Continuing Education in Radiation Protection in the Nuclear Fuel Cycle: The Case of Brazil Education and Training in the Uranium Production Cycle

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Abstract: The INB (Brazilian nuclear industries) act on the nuclear fuel cycle, from uranium mining to fuel production. In order to maintain and improve the security of the operations and the competence of the staff, continuing education and training in radiation protection cannot be neglected. This paper describes the pedagogical concept of the training in radiation protection conducted in three uranium production units: the Uranium Concentration Unit at Caetité (URA), state of Bahia, the Ore Treatment Unit (UTM), at Poços de Caldas, state of Minas Gerais and the Unit of Heavy Minerals at Buena (UMP), state of Rio de Janeiro. It also describes a pilot training performed in 2004. The groups of workers to be trained are here characterized, as well as the profile of the trainers, the level and kind of trainings and their frequency. At the end of training, workers were subjected to a test and a grade was awarded. At URA 79 workers were trained during 9 h, the grades they obtained ranged from 7.5 to 10. At UTM; 200 workers were trained, their grades ranged from 8.8 to 10; Finally, at UMP 151 workers were trained, their grades ranged from 8.6 to 9.0. Thus a total of 180 h for 430 employees was spent training, no one flunked. Currently, the general training has been abolished since it hindered production, and the option is now to train small groups of workers when they join their Units, and also all along the year were in small classes.

Key words: Radiation protection, training in radiation protection, continuing education, nuclear fuel cycle education.

1. Introduction

The activities in the nuclear fuel cycle require a continuous program of training and human resource development. The IAEA (International atomic energy agency), possess several recommendations for the training [1-3]. In the same vein, another recommendation on occupational doses appraisal [4], points out the training as a way to reduce the doses to which workers are exposed. The IAEA [5] also points out training as a fundamental key in radioprotection those results in optimization of the doses received by

the worker. Similarly, in other areas where people work with radioactive sources, training is also a predominant focus [2, 6-8].

The IAEA encourages cooperation between the academia, industry and government both in training and education related to the nuclear industry [9]. This same report points as best practices of nuclear education the following items: 1) human resource development; 2) cooperation between education and training institution; 3) creation of networks; 4) quality of education and training; 5) use of technology; and 6) outreach.

The first security principle in the use of nuclear energy is: responsibility for safety. The main ways to

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achieve this principle are to establish and maintain the necessary skills and to provide adequate training and information [10].

Even the transport of radioactive material requires training. This training need to be registered and people should be retrained at predetermined periods or in the event of changing conditions of transport [11, 12].

The nuclear training is required in the licensing of nuclear facilities in Brazil [13], as well as the licensing of radioactive installations [14] and the system to warrant the quality of nuclear installations [15]. Training is of vital importance in the preparation of a radiation protection program, [16], in structuring the radiation protection service [17], as well as in formation of the responsible for radiation protection [18].

Training is well disseminated in the nuclear medicine area [19, 20], but also in the industrial area [21, 22].

In Brazil, only the “Indústrias Nuclear do Brasil - S.A (INB)” operate the nuclear fuel cycle. Being a small market restricted to a single company, the required technical training is only performed by the CNEN (National Commission of Nuclear Energy) or by the INB itself.

Aware of their responsibilities with regard to the safety of workers and the population, INB initiated a program of internal training of human resources to increase worker’s competence in radiation safety. This training program is a requirement of national standards for radiation protection [16, 17].

2. Objectives

Here We describe the conceptions that oriented the training procedures in radioprotection of the employees of INB.

3. Methodology

3.1 Training Places

The overall training was conducted in three units that belong to INB: the Uranium Concentration Unit (URA) under production in the city of Caetité, state of Bahia,

the Ore Treatment Unit (UTM) undergoing decommissioning at Poços de Caldas, state of Minas Gerais and the Unit of Heavy Minerals (UMP), at Buena, state of Rio de Janeiro.

3.2 Distribution of the Employees in Homogeneous Groups for Training

The employees were distributed in two groups: one belong to the Radioprotection Service and the other employees, as depicted in Fig. 1.

3.3 Level of Training to be Developed

Three levels of training were considered. They focus respectively on: a) the acquisition of competence; b) the maintenance of competence and c) the broadening of competence.

3.4. Kinds of Training to be Developed

3.4.1 Theory Classes

They should provide the theoretical background that need for the development of other forms of training. When possible, they should be accompanied by practices whose workload has different scores, such that each two hours of practice should be equivalent to one hour of theory.

3.4.2 Practical Classes

They should provide sedimentation of knowledge acquired in classes of theory, and as far as possible, bring new information.

3.4.3 Lectures

They should deepen theoretical and/or practical issues, with a maximum duration of 2 hours.

3.4.4 Internal Workshop

They should deepen theoretical and/or practical issues, with at least 4 h and up to 8 h.

3.4.5 Courses

They should deepen theoretical and/or practical issues, with a minimum of 20 h.

3.4.6 Exchanges

They should be rapid (within one week) and targeted (solve specific problems).

Fig. 1 Classification of employees from Mineral Resources Directorate-DRM-depending on hierarchical level and workplace and academic formation used in the training and their respective frequencies.

3.4.7 Stages

They should be longer than the exchanges (at least two weeks), giving preference to facilities outside the company.

3.5 Forms of Assessment

All training must be evaluated by written tests with at least 5 essay questions or ten multiple choice questions. The minimum approval grade is seven (7.00). If not approved, the trainee will still be considered in the learning process, being enrolled again in the next training.

3.6 Record of Training

All training must be recorded. A certificate of attendance and achievement should be delivered to participants, and a copy must be archived at the Office for Radiation Protection.

3.7 Instructors Profile

Instructors must have at least five years of experience in the area or the title of supervisor of radioprotection, with a Master's degree in pertinent

area. The company's employees that address the above requirements are considered native coaches. Instructors outside the staff of the company should have their "curriculum vitae" approved by the supervisor of radioprotection, before assuming the role of instructor.

The radiation protection supervisor must be trained by another Supervisor of Radiation Protection.

3.8 Training Content/Program

The program of basic training in radiation protection should be available for external audit at the Radiation Protection Service.

4. Results and Conclusions

Training was composed of theory classes that lasted 9 h for each class. A discursive individual proof, with consultation, was applied where trained workers developed radioprotection topics covered in class during the theory classes.

The discursive proofs were corrected according to expected responses. After correction, all operators trained were allowed to look at their tests for considerations about the answers.

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Table 1 Number of students (NrS) and average grades (AVG) per class.

Class	URA		UTM		UMP	
	AVG	NrS	AVG	NrS.	AVG	NrS
T01	9.36	7	8.59	17	9.00	24
T02	9.20	12	8.22	11	8.61	45
T03	8.66	9	8.00	13	8.90	33
T04	8.92	7	8.58	14	8.62	23
T05	9.08	19	8.66	21	8.58	32
T06	9.46	25	9.07	35	***	***
T07	***	***	9.78	18	***	***
T08	***	***	8.50	10	***	***
T09	***	***	9.43	61	***	***
Total S	-	79	-	200	-	151
AVG	9.18	13	8.98	22	8.71	31
Min-max grade	7.5-10	-	8.8-10	-	8.6-9.0	-

Legend: *** no classes; Total S: total students.

At URA 79 employees were trained. They were distributed into six groups, with an average of 13 operators per class. Among the six groups, the grades ranged from 7.5 to 10 with an average note of 9.2. The averages and the numbers of students per class are show in Table 1.

At UTM, 200 employees were trained (62 employees of INB, 134 outsourced, 2 PhD students of the Institute of Biology of the University of São Paulo and 2 employees of CNEN/Poços de Caldas). Participants were organized into 9 classes with each 22 students. Their grades ranged from 8.8 to 10 and the average note was 8.98.

At UMP, 157 employees were trained. Five classes were held, with an average of 31 students per class; their grades ranged from 8.6 to 9.0 with an average note of 8.71.

Minor changes in how to conduct the training have been proposed by the participants and are being incorporated. The number of employees involved in collective training resulted in low production of the facility, caused by lack of staff in the production lines. From this observation the training program was rescheduled. Nowadays, new trainings are made in individual form. Organization of classes only occurs for initial training. This training occurs only when new employees are admitted, requiring formations of

classes. In these cases the classes are small, with no more than 5 employees per class.

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