



## Gamma ionization logistical protocol for decontamination of bibliographic collections: experimental research

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### 1. Introduction

Radiation processing has been conventionally applied to various types of materials, such as disposable medical products, foods, polymers, etc. to sterilize, disinfect, inactivate viruses or modify physical properties. Ionizing radiation technology also comprises gamma rays and electron beams, applied to preservation of cultural assets. The procedure is performed by commercial or research irradiators, using cobalt-60 or an electron beam. A relevant characteristic is that the materials, after being irradiated, do not become radioactive and can be manipulated immediately after the process. This research indicates gamma ionization as a possibility for preventive and curative treatment of cultural assets, in terms of a logistical protocol. In this sense, it is important to highlight the concepts of decontamination, in which a contaminating agent – which can be translated in terms of microorganisms – is eradicated from a body, as well as disinfestation, which deals with the elimination of insects or pests in materials. Finally, disinfection is the concept related to stopping the development of fungi. The motivation for developing a protocol in this study is supported by the possibility of expanding the use of gamma irradiation technology, using cobalt-60, with effective and safe elimination of fungi and microorganisms into collection, in a very safe manner.

### 2. Methodology

The experimental research, decontamination of a fraction of the special collection from the library of the Center for Health Sciences at Federal University of Pernambuco (CCS/UFPE), with gamma ionization by the Center for Radiation Technologies of the Institute for Energy and Nuclear Research (CETER/IPEN), involved visits to several IPEN centers; varied logistics, such as: packaging, transportation and coordination and monitoring of all stages of the decontamination process with gamma ionization.

A tool was developed, entitled “logistical protocol for decontaminating collections with gamma ionization”. The drafting of the aforementioned protocol comprised four actions:

- a) bibliographic surveys of ionization, identifying the existence of protocols by Nagai (2019) [1], focusing on photographic and cinematographic films and by Lima (2021) [2], on herbal material;
- b) bibliographical surveys on logistical steps, in Rosado (2008) [3], Teixeira, Ghizoni (2012) [4] and Feitosa *et. al* (2013) [5], in addition to documents quoted by them;
- c) elaboration of a gamma ionization flowchart process by CETER;
- d) writing of the protocol in question with contributions from experimental research.

Application to collections at the Federal University of Pernambuco could constitute a new paradigm in the conservation of institutional memory, as this has not yet been carried out in the organization. The technique was used in a fraction of the collection of rare material at the UFPE Health Sciences Center, which has a collection of books and periodicals from the end of the 19th century, of great relevance to researchers. There are contaminated items in this collection due to time and storage conditions.

### 3. Results and Discussion

The accomplishment of the experimental research included steps is detailed in table I. This schedule is also detailed below.

Table I: Experimental research schedule.

Steps	Dates
1 Approval to carry out experimental research	Jun./2021
2 Decision to decontaminate a collection fraction with gamma ionization	Nov./2022
3 Selection of material to be decontaminated	Dec./2022
4 Coordination of the decontamination procedure with CETER/IPEN	Jan./2023
5 Packaging of the material to be transported	May/2023
6 Transport of material to CETER/IPEN	May/2023
7 Receipt of material by CETER/IPEN	Aug./2023
8 Ionization of the collection fraction	Date: 08/10/2023
9 Return of post-ionization material	Aug. to Dec./2023

The first stage, approval of the experimental research on decontaminating a fraction of the collection with gamma ionization, occurred when the research project was approved. The second one, decision to decontaminate a fraction from the special collection from the Health Sciences Center library, comprised: clarification to the coordination of the aforementioned library, regarding the effectiveness and safety of the application of nuclear technology; acceptance of the decontamination proposal by supervisor; and indication of the coordinator for the decontamination process.

The third, selection of material to be decontaminated, covered the importance of the books for the library and UFPE itself, their value as a source of information, the state of conservation, the possibility of being taken out of the special collection for a period and their physical dimensions. Finally, choosing two books that met the aforementioned selection criteria.

The fourth, coordination of the decontamination procedure by CETER/IPEN, consisted of: filling out and sending the request letter form; receipt of acceptance communication by CETER/IPEN; scheduling the irradiation date; and forwarding the irradiation form to CETER/IPEN.

The fifth one, packaging of books to be ionized, included:

- wrapping in brown paper sheets; packaging in a cardboard box reinforced with adhesive tape, with the interior lined with clean, crumpled paper to stabilize vibrations and impacts;
- covering the box externally with sheets of brown paper;
- registration of the following words on the outside: collection fraction, Federal University of Pernambuco, Health Sciences Center and date of ionization, 08/10/23 (figure 1).

The packaging of the box and each book as well had two functions, protective and stabilizing.

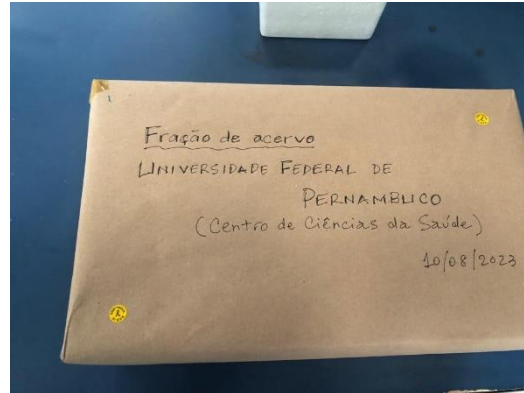


Figure 1: Part of the collection, packaged.

The sixth, transporting the books to CETER/IPEN, consisted of:

- a) decision on the means of transportation (aerial);
- b) decision on where to transport the books: the personal luggage of the coordinator for the decontamination process;
- c) taking the irradiation form issued by CETER/IPEN;
- d) transfer of packed books to Recife airport and then from Guarulhos airport to CETER/IPEN.

The seventh one, receipt of the books by CETER/IPEN, involved two steps: delivery of the books and the irradiation form by the coordinator of the decontamination process to the person responsible and checking of the irradiation form by the aforementioned recipient.

Finally, the last two steps:

- a) calculation of irradiation time, approximately 4 hours of exposure;
- b) calculation of the irradiation dose, 6 kGy of  $^{60}\text{Co}$ , one of the five doses indicated as successful by Choi *et al.* (2012) [6] and the minimum for eliminating fungi for Vasquez, Nagai (2020) [7];
- c) presence of the coordinator of the decontamination process on the CETER/IPEN premises during the ionization process (figure 2);
- d) receipt of post-ionization books by the coordinator;
- e) transportation of ionized books to Guarulhos airport, and then from Recife airport to the CCS/UFPE library and return of ionized books to the aforementioned library.



Figure 2: Multipurpose irradiator, CETER/IPEN.

#### 4. Conclusions

The practice of decontaminating a fraction from a collection, specifically two books from the special collection of the CCS/UFPE library with gamma ionization, carried out by CETER/IPEN, occurred successfully in all stages and in a planned manner. The gamma ionization protocol for decontaminating collections was developed and is intended to guide professionals who work with cultural assets in the decontamination of infested or infected material using the CETER/IPEN multipurpose irradiator.

To summarize, the steps taken into account in the research process were: decision for gamma ionization; acceptance by the agents involved; selection of material for decontamination; coordination with IPEN; transport; material handling and movement; packaging; receipt of material by CETER/IPEN; ionization of the material; return of material; certificate of irradiation and post-ionization material hygiene.

The purpose of preparing a technical booklet was achieved; which serves as a guide for managers. Future studies to deepen the stages herein described may be appropriate in this context.

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