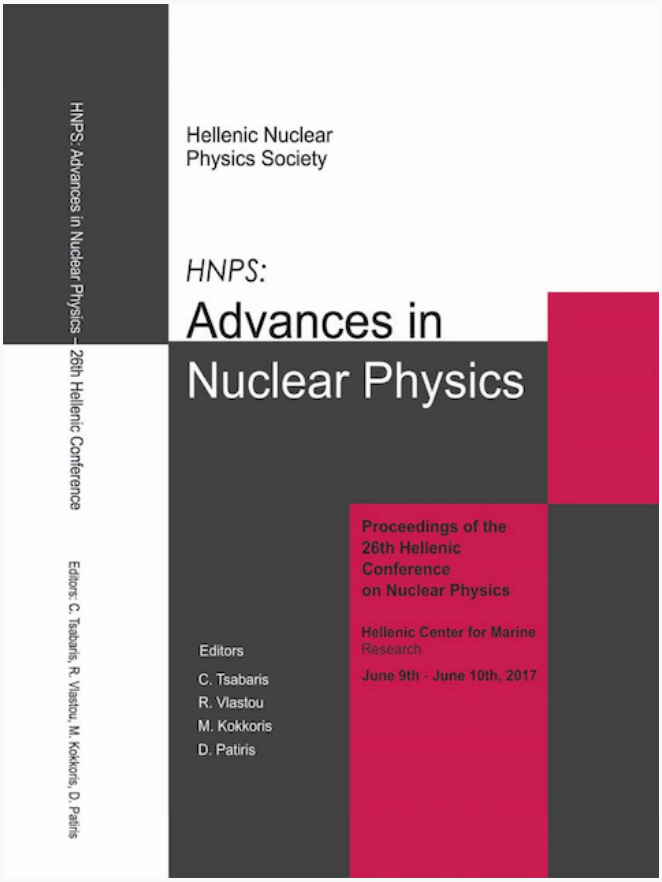
HNPS Advances in Nuclear Physics

Vol 25 (2017)

HNPS2017



Release of the Radiochemical Lab at the Tandem Accelerator Building

I. Karachristou, E. Ntalla, A. Savidou

doi: 10.12681/hnps.1990

Release of the Radiochemical Lab at the Tandem Accelerator Building

I. Karachristou [1,*], E. Ntalla[1], A. Savidou[1]

[1]*Radioactive Materials Management Laboratory, Institute of Nuclear & Radiological Sciences & Technology, Energy & Safety, NCSR "Demokritos", AgiaParaskevi, 15341, Greece.*

Abstract Scope of this work is the release from the regulatory control of the Radiochemical Lab at the Tandem Accelerator Building, which belongs to the Institute of Nuclear and Particle Physics. The operation of the Lab was stopped 10 years ago, in 2007. The main activity was the production of radioactive calibration sources. The radioisotopes used were Eu-152 (doped with 7% Eu-154) and Cs -137. Before that, thirty years ago, the Lab was used for preparation of calibration sources for PIXE (Proton Induced X-ray Emission) analysis. At that time, was occurred a contamination with an unknown radioisotope at the Lab bench, probably by a pure beta emitter. Afterwards, the bench was decontaminated. For this reason the radiological characterization of the area was held. Specifically, dose rate measurements and area monitoring were performed. Furthermore, smear samples were collected from the floor, bench and the fume hood. The smear samples were analyzed by the gamma spectroscopy system of the Radioactive Waste Management Laboratory (RMML) and monitor as well by a-β-γ contamination monitor.

Keywords radiation protection, contamination, smear samples, release

INTRODUCTION

The Radiochemical Lab is located on the ground floor of the Tandem Accelerator Building of the Institute of Nuclear and Particle Physics. The area of 3X6 m2 is marked as "Controlled Area" and the access is allowed only to the specialized workers. Inside the Radiochemical Lab there are a lab bench and a fume hood.

Scope of this work is the release of the Lab from the regulatory control for general use. For this reason the radiological characterization of the area was held. Specifically, dose rate measurements and area monitoring were performed. Furthermore, smear samples were collected from the floor, bench and the fume hood. The smear samples were analyzed by the gamma spectroscopy system of the Radioactive Waste Management Laboratory (RMML) and monitor as well by a, β, γ contamination monitor. The operation of the Radiochemical Lab at Tandem Accelerator Building was stopped 10 years ago, in 2007. The main activity was the production of radioactive calibration sources. The preparation of the calibration sources was on the lab bench, behind a lead shielding. The radioisotopes used were Eu-152 (doped with 7% Eu-154) and Cs -137. The Eu-152 was in 3-4 ml solution of activity 2-3 mCi. At the lab, about 30 years ago, occurred a contamination with an unknown radioisotope at the Lab

* Corresponding author, email: ikarachristou@rrp.demokritos.gr

bench, probably by a pure beta emitter. Afterwards, the bench was decontaminated.

MATERIALS AND METHODS

Sampling method

Smear samples were collected from the liable for contamination surfaces for qualitative determination of the possibly radiological contaminants. Seventeen smear samples (damp absorbent paper) were taken from the bench, the fume hood, the shielding blocks, the floor and the light switch (Table 1). Specifically, four samples were taken from the bench, five from the fume hood, two from the shielding blocks, four from the floor, one from the light switch and one from the closet under the right part of the bench. Smear samples were small (circle with 5 cm diameter) or large (33 cm x 20 cm), depending on the area over which smear should be taken. For estimation of the specific surface activities, the performance of the smear sampling was considered 10 %.

Gamma Spectrometry measurements of the smear samples

The gamma spectrometry detector system is situated in the radiological measurements laboratory of the RMML. It is consisted of the following main parts: i) the Detector Unit: a BicronMonoline scintillation detector NaI(Tl) (Model 3M3/3, ii) lead shielding structure with thickness 5 cm, iii) Electronics and Acquisition Unit: a digital signal processing unit (Osprey Digital Tube Base MCA) and iv) a high voltage supply system Genie 2000 Gamma Spectroscopy software. The calibration of the system was performed with a multiple gamma ray emitting large volume source and a multiple gamma ray emitting large area source, in the energy range from 46 to 1600 keV.

Gamma spectrometry measurements were conducted with volume or area source geometry, depending on the sample size. The sample was placed on a base made of plexiglas which was in conduct with the detector. Seventeen samples were measured in total and the duration of each measurement was 7200 sec for volume source (VS) sample geometry and 3600 sec for area source (AS) sample geometry. The lower measuring time for the area source geometry is due to the higher efficiency of the detector comparing to the efficiency of the volume source geometry. For large smear samples the VS geometry was used, whereas for small smear samples the AS geometry. The detection limit (DL) in units of Bq was evaluated by the following formula:

$DL=(3*\sqrt{B})/(eff_p*t*A)$, where, B are the counts of background at the spectrum area of the peak, eff_p is the detector efficiency at the specific energy peak p, t is the measurement time and A is the abundance of γ rays.

Contamination monitor measurements of the smear samples

The 17 smear samples that were measured through gamma spectroscopy were also checked for β and γ radiation with the contamination monitor Thermo FHT 111M (Xenon gas filled counter tube). Measurements were performed with and without the stainless steel protective frame in order to determine the difference between β and γ radiation. The monitor was operated at integration mode and the integration time of each measurement was 60 sec.

Survey

For survey, the contamination monitor FHT 111M was used. The sensitive window area of the monitor is 10X10 cm^2. The instrument was calibrated for two radioisotopes: Eu-152 and Cs-137. For calibration, closed reference point sources of Eu-152 with activity 45.51 kBq on 1/3/2004 and Cs-137 with activity 416.4 kBq on 1/10/1995 were used. The calibration of the monitor was based on gamma emission from the sources and therefore it held with the protective frame on the sensitive window. It should be mentioned that point sources were used for the calibration of the monitor because appropriate open area calibration sources weren't available.

Firstly, all the surfaces (bench, fume hood and floor) were surveyed by the contamination monitor without the protective frame for detection of potentially contaminated areas. The bench and the fume hood were divided into areas of 20x20 $cm^2$and the floor to areas of 1 m^2. The monitor was operated at the integration mode with measurement time 90 sec at each square. The background was measured at the corridor outside of the room also at the integration mode for 90 sec and was automatically subtracted. The detection limit of the monitor was set 0.753 cps.

Then, the area of higher counts per sec (it was only one area) was scanned with the protective frame on the window of the monitor for surface specific activity determination. The background was measured at the left part of the bench where no contamination was detected. The background was automatically subtracted. It should be mentioned that the survey of the bench was initially done by subtraction of the background that was measured at the corridor.

RESULTS AND DISCUSSION

Smear Samples Analysis Results

All the results of the analyses are presented on Table I. The surface specific activities correspond to surface contamination of the Lab areas (after the correction 10 % for the smear sampling performance). The monitoring of the samples by the contamination monitor showed that there isn't any significant difference between gamma (monitor with the frame) and beta-gamma (monitor without the frame) that could justify the presence of pure beta emitters.

The samples were taken from surfaces <1 m^2 which is the acceptable area for averaging of contamination [2]. The results of smear samples analyses by gamma spectrometry showed that only the right side of the bench presented low contamination by Eu-152 at the level of 0.02 Bq/cm^2. It should be mentioned that the clearance level for direct reuse of Eu-152 is 1 Bq/cm^2 and for Cs-137 is 10 Bq/cm^2 [2]. The limit for β-γ emitters mentioned at the Greek Radiation Protection regulations is 4 Bq/ cm^2 [3]. Therefore, the smear samples analyses indicated that no significant contamination was detected inside the Lab. The only radionuclide that was detected was Eu-152.

Survey results

After survey, only one contaminated area 20x20 cm^2 was found, on the right part of the bench. The analyses of the smear samples by the gamma spectrometry showed Eu-152 at this part of the bench. Therefore the calibration factor of Eu-152 was used. This area was scanned with the contamination monitor operated at the integration mode with measurement time 60 s. For surface specific activity 1 Bq/cm^2 (equal to the clearance level for Eu-152 mentioned at the Radiation Protection 89 [2]), the acceptable mean activity on the area 20x20 cm^2 is 400 Bq. This corresponds to 2.39 cps after subtraction of the background.

The scanning of this area indicated 2.37±0.24 cps. Therefore, the activity on the contaminated area was 396 ± 40Bq and the surface specific activity 1 Bq/cm^2. It should be mentioned that without the protective frame, the scanning of the same area indicated 13.2±0.42 cps after subtraction of the background (4.56±0.29 cps).

Although the contamination was at the level of clearance for direct reuse 1 Bq/cm^2 for Eu-152 [2] and well below the limit of 4 Bq/ cm^2 for beta gamma contamination [3], the area was cleaned by RBS25. After decontamination, the scanning result was 1.73±0.24 cps which corresponds to 289 Bq and to surface specific activity of 0.7 Bq/cm^2.

CONCLUSIONS

The dose rate measurements, the area survey and the analyses results of the smear samples taken from the liable for contamination surfaces at the Radiochemical Lab, showed that no significant contamination is presented. The total horizontal surfaces of the floor, the fume hood and the bench as well as the total surface of the lead shielding blocks and the Plexiglas that was covered the bench in the past, were scanned. Only one contaminated area 20x20 cm^2 was found, on the right part of the bench. The results of smear samples analyses by gamma spectrometry showed also that only the sample that was taken from a surface of 40x90cm^2 at the right side of the bench presented low contamination by Eu-152. The evaluated average surface specific activity of this area was at the level of 0.02 Bq/cm^2. Also the scanning of the 20x20 cm^2area, that presented contamination, by using the calibration factor for Eu-152 showed surface specific activity of 1 Bq/cm^2which is at the level of direct reuse mentioned in Radiation protection 89 [2] and well below the limit of 4 Bq/ cm^2 for β-γ contamination mentioned at the Greek Radiation Protection regulations [3]. Nevertheless, this

area was decontaminated for removal of the loose contamination. The surface specific activity after decontamination was 0.7 Bq/cm^2. Furthermore, the comparison between gamma and beta-gamma measurements of the samples performed by the contamination monitor indicated that there isn't any significant difference that could justify the presence of pure beta emitters.

Hence, the Lab can be released from the regulatory control for general use. Attention should be taken that the radiological characterization of the filter of the fume hood wasn't included in the tasks of the present work. Therefore, the hood should not be dismantled without further survey and permission.

References

[1] Information given by Dr. K. Kalfas, March 2017.
[2] Radiation Protection 89, Recommended Radiological Protection Criteria for the Recycling of Metals fromthe Dismantling of Nuclear Installations. Luxemburg: Office for Official Publications of the EuropeanCommunities, 1998.
[3] Joint Ministerial Order 1014 (FOR) 94, Official Gazette No. 216/B/06-03-2001, "Radiation Protection Regulations". (in Greek).