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INTERACTIVE COMPUTERIZED BASED TRAINING, IN RADIATION PROTECTION AT NRC-NEGEV

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1. INTRODUCTION.

According to the rules of safety at the working places in Israel (1), all radiation employees in Israel should receive once a year a refreshing course in several areas of safety. At the NRC-Negev there are two kinds of radiation employees: the "hot area" employees, who work in an environment of radioactive materials or radiation machines and the "cold area" employees (all the other employees in the NRC-Negev).

One of the main goals of the Department of Human Resources Development and Training at the NRC-Negev was to organize safety refresher courses. All "hot area" employees received a training program of two days in safety subjects, each year. The "cold area" employees received the same course, each second year. The former training program included several lectures in radiation protection, health physics, biological effects of ionizing radiation, etc., as well as some lectures in industrial safety, first aid, fire fighting, emergency procedures, etc. The safety refresher courses were given by frontal lectures. There were a lot of disadvantages in these frontal lectures: The lecturers are employees of the NRCN who had to stop their routine work in order to lecture; the lecturers had to carry out identical training for each course for a large group of workers; there was a lack of testing methods or any other certification for the employees.

Recently, seven safety courseware were developed by the NRC-Negev and the CET (Centre for Educational Technology), in order to perform these safety refresher courses. The courseware are based on an interactive computerized training including tutorials and quiz. The tutorial is an interactive course in each subject. The employee gets a simple and clear explanation (including pictures). After each tutorial there is a quiz which includes 7 American style questions. The first two courseware are for all the employees, the next 4 courseware for the "hot area" employees, and the seventh for the "cold area" employees (the seventh is a short summary of the last 4). Thus, the "hot area" employees have to perform 6 courseware (and 6 quiz) and the "cold area" employees have 3.

In this paper we will present the methods used to develop and produce this radiation protection courseware at the NRC-Negev.

2. THE METHOD OF COURSEWARE PREPARATION

The courseware were prepared by a collaboration between the division of safety in the

NRC-Negev responsible for the professional backup, and the Centre for Educational Technology (CET) – to implement the computer software. The basic principles are:

A-1. The refreshing course is intended for all the spectrum of education (from scientists to service employees), therefore the courseware have to be simple, but with high accuracy.

A-2. The trainee can pass several times the tutorial (or part of it); on the other side, if he is familiar with the tutorial, he can pass only the quiz.

A-3. In almost each chapter of the tutorials there is a detailed knowledge (called “enlargement”). The trainee can study this part of the tutorial, if he is interested in it.

A-4. The verbal presentation is performed by a professional actor (Hanan Goldblat) – not by a scientist.

A-5. All the animations, video films and photo stills are simple and understandable.

A-6. Each courseware has a “reservoir” of at least 20 American style questions, for the quiz, which are covering all the subjects of the courseware.

The following steps were performed:

- A. Assign the subject leaders (administrative organizer of the project, professional coordinator, specialists for each courseware and computer experts from the CET).
- B. Determine the frame of the project, prepare training program which include all the aspects of radiation protection and health physics, needed for the refresher course.
- C. Determine all the subjects in each courseware of nuclear safety and nuclear medicine.
- D. The computer expert from the CET and his team are studying the theoretical subjects of each courseware, and after consulting with the professional coordinator and the specialists, they are deciding about the frame of the courseware.
- E. The draft is distributed to several specialists for evaluation before deciding about the final scenario.
- F. The preparation of the final scenario (including the text of the courseware, animation, pictures, video film, etc.): was performed by the computer expert from the CET together with the professional coordinator and the specialists. It took an average of six iterations between the two authorities to reach the final version.
- G. In the next step, the following three teams are working in parallel:
 - the team of verbal presentation
 - the team of animation
 - the video film and photographer team with genuine actors from the NRC-Negev.
- H. The professional coordinator has to approve the verbal presentation, animation and all the pictures and the video films. Correction will be performed, if needed.
- I. Integration of all the parts of the courseware is done, including the questions and the answers of the quiz approved by the professional coordinator.
- J. The courseware is finished and has to be approved by highest authority of training programs in the NRC-Negev.

Each courseware includes the tutorial and the quiz. The quiz includes seven American style questions chosen randomly (from the file of the questions). In order to pass the quiz it is required to answer correctly at least 5 of the 7 questions (to have a minimum grade of 70%). The trainee is introduced to the management program by his identity number and then directed to his refreshing course (hot or cold area). The management program will keep a file of the grades of each quiz for every trainer and will produced a certificate of passing the refreshing course. In case of fail (more than 2 mistakes in one of the quiz), the management program enables the trainee to have the right answers of every question in the quiz, and the instructor in the class will allow the trainer to have one more quiz for the same courseware.

All the seven courseware were prepared by the described steps and were approved. At the beginning of November 1998, a running test was performed on some tenths of different types employees by giving them the new refresher course and checking the feedback. In January 1999 the routine refreshing courses began.

In the next sections we present in detail two of the courseware in nuclear safety: the biological effects of the ionizing radiation and nuclear safety for “cold area” employees.

3. THE BIOLOGICAL EFFECTS OF THE IONIZING RADIATION

This tutorial, named “the radiation and the human body”, includes the following five chapters:

A. Introduction.

The ionizing radiation is useful in power plants, in medicine, industry, research, etc., but it is dangerous for the human body.

B. The exposure policy.

The IAEA established the following three principles for exposure limitation: justification, limited doses and ALARA. The dose of the employees obtained from external and internal exposure is limited to as low as possible, much lower than the maximum permitted dose. The occupational exposure is presented as well, for special cases: children, pregnant women, and accidental exposure.

C. External and internal exposure.

The external exposure is due to any radioactive source outside the human body. There are two kinds of external exposure: the penetrating dose and the non-penetrating dose (skin dose). The internal exposure is due radioactive materials inside the human body. Physical half life, biological half life and effective half life, are presented.

D. The human body.

The human body is composed of cells. The radiation can ionize the atoms of the cells and the cell can be damaged. At low doses, the cell usually repairs the damage, but damage to the DNA can cause an irreversible genetic alteration. If the mechanism of cell division is damaged, cancer can occur.

E. The effects of radiation.

Radiation damage in the cells is induced by ionizing the molecules of the cells. There are two kinds of radiation effects: the immediate and the delayed effect. The delayed effect can appear after several years (e.g. damage in the DNA). The influence of low radiation dose and high radiation dose on the human body is explained.

4. NUCLEAR SAFETY FOR “COLD AREA” EMPLOYEES

This tutorial, named “radiation protection for cold area” includes the following three chapters:

A. Sequence and control.

The main function of the control arrangements is to ensure reasonable safety rules for the radiation workers, in order to perform their tasks with minimum risk to the environment.

The sequence and control is performed in three levels: for the workers, for the work environment and for the environment of the NRC. The managers, as well as the workers themselves, are responsible for the safety.

Personal dosimetry includes the routine measurement of the external and the internal exposure of all the employees. The external exposure is measured routinely by the TLD badge; sometimes the electronic dosimeter is used for the measure of beta rays and photons in the range of 0-2 mGy. The internal dose is estimated by measuring radioactive isotopes in the urine or by using the whole body counting.

In the environmental dosimetry, the dose is measured by background badges in different places and other instruments.

B. Radiation protection.

The three important elements of radiation protection are: distance, shielding and time.

It is well known that the exposure of a radioactive source decreases with the square of the distance in case of point source, or decreases proportionally with the increase of distance in case of linear source. Thus, by increasing the distance, the exposure can be reduced significantly.

Another method of reducing the exposure is by shielding the radioactive sources: the beta sources are usually shielded by light materials as perspex and the gamma sources by massive materials like concrete or lead.

The third element of reducing the exposure is the time, e.g. reducing (as much as possible) the time of exposure to the radiation field.

C. The behavior rules in the working place.

There are some rules of behavior in working areas where radioactive sources or pollution can be in the environment:

1. To wear personal badge (TLD badge), sometimes an electronic dosimeter is needed, too.
2. To fit the cloth – overall and special working shoes for the radiation workers, dressing gown and shoes cover for guests.
3. To keep the rules of entering and exiting from radiation area, especially to check hands and feet with special counters.
4. Not to eat, drink or smoke in the radiation area.

5. DISCUSSION

- A. The training program by courseware is more attractive than the one based on frontal lectures.
- B. Interactive learning would enable the employee to choose his own progress route.
- C. Adaptive learning is adjusted to the employee's level and ability to advance at an individual rate.
- D. Possibility of corrective studies and quiz.
- E. Certification and follow up.

6. REFERENCES

1. The safety regulations at working places in Israel (ionizing radiation) - 1992.