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EVALUATION OF CONTROLLED AREAS IN THE FUEL ELEMENT FACILITY IPEN/CNEN/SP BY THE TECHNIQUE OF SURFACE CONTAMINATION

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ABSTRACT

Working with radioactive materials makes the safety culture is present in everyday life of nuclear facilities. The radiological protection management provides the monitoring program for occupational exposure occupational individual (OEI) and for the working place. The facilities are monitored by the radiometric surface and air survey. This paper presents a surface monitoring technique which assesses the workplace and estimates the dose in real time that the worker is subject to, considering the radionuclides used in the process. In this study, the radionuclide is uranium enriched to 19.5%.

1. INTRODUCTION

The radiological protection management developed a monitoring program for the workplace in agreement with the radioprotection plan for the fuel element facility. The installations of the fuel element facility include specific sectors, such as: Chemical Process (CCR) with the transfer of uranium hexafluoride UF_6, uranium hexafluoride reconversion, the laboratory for uranium recuperation; Metallurgic Process (CCL) with the production metallic uranium, Mechanic-Metallurgic Process (CCP) with the production of briquettes, fabrication of fuel element plates and assembly of fuel element. These sectors are classified as controlled area, any area in which specific protective measures or safety provisions are or could be required for: controlling normal exposures or preventing the spread of contamination during normal working conditions; and preventing or limiting the extent of potential exposures.[1,2] Monthly, the workers are individually monitored as for external irradiation and the workplaces, also, undergoes monitoring. In this paper it will showing the places contaminated which were identified by the way indirect monitoring superficial smears. These smears were performed considering $100cm^2$ area. A scintillation detector Zinc Sulfide activated with silver (ZnS)(Ag),from Ludlum, was used for smears reading. The radioactive material is uranium enriched to 19.75%. The objective of this work is to show the points of the workplace during the year 2012, which showed surface contamination values above $1Bqxcm^{-2}$ [3] , as well as to evaluate the potential doses workers were submitted to, considering the actual time worked.

2. INDIRECT MONITORING PERFORMED IN DIFFERENT SECTORES OF THE NUCLEAR FUEL ELEMENT FACILITY

The nuclear fuel element facility includes three sectors CCR, CCL, CCP in which the smears to identify the contamination spread in the workplace were carried out.

2.1. Quantification of the Contamination Spread in the Workplace

Surface monitoring was done. The smears were read using the scintillation detector ZnS(Ag), and quantified $Bqxcm^{-2}$ for each smear. Using the detector calibration certificate 'formula 1, $Bq\ xcm^{-2}$calculations where found below

$$N-No \div Ei \times Es \times F \times Se \times 60 \quad (1)$$

N = Instrument reading (cpm)
No = Reading of the background radiation
Ei = Efficiency of probe
Es = Efficiency of the emission source
F = Transfer factor of the smear (average 10%)
Se = rubbed surface area ($100cm^2$)

2.1.1. Workplaces monitored and activity calculated

Table 1 shows the contaminated sites and the calculated values. The reference levels were adopted in 1 $Bq\ xcm^{-2}$.
The ccr is a place where the chemical process is developed: it includes the UF_6 transfer sector, reconversion and laboratory for uranium recovery.

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Table 1: CCR results

Transfer sector UF_6	Floor close to	Bq xcm^{-2}	January
	cylinder	1.16	
	valves	1.29	
Laboratory for uranium recovery	sink	2.45	
Transfer sector	Transfer line valve	2.01	March
	Floor next the cylinder	2.12	
Reconversion sector	Floor next to the hydrolysis reactor	1.90	
Laboratory for uranium recovery	Weighing-machine	2.09	
Reconversion	Floor next to UF_4 reactor	1.35	April
	Recirculation pump	1.80	
	Floor next to UF_4 effluents	1.71	
Reconversion	Extraction column	2.34	November
Laboratory for uranium recovery	sink	1.65	

Table 2
<u>CCLresults</u>

Hood	Floor close to	Bq xcm^{-2}	
	hood	2.67	January
		2.64	February
	Floor next the cut off	8.91	January
		6.18	February
Stand	Floor	1.77	January
		2.12	February
	Floor near the bench tray	2.09	January
	Floor of the entrance to the laboratory	1.13	January
	Control point of the lab.	1.87	March
	Floor next to control point	1.38	
	Telephone table	1.51	
Glove box	floor	1.74	
Out of glove box	floor	1.90	
Central part of the workplace	floor	1.48	
Computer desk		1.51	
hood		1.32	
hood		1.64	April

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Countertop dismantling	floor	1.77	March
Countertop dismantling	floor	2.22	April
Countertop dismantling	floor	2.45	May

CCP

In this workplace, contamination was not found.

Table 3 Metallography Laboratory

Hood		6.69	July
Bench cutter		1.45	July
Hood		11.97	September

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Table 4 **The worst contamination places**

Laboratory for uranium recovery	sink	2.45	January	CCR
Transfer sector	Floor next the UF_6 cylinder	2.01	March	CCR
Reconversion	Recirculation pump	1.80	April	CCR
Reconversion	Floor next to UF_4 effluents	1.71	April	CCR
Reconversion	Extraction column	2.34	November	CCR
Laboratory for uranium recovery	Sink	1.65	November	CCR
Hood	Floor next the cut off	8.91	January	CCL
Stand	Floor	1.77	January	CCL
Stand	Floor	2.12	February	CCL
Out of glove box	Floor	1.90	March	CCL
Cut off	Floor	2.99	March	CCL
Cut off	Floor	3.51	May	CCL
Countertop dismantling	Floor	2.45	May	CCL
Stand	Floor	2.03	May	CCL
Glove-box	Floor	3.99	September	CCL
Cut off	Floor	4.54	September	CCL
Hood		6.69	July	Metallography Laboratory
Hood		11.97	September	Metallography laboratory

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3. DISCUSSION OF RESULTS AND CONCLUSIONS

Tables1, 2 and 3show the contaminated places in $Bqxcm^{-2}$ to uranium reference level of 1 $Bqxcm^{-2}$, corresponding to a potential dose of 20mSv per year/work for the IOE.

To analyze these results, it was necessary to calculate the air concentration reference level for fuel element facility sectors. The chemical sector presents composed soluble uranium such as UF_6, and UO_2F_2, from the point of view of radiological protection, they are classified D class [4].

Utilizing the number 003 regulatory position of the CNEN [1] standard, the annual incorporation limit was calculated, with the relation between potential dose for OEI and the committed effective dose for each composed uranium, taking into account the elimination degree by the organism: how fast, moderate and slow the absorption from the lung was, respectively.

To calculate the reference level for air concentration each annual incorporation limit was divided by the volume of air inhalation during one year/work, corresponding to $2.4x10^{2.}$ m^3 [5]. The results for the level of reference for air concentration, concerning composed uranium D class[4], were 5.4 $Bqxm^{-3}$. For the uranium tetrafluoride W class [4] the level was 9.8 $x10^{-1}$ $Bqxm^{-3}$. In the CCl, CCP and metallographic laboratory, with composed uranium Y class[4], U_3Si_2 , the level of reference for air concentration was $3.5x10^{-1}$$Bqxm^{-3}$ .After having calculated the reference level for air concentration for each enriched composed uranium specific sector, the more restrictive value for reference level to surface contaminated of uranium was calculated.

The reference level is not rigid value, it may alter. This reference level is defined by the air concentration and the resuspension factor. It was calculated the reference level for surface contamination with resuspension fator of $5x10^{-6}$ x m^{-1}, very restrictive, to be used when the real value was not known [6]. So, the reference level was calculated, not more considering 1Bqxcm-2 [3]. For each sector, the reference level for the CCR was calculated considering the reference level for UF_6, UO_2F_2 composed: the value is 108 Bq x cm^{-2} ; for the UF_4 production place it was calculated 19.6 Bq x cm^{-2}. For CCl, CCP sectors and metallographic laboratory, it was calculated a reference level equal to 7 Bq x $cm^{-2.}$

For the analysis of table 4 results, the reference level 7 Bq x cm^{-2} was considered, because this value is more restrictive than other reference levels calculated. Observing table 4, there are only two points above the reference level adopted. Considering the OEI real time of work, the personnel worked 960 hours in the year. This allows the reference level to be enlarged to factor 2.1. Why? Because the real time of work was $2x10^3$ hours, reduced to 960 hours, resulting a more restrict reference level of 7 Bq x $cm^{-2}$for 14.7 Bq x cm^{-2}. Following this reasoning, table 4 has values in reference to Bq x cm^{-2} for surface contamination below the reference level adopted of 14.7 Bq x cm^{-2} . It should be explained that the values of tables 1, 2, 3 are independent results. Each month, after chemical, mechanic-metallurgic processes, the facilities are monitored by radiological protection technicians. For each new batch, the sectors are decontaminated by operational workers under the supervision of the radiological protection management.

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