INTERNATIONAL CBRNE MASTER COURSES SERIES

COLLANA DI SICUREZZA CHIMICA, BIOLOGICA, RADIOLOGICA E NUCLEARE

15

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Peace cannot be kept by force; it can only be achieved by understanding.

Albert Einstein

The CBRNe Book Series was born as an initiative of the Directive Board and of the Scientific Committee of "International Master Courses in Protection Against CBRNe events" (www.mastercbrn.com) at the University of Rome Tor Vergata. The evolution and increase in Security and Safety threats at an international level place remarkable focus on the improvement of the emergency systems to deal with crisis, including those connected to ordinary and non–conventional events (Chemical, Biological, Radiological, Nuclear, and explosives). In every industrial Country there are multiple entities with specialized teams in very specific fields, but the complexity of the events requires professionals that not only have specific know-how, but also expertise in the entire relevant areas. Given the global interest in these issues, the Department of Industrial Engineering and the Faculty of Medicine and Surgery of the Tor Vergata University organize the international Master Courses in "Protection against CBRNe events": I Level Master Course in "Protection against CBRNe events" (120 ECTS) and II Level Master Course in "Protection against CBRNe events" (60 ECTS). These courses aim at providing attendees with comprehensive competences in the field of CBRNe Safety and Security, through teaching and training specifically focused on real needs. Both Master Courses are designed according to the spirit of the Bologna Process for Higher Education, the Italian law and educational system. The Master Courses are organized also in cooperation with the following Italian Public Entities:

— Presidenza del Consiglio dei Ministri (Prime Minister's Office);
— Ministero della Difesa (Ministry of Defence);
— Ministero dell'Interno (Ministry of The Interior);
— Istituto Superiore di Sanità (National Health Institute);
— Istituto Nazionale di Geofisica e Vulcanologia (National Institute for Geophysics and Vulcanology);
— ENEA (Italian National Agency for New Technology, Energy and Sustainable Economic Development);

— University Consortia CRATI, MARIS and SCIRE;
— Comitato Parlamentare per l'Innovazione Tecnologica (Parliamentary Committee for Technological Innovation).

And together with the following International Entities:

— OPCW (Organization for the Prohibition of Chemical Weapons)
— NATO Joint Centre Of Excellence (Czech Republic);
— NATO SCHOOL of Oberammergau (Germany);
— HotZone Solutions Group (The Netherlands);
— VVU–026 Sternberk (Czech Republic);
— Seibersdorf Laboratories GmbH (Austria);
— Chernobyl Centre (Ukraine).

All the above–mentioned organizations have signed official cooperation agreements with the University of Rome Tor Vergata in the aim of Master course activities. The Master have also cooperation with OSCE, IAEA, ECDC, KEMEA in the aim of the didactical activities and we are working to formalize this collaboration with a formal cooperation agreement.

Both Master Courses have been officially granted the "NATO selected" status and have been included in the NATO Education and Training Opportunities Catalogue (ETOC) and also they are supported by OPCW.

The purpose of the CBRNe book series is to give a new perspective of the safety and security risks from both a civil and military point of view, touching all the aspects of the risks from the technological to the medical ones, talking about agents and effects, protection, decontamination, training, emergency management, didactic, investigation, communication and policy.

The authors will be experts of the sector coming from civil, military, academic/research and private realities. A special thanks for the realization of this series goes to Prof. Carlo Bellecci for his initial encouragement, continuous support and help.

Nel mese di Agosto 2016 il Ministero dell'Istruzione, dell'Università e della Ricerca (MIUR) ha inserito la collana nella lista di quelle ufficialmente riconosciute con i seguenti riferimenti:

— codice di classificazione: E237557;
— titolo: CBRNE BOOK SERIES.

During the month of August, 2016, the Italian Minister for Instruction, University and Research (MIUR) has officially added this book series in the list of the official publications recognized by the Minister itself with the following references:

— classification code: E237557;
— title: CBRNE BOOK SERIES.

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Contents

Part I
Training facilities and centers, education and research projects

Part II
Detection, identification, nuclear measures and instruments

Part III
Radioactive / Nuclear Safety, Decommissioning and Decontamination

Part IV
Numerical simulation for radioactive safety and security

Part I

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UNIPI irradiation facility

R. Ciolini, A. Marini, V. Giusti, F. d'Errico*

Abstract

The neutron and gamma irradiation facility of the University of Pisa (UNIPI irradiation facility) consists of a large room (5.0 x 8.0 x 2.5 m^3) with concrete walls, designed to minimize radiation scattering. Two ^{241}AmBe radionuclide neutron sources with a total calibrated emission rate of 8.4×10^5 s^{-1}, and a ^{60}Co with a calibrated free–air kerma rate of 0.39 mGy h^{-1}, are available. The reference neutron $H^*(10)$ rate is 11.4 μSv h^{-1} at 1 m from the AmBe sources. However, a broad range of neutron and gamma dose rates can be obtained by varying the distance between the source and irradiated devices with a dedicated apparatus. The assessment of the room scatter contribution to the reference dose values is determined by means of Monte Carlo simulations of the facility, for both neutron and gamma exposures.

Keywords: Irradiation facility; neutron source; neutron albedo; Monte Carlo simulation.

1. Introduction

The object of this work is the evaluation of the room scattered contribution at the reference calibration points of a fast neutron and gamma irradiation facility available at the University of Pisa, the UNIPI irradiation facility. The facility is a quite large irradiation room (5.0 x 8.0 x 2.5 m^3) with concrete walls, designed to minimize radiation scattering (Fig. 1). Two sealed ^{241}AmBe neutron sources with a total calibrated emission rate of 8.4×10^5 s^{-1}, corresponding to an activity of 14.1 GBq, and a ^{60}Co gamma source with a calibrated free–air kerma rate of 0.39 mGy h^{-1}, corresponding to a nominal activity of 1.3 GBq, are available (all the emission data are referred to the 1st January, 2019). The

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sources are normally stored in a 2 m deep ground repository. A broad range of neutron and gamma dose rates for calibration purposes can be obtained by varying the distance between the source and irradiated devices with a dedicated apparatus. The facility includes ancillary equipment such as an aluminum support for the source and the device to be irradiated, a Bonner sphere spectrometer system, shadow cones, 30 x 30 x 15 cm^3 ISO phantoms, and neutron and gamma monitors (Fig. 2). An air conditioning system maintains the room temperature at a constant environment value during the exposures.

The irradiation process involves the extraction of the radioactive (neutron or gamma) sources from the storage box and their positioning in the source point S inside the room (Fig. 1), at 1.3 m height from the ground. The source is hold by an aluminum support, having the shape of a disk of 0.76 m diameter, with rectangular radial grooves to fix the device/detectors to be irradiated or calibrated at a precise distance from S and the same height from the floor. Different reference points can be selected in the (x,y) plane. At the end of the exposure, the sources are stored again in the repository. No particular restrictions are required for the items to be irradiated; there are only limitations on their sizes due to the dimensions of the room and its entrance door. The duration of each exposure can normally be 0–24 h, but longer times are possible. All irradiation procedures and instrument calibrations are performed according to an ISO 9001 standard certification procedure.

2. Neutron albedo and gamma backscattering evaluation

For each reference irradiation point, the assessment of the room scatter contribution (neutron albedo or gamma backscattering component) was determined by Monte Carlo simulations of the entire facility with the MCNP6 code (Pelowitz, 2011). The irradiation room was simulated as a rectangular–based box with internal dimensions of $5.0 \times 8.0 \times 2.5$ m^3 filled with air, having a 0.3 m thick concrete lateral walls and floor, and 0.2 m thickness ceiling (Fig. 1 – the support is not shown but it was considered in the simulation). Any particle escaping from the outside surface of walls, ceiling and floor is considered lost and hence not followed anymore. To evaluate the contribution of the scattered component, the "cell–flag" option of MCNP6 has been used. Doing so, the code calculate the required physical or operational quantity in each point, considering the contribution of the neutrons or photons that underwent at least one scatter event in the walls, ceiling, floor or aluminum support before interacting in the target point (scattered component): the difference between the total and scattered components represents the contribution of neutrons or photons coming directly from the source without any interaction (primary or direct component).

The neutron and gamma flux and ambient dose equivalent $H^*(10)$ rates have been computed at different distances from the source: 0.2, 0.4, 0.6, 0.8 and 1 m. For each distance a set of points in a circle in the (x,y) plane having the source S as the center and the chosen distance as the radius, has been considered to evaluate potential asymmetries due to the different positions with respect to the room walls. Since no significant differences have been found in the neutron or gamma flux and $H^*(10)$ by varying the rotation angle at the same horizontal distance from the source, the results are presented only for the points along the $-x$ direction (see the points 1, 2, 3, 4, and 5 in Fig. 1), where the scattered contribution is the lowest.

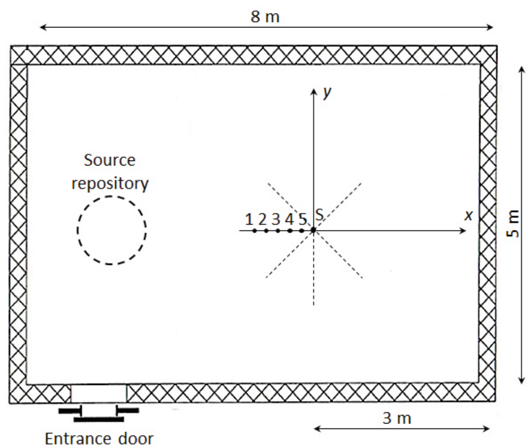

Figure 1. Irradiation room schematic plan view (S = source point; 1, 2, 3, 4, 5 = measurement points along the $-x$ direction). The height from the ground is 1.3 m for all points.