



Designation: F 1355 – 99

Standard Guide for Irradiation of Fresh Fruits as a Phytosanitary Treatment¹

This standard is issued under the fixed designation F 1355; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

The purpose of this guide is to present information on the use of ionizing energy (radiation) in treating certain fresh fruits to control insects and other arthropod pests, in order to meet phytosanitary requirements.²

This guide is intended to serve as a recommendation to be followed when using irradiation technology where approved by an appropriate regulatory authority. It is not to be construed as a requirement for the use of irradiation nor as a required code of practice. While the use of irradiation involves certain essential requirements to attain the objective of the treatment, some parameters can be varied in optimizing the process.

This guide has been prepared from a Code of Good Irradiation Practice published by the International Consultative Group on Food Irradiation (ICGFI), under the auspices of the Food and Agriculture Organization (FAO), the World Health Organization (WHO), and the International Atomic Energy Agency (IAEA).³

1. Scope

1.1 This guide provides procedures for the radiation processing of fresh fruits as a phytosanitary treatment. Because many insect pests are found on more than one type of fruit, this guide is directed primarily toward the treatment needed to control certain insect pests commonly associated with various fresh fruits.

1.2 The absorbed dose range covered by this guide is between 75 gray (Gy) and 1.0 kilogray (kGy). The practical minimum or maximum dose of a treatment may be higher or lower than this range, depending on the type of pest to be controlled and the radiation tolerance of a particular type of fruit. If the minimum effective dose necessary to achieve the desired phytosanitary effect is greater than the radiation tolerance of the fruit, then irradiation is not an appropriate treatment (see 5.2).

2. Referenced Documents

2.1 ASTM Standards:

E 170 Terminology Relating to Radiation Measurements and Dosimetry⁴

E 1204 Practice for Dosimetry in Gamma Irradiation Facilities for Food Processing⁴

E 1261 Guide for the Selection and Calibration of Dosimetry Systems for Radiation Processing⁴

E 1431 Practice for Dosimetry in Electron and Bremsstrahlung Irradiation Facilities for Food Processing⁴

E 1539 Guide for Use of Radiation-Sensitive Indicators⁴

F 1640 Guide for Packaging Materials for Food to be Irradiated⁵

2.2 *Codex Alimentarius Commission Recommended International Codes and Standards:*⁶

STAN 1-1985 General Standard for the Labelling of Pre-packaged Foods

STAN 106-1983 General Standard for Irradiated Food

2.3 *ISO Standards:*⁷

ISO 873 Peaches—Guide to Cold Storage

ISO 931 Green Bananas—Guide to Storage and Transport

ISO 1134 Pears—Guide to Cold Storage

ISO 1212 Apples—Guide to Cold Storage

ISO 1838 Fresh Pineapples—Guide to Storage and Transport

¹ This guide is under the jurisdiction of ASTM Committee E-10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.06 on Food Irradiation Processing and Packaging.

Current edition approved May 10, 1999. Published August 1999. Originally published as F 1355 – 91. Last previous edition F 1355 – 93.

² The term pests is used in this guide to mean insects and other arthropod pests.

³ International Consultative Group on Food Irradiation, *Code of Good Irradiation Practice for Insect Disinfestation of Fresh Fruits (As a Quarantine Treatment)*, ICGFI Document No. 7, Issued by the Secretariat of ICGFI, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Vienna, Austria, 1991.

⁴ *Annual Book of ASTM Standards*, Vol 12.02

⁵ *Annual Book of ASTM Standards*, Vol 15.09.

⁶ Available from Joint FAO/WHO Food Standards Programme Joint Office, FAO, Via delle Terme di Caracalla 00100 Rome, Italy.

⁷ Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

ISO 2168 Table Grapes—Guide to Cold Storage
 ISO 2826 Apricots—Guide to Cold Storage
 ISO 3631 Citrus Fruits—Guide to Cold Storage
 ISO 3659 Fruits and Vegetables—Ripening After Cold Storage
 ISO 6660 Mangoes—Guide to Storage
 ISO 6661 Fresh Fruits and Vegetables—Arrangement of Parallelepipedic Packages in Land Transport Vehicles
 ISO 6664 Bilberries and Blueberries—Guide To Cold Storage
 ISO 6665 Strawberries—Guide to Cold Storage
 ISO 6949 Fruits and Vegetables—Principles and Techniques of the Controlled Atmosphere Method of Storage
 ISO 7558 Guide to the Prepacking of Fruits and Vegetables

3. Terminology

3.1 *Definitions*—Other terms used in this guide may be defined in Terminology E 170.

3.1.1 *absorbed dose, n*—the quantity of energy from ionizing radiation absorbed per unit mass of a specified material (for example, food). The special name for the unit of absorbed dose is the gray (Gy). One Gy is equal to one joule of absorbed energy per kilogram of food. Formerly, the unit of absorbed dose was the rad (1 rad=0.01 Gy).

3.1.1.1 *Discussion*—A standard definition of absorbed dose appears in Terminology E 170.

3.1.2 *dose distribution, n*—the variation in absorbed dose within a process load exposed to ionizing radiation.

3.1.3 *phytosanitary, n*—pertaining to the killing, removal, or rendering infertile of regulated plant pests on shipped commodities.

3.1.3.1 *Discussion*—The term “phytosanitary treatment” includes, but is not limited to, treatment to satisfy quarantine requirements.

3.1.4 *process load, n*—a volume of material with a specified loading configuration irradiated as a single entity.

3.1.5 *transport system, n*—the conveyor or other mechanical means used to move the process load through the irradiator.

4. Significance and Use

4.1 The purpose of radiation treatment, as referred to in this guide, is to accomplish appropriate and effective control of agricultural pests that infest fresh fruits.

4.2 The objective of irradiation as a phytosanitary treatment is usually to prevent development or emergence of the adult stage, in fruits where adult pests are not present (for example, fruit flies) or to sterilize the adult pest, where the adult stage is present (for example, weevils).

5. Selection of Fruits for Irradiation

5.1 Most fresh fruits are not adversely affected at the doses indicated in 7.5.2. In particular, the following fruits have been found to be tolerant of those doses: apple, cantaloupe, carambola, cherry, citrus, currant, date, fig, grape, guava, honeydew melon, kiwi, lychee, mango, muskmelon, nectarine, papaya, peach, prune, raspberry, strawberry, and tomato.

5.2 Other fruits may be damaged or exhibit unacceptable changes in shelf-life, color, taste, or other properties at the

doses indicated. If fruits other than those listed above are considered for irradiation as a phytosanitary treatment, it is necessary to evaluate the effects of irradiation on the fruit at the required dose level. Differences among varieties, origins, growing and harvest conditions of a fruit, and elapsed time between harvest and processing should be considered.

5.3 Only fruits of good marketable quality should be accepted for irradiation. Irradiation may preserve quality, but it will not improve it.

6. Pre-Irradiation Product Handling and Treatment

6.1 Fruits to be irradiated should be of good overall quality and reflect the results of good agronomic practices.

6.2 Normal storage procedures should be used prior to radiation treatment. Pre-irradiation storage should include appropriate temperature and atmospheric conditions. Information on storage conditions is provided in ISO Standards (see 2.3).

6.3 There are no special requirements for treatment or handling of fruits before irradiation except to provide means to prevent post-irradiation re-infestation. A safeguard system that provides adequate security (for example, product packaging or storage in a separate, insect-free room) should be provided. Irradiation combined with other forms of treatment may improve efficacy, increase the range of pests controlled, or further improve product shelf-life.

6.4 *Product Separation*—It may not be possible to distinguish irradiated from unirradiated product by inspection. It is therefore important that appropriate means integral with facility design, such as physical barriers or clearly defined staging areas, be used to maintain unirradiated product separate from irradiated product.

7. Irradiation

7.1 *Scheduled Process*—Irradiation of food should conform to a scheduled process. A scheduled process for food irradiation is a written procedure that is used to ensure that the absorbed dose range and irradiation conditions selected by the radiation processor are adequate under commercial processing conditions to achieve the intended effect on a specific product in a specific facility. The scheduled process should be established and validated by qualified persons having expert knowledge in irradiation requirements specific for the food and the processor's irradiation facility.

7.2 *Radiation Sources*—The sources of ionizing radiation that may be used in irradiating fruits are limited to the following (see CAC Standard 106-1983):

7.2.1 Gamma rays from the radionuclides ^{60}Co or ^{137}Cs ,

7.2.2 X-rays generated from machine sources operated at or below an energy level of 5 MeV, and

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

NOTE 1—The depth of penetration of electrons in a material is dependent upon the energy of the electrons and the density of the material.

7.3 *Radiation Process Parameters:*

7.3.1 *Absorbed Dose*—Food irradiation specifications from the owner of the product should include minimum and maximum absorbed dose limits: a minimum necessary to ensure that