

## **NEW EDUCATIONAL PACKAGE FOR FLAMMABLE MATERIALS**

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### **ABSTRACT**

To avoid accidents it is important to understand the properties of handled materials and also to understand the basic phenomena involved in their normal reactions. It is not always safe to rely only on written instructions and rules. Sooner or later you will meet situations where there are no written rules – you may then act according to instinct or knowledge. Here we believe that knowledge is the prime basis.

At FOI, the Swedish Defence Research Agency, there was an early agreement that safety was promoted by knowledge and that all personnel should have a good basic education on explosives and explosives effects before they were allowed to work with explosives. A course was created which has been successively improved and extended, and has now been run for more than 30 years by FOI. Employees from the Scandinavian explosives manufacturers and from governmental institutions also attend the course today. This education is available on CD-ROM.

People working with research and manufacture of explosives also use chemicals. Many chemicals are combustible and highly reactive and may cause fire and explosion. Therefore a basic course on fire and flammable materials should be the next logical step to promote safety, not only for the explosives industry but also for the chemical industry.

### **PERSPECTIVE FOR THE NEW COURSE**

Companies are not so likely to send personnel to courses any more; down-sizing has made them short of people. They want the working teams to be available at the site, not being away on courses.

A realistic possibility is to make the education accessible on demand on the sites and at home through Internet.

Education involves teachers. The role of the teacher is twofold: to help the students (answer questions) and to make sure that they have understood (examination). It is not necessary that the teacher be present in the same room as the student, but it is important that he or she can be reached within a reasonable time, say within 24 hours.

People reading this course will have different backgrounds and experiences and will be of different ages. Therefore it is important to start from a very basic level and include facts on, *e.g.*, units. Also, handling the computers should be easy.

To maximize learning efficiency a combination of text, sound and exercises should be available. This means that multi-media computers would have to be used.

The course should focus primarily on science rather than on regulations. Of course, laws and regulations are necessary to know, but it is better to start with science and follow up with regulations. Doing it that way we will understand more and therefore be motivated to follow the regulations.

### **THE PEDAGOGICAL IDEA**

To describe Flammable Materials we will have to specify what happens in a flame, show how to recognize the various substances, to define what energy is, and show how heat is measured, to show what combustion products are formed, and finally to deduce what the hazards can be from all these facts.

We have seen from the course on explosives that chemistry provides an easy way to understanding, provided it is limited to and focused on the actual problem. Here we introduce only a few of the 92 elements found in nature: C, H, N, O, S, Cl, and some metals. We show how compounds are built from the elements, what empirical formulas mean, and which stable combustion products must be formed from a given substance. For heat of combustion we examine the empirical formula and can then estimate an approximate value.

Combustion is defined as a reaction between gases: oxygen from the air and a combustible gas, combustible vapour or a combustible pyrolysis gas. The conditions for combustion are described, and so are ignition energies and ignition sources.

The hazards described are heat and heat radiation effects and toxic effects of the combustion products.

Prevention and fire fighting are the last elements in the course and are described in the terms learned in the first parts.

### **PART I: PHENOMENA**

This part of the course deals with basic chemistry and physics and has 5 chapters:

- Fire – a chemical reaction
- Ignition
- Energy and power
- Combustion products
- Hazards associated with flammable substances

After each chapter there is a quick test (20 questions with 4-5 answer options) to check the present knowledge. It may be repeated as many times as wanted. To go on it is recommended that more than 17 questions should have been answered correctly.

There are also two questions for each chapter these must be answered in writing. This is done *via* the built-in mail system. These two questions must be answered correctly for each chapter to get an examination.

In this part of the course there are six “lab exercises”. Here the student can do exercises on chemical formulas and energy units and perform experiments to determine explosion limits and ignition energies, flash points and heats of combustion.

### **PART 2: FLAMMABLE SUBSTANCES**

This part of the course describes flammable substances sorted according to the transport regulations and has the following 5 chapters:

- Flammable gases
- Flammable liquids
- Flammable solids
- Substances liable to spontaneous combustion
- Substances which give off flammable gases on contact with water

The chapters are ended with quick tests and written exercises and some include “lab exercises” as in Part 1.

Three “lab exercises” are included. They deal with combustion data for flammable gases and metal powders and exercises on chemical formulas.

### **PART 3: FIRE PROTECTION**

In the last part of the course there are the following 5 chapters:

- Fire indoors as a scenario
- Storage and transportation
- Fire fighting
- Prevention of fires
- Detectors

The first chapter is more or less a summing up of what has been taught in the first two parts of the course, and is focused on a person inside a room that is burning. The impact of heat, concentration of toxic combustion products, and low oxygen concentration on man is described. We added this chapter because we realised that ordinary people do not have the insight into the dangers of trying to enter a room that is on fire, unprotected, to rescue other people or to fetch their belongings.

The chapters are ended with quick tests and written exercises and some include “lab exercises” as in part 1.

“Lab exercises” in this part are calculations of fire load index, total combustion energy divided by total cooling area of the room (floor + walls + ceiling).

### **TEST COURSES**

When chapters 1 and 2 of the course were produced these parts were evaluated by a group of people from the Swedish explosives and chemical industry. They liked the course and found it easy to use and understand. A few had trouble in getting access to the server used by the course through their company firewalls and had to use computers at home.

A reference group with members from the trade unions, the Inspectorate of explosives, the explosives industry and chemical industry monitored the production of the course. They considered the members of the test course to be too well educated (some were engineers) and decided that another test course should be run for “ordinary people” when all chapters were ready.

The full course was tested on a small group of “ordinary people”, some were unemployed. They all finished the course and got their examination. They used more time for it than the first test course, but not more than the nominal recommended time of 150 hours. They all liked the course and were active in communication with the teacher. The need for a teacher was obvious.

### **COURSE STATUS TODAY**

The course has been approved by the reference group and was ready for production in June 2002. The first full course for production people was run in late 2002 with graduation in March 2003. Excellent results were recorded.

The course is in Swedish. Translation to other languages can be made. For information, contact Prevent, P. O. Box 20133, S-104 60 Stockholm, Sweden. Email address: [info@prevent.se](mailto:info@prevent.se).