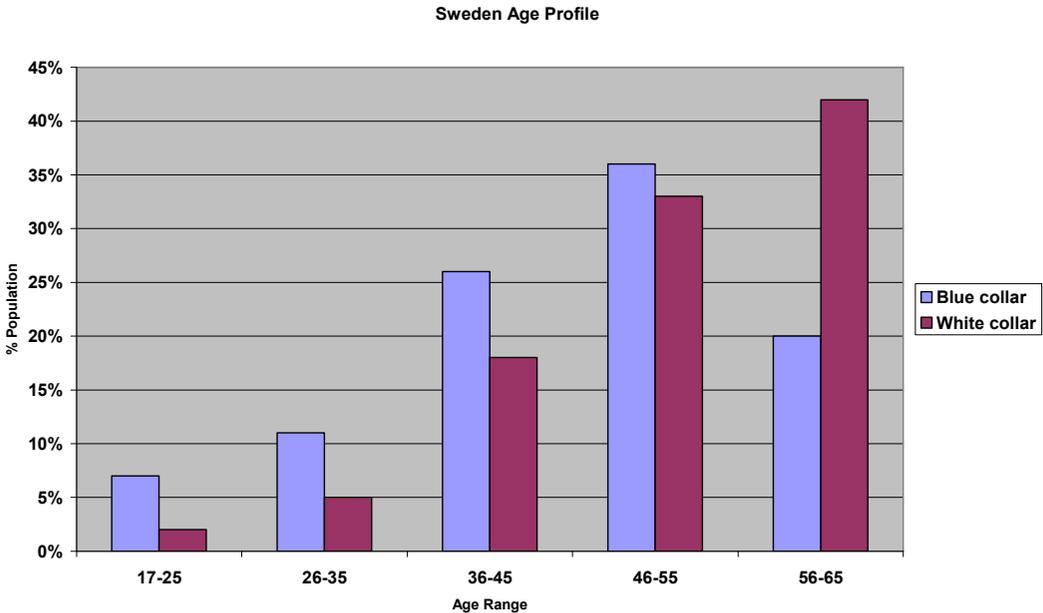


Figure 1. Age profile of white and blue collar workers in the explosives industry in Sweden.

The following objectives were identified as the keys aims of EUExcert:

- Identify the competencies required to sustain a safe and competitive explosives industry in the EU.
- Establish the current and future needs for these competencies in the EU.
- Develop training and educational programmes designed to develop this range of competencies.
- Develop a range of novel education and training packages that form part of the programme.
- Develop explosives qualifications which will be recognized and accepted across Europe.
- Reverse the decline in expertise, knowledge and skill in European explosives business.

In October 2006 the phase 1 of EUExcert was completed with the submission of a final report to the Leonardo da Vinci programme office. All the objectives above were achieved except for objective ‘6’ which will take some time to achieve.

Below are highlights of some of these achievements.

To accomplish the first of these objectives the EUExcert team looked around the EU and indeed to other nations to find suitable examples of competency frameworks. It became apparent that the UK work on Occupational Standards represented the most thorough and mature approach. A functional map and competency framework for workers in the explosives sector was being developed in the UK by the Standards Setting Body (SSB) for Explosives Substances and Articles. This body had representation from all of the major stakeholders, both military and civilian, from the UK explosives community. 13 Key roles were identified and 440 National Occupational Standards (NOS) were written and validated in the UK(CESA). From these 440 NOS; 24 National Vocational Qualifications (NVQs) were developed. Table 1 gives details of the 13 key roles.

Using the competencies a qualification framework was developed in the UK. These qualifications are divided into 3 levels. Level 2 is the operator level, level 3 is the supervisor level and level 4 is the manager level. Details of this framework are presented in table 2.

Table 1. Thirteen key roles for workers in the explosives sector.

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### Key Role

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- |    |                                                                                                                                         |
|----|-----------------------------------------------------------------------------------------------------------------------------------------|
| 1  | Research, design 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 of explosive substances and articles                                                                                          |
| 9  | Manage explosive facilities                                                                                                             |
| 10 | Prepare and use explosive substances and articles for engineering and entertainment purposes                                            |
| 11 | Disposal 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                                                                                  |
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Table 2. Details of the qualification framework.

<b>Key Role</b>	<b>Description</b>	<b>NVQ level</b>
Research, Design and Development	Research into Explosive Substances and/or Articles	Level 4
	Design and/or Development of Explosive Substances and/or Articles	Level 4
	Research, Design and Development of Explosive Substances and/or Articles	Level 3
Safety Management	Explosives Safety Management and/or Advice and/or Regulation	Level 4
Test & Evaluation	Test and Evaluation Management of Explosive Substances and/or Articles	Level 4
	Test and Evaluation Supervision of Explosive Substances and/or Articles	Level 3
	Test and Evaluation Operations of Explosive Substances and/or Articles	Level 2
Manufacture	Explosive Substances and Articles Manufacturing Management	Level 4
	Explosive Substances and Articles Manufacturing Supervision	Level 3
	Explosive Substances and Articles Manufacturing Operations	Level 2
Maintenance	Explosives Maintenance Management	Level 4
	Explosives Maintenance Supervision	Level 3
	Explosives Maintenance Operations	Level 2
Procurement	Explosive Substances and/or Articles Procurement Management	Level 4
	Explosive Substances and Articles Procurement	Level 3
Storage	Explosives Storage Management	Level 4
	Explosives Storage Supervision	Level 3
	Explosives Storage Operations	Level 2
Transport	Explosives Transport Supervision	Level 3
	Explosives Road Transport Operations	Level 2

Key Role	Description	NVQ level
Disposal	Explosives Transport Supervision	Level 3
	Explosives Road Transport Operations	Level 2
Hybrids	Explosive Substances and/or Articles Disposal Management	Level 4
	Explosive Substances and/or Articles Disposal Supervision/Operations	Level 3
	Explosive Substances and/or Articles Disposal Operations	Level 2

The 24 NVQ qualifications have been underpinned by a flexible educational and training programme, with vocational training as the main part of the learning objectives together with workplace training and e-learning based on CD-Rom and the internet. On-line e-learning lessons have been developed in 'Introduction to Explosives', 'Burning and Detonation', 'Initiation' and 'Management and Legislation'.

### 3. EUEXCERT PHASE 2

The Leonardo da Vinci programme office awarded EUExcert with a further two years funding in October 2006. The objectives of phase 2 was to improve the skills and competencies of workers in the explosives industries by building on the work completed in phase 1 and transferring this to a European competency and qualification framework for the explosive sector. It was intended to set-up a 'Foundation' in order to regulate this new European competency and qualification framework and also provide a degree of transparency for an EU wide EUExcert certificate.

At the present time the number of participating countries in EUExcert is 10, these are UK, Sweden, Norway, Finland, Italy, Portugal, Germany, Estonia, Lithuania and the Czech Republic together with a member from EFEE. In order to improve the network capability and capacity of the partners a database of organizations and institutions who are interested in this programme of work has been set-up. The members of the network receive regular newsletters and updates of EUExcert activities. Currently there are 183 people registered with an interest in

explosives from which 10 are outside the European community. Registration can be carried out by logging on to the EUExcert web-site at [www.euexcert.org](http://www.euexcert.org). In order to increase the number of participating countries the work undertaken in this project is widely disseminated by writing and presenting papers and posters on the outcomes of the EUExcert project at national and international conferences, seminars etc.

The European qualification framework has been developed which is based on the qualification framework developed in the UK. It is intended to award 7 certificates at the Introductory level (operator), 8 certificates at the Intermediate level (supervisor) and 9 certificates at the Advanced level (manager) although this number may increase. In order to be awarded these certificates the students must have completed a study of training at their place of work and assessed by an Internal Assessor. The language for the development of the curriculum and study material is in English; however the educational and assessment material will be prepared for translation to other languages. The educational material is adapted for flexible learning and to work based training. The target groups are adult workers in the explosive industries who want to undertake their training at their place of work. It is intended to use partner groups to deliver some of the training via video conferencing. This type of activity has already taken place between the UK and Sweden where the lesson was given in the UK to a group of students in Sweden via video conferencing. This type of activity will be encouraged between other partner countries. Learning centres are also being explored. The Learning Centre at Masugnen in Sweden allows

the students to have access to computers, video conferencing, study facilities and training aids. Other methods of delivering training have also been investigated particularly for countries where learning centres may be difficult to set-up. Here the training will be a combination of work-base and web-base training, where the student may be required to attend educational establishments for a short period of time. Exchange of students or distance education between partner countries will take place using a separate programme i.e. the EU Mobility programme. Students who will be registered for the EUExcert will be able to study in one of the partner countries.

#### 4 CONCLUSION

The EUExcert project has drawn on a number of national initiatives in order to deliver the objectives of the EUExcert 1 and the EUExcert 2 programmes. To progress the EU explosives qualification framework further it is proposed that a European vocational qualification organization needs to be established. This organization will be responsible for the validation and accreditation of the qualification and the issuing of EUExcert certificates. Discussions have been undertaken in Sweden with the view to setting up an 'Association' for the EUExcert qualification. This vocational qualification will be trans-national between partner countries and in the longer term be recognized throughout Europe. At the present time there is no European regulating board to either access or impose competencies in the explosive sector. Therefore there is a strong driving force by workers in the European explosive sector to continually improve the safety of handling explosives by ensuring that all workers are competent. This project will be one way of improving this situation by delivering a European Explosive certificate regulated by this 'Association'. The certificate is aimed at workers in the explosives sector who are required to be competent. The impact of this certification will be of great benefit to the employers and employees. It will lead to an increase in mobility and employability of workers across Europe and it will also lead to an increase in the awareness of the hazardous nature of the explosive materials which, in the long term, will lead to fewer accidents. In the longer term this programme of work will increase the opportunities for career development; improve the knowledge, skills, employability and mobility of the beneficiaries and target groups. A

new proposal for Phase 3 is already underway with the Institute of Explosive Engineers representing the UK.

#### REFERENCES

CESA UK Explosive Substances and articles national occupational standards.

[http://www.ukstandards.org/Find\\_Occupational\\_Standards.aspx?NosFindID=4&FormMode=ViewModeSuite&SuiteID=791](http://www.ukstandards.org/Find_Occupational_Standards.aspx?NosFindID=4&FormMode=ViewModeSuite&SuiteID=791)

[cited 1 June 2009].

# Benefits and barriers to the harmonisation of vocational training on explosives in Europe

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**ABSTRACT:** The explosive civil sector presents similar characteristics in most European countries. Companies in this sector have transnational activity and employees are pushed to work in several countries. Although the instruments developed to promote convergence of VET across Europe the mobility in this sector is low. In many countries this sector is still regulated by old laws and European qualification framework is highly abstract to assist transference between skills levels. The purpose of this paper is to discuss the vocational education and training of individuals in the explosive civil sector, in particular that of shot-firers. This is the result of numerous discussions within EFEE and EUEXCERT project. Instruments used to measure qualifications and to provide information in respect of learning methods are discussed. Benefits and barriers to develop common vocational education and training for European blasters and to build a European Regulating Board to provide guidance for a functional map competence are analysed.

## 1. INTRODUCTION

The internationalization of almost all spheres of society and the continuous process of European integration are leading to the development of a European vocational education and training (VET) architecture. The strategy adopted by the European Union for the establishment of a European area of vocational education is confronted with a dilemma. The European Qualifications Framework is highly abstract since any reference to real educational programmes and qualifications and any concrete provision for the transition and for the transferability between educational levels and sectors (vocational and higher education, initial and continuing training) was avoided in order to adhere to the anti-harmonisation clause (Raune

2008). The last decade has witnessed an increasing focus on human resource development (HRD) and work-based education and training, as instruments for enhancing productivity, competitiveness and economic growth. Unfortunately, the increasing interest in these issues has only been followed by more profound changes in existing practices concerning HRD, training and other forms of competence development in companies (Carbery and Garavan 2005). The biggest break from current practices is likely to be the shift to measuring what people know regardless of how they acquired their competencies.

Compensation for investing in learning has a good chance of finally creating the incentives that might make the so far unsuccessfully pursued goal of broad participation in lifelong learning a reality.

Additionally, a much more refined and supple way of measuring what people know could significantly improve the way choices are made by individuals and employers looking either to make new investments in human capital or make better use of existing knowledge assets. Building up highly neutral, flexible, diversified and efficient systems of prior learning assessment will depend on the development of the appropriate norms, rules, organisations and relationships. Knowledge depends on the needs and preferred strategy of the country or the industry/company. Innovations in the evaluation of this field are strictly constrained by vested interests. Consider the four most obvious constituencies: Individuals naturally want to see their skills portrayed in the best light. Teachers and the organisations to which they may belong want to see that their pupils receive the most recognition. Employers have a clear interest in paying only for the minimum qualifications needed to complete a particular task. Governments hope to ensure that there is sufficient investment in the skills which may be generally beneficial to the public good, beyond what individuals or organisations might finance on the basis of their narrower interests.

## 2. EUROPEAN QUALIFICATION FRAMEWORK

Compulsory full-time schooling in European Union countries generally commences at age of six and continues for the next 12 years. Once this full-time compulsory schooling (general education) has been completed, the students may enter vocational training (full-time vocational schools or apprenticeships) for two or three years or move into more further education at the universities or polytechnics (Misko 2006). On completion of a secondary school certificate or leaving school before completion, students may opt to undertake a training program in a public or private technical institute. Although traditional apprenticeships have existed in many countries, over the last decades they have declined in popularity with students, which in turn has led to significant skill shortages in the technical trades. In most of countries a division of tasks has been created between the school system and the workplace. The school system provides general education and in some cases preliminary vocational training. The workplace imparts skills to employees and concentrates on occupational competences (Guggenheim 1999).

In 2002, the Copenhagen Declaration set up steps to improve transparency in competencies and qualifications in vocational education, cooperation, mobility schemes, and integrated programs of study, training research. Plans were made to implement a new uniform framework for improving transparency, called the Europass. The Europass, presented in a common format for curriculum vitae, includes a diploma supplement for higher education and certificate supplement for vocational education. The Europass also includes a European language portfolio which documents their linguistic skills and cultural expertise (Europass 2009).

## 3. ASSESSMENT VOCATIONAL EDUCATION TRAINING IN EUROPE

In general the procedures for the award certificate of competencies apply principles based on National Vocational Qualifications (NVQ) based on occupational standards identified by industry (Misko 2006). The assessment in these cases takes place usually thorough on-the-job observation and questioning by assessors who test the candidate's knowledge, understanding and performance of workplace competence (Guggenheim 1999). Learning is evaluated in the light of results in the work situation, using specially 'certified' assessors. The transparency of experience-based knowledge, using the same benchmarks as in training, is helping to strengthen the links between training and work. Although the principle of taking work-experience into account in order to shorten the training itinerary is relatively widespread in most continuing training schemes, the idea of not claiming examinations leading to certification mark a cultural revolution in many countries. The current pressure for the development of schemes for the validation of experience-based knowledge is promoting the search for new techniques for the writing of benchmarks. It is far harder to formalise the assessment of what has been learned through experience than it is in the case of training-based knowledge. Work experience is acquired in different contexts, and what is learned does not necessarily relate to a preset corpus of knowledge. In France, for example, the Education Ministry developed a specific assessment method based on detailed information provided by the candidates about their actual work (Guggenheim 1999). The candidate must produce a dossier setting out a description of their activities, which is then

referred to by a board in order to identify the knowledge that is relevant to the diploma benchmarks. Guidelines for the qualifications are drawn-up by experts and provide very general instructions for preparing the tests and assessment. The tests usually take two to five days. They may be held at the candidate's own workplace, or other place where they can create conditions as authentic as possible.

In many countries the recognition of prior learning and the application of credit transfer based on hours have not generally been used in the vocational education sector. The distance learning method for certification is the way of the future, allowing an interactive experience and guidance step-by-step. This method allows the convenience of studying right from your home computer. An online account will provide the access to several courses that require completion throughout the duration of the studies. This method which allows that the online student when he feels prepared to take the exam, simply contact the closest test site and schedule an appointment. How much distance will be necessary to adopting these methods to explosive sector, in particular to shot-firing?

Vocational training in blasting activity is still supported by traditional methods and programmes are not the same in all countries. The difference between vocational training (courses and the practices) in each country become from the different knowledge requested by the nature of explosives and nature of material to blast. Consequently different blasting certificates are available according to the main expected activity to be carried out by the blaster depending on the nature of the explosives substances used (gun power, explosives, other explosives substances...) or the nature of the work to carry out (demolition, rock excavation, outside work on urban site, explosion in agricultural and forest fields, underwater explosion, opening trenches, avalanches, ...) (Michel 2003). In addition, local regulations contribute to difference increasing. Most European countries (Norway, Finland, Denmark and Switzerland, Greece, Czech Republic, ...) propose two or three shot-firer level certificates. The licence certificate attesting the competence is obtained by the approval in an exam (attesting theoretical and practical knowledge) after a period of training in the workplace under the supervision of a licensed blaster and a short training course at a vocational training school or a professional association during one or two weeks. For high certificate level

the period of training in workplace could reach about 12 months and must involve a significant range of blasting operations. Adding to the approval in the exam generally requires an official document attesting the moral standing of the candidate (required in Austria, Portugal, France, Greece) (Michel 2003). In Austria the approval in the exam or the recognition of a diploma obtained at university received by the Ministry of Industry or Social Affairs requires in addition the recognition of police authorities to start the activity. In addition some countries, like Portugal, only provide the blasting licence if the candidate possess a valid contract with a company with a license to use explosives (Góis *et al.* 2009).

#### 4. MUTUAL RECOGNITION AND PORTABILITY OF QUALIFICATIONS

The desire of a shot-firer to work in another country is often linked to local job opportunities, so this period of time is often of short duration. This scenario is common for demolition shot-firing. The relatively short time required to perform the work does not justify a long time for the national authority of the country to deliver a licence according the traditional procedures. The mutual recognition principle means that registered training organisations are bound to accept the qualifications awarded by other registered training organisations. In theory, the mutual recognition of qualifications enables the portability of qualifications and credit between states and territories. The possibility of taking into account proofs qualification and competence from another system of education and training is not ruled out in most of the countries and multiplicity systems assessment can be an obstacle to establish correspondence levels.

A shot-firer must demonstrate basic knowledge about explosives, initiation systems and the characteristic behaviour of materials to be ruptured by explosives (geology, building construction), blasting design and safety & environmental aspects. This knowledge must be merging with technical and practical ability to carry out operations within the respect of ethical values. EFEE has approved the basic requirement for training the rock blasting and demolition shot-firer (Aslak 2007). These basic requirements approved by 19 nation membership are organised in key roles covering the main knowledge and skills that a shot-firer must demonstrate. Although the basic requirements for shot-firers are accepted by

national membership of EFEE the recognition and validation of competencies by national authorities of the different European countries are still different. The importance to establish an agreement that allows in future validating the qualifications and competencies of workers in explosive sector has conducted to the development of EUEXCERT project with the purpose of certifying expertise in European explosive sector (Wallace *et al.* 2005). The objective of this project is not only to identify the competences required to each activity (both military and civil domains), but also to develop training and educational programmes designed to express this range of competencies and to develop qualifications in explosive sector that can be recognised and accepted across Europe, avoiding the obstacles to mobility (Akhavan *et al.* 2007). More details about this project are presented in this Conference. Under the same European Lifelong Learning Programme started on November 2008 a new project instituted ESSEEM with the purpose to support the improvements in quality and innovation the vocational education and training systems on rock blasting and demolition. This project has engaged eleven partners from six countries (Norway, Germany, Finland, Portugal, Czech Republic and Sweden) and also EFEE, which represents 21 countries.

Although the continuous approach of legislation between members states it is recognised by all experts participating in both European projects that legal regulations are relatively different between countries and the target to certifying qualifications and harmonise competence and skills in Europe must not force the harmonisation of the laws. The recent requirements on security approved by the European Parliament could be a good approach in this way (EU Action Plan on Enhancing the Security of Explosives 2008). But on the other hand the required control of all activities related to explosives may produce a supplementary barrier to promote mobility. As blasting activity requires a good level of communication and a good transmission of orders between those involved in a blasting operation the different languages in Europe can also be a supplementary barrier to mobility.

To put into practice a functional map of the competencies and validation of qualifications a regular body must provide a matrix with a range of suitable qualifications with sufficient flexibility to allow individuals to be able to opt for a variety of

modules in different countries in order to gain a qualification in blasting and to be recognised from one country to another or from one subsector to another. Concerning learning methodologies universities and vocational training schools are developing modular courses on rock blasting and demolition that can be followed in part-time or by e-learning system (A-Z list of short courses at DCMT 2009; EAD – e-learning: la formation par les NTICE, 2009).

## 5. CONCLUSIONS

Educational framework and factors affecting vocational training, skills and qualifications of blasters are identified. Today new technologies associated with the use of computers and video conferences facilities allow to use e-learning system and workplace training to perform specific vocational training in some areas. Universities and vocational schools are preparing courses using these technologies; by these means industry is developing methods for learning through experience. Although European convergence of education and training practices and principles has been implemented in some sectors of activity convergence of education and training practices in the explosive sector has some way to go to be achieved. Many obstacles still exist related to national regulations, language and recognition qualification and competence from one education and training system to another. In spite of the contribution of EFEE towards the harmonisation of vocational training in civil blasting activity and the development achieved by EUEXCERT project there is no European Regulating Board to either access or impose competencies in the explosive sector. Only a technical board within the framework of the European Union will be able to regulate European qualifications and competency framework of European blasters providing a simple matrix of equivalence in order to allow transparency and recognise qualification and competence between different educational and vocational training systems.

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# A summary of EFEE shotfirer committee work for the development of the European shotfirer education

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**ABSTRACT:** The EU oriented inter-European construction market of today is liberalised and open for contractors. This includes the segment of blasting operations. Contractors undertaking demolition or rock blasting are free to tender for contracts in all concerned countries. Discrimination over the borders is not accepted. The contractors are entitled to use their own staff and operators, machinery and equipment for their contracts disregarding the country of work. There are, however, a number of obstacles. In this paper we will focus on competence and shotfirer licensing only. A trained shotfirer with license from his country of domicile will usually face a practical problem when crossing a national border. He has to obtain a new valid license before being allowed to fire a blast in that particular country. He has to pass an examination, not only to control his competence concerning the national laws, regulations governing safety and specific regulations for blasting work, but even also for his technical skills.

EFEE wants to change this; knowing that the blasting technology can be learned and used across the borders. EFEE wants to make it possible for blasters to acquire exactly the same up-to-date education in all of the 20 EFEE member countries and also that such training shall be available in the actual mother tongue. Thus to avoid any doubt as to technical competence. EFEE has previously prepared training requirement manuals for rock blasting and demolition blasting work and has initiated the development of the means for the training of blasters. This work is now established within an EU-supported project, called ESSEEM, 'European Shotfirer Standard Education for Enhanced Mobility'.

The project is divided into 13 work packages covering the training segments as defined by EFEE.

The work load is passed on to the Partners in the project, each taking on one or more work packages. The partners are companies, universities and schools in 6 European countries. The work is partly financed through the EU Leonardo da Vinci programme. The work commenced toward the end of 2008, and will be completed by the end of 2010. This paper deals with the need for a common education level for blasters, a summary of project work packages, specific examples, the project structure, aims and a view on vocational training for blasting in Europe.

## 1. INTRODUCTION

The European Federation of Explosives Engineers, EFEE, was established in Aachen by representatives from six countries 20 years ago. The Federation today consists of national societies

from some twenty European countries as well as individual and corporate members.

An important objective of the Federation is the promotion of standardisation and harmonisation of shotfirer training in Europe and thereby to contribute to the improvement of matters like

safety, health, environment and security in the field of explosives technology.

This paper concentrates on the EFEE efforts to develop harmonised high quality education for European shotfirers and personnel undertaking blasting of geo materials (rock) and demolition.

## 2. EUROPE

Topographic as well as cultural, Europe is a complex and strange conglomerate. The landscapes change from wide regions with deep layers of loose materials like moraine, gravel, sand, silt and clay to regions with high mountains caused by tectonic processes. Ore and coal deposits are (were) abundantly available, both as surface deposits and deep seated.

The European countries have long traditions in the mining industry and were, for centuries, in the frontline of science and the practical implementation of new mining methods. This includes explosives, ignition systems, drilling methods, machinery and materials for surface and subsurface activities.

The construction and development of residential and commercial buildings, infrastructure like water supply, wastewater treatment, communication systems, energy projects and facilities in general for education, health care and much more, most needed explosives and blasting operation; if not for developing purposes then at least for demolition.

## 3. EDUCATION

We are living in a volatile world. Inter-European borders are to a large extent not physical borders any more. It is easy to travel, many borders are wide open. Cross border activities, social, cultural, commercial, economic and political are established as vital parts of European life. But still some of us look forward to increased harmonisation, also in the explosives sector. EFEE contributes to such development.

EFEE has scrutinised the education of shotfirers in the majority of the EFEE member countries and has concluded that these countries have an education level considered acceptable as 'EFEE basic standard education'. EFEE has appointed national approvers in the recognised countries to control the valid national certificate of an applicant for European Certificate. Subject to acceptance by the national approver; EFEE may issue an EFEE Standard European Shotfirer

Certificate to the applicant. This certificate is then valid in combination with the valid National certificate. If a National certificate is withdrawn by the domestic authorities the related European EFEE certificate is also not valid.

Even if EFEE has approved the basic competence level in member countries, it is no doubt, differences in the general competence level in various European regions. In some countries, especially those geologically dominated by deposits of loose materials, rock blasting is of lesser importance. Whereas using explosives for sub-surface mining or demolition purposes may be important with well developed technology. In other countries, dominated by mountainous regions and outcropping rock areas, the tunnelling and the preparation of building sites by the use of explosives is well developed.

EFEE, in its discussions on the national standard of training and training requirements, has had to accept compromises. The EFEE-shotfirer certificate is thus a confirmation of basic competence only and not a detailed verification of the skills of the certificate bearer.

This situation is, in the opinion of the EFEE Shotfirer Committee, not satisfying in view of today's advanced blasting technology. The seriousness and consequences of misuse of explosives in rock blasting or demolition call for better training of personnel.

Better training enhances safety, economy, eases cross border activities, benefits the individual and the society.

EFEE aims for a high quality certificate based on harmonised, comprehensive and well structured training satisfying the EFEE requirements. We believe that such a certificate in due course will be accepted as a confirmation of first class technical competence by the authorities, the insurance companies, the owners and the employers wherever the certified person would work.

## 4. NO CROSS-BORDER DISCRIMINATION IS ACCEPTABLE

In Europe today, contractors and companies may submit tenders for almost any kind of project or supplies. When awarding contracts within the EU, or in countries linked to it, discrimination based on nationality is forbidden.

Commercial activities using explosives still encounter national differences. Contractors are not allowed to use their own shotfirers and staff as responsible individuals while undertaking blasting

operations outside homeland (some exceptions). Shotfirers must frequently pass a local examination and a test as to their competence prior to undertaking blasting operations. We find this so far well justified.

Some ten years ago the shotfirer committee concluded that an all-European EFEE shotfirer certificate should be established. It was also concluded that such certificate in the future had to be a high quality document. The first draft for an 'EFEE training manual' aimed at covering Europe was prepared in 2001. During a three year period this draft was discussed, modified and debated in several meetings until being unanimously adopted in 2004. A similar document covering demolition was adopted in 2006.

The primary objectives of EFEE concern the development of good practise, harmonisation of rules and regulations in Europe for the use of explosives in the civil sector from a technical point of view. The harmonisation of laws and regulations, however, are matters connected to politics and bureaucracy. That part of harmonisation is beyond the EFEE scope of ambitions today.

The EFEE goal of objectives is to further professional competence, to enhance cross-border activities and to ease the exchange of resources between European countries. We look forward to days when certified European shotfirers may operate independently in European countries without additional tests and examinations.

## 5. RISKS INCIDENTS AND FATALITIES

Blasting operations include risk factors. Yesterday, today or tomorrow, risks cannot be ruled out. Fly-rock, vibrations, accidental drilling, overcharging, unexpected geological faults, misunderstandings, mistakes, careless work and more, are risk factors never to forget.

Fly-rock from 100 mm holes has been observed more than 1000 metres away. For tiny charges of 30 mm diameter fly-rocks have been thrown more than 300 metres! When blasting in built-up areas with people, buildings, sensitive infrastructure in the vicinity, it is necessary to use protective coverings such as rubber mats, steel mesh units and tarpaulins. Such means may give false safety impressions. In very few situations security means may compensate for wrongdoings. Cautious planning, precise drilling of the holes, correct charging and ignition, and adequate warning are the ingredients of safe blasting.

The EFEE objectives are that shotfirers from any European country shall have access to the same good quality training.

## 6. THE ESSEEM PROJECT

EFEE appreciates that the development of shotfirer training programs in a European perspective is a challenging project; without financial support it is rather difficult for EFEE to undertake. Partners from the Czech Republic, Germany, Finland, Sweden, Portugal, UK and Norway submitted last year an application for financial support from the European Union through the Leonardo da Vinci program TOI. The application was addressed to SIU, the national programme agent in Norway. The application process is governed by a standard application form requiring detailed information as to plans, partners, budget, economy and output. The grant was confirmed last autumn and a contract signed in November 2008. During the next 24 months the consortium will develop up-to-date material designed to meet the requirements for European Shotfirers, education level 4. Education level 4 means a shotfiring master in a regime of five levels.

The project includes 13 Work Packages, each partner to cover one or two packages. In summary the work packages cover:

- Geology in general (valid for Rock blasting); Minerals and composition of rock materials; Rock properties and their influence on drilling; Rock properties and their influence on blastability
- Drilling methods and commonly used machinery. Tools, drilling rig, drill bits, accurate drilling of the pattern
- Construction materials in general (valid for Demolition). Breakage, fragmentation and direction of the throw
- Explosives and main characteristics (Rock blasting and Demolition)
- Initiation systems, different detonators and their characteristics
- Blasting theory
- Introduction to structural design. (demolition)
- Suitable explosives and detonating systems for bench blasting (Rock blasting)

- Blasting close to existing structures (Rock blasting)
- Safety aspects (Rock blasting and Demolition).
- Commercial aspects Cost estimation (Rock blasting and Demolition)
- The managing of the ESSEEM project.
- Harmonising of the work and the dissemination plan

Dissemination is the key to later use of the output that will be available for all EFEE members.

Project costs are estimated to approx. €350.000. The partners are a blend of expert units, industrial enterprises, science and education. The previous mentioned documents ‘Training requirements...’ are the bases for work packages. The output will serve education, it will not be textbooks. The project language is English, and the project output will be available in English.

Shotfirers are practical people, using trade terms and local expressions, all texts must be translated and adapted. Some 15 versions may be foreseen. This work is not part of the ongoing project, we feel confident resources will be made available in due course, either resources in the various language regions and/or supported through a second stage EU project.

The first partner meeting took place early December 2008 in Berlin. The next meeting is planned for Prague late April 2009. The first conference takes place in Germany (Cologne area) in late November 2009 and the project winding up will be at a second conference in 2010.

The partners are eager to establish close contact with relevant authorities and individuals engaged in the training of staff executing projects based on the use of explosives.

## 7. THE TARGET GROUP IS THE END USERS OF EXPLOSIVES IN THE CIVIL SECTOR

End users as defined by EFEE are individuals or companies using explosives and detonators as part of their activities. Some examples are quarrying, mining for minerals or metals, underground infrastructure, storing facilities for crude oil, refined products or gas, underwater construction, surface blasting for roads, site preparation for industry and much more. Research and exploration are also consuming explosives.

It starts with the planning, purchase and deliveries, through the execution, and ends with reports and payments. This is an important part of the activities in any country, the turnover related to blasting is immense and the number of people involved is very large.

## 8. THE LEVELS OF COMPETENCE – WHAT IS A SHOTFIRER?

EFEE has based its approach to the harmonisation process on observations of the existing situation in the member countries and discussions both in the shotfiring committee and discussions in the twice-annual council meetings.

It seems to be a common understanding of the existence of five levels of competence. The naming of these levels is not easy. EFEE has used the word Shotfirer connected to level 4.

Literally translation to German, French, Spanish, Portuguese, Russian, Czech and Slovakian, Finnish, Slovenian, Bulgarian and three Scandinavian languages is easy. One will find the right word, the content or understanding of inherent qualifications and the hierarchical position, however, is still different:

- A shotfirer in one country may be unskilled; his duty may be limited to the use of matches.
- On the other extreme a shotfirer may be a certified person handling, planning, executing and also being the responsible legal party to bear the blame for any accidents.

In short, the term shotfirer is not established at a defined common competence level in Europe. This is a part of the work that remains to be solved.

From an EFEE point of view the ongoing work is based on the following basic understanding:

- **Beginner.** This is an individual without practical or theoretical training participating in a blast operation. This person may be:
  - a trainee during the two first years of 4 years as apprentice or
  - a student during the first two years of vocational training (VK I/ VK II.)
- **Skilled worker/operator.** This is defined as:
  - an individual having passed the first two years as trainee or

- an individual having passed two years of vocational training now gaining on-the-job experience, still waiting for the testing to obtain his shotfirer certificate.
- **Supervisor** is a journeyman that has obtained his certificate and undertakes blasting operations.
- **Manager** is a master shotfirer that has obtained his certificate and the managerial skills to simultaneously manage several blasting operations. This person has the competence as required in the established ‘EFEE shotfiring requirements’
- **Expert.** This is an individual that has obtained expertise – special knowledge or competence within one or more sectors of blasting. That could be within underground blasting or underwater blasting or the dealing with hot masses or concrete or metals or special demolition or other specialities.

The requirements of shotfirer training established by EFEE give, in some detail, the direction of the training, what must be covered by training manuals and other means. EFEE has the intention to prepare the basis to be used in the various countries for their needs.

We know that we have the competence to do it, we know how we will do it and the consortium has the required resources.

## 9. THE FUTURE

Cross border harmonisation is a time-consuming process. EFEE and ESSEEM want to play a progressive part in this process. There have been some warnings; one should be careful not to overplay, avoid confrontation with domestic bodies, better teaming up. That is appreciated. At the same time we cannot afford to go slow. We feel confident that rules will one day be established by the European authorities. These should be based on competence and nearness to the active blasting life in Europe: in essence, the ESSEEM project partners and the efforts of EFEE.



## Training of Portuguese shotfirers

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**ABSTRACT:** Portuguese shot-firers are licensed by the Guns & Explosive Department of the Police Authority. Licenses are awarded after a qualification method based essentially in an exam regarding legal aspects and safety requirements in explosives use. Knowledge about blasting techniques and the effect produced by different types of explosives are relatively lightly assessed in this exam. Recognizing this lack in the qualification requirements demanded by the Police Authority, both national associations in explosive sector (AP3E and ANIET), in collaboration with ISEP and University of Coimbra developed a training manual for shot-firers. This manual provides an adequate training regarding blasting techniques and explosive products, safety and environmental aspects concerning blasting operations responding to the basic level requirements set by EFEE, being a contribution to shot-firer mobility within European area. This paper presents the steps of this collaboration process and the main subjects of this manual as well the planning of future training courses.

### 1. INTRODUCTION

Similar to other European countries a professional shot-firer in Portugal must have a Shot-firer Certificate issued by Portuguese Police Authority. According to Portuguese requirements, approved by Portuguese law, the candidate must have cumulatively:

- 21 years of age;
- Compulsory schooling;
- No criminal register;

- Be succeeding in a theoretical and practical exam regarding rock blasting activity;
- A valid contract with a company with a license for explosives use issued by the Police Authority.

This theoretical exam has been focused on safety requirements imposed by Portuguese laws for the explosive civil sector. The law nº 364/84, which is the main legislation, is more than 20 years old and covers the follow subjects:

- (A1) – Licensing to manufacture and/or to storage;
- (A2) – Requirements regarding manufacture, storage, trade and use;
- (A3) – Inspection.

Regarding safety rules for the manufacture and storage the Portuguese law n° 139/2002 was revised in 2002 and includes safety distances for the manufacture and storage, specifications about materials and design of storage and manufacture elements, fortifications and safety procedures. The practical exam assesses the skills on explosives handling and blasting procedures. This model to obtain shot-firer certificate has a gap concerning the assessment of knowledge and apprentices regarding the main safety problems about environmental impact, which are the cause of a high number of incidents.

In Portugal there is no vocation training school providing regular courses to offer the knowledge and qualification required to the professionals in this sector. A few short courses on blasting regarding basic concepts for rock blasting in quarry and excavation work has been organised by public universities, private schools and traders. These courses have as their target the supervisors of quarry activity and civil construction. The approval in these courses does not guarantee the Shot-firer Certificate without previous approval in the exam provided by the Police Authority or the Ministry of Economy and Innovation. The apprenticeship of candidates for the shot-firer exam is carried out in the workplace under the supervision of a qualified shot-firer. This formula requests a previous contract of individual with the company. This previous training is basically conducted to apprenticeship concerning loading and feeding arrangement for explosive charge, connections of initiation devices and use of instruments to check circuits, highlighting for safety requirements imposed in the legislation. Generally this sort of training does not provide relevance to the characteristics of several explosives and initiation devices, as well to blasting phenomena, rock characteristics and propagation of detonation shock wave and rock behaviour. The relationship between blasting results and the effects of rock characteristics and drilling quality is not understood by a large number of candidates during this stage of training. Furthermore the knowledge regarding the risks connected to bad practises and unfavourable

conditions to performing explosive blasting is as well poor. The different safety procedures to reduce the risks linked to blasting and its effects become largely dependent on the blasting activity of the company where the candidate carries out there apprentice. The major causes of incidents related to explosives in Portugal are breaches of blast exclusion areas, flyrock and misfires. Inadequate procedures concerning safety, deficient planning of work and bad evaluation of geological characteristics during the drilling process are the most common contributing factors.

Supported by the basic requirement approved two years ago by EFEE for European Shot-firing Certificate concerning rock blasting, both national associations, the Portuguese Association of Studies and Explosive Engineering (AP3E) representing engineers, manufactures and end-users, and member of EFEE; and the National Association of Extractive and Transformer Industry representing quarries, mines and ornamental stones manufactures join their experiences to build training courses and a manual following the requirements established by EFEE. EFEE requirements were established with the purpose of assisting the national authorities with a European standard to support the recognition of competences of shot-firers in Europe improving mobility. The prime objective of these courses is to improve the knowledge and qualifications of shot-firers in Portugal based on a complete and attractive manual and a team of teachers and experts with large experience in the explosive sector with specific skills in blasting. The second objective is to obtain the acceptance and recognition of these courses by the National Authority. Third is to spreading them to cover all parts of the country.

In the current global marketplace more Portuguese companies are extending their activities to other countries and more foreign companies are expanding their activities in Portugal. In some sectors the Portuguese authorities have been recognising the qualifications and competences of these professionals with success, despite the resistance often imposed by professional societies.

## 2. PROTOCOL BETWEEN THE ASSOCIATIONS AND THE NATIONAL AUTHORITY

The Protocol established between AP3E and ANIET and the Police Authority has as a major

objective the construction of vocational education training for professionals of explosive sector providing the qualifications and skills of individuals to use explosives in civil construction according the standard approved by EFEE. These vocational courses aim to provide delegates with the theoretical knowledge and practical ability to succeed in the exam approved by the Police Authority. Theoretical and practical lessons are performed with a mix of university teachers and experts with large experience in rock blasting, excavation and civil construction using explosives. The exam is proposed or approved by the Police Authority, which can also conduct or supervise it in the locality where the courses are held. Success in the exam results in the issue of a National Shot-firer Certificate by the Police Authority. Moreover this Protocol the candidates proposed by quarries can opt for the exam in their workplace performed by the Ministry of Economy and Innovation, nevertheless a long period of time from the demand to the date of exam is required. This Protocol does not impede candidates to be submitted to the exam proposed by Police Authority without previous vocational education courses built by both associations. This means that other paths to acquire knowledge and qualification in order to be succeeded in the exam are possible.

### 3. VOCATIONAL TRAINING COURSES

#### *3.1 Methodology adopted to organise didactic material*

The organisation and contents of didactic support material was a dilemma. Although the goal is the model approved by EFEE it was clear for us the relatively poor knowledge of candidates regarding the geomechanical phenomena and the technologies used for blasting operations. In fact the compulsory school required for all candidates to shot-firer Certificate does not offer the knowledge and qualifications required on geology, rock characteristics or civil construction that a European shot-firer must demonstrate. Compulsory school can be reached following different approaches and the higher part of paths does not include these subjects. Another dilemma was regarding the addition of legislation in the manual. The legislation is of major importance and provides the guidelines for the shot-firer to carry out their work with full regard to the law. Although the Portuguese laws that govern the explosive civil sector are relatively old there is a

high probability of these laws may be modified. To support this prediction is the recent nomination of a Group of Experts with members of AP3E, ANIET, pyrotechnic associations and members of police authorities and industry by legal order of the Minister of Internal Affairs with the purpose to identify the gaps and difficulties in the explosive sector and to suggest reforms in the short and medium term. The inclusion of legislation in the manual for shot-firing Certificate imposes an immediate revision every time laws change or a new ones appear. Although there is continuous improvement of technological tools the basic knowledge stays the same and the requirement to update the manual is less. Attending to the people involved in blasting in civil construction, mines and quarries it was firstly intended to produce two manuals: one with basic requirements for the shot-firing certificate and another one more suitable for supervisors. In order to avoid gaps and minus approach to EFEE basic requirements the preference was the construction of a complete manual. The manual should be simple to read and easy to understand, with several pictures and schemes to support the text and with specific signals about obligations, recommendations, dangers and procedures to avoid. Five signals were selected: definition, recommendation and obligation, risks scenarios and forbidden, general rules, laws.

#### *3.2 Contents of manual and competences criteria*

The manual is organised in 9 chapters: 1-Geology, 2-Drilling, 3-Explosives and initiation devices, 4-Blasting design, 5-Explosive handling and blasting procedures, 6-Environmental impacts, 7-Safety procedures, 8-Legislation and 9-Glossary. Table 1 shows the knowledge and basic competences to achieve in each subject of this manual.

#### *3.3 Theoretical and practical training*

The course is planned for 30 hours of theoretical knowledge and 6 hours of practice in the workplace. Each theoretical lesson has 6 hours duration and transmission of knowledge is supported by slides, PowerPoint presentation, videos and demonstration of tools & instruments used in blasting process control. Practical lesson is conducted in the workplace by a shot-firer with a maximum of 10 persons. Each applicant is pushed to carry out all steps of a typical blasting operation. Special attention is paid to misfires,

Table 1. Contents of manual and competences to achieve.

<i>Contents</i>	<i>Knowledge</i>	<i>Competencies criteria</i>
Geology	Type of rocks, characteristics and properties, influence of rock characteristics on economical results of blasting and risks scenarios.	Identify risk scenarios, use blast results to improve blasting design, adopt blast design according geological characteristics of the area.
Drilling	Methods of drilling and process. Drilling deviation, penetration rate and drilling capacity.	Be able to select the proper drill pattern, depth and inclination of the holes, to judge back breakage, risks of flyrock and fragmentation distribution.
Explosives and initiation devices	Properties and characteristics of different types of explosives and types of initiation devices. Type and use of measuring tools instruments.	Be able to select the composition and amount of explosives to be used according the characteristics of the rocks or other materials and the safety area. Be able to select initiation systems according atmospheric conditions and environment constraints.
Blasting design	Understand blasting wave propagation and interaction with rock and fragment phenomena. Identify the particular parameters related to underwater and tunnelling design.	Be able to use design parameters to achieve blasting objectives without to produce uncontrolled risks and with an adequate cost.
Explosive handling and blasting procedures	Different loading methods according the different explosives. Characteristics and use of manual and mechanical charging equipment.	Be able to adopt loading method to the quality of the holes and the area. Be able to connect the charged holes, using electrical or non electrical initiation systems, identify current leakage danger. Adopt safety procedures.
Environmental impacts	Understand vibration, air blast, noise and dust phenomena associated to blasting.	Be able to identify potential risks and adopt mitigation procedures and evaluate impact results.
Safety procedures	Identify correct procedures and proactive safety attitudes.	Adopt usually safety procedures and be able to cancel blasting when risks cannot be controlled.
Legislation	Storage, manufacturing in situ, explosive handling, safety distances, explosive disposal.	Adopt the best practices according the legislation requirement.
Glossary	Understand means of different terms used in blasting sector	Adopt the correct technical vocabulary for orders transmission.

flyrock and vibrations. The applicant is impelled to analyse the blasting results and to discuss hypothetical scenarios.

#### *3.4 Test and assessment through on-job-observation*

Testing of knowledge and assessment in the work situation is carried out under the supervision of the Police Authority. Assessment of knowledge is based on a written examination with several questions regarding all the contents of the manual. Assessment of ability to conduct blasting in workplace is carried out in the same place of practical lesson or a similar. The approval in the exam is the first requirement to obtain Shot-firer Certificate. In addition the candidate must present a valid contract with a company in the blasting sector and demonstrate their knowledge and practice of ethical values.

#### 4. CONCLUSIONS

Despite no accidents in recent years in Portugal the vocational education training of shot-firers is essential to assure the knowledge for a shot-firer accords with the basic requirements approved by EFEE. In order to achieve this goal the Portuguese associations in the explosive sector established a collaboration with the University of Coimbra and ISEP and celebrated a protocol with the Police Authority to develop a manual and organise vocational training courses to improve the qualification of shot-firers and to contribute to the greater international mobility of shot-firers.

