Code of Hygienic Practice for Radiation Processing of Food
Foreword

The Philippine National Standard on the *Code of Practice for Radiation Processing of Food* was developed to provide guidance for the relevant stakeholders on the sanitary and phytosanitary aspects of radiation processing. The Codex Alimentarius Commission developed two (2) standards that deal with the regulatory control of food irradiation, these are: *General Standard for Irradiated Foods* (CODEX STAN 106-1983, Rev. 1-2003) and *Code of Practice for Radiation Processing of Food* (CAC/RCP 19-1979). In 2003, the Codex Alimentarius Commission revised the *Code of Practice for Radiation Processing of Food* (CAC/RCP 19-1979, Rev. 1-2003). This Code of Practice is an adoption of the revised Codex Code of Practice with additional inputs from the *Good Food Irradiation Practice* developed by the International Atomic Energy Agency (IAEA) in 2013.

A Technical Working Group (TWG) was created through Special Order No. 220 Series of 2014 to develop the draft Code of Practice for Radiation Processing of Food. The TWG represented the relevant agencies of the Department of Agriculture (DA), Department of Science and Technology (DOST), Department of Trade and Industry (DTI) and the University of the Philippines (UP). Public consultations were conducted in Regions 7, 11 and the National Capital Region (NCR), which represented the major and possible users of irradiation facilities. Comments and recommendations were solicited from the relevant government agencies, academe, private sector and non-government organizations. Therefore, this Code of Practice is the final output of the public-private sector collaboration between, and among the TWG and the relevant stakeholders who participated in the public consultations.
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</table>
I. INTRODUCTION

1. Food irradiation is the processing of food products by ionizing radiation (gamma rays, X-rays or accelerated electrons) in order to, among other things, control foodborne pathogens, reduce microbial load and insect infestation, inhibit the germination of root crops, and extend the shelf life of perishable foods. During irradiation, energy is transferred from a source of ionizing radiation into the product. In relation to trade, it helps the government respond to the increasing sanitary and phytosanitary requirements for trading food products.

2. Foods may be irradiated for sanitary or for phytosanitary purposes as shown in Table 1.

<table>
<thead>
<tr>
<th>Dose (kGy)</th>
<th>Technological Purpose</th>
<th>Example of Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>Prevent sprouting</td>
<td>Garlic, onion, potatoes, yams</td>
</tr>
<tr>
<td></td>
<td>Kill worms (<em>Trichinella spiralis</em>)</td>
<td>Pork carcasses</td>
</tr>
<tr>
<td></td>
<td>Kill insects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phytosanitary measure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prevent infestation</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Delay ripening</td>
<td>Some fresh fruit</td>
</tr>
<tr>
<td></td>
<td>Inactivate pathogens</td>
<td>Meat, poultry, fish, seafood, fresh or frozen</td>
</tr>
<tr>
<td></td>
<td>(<em>Salmonella, Campylobacter…</em>)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inactivate microorganisms</td>
<td>Meat, poultry, fish</td>
</tr>
<tr>
<td></td>
<td>Extend shelf-life</td>
<td>Dried food ingredients, spices</td>
</tr>
<tr>
<td></td>
<td>Improve hygiene</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Sterilize</td>
<td>Food for patients on special diet, astronauts</td>
</tr>
</tbody>
</table>

3. Currently, the two (2) Philippine national regulations governing food irradiation are:

   a. *Prescribing Regulations of Irradiated Food*: Department of Health (DOH) Administrative Order (AO) No. 152 Series of 2004; and

4. The purposes of the regulatory controls of irradiated food products are:

a. to ensure that radiation processing of food products is implemented safely and correctly, in accordance with all relevant Philippine National Standards and codes of hygienic practice;

b. to establish a system of documentation to accompany irradiated food products, so that irradiation as a processing method can be taken into account during subsequent handling, storage, distribution and marketing; and

c. to ensure that exported and imported irradiated food products conform to acceptable standards of radiation processing and are correctly labeled.

5. Part 1 of this Code is to provide principles for the processing of food products with ionizing radiation that are consistent with relevant Philippine National Standards and codes of hygienic practice, and with Codex standards. Food irradiation shall be incorporated as part of a Hazard Analysis and Critical Control Point (HACCP) plan, where applicable, however, a HACCP plan is not required for the use of radiation processing of food processed for technological purposes other than for food safety as specified in Table 1. Part 2 of this Code will provide guidance to the irradiator operator to apply the Code of Practice for Radiation Processing of Food (CAC/RCP 19-0979, Rev. 1-2003), and the Codex Recommended International Code of Practice- General Principles of Food Hygiene (CAC/RCP 1-1969, Rev. 4-2003), where applicable for food safety purposes, to foods processed by ionizing radiation.

II. OBJECTIVE

6. This Code of Practice for Radiation Processing of Food identifies the essential practices to be implemented to achieve effective radiation processing of food in a manner that maintains safety and quality in food products suitable for human consumption.

III. SCOPE, USE AND DEFINITION

3.1 Scope

7. This Code covers all food processed by gamma rays, X-rays or accelerated electrons for the purpose of, among other things, control of foodborne pathogens, reduction of microbial load, control of quarantine pest, inhibition of the germination of root crops, and extension of shelf life.

8. This Code also covers the requirements of the irradiation process in a facility. It also considers other aspects of the process as primary production, post-harvest treatment, storage and shipment, packaging, irradiation, labeling, post-irradiation storage and handling, and training.
3.2  Use

9. The Revised Guidelines on current Good Manufacturing Practice in Manufacturing, Packing, Repacking, or Holding Food (DOH AO No. 153 Series of 2004), as well as other relevant Philippine National Standards and codes of hygienic practice should be used in conjunction with this document. The national regulations of particular relevance are: (1) DOH AO No. 152 Series of 2004; and (2) BPI Quarantine AO No. 02 Series of 2008.

3.3 Definition

10. For purposes of this Code, the following are operationally defined:

Dose - the absorbed dose, sometimes referred to simply as 'dose', is the amount of energy absorbed per unit mass of irradiated food product. Gray (Gy) is the unit of absorbed dose which is equivalent to 1 joule/kg.

Dose (maximum) – the highest dose from which structural integrity, functional property and sensory attributes are not adversely affected.

Dose (minimum) – the lowest dose from which a defined technological purpose is reached.

Dose Distribution - the spatial variation in absorbed dose throughout the process load with extreme values being the maximum absorbed dose and the minimum absorbed dose.

Dose Limit - the minimum or maximum radiation dose absorbed by a food product prescribed in regulations as required for technological reasons. Such dose limits are expressed as ranges or as single lower or upper values (i.e. no part of the food product shall absorb less than or more than a specified amount).

Dose Uniformity Ratio - the ratio of maximum to minimum absorbed dose in the process load.

Dosimeters – a device having a reproducible, measurable response to irradiation which can be used to measure the absorbed dose in a given system.

Dosimetry - the measurement of the absorbed dose of radiation at a particular point in a given absorbing medium.

Dosimetry System – includes the dosimeters, the instruments that measure them, the procedures and the standards.

Food - refers to any substance or product whether processed, partially processed or unprocessed that is intended for human consumption. It includes drinks, chewing gum, water and other substances which are intentionally incorporated into the food during its manufacture, preparation and treatment.
**Food Irradiation** - processing of food products by ionizing radiation for a technological objective or to serve a hygienic purpose.

**Ionizing Radiation** – charged particles and electromagnetic waves that as a result of physical interaction create ions by either primary or secondary process.

**Irradiation Facility** - establishment where the irradiation process is performed. There are different types of irradiation facilities depending on the irradiator type, the radiation source, the conveyor system and the operating mode. It consists of an irradiator, shipping and receiving docks, storage zones for irradiated and non-irradiated products, conveyor system, safety systems, and the infrastructure for personnel and facility services, including record control.

**Irradiator** - the assembly of equipment and its housing where product is exposed to ionizing radiation. The irradiator provides for safe and reliable radiation processing and includes the source of radiation and associated mechanisms together with the conveyor, safety devices and biological shield.

**Irradiator Operator** – organization or body responsible for irradiating the product.

**Irradiated Food** - any food product, which has been subjected to treatment by ionizing radiation with an appropriate absorbed dose. This does not apply to foods exposed to radiation imparted by measuring instruments for inspection purposes.

**Phytosanitary Treatment** - includes preventing the introduction or spread of regulated pests. This may be realized by achieving certain response in the targeted pests such as mortality, preventing successful development (no emergence of adults), inability to reproduce (e.g. sterility) or inactivation. The treatment may be performed prior to export or in the importing country.

**Primary Production** - refers to the production, rearing or growing of primary products including harvesting, milking and farmed animal production up to slaughter, and the rearing and growing of fish and other seafood in aquaculture ponds. It also includes fishing and the hunting and catching of wild products.

**Process Load** - a volume of a material with specified loading configuration irradiated as a single entity.

**Sanitary Treatment** – includes applications based on the lethal effects of irradiation on: microorganisms, such as those causing foodborne disease, reducing storage time or shelf life, or contaminating products to an unacceptable level for the intended use; parasites, such as the helminthes that can infest carcasses; and insects that cause post-harvest losses. Sanitary measures also include applications based on the physiological effects of irradiation on plants such as: inhibition of sprouting; delayed senescence; and delayed ripening.

**Stakeholders** – refer to the food manufacturers/processors intending to use irradiation for their products, operators of irradiation facilities, importers, exporters, regulators of irradiated foods, and researchers from private and public institutions.
PART 1

PRE-IRRADIATION TREATMENT

I Primary Production


12. The irradiation of food is justified when it fulfills a technological requirement and/or is beneficial for the protection of the consumer health. Irradiation cannot be used to correct quality deficiencies. Undue contamination with microorganisms and pests prior to irradiation should be avoided, and where contamination appears unavoidable, all possible measures should be taken to make it minimum.

13. The *IAEA Good Food Irradiation Practices* (*IAEA, 2013*) provides recommendations for the sanitary and phytosanitary applications of food irradiation for various product classes. It also identifies recommended food safety and quality specifications for each product class prior to treatment.

14. The requirements to ensure that the product or commodity is suitable for an effective irradiation treatment are also contained in the International Standards for Phytosanitary Measures (ISPM) (*ISPM 18: Guidelines for the Use of Irradiation as Phytosanitary Measures*).

II Packaging

15. In general for sanitary treatments, in order to avoid contamination or infestation after irradiation, food should be packaged in materials that provide an effective barrier to re-contamination and re-infestation. Packaging should meet the requirements of the buyer, the irradiation facility, and concerned regulators.

16. For phytosanitary treatments, the articles should be contained in insect-proof packaging (*e.g.* insect proof cartons) which has no openings that will allow the entry of regulated pests. If openings are necessary for ventilation, they should be covered with mesh of a size that will not allow entry of pests. The cartons may be constructed of any material that prevents the entry of pests and prevents oviposition into the articles in the carton. At present, fresh produce in modified atmosphere packaging (MAP) is generally not recommended for irradiation.

17. If phytosanitary treatments are not conducted in insect proof packaging, treated lots should be wrapped before leaving the irradiation facility in one of the following ways:
• With shrink wrap;
• With net wrapping; or
• With strapping, so that each carton on an outside row of the pallet load is constrained by a metal or plastic strap.

18. The size, shape and type of containers that may be used for irradiation are determined, in part, by the operating characteristics of the irradiation facility. These characteristics include the product transport system and the irradiation source, as they affect the dose distribution within the container.

III Handling, Storage and Transport

19. Food intended for radiation processing should conform to handling, storage and transport requirements of the DOH AO No. 153 Series of 2004, CAC/RCP 1-1969, Rev. 4-2003, as well as relevant PNS, other Codex standards and codes of practice for specific food products. All stages of the processing, i.e., pre-irradiation, irradiation and post-irradiation, should be in accordance with Good Agricultural Practices (GAP) and current Good Manufacturing Practices (cGMP) to maximize quality, to minimize contamination, and, if packaged, to maintain package integrity.

PART 2

IRRADIATION PROCESS

I Irradiation Facility Requirements

1.1 Regulatory Requirements

20. Food irradiation facilities should seek license or official accreditation from the relevant competent authorities for radiation processing to irradiate food products. License or official accreditation are issued for specific classes or groups of food products.

21. For gamma irradiation facilities (using Cobalt-60 or Cesium-137 radionuclides), a license for the use of radioactive sources should be acquired from the Philippine Nuclear Research Institute (PNRI), Department of Science and Technology (DOST). For electron beam and X-ray irradiation facilities, a license should be acquired from the Food and Drug Administration-Center for Device Regulation, Radiation Health, and Research (FDA-CDRRHR), DOH.

1.2 Design and Layout

22. Radiation facilities should be designed to provide an absorbed dose in the food product within minimum and maximum limits in accordance with process specifications and government regulatory requirements. For economic and technical reasons (e.g. maintaining product quality), various techniques are used to minimize the dose uniformity ratio.
The following factors largely govern the selection of irradiator design:

a) Means of transporting food products: The mechanical design of the irradiation and transport systems, including the source-to-product geometry in a given process, as required by the form of the product, e.g. bulk or packaged, and its properties.

b) Range of doses: The range of doses needed to process a wide variety of products for various applications.

c) Throughput: The amount of product to be processed within a defined period of time.

d) Reliability: The property of providing correct performance as needed.

e) Safety-systems: The systems intended to protect operating personnel from hazards posed by radiation.

f) Compliance: The adherence to cGMP and relevant government regulations.

g) Capital and operational costs: The basic economic considerations necessary for sustainable operation.

23. An irradiation facility is essentially a warehouse that contains an irradiator as shown in Figure 1. An irradiator (Figures 2 or 3) is composed of a bunker in which products are exposed to a source of ionizing radiation. In electron beam and X-ray irradiators, switching off the power supply stops the emission of the beam. In gamma irradiators, emission of gamma rays cannot be stopped so the source needs to be placed into a pit (dry storage) or at the bottom of a pool (wet storage) to stop product irradiation. The thickness of the bunker walls should be such that it is safe to be in immediate proximity outside the irradiator where irradiation is taking place. In continuous irradiators, there should be a maze (or labyrinth), a passage linking two areas that is designed to follow a tortuous path such that no radiation originating in one area can reach the other area without undergoing at least one reflection or scattering off the passage wall. Products can thus enter and leave the irradiator without having to interrupt irradiation. In batch irradiators, a maze is not needed since irradiation is interrupted while products are taken in and out of the irradiation chamber. In some batch models, packaged products to be irradiated are lowered in a “bell” to the bottom of a pool where a radiation field is created by fixed radioactive sources.

24. Irradiation facilities should be laid out to provide separate storage for irradiated and non-irradiated food products (under ambient, refrigerated and/or freezing temperature conditions), an irradiator, and the normal accommodation and infrastructure for staff and plant services, including record maintenance. Where the power supply is not stable, a backup generator should be available.

25. Where products are treated for phytosanitary purpose, there should be holding rooms secured at all times to prevent re-infestation of treated products. Extra
fixtures such as double doors, air curtains, screens on windows and other openings, and loading dock seals are required to prevent the possibilities of insects entering the warehouse.

II Radiation Sources

26. As described in the DOH AO No. 152 Series of 2004, the following sources of ionizing radiation may be used in food irradiation (see Figure 4):

a. Gamma rays from radionuclides Cobalt-60 or Cesium-137;

b. X-rays generated from machine sources operated at or below an energy level of 7.5 MeV; and

c. Electrons generated from machine sources operated at or below an energy level of 10 MeV.

The ways in which ionizing radiation are produced differ as shown in Figure 5. The dose rates, or quantity of energy absorbed per unit of time, which determine the processing times, also differ. Usually, the orders of magnitude are:

- kGy per hour for gamma radiation
- kGy per minute for X-rays
- kGy per second for electron beams

III Irradiation and Dosimetry

3.1 Process Determination

27. All steps in the determination of process procedures should be documented to:

a. ensure that the application of the process complies with relevant regulatory requirements;

b. establish a clear statement for the technological objectives of the process;

c. estimate the dose range to be applied to achieve the technological objective based on appropriate knowledge of the food product (see Table 2);

d. demonstrate that irradiation of test samples has been carried out to confirm the estimated dose range under practical production conditions;

e. ensure that technological requirements (e.g. dose range and effectiveness of treatment) are met under practical production conditions; and

f. establish the process parameters under practical production conditions.
3.2 Dosimetry

28. Select appropriate dosimetry system for radiation processing of food, depending on the dose range needed to achieve a particular technological objective, cost, availability, and ease of use.

29. Relevant ISO/American Society for Testing and Material (ASTM) standard practices and guides for dosimetry in food irradiation facilities should be consulted. The calibration of the dosimetry system used in radiation processing should be traceable (i.e., calibrated) to national and international standards.

30. The overall influence of various parameters (e.g. radiation source type, activity and geometry; conveyor speed and irradiation time; food product density and loading configuration; and carrier size and shape) on dose distribution should be taken into account. This is to ensure that the intended technological objective is achieved throughout the irradiation lot since absorbed dose is the key element that governs the process.

IV Process Control

4.1 Requirements for Process Control

31. Requirements for process control are indicated in the DOH AO No. 152 Series of 2004. Measuring the dose and monitoring of the physical parameters of the process (e.g. conveyor speed, irradiation time) are essential for process control. The need for adequate record keeping, including records of quantitative dosimetry, is emphasized in CAC/RCP 19-1979, Rev. 1-2003.

32. Irradiation of products should take place only if the facility is in good working condition.

33. The irradiator operator should record incoming products and give them a unique code related to the customer lot identification in order to identify products at each step in their path through the irradiation facility. This unique code should appear on all related records for easy reconciliation. The organization sending products to the irradiator operator should ensure compliance to Part 1 of this Code.

34. There should be procedures to handle products and maintain their integrity before, during, and after irradiation. Systems for quantifying product and maintaining product inventory should be implemented throughout product receiving, loading, unloading, handling and release. Any discrepancy in the inventory or damage to product should be resolved before processing and/or release.
### Table 2 - Recommended Technological Dose Range for the Irradiation of Foods (DOH, 2004)

<table>
<thead>
<tr>
<th>Classes of Food</th>
<th>Purpose of Treatment</th>
<th>Technological Dose Range (kGy)</th>
<th>Minimum Dose</th>
<th>Maximum Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1: Bulbs, roots and tubers</td>
<td>inhibition of sprouting</td>
<td></td>
<td>0.05</td>
<td>0.2</td>
</tr>
<tr>
<td>Class 2: Fresh fruits and vegetables (other than class 1)</td>
<td>a) delay of ripening</td>
<td></td>
<td>0.20</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>b) shelf-life extension</td>
<td></td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>c) quarantine control*</td>
<td></td>
<td>0.15</td>
<td>1.0</td>
</tr>
<tr>
<td>Class 3: Cereals and their milled products, nuts, oil seeds, pulses, dried fruits</td>
<td>a) insect disinfestation*</td>
<td></td>
<td>0.25</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>b) reduction of microbial load</td>
<td></td>
<td>1.5</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>c) inhibition sprouting</td>
<td></td>
<td>0.15</td>
<td>1.0</td>
</tr>
<tr>
<td>Class 4: Fish, seafood and their products, frog legs, freshwater and terrestrial invertebrates (fresh or frozen)</td>
<td>a) reduction of pathogenic microorganisms **</td>
<td></td>
<td>1.0</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>b) shelf-life extension</td>
<td></td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>c) control of infection by parasites **</td>
<td></td>
<td>0.1</td>
<td>2.0</td>
</tr>
<tr>
<td>Class 5: Raw poultry and meat and their products (fresh and frozen)</td>
<td>a) reduction of pathogenic microorganisms **</td>
<td></td>
<td>1.0</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>b) shelf-life extension</td>
<td></td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>c) control of infection by parasites **</td>
<td></td>
<td>0.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Class 6: Dry vegetables, spices, condiments, dried herbs and herbal tea</td>
<td>a) reduction of pathogenic microorganisms **</td>
<td></td>
<td>2.0</td>
<td>30.0</td>
</tr>
<tr>
<td></td>
<td>b) insect disinfestation*</td>
<td></td>
<td>0.3</td>
<td>1.0</td>
</tr>
<tr>
<td>Class 7: Dried food of animal origin</td>
<td>a) insect disinfestation*</td>
<td></td>
<td>0.3</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>b) control of molds</td>
<td></td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>c) reduction of pathogenic microorganisms **</td>
<td></td>
<td>2.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Class 8: Ethnic food and miscellaneous foods, including but not limited to: health foods, ethnic preparations of hospital foods, gum arabic and other thickeners, military rations, honey, space foods, special spices, eggs</td>
<td>a) reduction of pathogenic microorganisms **</td>
<td></td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>b) sterilization</td>
<td></td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>c) quarantine control*</td>
<td></td>
<td>***</td>
<td>***</td>
</tr>
</tbody>
</table>

* Minimum dose may be specified for a particular pest  
** Minimum dose may be specified keeping in mind the objective of the treatment to ensure hygienic quality of food  
*** Maximum dose to be specified for particular purpose and foodstuff
35. Dose distribution measurements should be carried out to characterize the process for each food product. Dosimeters should be used routinely to monitor correct execution of the process in accordance with internationally accepted procedures. Dosimeters should be placed in the process load, at the predetermined maximum and minimum dose positions or at a qualified reference dose location with the required frequency.

36. In continuous gamma irradiators, the frequency of dosimeters should be such that there should always be at least one dosimeter inside the irradiation chamber. In addition, a dosimeter should be placed on the first and last irradiation container of a production run. In an electron beam facility, there should always be one dosimeter at the start of a production run. For long runs, dosimeters should also be placed at minimum near the middle of the run and at the end of the run, and at other intervals as appropriate.

32. Products should be loaded in the product loading configuration according to the process specification. Only authorized personnel should set the process parameters.

33. Products should be placed in the specified zone of the treated products area. The processing records, the quantity, and the integrity of the products should be checked and any issue resolved before release.

34. Dosimeters should be retrieved, counted and stored properly before reading. Validation of dosimeter readings should be undertaken at regular frequency. Dosimeter records should be available to provide traceability.

35. There should be a procedure in place to handle out-of-specification results. This may involve informing competent authorities or communication with the customer. All out-of-specification results should be recorded as a non-conformance and an investigation should be performed to include root cause analysis, and the implementation of correction, corrective action and/or preventive action.

4.2 Product and Inventory Controls

36. An adequate system should be in place so that specific consignments of food products can be traced back both to the irradiation facility and the source from which they were received for processing.

37. Plant design and administrative procedures should ensure that it is impossible to mix irradiated and non-irradiated food products. Incoming products should be recorded and given a code number to identify the packages at each step in its path through the irradiation plant. All relevant parameters such as date, time, minimum and maximum dose, etc. should be recorded against the code number of the products.

38. Appropriate means, such as physical barriers, should be employed to keep the irradiated and non-irradiated products separate. Color change indicator label on each package may also be used to distinguish irradiated and non-irradiated products.
V Post-Irradiation Storage and Handling

39. Stakeholders should refer to the CAC/RCP 1-1969, Rev. 4-2003 and DOH AO No. 153 Series of 2004 for general storage and handling guidelines. For phytosanitary treatment, BPI AO No.02 Series of 2008 should be used as reference.

VI Labeling

40. The DOH AO No. 152 Series of 2004 and the BPI Quarantine AO No. 02 Series of 2008 contain provisions for labeling of irradiated foods. This include the following, aside from the mandatory labeling information required for pre-packaged food in the Revised Rules and Regulations Governing the Labeling of Prepackaged Food Products (DOH AO No. 2014-0030); the internationally recognized radura symbol (Figure 6) and/or the statement “treated by irradiation” or “treated with radiation,” and treatment facility identification name and/or number and location. All food labeling should meet any additional requirements established by the relevant authorities.

VII Documentation and Recordkeeping

41. Irradiator operator should maintain adequate records showing the food processed, identifying marks if packaged or if not, the bulk density of the food, the dosimetry results, including the type of dosimeters used and details of their calibration, the date of irradiation and the type of radiation source. Other documents to be maintained are also specified in the DOH AO No. 152 Series of 2004. All documentation should be available to authorized personnel and accessible for a period of time established by food control authorities.

VIII Requirements for Personnel

42. In order to implement these irradiation practices, facilities should be adequately staffed by competent personnel trained in dosimetry and its application in radiation processing. The personnel of an irradiation facility should comply with relevant sections of the DOH AO No. 153 Series of 2004 for personal hygiene guidelines and the CODEX STAN 106-1983, REV. 1-2003 for adequate, trained and competent personnel. The management should ensure that the employees are aware of the relevance and importance of their activities. In each employee’s file there should be an updated job description and list of critical tasks for which the employee is authorized.

43. There should be a plan to train employees in order to provide new or updated knowledge or skills.
Figure 1 - Typical Layout of an Irradiation Facility (IAEA, 2013)

Figure 2 - Elements of a Gamma Irradiator (IAEA, 2013)
Figure 3 - Elements of an Electron Beam Irradiator (IAEA, 2013)
**Figure 4 - Sources of Ionizing Radiation Used in Food Irradiation (IAEA, 2013)**

- **Gamma Radiation**
  - Photons
  - No static mass
  - No electric charge
  - Good penetration
  - Whole pallets can be treated

- **X-rays**
  - Photons

- **Accelerated Electrons**
  - Electrons
  - Mass
  - Electric charge
  - Limited penetration
  - Treatment by cartons

- **Man-made radioisotope** (Cobalt-60 or Cesium-137)
  - Emission cannot be stopped
  - Continuous operation (24/7)

- **Machines using electricity**
  - Emission can be switched on/off
  - Non continuous operation

**Figure 5 - Production of Ionizing Radiation (IAEA, 2013)**
Figure 6. Radura International Logo.
REFERENCES


Code of Philippine Nuclear Research Institute Regulations (CPR) Part 15: Licenses for Large Irradiators.


Department of Health (DOH) AO No. 152 Series of 2004: Prescribing Regulations of Irradiated Food.


International Standards for Phytosanitary Measures (ISPM 18): Guidelines for the Use of Irradiation as Phytosanitary Measures.

PNRI: Irradiation for Food Safety and Quality. 2007.

PNS/BAFPS 129:2013 Code of good agricultural practices (GAP) for banana production

PNS/BAFPS 49:2011 Code of good agricultural practices (GAP) for fruits and vegetable farming

PNS/BAFPS 45:2009 Code of good agricultural practices for Mango

PNS/BAFPS 108:2014 Code of good agricultural practices (GAP) for onion production

PNS/BAFPS 60:2008 Code of good animal husbandry practices (GAHP)


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