

Vocational training for Personnel in the Swedish Explosives Sector

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Abstract

Since the time of Alfred Nobel the explosives sector has worked systematically to create and maintain a safe and efficient industry. A rapidly changing world however put new issues on the agenda. A new branch, Demilitarisation of old ammunition for example claims not only written technical information as drawings and specifications, but also lots of unwritten experiences and knowledge, which must be handed over to new generations as long as the ammunition is in stock. At the same time new explosives and products are introduced for production.

Accidents with Explosives 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 production and 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 the necessary competencies, skills and training of the people concerned.

This paper describes some of milestones passed in the Swedish explosives sector during the earlier Millennium. It will also describe initiatives being taken in Sweden and also the Leonardo da Vinci programme of the European Union to ensure that workers at all levels in the explosives community in the EU have the skills and competencies required to safely sustain activities involving explosives. It will describe the development and evolution of a range of explosives competencies and the training and qualifications framework being developed to generate and maintain the competencies.

Finally, the novel Swedish distance learning model for vocational education in the explosives industry which is designed and built on modern technology and active search for knowledge will be presented.

The historical background for Explosives in Sweden

Explosives, like black powder, were discovered accidentally in all probability by a Chinese alchemist some time during the Han-period in China. Black powder reached Sweden around the fifteenth century, but it was not before the end of the nineteenth century, when Industries manufacturing explosives, among others, expanded at a rapid rate. In the Energetic sector two inventors Alfred Nobel and Erik Gustav Pasch must be remembered. The Safety Match was patented 30 October 1844 in Sweden by Gustav Erik Pasch and the Mercury fulminate based Detonator (1864) and Dynamite (1867) was patented by Alfred Nobel thus creating Industrial Imperials.

A number of accidents in the growing industrial sector induced a reaction from the state and protective measures against occupational hazards were ordained by law. In 1889 three inspectors of factories were appointed by the Government and Six years later (1895) a further number of three inspectors were nominated, among which one was appointed as a temporary inspector of the manufacturing of explosives in the country. This appointment was the beginning of the Swedish Inspectorate of Explosives.

In year 1897 a new authority was formed, the Inspectorate of Explosives, as a subsidiary to the Swedish Board of Commerce. The Inspectorate changed name in 1920 to the Inspectorate of Explosives and Flammables. The Inspectorate's task was in main to ensure that the regulations for explosives were being followed. In connection with a new Ordinance in 1921 the field of the Inspectorate's work came that year to include flammable oils as well.

During the years of 1973-1981 the Inspectorate was subsidiary to the National Board of Industries. On the 1st of July 1981 the National Inspectorate of Explosives and Flammables (NIEF) became a central administrative authority for questions dealing with explosives and flammables. 1st July 1989 a new Act on Explosives and Flammables came into force. The Act is valid for civilian and military activities. The Inspectorate expanded, reorganised and moved to new premises that same year. NIEF not only supervises and inspects, authorizes explosives as well as issues licenses to manufacture the explosives, but also issues regulations and recommendations that govern the implementation of the Act. From the 1st of October 2001 NIEF was merged with a much larger organization, the National Fire Rescue Service.

Achievements during the seventies and eighties

Education and research soon divided into Civilian Explosives sector much driven by Sweden's mining and rock industry respectively the defence industry sector. Both Sectors were very successful on the Global arena. Much of the education and research was made inside the companies.

In the late seventies the Swedish explosives industry was in a situation of alternation of generations. Most of the management with long experience retired and the new had a lot of competence in economy, marketing and management but not so much in the area of handling explosives. 1978 persons responsible for safety in the Explosives industry invited the main actors in the Explosives Sector to a workshop on the area of how to co-operate in The Field of Explosives Safety and how to transfer knowledge and competence from old experienced personnel to new generations.

As a result of the discussions a new training and education concept was formed, the FEX Management education. The concept was developed by a working group with people from the explosives industry and the Inspectorate of Explosives and Flammables. The first FEX course was held in 1980. After some years the course had such a good reputation that people from other Nordic countries (Norway, Finland and Denmark) wanted to participate. The first Norwegian and Finn attended the course in 1984.

FEX is a unique workplace based management training and education concept where the Industry and governmental bodies take active part during the 5 weeks spread out during a year are hosted by Industry and research centres in Scandinavia.

The course activities are governed by the FEX Steering committee. The Steering committee, who constantly is renewing the concept, is formed from a number of experts with long experience from explosives handling and a personal interest and dedication to avoid accidents and decline of competence in the Explosives Sector. The Steering committee has members from the explosives industry, research centres and authorities.

The FEX concept now is working towards its 25 years Anniversary 2005 and has grown and incorporates today other training, education and seminars as FEX, ALLEX, SOEX, FLEX and EPOK, see Annex 1.

Results

What were the results of the efforts to improve the competency by a comprehensive training and education program? This is of course impossible to give an exact statement about because you do not what had happened if you had not made those efforts. But it is clear that safety again was an important point on the agenda for the top management. Had it not been that before? The discussions during the seventies and the eighties indicated that the top management naturally realised the importance of safety but they did not focus on it. The top management took it for granted that safety was taken care of in a proper way on a lower level.

Also if you study the number of fatalities in the Swedish explosives industry there is a clear indication that the training programmes improved safety, table 1.

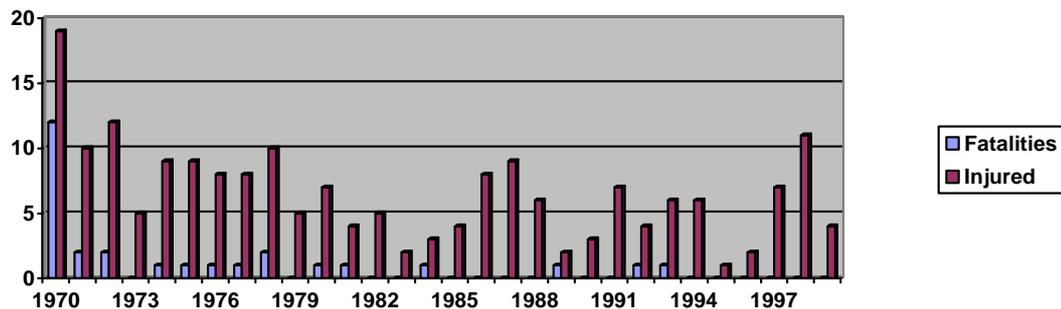


Table 1. Number of fatalities in the Swedish Explosives industry from 1970-99

As you can see the number of fatalities is low. But the trend is very clear. The picture for the number of injured does not show the same clear trend. But you have to bare in mind that reporting of accidents and incident improved a lot from 1970 to 1999. During the nineties a number of explosive industries also improved their system for reporting of near-accidents.

Development during the last fifteen years

Since the beginning of the nineties the explosives industry and the military force in Sweden has undergone substantial changes. The numbers of employees have been reduced, in some case with more than 75 %. Some companies have merged and got new owners. Other companies have been divided into a number of smaller companies and merged with other Swedish or foreign companies. This has lead to a fragmented Swedish Explosives industry, dispersion of technologies and difficulties to keep wide reaching resources. Due to this downsizing of the explosives industry many experienced people have left the industry, others

have retired or are close to retirement. The picture in some other countries in Europe is similar.

We have also noted that explosive 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 material value, production resources and capability. 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 the necessary competence, skills and training of the people concerned.

A pilot project

There is a great need for qualified people in today's explosives industry. As already mentioned a great number of people with substantial competence have retired or been traded to other industries during the downsizing that has affected the explosives industry in recent years. In order to break this negative trend, an educational programme has been envisaged and put together, and tested at Nammo Vingåkersverken at Vingåker, Sweden. The Swedish explosives industry is geographically widespread and located outside the large town areas, so a necessity for this kind of education is modern Information Technology, IT.

Therefore, in the newspaper advertisements about this education opportunity it was made clear that the Nammo Company was searching for people with modern IT knowledge and experience. Among more than a hundred applicants, only fifteen were selected; six came from the Nammo Company and nine from outside. An important issue was that the students should represent different backgrounds and ages. A fundamental principle of the education was that it should be a well-amalgamated combination of theoretical study and practical training. The knowledge needed in the industry changes all the time and it is therefore necessary to pursue the studies in the same industrial environment where the acquired knowledge should be put into practice later.

One of the goals of the education strategy was to create a starting point for "A life-long learning situation at the factory". Because of the need for specific industry-related knowledge, a great part of the education had to be compulsory and related to the special demands on knowledge and competence required at Vingåkersverken. The voluntary part of the education was entirely chosen by the students themselves. There were a number of theoretical subjects, which the students could choose from. An important issue was that every student should have something to do all the time; for example, a student who worked faster with the compulsory part could manage to do more voluntary courses.

The courses the students took were equivalent to an upper secondary school level. The students received upper secondary school grades after each completed course. The learning process in the production was called PLIP – Practical Learning in Production. In the production, the students could apply the theoretical knowledge they had acquired at the learning centre. The students were studying theory in the mornings and then practice in the afternoons. It was popular among the students to have it that way, and it turned out to demonstrate the strength of this kind of education compared to old school models.

The learning centre, as the classroom was called, contained all kinds of IT equipment. For example, access to the Internet, a videoconference facility, video and live TV-picture, and Conference telephones. The teachers in every subject were accessible on the Internet or over the videoconferences system, but at the start of a course the teacher appeared personally at the learning centre. Here he introduced the subject and held the first lesson. In this way good personal contact was established and then maintained when the students met the teacher on the TV or Internet.

New Opportunities through New Technology

These days' technological capabilities exist for flexible forms of training. New technology is continually developing and thereby provides an increasingly improved training environment. Thanks to computer communications and multimedia, skills formation can be successfully undertaken directly at the workplace. The tried and tested ways of training through distance methods are thus easily adaptable in a new setting.

In this way organisations can benefit from training programmes that are relevant for organisational and individual development. This also provides continuity in the permanently necessary and increasingly important role of skills formation in working life. This way of working will become a significant element of **life-long learning**.

Implementing Training at the Workplace

The flexibility in the model of training at the workplace not only implies greater freedom in time and space but also in terms of training levels, content and arrangements.

Flexible working can imply either more or fewer elements of the contemporary methods available for distance learning.

The training takes place directly at the workplace or in close proximity to it. The method also implies that theoretical training can be acquired directly by learning through practical work. Most training is thus undertaken directly at the workplace supported by some form of computer communication combined with tutoring in situ. The trainers, engaged through a Learning centre, impart knowledge, instruct, and support with the help of various methods. They communicate over distances or through 'local meetings' and are thus in effect 'permanently accessible'. A local tutor is also selected as a contact person for the training programme.

Workplace-based training involves the active quest for knowledge as a way of working. It also has many requirements beyond the important activity of student tutoring. This way of working also needs access to various databases. These 'knowledge banks' can, for example, be materials accessible via the Internet. This is a fantastic instrument that, if used properly, is a really effective tool for active knowledge searches.

Naturally, the knowledge banks can also consist of encyclopaedias and other information sources that are also in the form of multimedia or books and newspapers.

Mini-learning Centres and Equipment

A small training building or designated room serves as a meeting point for those undertaking the workplace training. We call this a mini-learning centre. It is equipped with computers and the equipment required for communication. Laptop computers are particularly useful to enable the greatest possible mobility. At the current time this does not involve any major investment.

This meeting point is important for the training participants. They can walk from their workplace and work on training projects either themselves or together with their group. It is also possible to connect to the Internet in the mini-Learning centre.

The modern industry operator handling of explosives

Now, in the beginning of the 21st century, the organisation of the explosives industry is rapidly changing. Process-orientated, target-focused operators using standardised systems such as ISO or OSHA take many new roles in flexible, modern workplaces with flat organisation. Computers and industrial robots are constantly replacing white- and blue-collar employees. The new global market means that new ways for communication are necessary. Information is gleaned from the Internet and from large open or restricted databases.

PC terminals or hand-held terminals are spreading new information all over the factory areas. Organisations have to accept a new situation, and see that continuous training of its personnel is taking place in order to meet new market situations. Inarguably, the search for excellence in Safety is the most fundamental aspect for the explosives industry. Well-educated and experienced personnel on all levels are the fundament upon which a safe industry will meet the 21st century.

Career counselling guidance for all personnel is a tool that can be used to meet the need for attractive working positions.

The World has changed dramatically since the end of the Cold War. We now have a new situation where handling of explosive materials also means demilitarisation. Environmental aspects are focused in a new manner. The new Swedish education programme includes at the moment courses as below. The process of development of new courses and material specially designated for distance education continues. A specification of what material that will be used in the course starting now is found in Annex 2.

EUExcert a trans-national European co-operation

Founded upon the experiences gained in Sweden, KCEM was actively searching for transnational partnerships. At the DoD Explosives Safety Seminar, Atlanta, August 2002 we presented the situation in Sweden and announced our interest in finding partners for co-operation. In June 2003 the EUExcert pilot project was formed with partners from Finland, Italy, Norway, Sweden and UK.

There is a perception and some evidence that in Europe competence in this key technological area is being eroded. In several member nations a high proportion of the most experienced and knowledgeable personnel are retiring or nearing retirement. Urgent efforts are therefore underway in some partner nations to replenish this expertise.

The aim of this pilot project is to establish a training and education programme aimed at restoring and maintaining the competence of workers engaged in European explosive business. The programme places increased emphasis on improving the quality of the educational material and in improving access to training through use of workplace and e-learning. Improvement in competence and skills will enhance the status of explosives workers, improve worker and public safety and improve European industrial competitiveness through greater worker mobility and the ability to react rapidly to a fast changing economic and industrial environment.

To achieve this aim the partners in the programme will conduct a comprehensive analysis of explosive business conducted throughout the EU. It will identify for each member state, the size and scope of the explosives worker community, from top management level, to technician and process worker level. It will identify the competencies and skills required by these workers, in order to successfully prosecute the full scope of explosives business. This

will be accomplished through close consultation with stakeholder organisations in each of the member nations. An inclusive framework illustrating all of the required competencies will be established.

The training and educational needs of the community of explosive workers will then be determined in relation to the required competencies. A comprehensive programme of education and training will be developed utilising the widest range of training and educational methods, ranging from traditional classroom-based teaching, workplace Learning and electronic Learning. These will be developed and delivered by a range of educational establishments, including universities and higher education institutions, professional bodies, trade union organisations and specialist further educational authorities. Pilot training and education programmes will be developed and tested in several member nations. Proposals will be presented outlining the need for a range of transferable qualifications for workers in this specialist field.

The results of the work will be widely disseminated through a programme of reports, demonstrations and presentations to stakeholder groups in the member nations. A network of interested individuals and organisations will be encouraged to promote the concept of a world class European explosives community.

More information about the project and its progress can be found on www.euexcercise.org.

Future development

EUExcercise will provide a comprehensive competency framework, a training and education programme which will identify the curriculum of subjects, topics and knowledge necessary to generate and develop the competencies. Based on this it is necessary to develop training and education material. The material must be modular built so a good flexibility can be achieved. It must also be adapted for personnel at all levels and educational background.

Training and education material is expensive to produce. Therefore it necessary to produce the material in a languages understood by many people for example English and in co-operation with partners from a number of countries.

References

1. Wallin H. EUExcercise a European pilot project within the Leonardo da Vinci programme for Developing and Maintaining Skills and Competencies among Personnel in the European Explosives Sector, Third International Disposal Conference, Karlskoga, Sweden, 2003
2. Wallace I.G. Educating the Next Generation of Explosives Specialists
3. Randle H. Conditions for lifelong learning – flexibility to promote learning and education

FEX

Main purpose of the course is to give the attendants the fundamental knowledge necessary in key objectives in the field of explosives. The course shall also provide possibilities for building up a contact network for exchange of experience in safety matters.

Main objectives in the course are.

- ❑ **Strengthen awareness about tasks and responsibility**
- ❑ **Gain knowledge of the legislation in the field of Explosives**
- ❑ **Increase knowledge in science of Explosives**
- ❑ **Initiate exchange of professional experiences in the branch**
- ❑ **Increase knowledge of safety principals and codes of good practise**
- ❑ **Gain knowledge of psycho-social environmental issues**
- ❑ **Activate creative processes according new thinking in the field of plant design, organisation development and production planning.**
- ❑ **Maintain continuous work for prevention and control of risk's**
- ❑ **Initiate training of employees in safe handling of explosives**

The course contents the following subjects:

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| ❑ Managing Risks | ❑ Static Electricity |
| ❑ Delegation | ❑ General Safety Principals |
| ❑ Juridical Responsibility | ❑ Fire Protection/ Sprinkler Systems |
| ❑ Contact with Legal Authorities | ❑ Demonstration of effects of different explosives in various situations |
| ❑ Contact with Media | ❑ Buildings in Explosive Plants |
| ❑ Legislation in the fields of Explosives | |
| ❑ Human Factor | ❑ Risk Identification |
| ❑ Communication | ❑ Risk Analysis |
| ❑ Case Histories of Accidents | ❑ Consequence Analysis |
| ❑ Crisis psychiatric | ❑ Risk Estimation |
| ❑ Methods of Accident Investigation | |
| ❑ Science of Explosives | ❑ Study Visits |
| ❑ Testing Methods | ❑ Project Studies |
| ❑ Destruction of Ammunition and Explosives | |

ALLEX

ALLEX is a four weeks long course with focus on the lower management such as foremen, constructors, process engineers, quality technicians and persons active in the field of testing.

Main purpose of the course is to give the attendants the general knowledge necessary in key objectives in the field of safety of explosives. The course shall also provide possibilities for building up a contact network for exchange of experience in safety matters.

Main objectives in the course are.

- ❑ **Gain knowledge of the legislation in the fields of Explosives**
- ❑ **Gain general knowledge in science of Explosives**
- ❑ **Increase knowledge of safety principals**
- ❑ **Gain knowledge about risk analysis and consequence analysis**
- ❑ **Gain knowledge about static electricity and electrical installations**
- ❑ **Give deeper knowledge in the participants own scope of work**

The course contents following subjects:

- | | |
|---|--|
| ❑ Legislation in the fields of Explosives | ❑ Demonstration of effects of different explosives in various situations |
| ❑ Internal control | ❑ Buildings in Explosive Plants |
| ❑ Electrical installations | |
| ❑ Human Factor | ❑ Risk Identification |
| ❑ Case Histories of Accidents | ❑ Risk Analysis |
| | ❑ Consequence Analysis |
| ❑ Science of Explosives | ❑ Risk Estimation |
| ❑ Static Electricity | |
| ❑ General Safety Principals | ❑ Study Visits |
| ❑ Fire Protection/ Sprinkler Systems | ❑ Project Studies |
| ❑ Maintenance | |

SOEX

SOEX is a two weeks long course for safety representatives.

Main purpose of the course is to give the attendants the general knowledge necessary in key objectives in the field of safety of explosives. The course shall also provide possibilities for building up a contact network for exchange of experience in safety matters

Main objectives in the course are.

- ❑ **Strengthen the knowledge of the legislation in the field of Explosives**
- ❑ **Increase knowledge in science of Explosives**
- ❑ **Give a general understanding of risk analysis**
- ❑ **Gain knowledge about human behaviour**
- ❑ **Gain general knowledge about maintenance and disposal of explosives**
- ❑ **Gain basic knowledge about crisis management**

The course contents the following subjects:

- | | |
|---|--|
| ❑ Legislation in the fields of Explosives | ❑ Science of Explosives |
| | ❑ Maintenance |
| ❑ Human Factor | ❑ Disposal of explosives |
| ❑ Crisis management | |
| ❑ Case Histories of Accidents | ❑ Near- accident reports and correcting measures |
| ❑ Risk Analysis | |
| ❑ Risk Estimation | ❑ Study Visits |

FLEX

FLEX is a one day seminar for top management.

The main purposes are to discuss general policy questions and to involve the top management in the development of the FEX concept.

The seminars deals with burning topics such as the legal responsibility of the top management, the significance of the top management for safety, humans and their reaction in organizations which constantly changes and how to build in a safety culture.

EPOK

EPOK is a 24-hour seminar for people who have attended FEX, ALLEX, SOEX or FLEX. The seminar is arranged once a year by the attendances from the latest FEX course. The seminar deals with burning questions such as

- human behaviour,
- automatization,
- humans and their reaction in organizations which constantly changes,
- how to build in a safety culture and
- terrorism.

COURSE CONTENT

A specification of the mandatory courses in the Swedish vocational training and education for operators in the explosives industry.

Vocational adapted course in technique and science	2 weeks
Technical English	2 weeks
Report writing and Presentation technique	1 week
PC basic and the Computer as a tool for development	1 week
Quality standards ISO 9000 and Environment ISO 14000	2 week
Group development	1 week
Explosive materials, basic	3 weeks
Flammable materials	4 weeks
Working systematically with HMS	2 week
Dangerous Goods (ADR)	1 week
Production Economy	2 weeks
Company support system for material and planning	1 week
Emergency awareness	1 week
Deviation and Risk management	2 weeks
Project work	2 weeks
Training in production/practical studies	13 weeks

Totally 40 weeks