REVEAM

A Modern Evaluation of Maximum Dose Limitations in Food Irradiation

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Nuclear Engineer/Radiation Safety Officer
Reveam, Inc.

CIRMS 2026

April 13th, 2026

REVEAM COMPANY OVERVIEW

Designer, manufacturer and operator of electron beam and X-ray accelerator systems for food treatment.

- Based in Atlanta, GA
  - Georgia Tech's Advanced Technology Development Center
  - "Incubators Changing the World"
- (8) patents for proprietary ECP® technology
- Rio Grande Valley ECP® Center in McAllen, TX
  - USDA, FDA, & Mexico's SENASICA
- **NEW:** ECP® Center for the Port of Miami & Miami-Dade County
  - Projected open in Q1/Q2 2027
- $8M grant from the Defense Advanced Research Projects Agency (DARPA)
  - Mobile ECP® Compact Unit
- Recently Acquired AcceleRAD Technologies
  - Vertical Integration

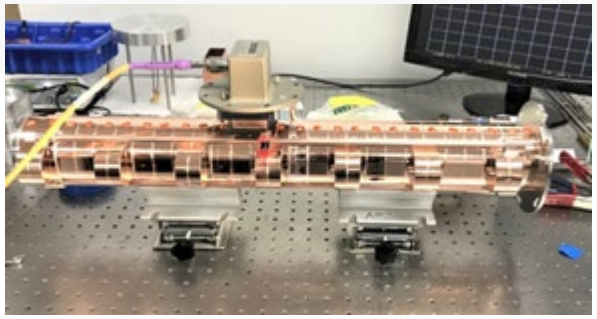
RIO GRANDE VALLEY ECP® CENTER
MCALLEN, TX
USDA CERTIFIED IN 2022 | 100,000 SF

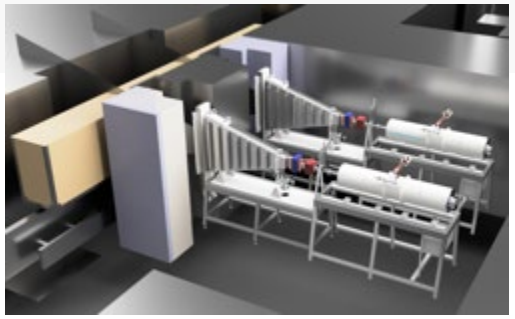
MIAMI ECP® CENTER
MIAMI, FL
PROJECTED OPEN IN 2027 | 350,000 SF

ACCELERAD
A REVEAM SOLUTION

Bringing Design, Manufacturing, and Operations together.

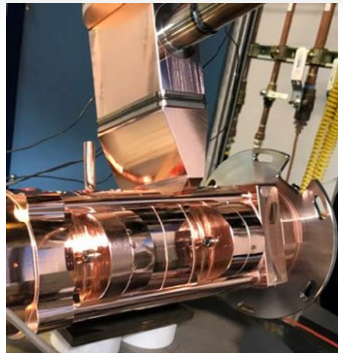
- We **design and manufacture** our own technology systems
- Build and operate our **own treatment facilities**
- E-beam and X-ray capabilities for **in-line and mobile solutions** for seamless integration
- **A complete, in-house approach** – unique in our industry

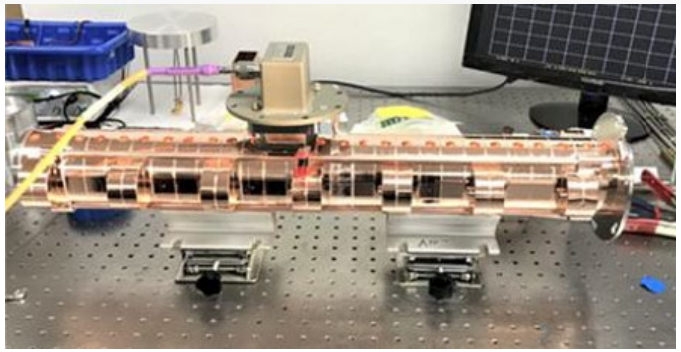




MADE IN USA

RECENT ACQUISTION FOR ECP INNOVATION





REVEAM

Solutions Customers Resources About

REVEAM ACQUIRES ACCELERAD TO DRIVE FOOD SAFETY AND INDUSTRIAL ACCELERATOR INNOVATION

Stay Informed

March 19, 2026

Combined company will scale Reveam's ECP® deployment and expand advanced accelerator applications across new industrial sectors.

ATLANTA, GA — March 19, 2026 — Reveam, a leader in advanced food safety and phytosanitary treatment technologies, today announced the acquisition of AcceleRAD Technologies, a global supplier of high-performance accelerator systems. The acquisition brings together Reveam's leadership in food safety applications and AcceleRAD's deep expertise in accelerator engineering and complete accelerator system solutions, creating a stronger platform to scale deployment, expand innovation, and pursue new industrial applications.

With AcceleRAD, Reveam significantly expands its engineering and manufacturing capabilities, supporting broader deployment of its proprietary Electronic Cold-Pasteurization® (ECP®) technology platform. Simultaneously, the company will continue advancing AcceleRAD's existing R&D and new market initiatives, leveraging the combined team's expertise in pulsed high-energy electron beam and X-ray applications across multiple industry sectors.

Under the terms of the agreement, AcceleRAD will operate as a wholly owned subsidiary of Reveam. Curtis Allen, Founder and President/CEO of AcceleRAD, will join the Reveam leadership team as Chief Technology Officer, where he will continue to lead accelerator engineering and technology development across the combined company.

Reveam's ECP® technology treats fresh foods in its final packaging using a precisely controlled beam of high-energy electrons to reduce pests and pathogens while extending shelf life without the use of chemicals or heat. Integrating AcceleRAD's engineering expertise with the ECP® platform allows for the design of compact, modular, and in-line systems that can be deployed directly at packing houses, food manufacturing facilities, distribution centers, and ports of entry.

"Reveam is transforming how the world protects its food supply, and we see even broader potential for accelerator technology," said Jeff Pelletier, CEO of Reveam. "By bringing AcceleRAD into our team, we are not only expanding the global footprint of our ECP® food safety systems, but also investing in the future of accelerator innovation across established markets and new industrial frontiers."

Reveam currently operates its flagship ECP® facility in McAllen, TX, and is actively expanding. The addition of AcceleRAD enables the company to scale manufacturing and deliver more flexible platforms worldwide.

"Joining Reveam allows us to scale and accelerate our existing initiatives while applying our deep accelerator system capabilities to the next generation of ECP® systems," said Allen. "Whether we are protecting the global food supply or developing specialized solutions for medical sterilization, soil and water decontamination, or other industrial applications, our combined expertise ensures these advanced technologies can operate wherever they are needed most."

Together, Reveam and AcceleRAD create a stronger platform to advance food safety, broaden industrial applications, and shape the next generation of accelerator-enabled solutions.

About Reveam
Headquartered in Atlanta, Georgia, Reveam is revolutionizing food safety and supply chain integrity through its proprietary Electronic Cold-Pasteurization® (ECP®) platform. Its advanced electron beam technology eliminates pests, pathogens, bacteria, and molds – enhancing safety, extending shelf life and unlocking new markets for fresh produce. For more information, visit www.reveam.com.

About AcceleRAD
Based in Hayward, California, with products deployed across the globe, AcceleRAD is the leading US supplier of high-power linear accelerator systems and self-shielded, in-line solutions integrating automated material handling and safety systems. For more information, visit www.accelerad.com.

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PORTMIAMI GRANT AWARD

PORT MIAMI ECP® CENTER

Introducing Reveam's upcoming state-of-the-art Phytosanitary Treatment and Cold Chain Processing Facility in Miami, FL. Strategically located near Miami International Airport, this state-of-the-art hub will handle over $1.5 billion in goods annually and support 16,000 jobs. With 100 new, well-paying jobs for Miami residents, this facility will boost the local economy and solidify PortMiami's role in global trade and logistics for decades to come.

This project was selected through a competitive Miami-Dade County RFP grant process seeking proposals for the design, construction, financing, and operation of a phytosanitary and cold chain processing facility.

PORT MIAMI ECP® CENTER QUICK FACTS

- 350,000 sq. ft. climate-controlled facility with cold-storage and logistics services
- Cutting-edge facility using proprietary Reveam dual E-beam and X-ray technology
- Construction underway, projected opening in Q1/Q2 2027
- Located next to Miami International Airport on Port of Miami owned property
- ECP® treatments for fresh produce, fresh cut fruits, cut flowers, seafood and more.

USDA FDA World Health Organization IAEA ISO International Organization for Standardization ASTM INTERNATIONAL


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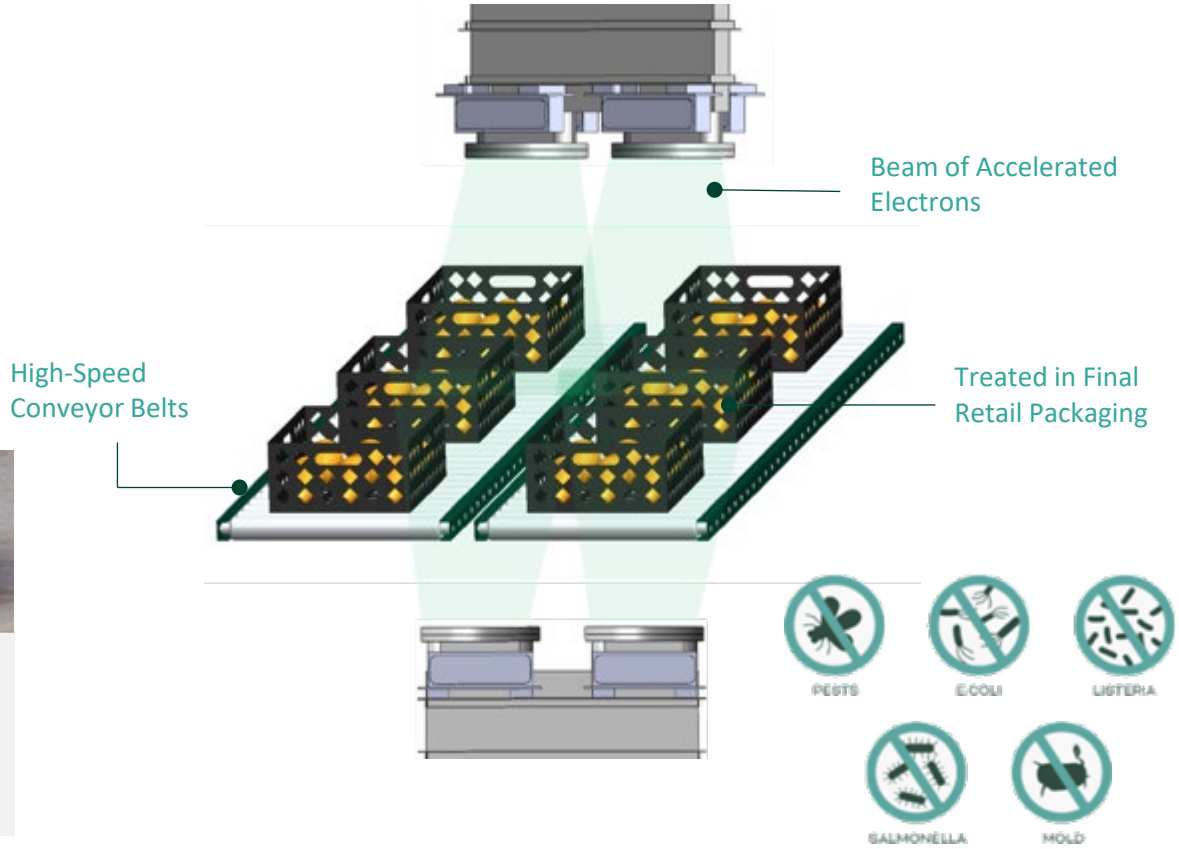
ELECTRONIC COLD-PASTEURIZATION® (ECP®)

- ECP® delivers a beam of ionizing electrons that sterilize insects, eliminate foodborne pathogens such as mold, bacteria and parasites in final retail packaging
- Optimized for throughput, cases of fresh produce pass through the dual electron beams (E-beam) in less than a second on (2) parallel high-speed conveyors

Sterilize unwanted insects, such as the Mexican and Mediterranean Fruit Fly, that may attach to fruits and inhibit trade

Breaks down microorganisms, reducing the presence of foodborne pathogens such as E. coli, Salmonella, Listeria and Cyclospora

Reduces bacteria, fungi, and molds, and delays the spoilage process, thus helping food last longer and extending shelf-life



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PATHOGEN REDUCTION & SHELF-LIFE EXTENSION

PATHOGEN REDUCTION & SHELF-LIFE EXTENSION TREATMENTS AT RGV ECP® CENTER

Reveam's ECP® treatment has proven highly effective in **reducing pathogens and significantly extending the shelf-life of fresh fruits and vegetables**, offering consumers and producers alike a solution to preserve quality while ensuring food safety.

- Reveam's ECP® reduces molds and microorganisms to extend the **shelf-life** of fresh produce
- ECP® improves **taste and appearance** while enabling alternative, cost-effect shipping methods to market
- ECP® reduces risks from **deadly human pathogens** with 99+% effectiveness

Institute for Environmental Health
Laboratories & Consulting Group

Final Report
Evaluation of Major Foodborne Bacteria Inactivation Using Electron-Beam

ECP® BENEFIT: FRESH CUT FRUITS

Fresh-cut Watermelon

Average 13-Days Shelf-Life Extension

CONTROL	ECP® TREATED

Fresh-cut Honeydew

Average 5-Days Shelf-Life Extension

Fresh-cut Pineapple

Average 6-Days Shelf-Life Extension

Fresh-cut Cantaloupe

Average 5-Days Shelf-Life Extension

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ECP® BENEFIT: FRESH BERRIES

Fresh Strawberries

Average 18-Days Shelf-Life Extension

CONTROL	ECP® TREATED

Fresh Blackberries

Average 8-Days Shelf-Life Extension

Fresh Raspberries

Average 19-Days Shelf-Life Extension

Fresh Blueberries

Average 13-Days Shelf-Life Extension

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ECP® BENEFIT: SLICED/WHOLE WHITE & BROWN MUSHROOM

Sliced, White Mushrooms

Comparison at 24-Days after treatment

Sliced, Brown Mushrooms

Comparison at 24-Days after treatment

Whole, White Mushrooms

Comparison at 24-Days after treatment

Whole, Brown Mushrooms

Comparison at 24-Days after treatment

ECP® ENABLES NEW PRODUCTS & BETTER MERCHANDISING

- Whole papayas are pathogen-free, enabling safe **sliced/diced formats**
- Controls anthracnose for **longer shelf life** and better appearance
- **No paper wraps needed**, allowing for cleaner, more appealing displays

New & Innovative Offerings enabled by ECP®

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Fresh Produce Is a Leading Source of Foodborne Illness

48M

Americans sickened by foodborne illness annually (CDC)

128K

Hospitalizations per year from foodborne pathogens

3,000

Deaths per year linked to contaminated food (CDC)

Fresh fruits and vegetables are consistently implicated in major outbreaks of Salmonella, E. coli O157:H7, and Listeria — yet the FDA's 1 kGy irradiation limit for produce is too low to meaningfully reduce these pathogens.

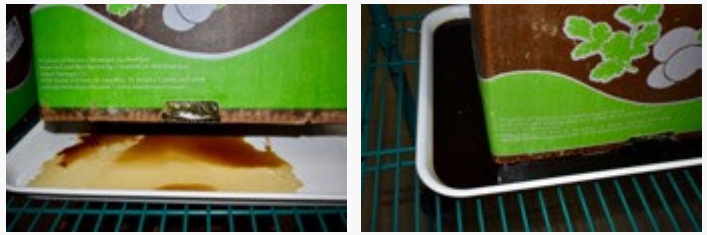
ECP® BENEFIT: INACTIVATE CYCLOSPORA & EXTEND SHELF-LIFE

PRODUCT	**Fresh Cilantro**
COMPARISON AT	29 Days

STUDY NOTES

- Samples not stored using ice
- Optimum Storage Conditions: 32 – 34 °F (0 – 1 °C).
- Packaging type: 60ct Box.
- Organoleptic analyses: Color, texture, water loss, odor, wilting.
- Pathogen: Cyclospora cayetanensis, Salmonella spp., Escherichia coli, Listeria monocytogenes.

Water collection (purging) from spoilage in Control Samples



Non-Iced Samples

CONTROL SUMMARY

- Samples maintained their freshness attributes for ~4 days
- Quality degradation
- Discoloration
- Wilting
- Increased water loss (purging) which accelerated the sample's deterioration

TREATED SUMMARY

- Samples stayed fresh for an average of **25 days**
- Maintained firm texture
- **Significantly reduced water loss (purging)** compared to control samples
- Scientific studies confirm *C. cayetanensis* is effectively inactivated in cilantro treated with irradiation within FDA-approved dose limits

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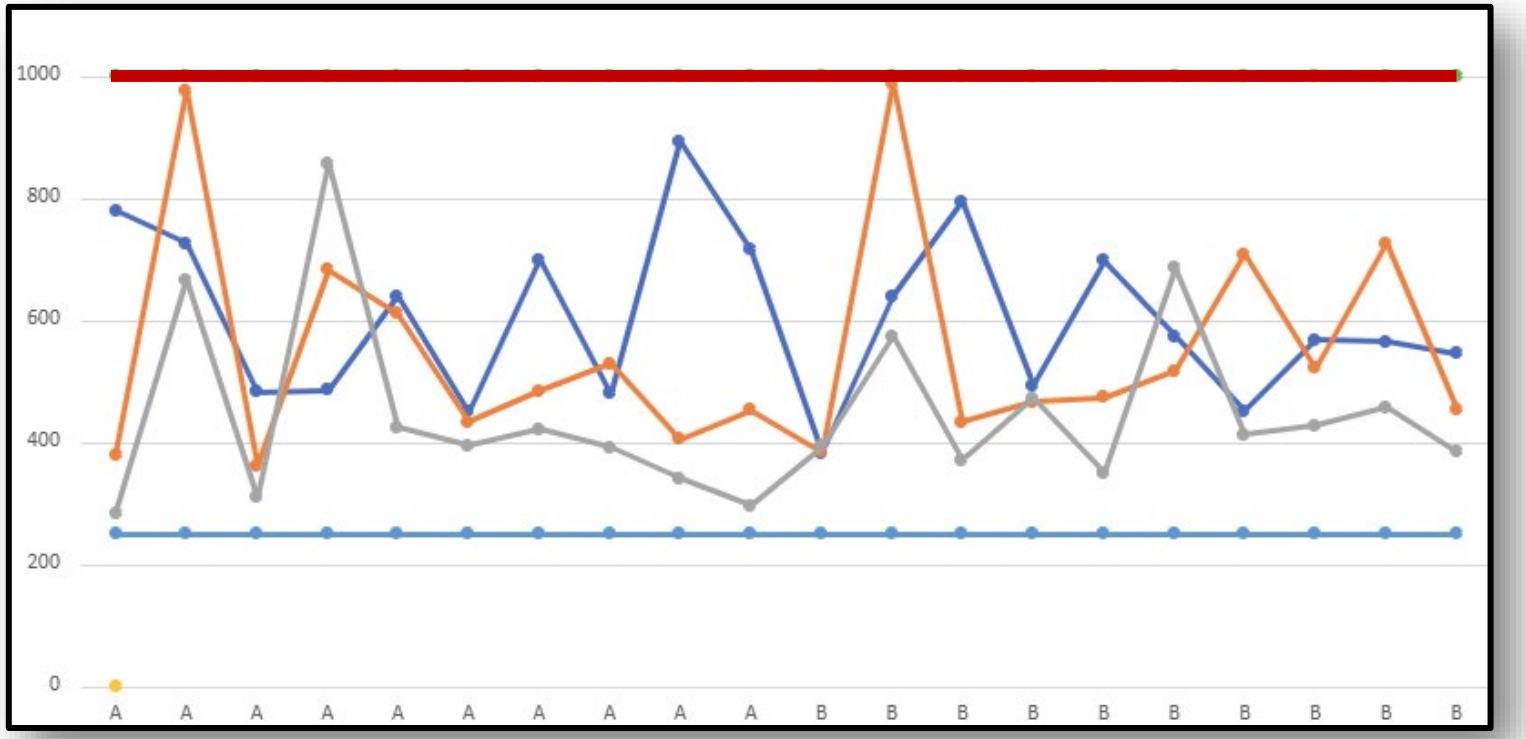
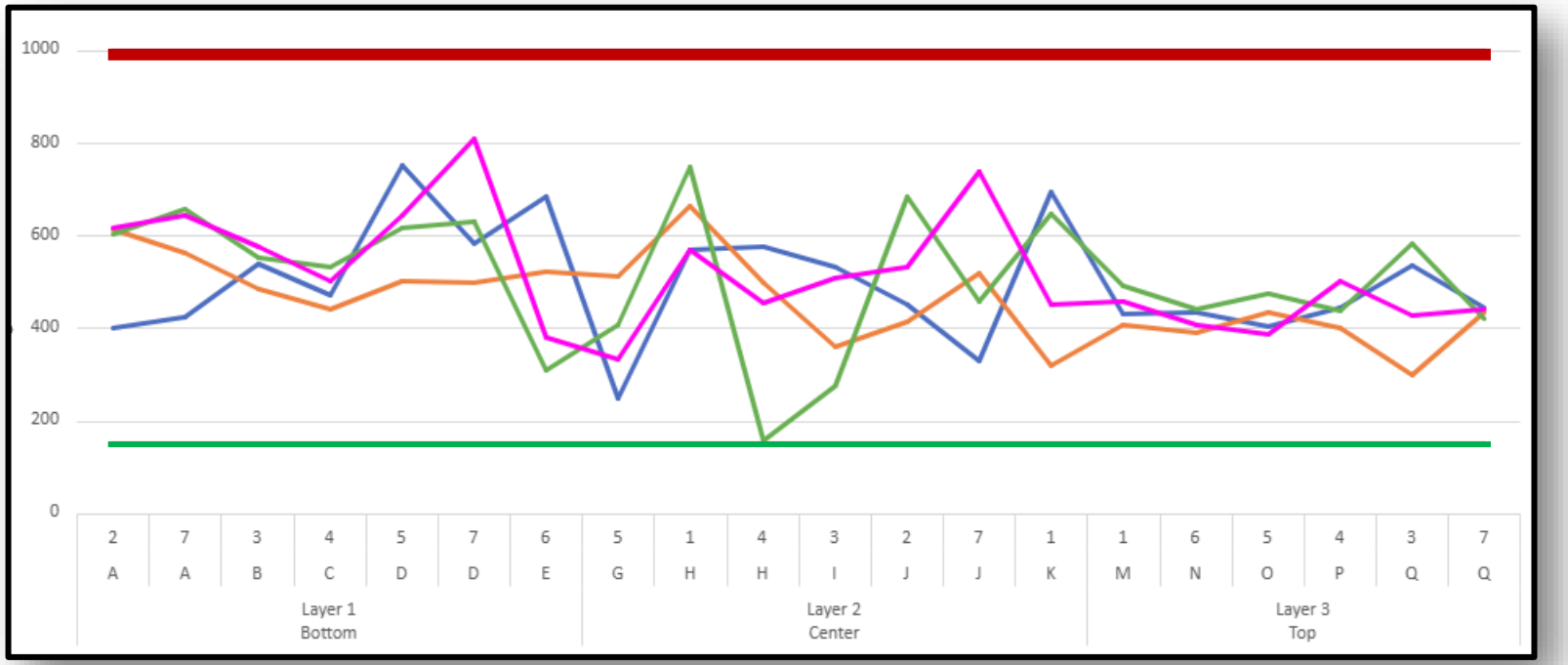
MAJOR BOTTLENECK – DOSE VARIABILITY

Apples – 2 Lb Bags – 2x6 Bag Arrangement



- Irregular Packing
- Arbitrary Maximum
- Minimum Requirement

Oranges – 2-3 Layers – Bulk Arrangement



- Irregular Packing
- Arbitrary Maximum
- Minimum Requirement

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PROPOSING A SCIENCE BASED MAXIMUM

Trends in Vital Food and Control Engineering

The Potential of Food Irradiation: Benefits and Limitations

By Ahari, et. al. 2012

Nuclear Science and Technology Research Institute

Purpose and effects	Dose range (kGy)*
Inhibition of sprouting of stored tubers, roots and bulbs	0.05-0.15
Prevention of post-harvest losses by destruction of insects in stored cereals, fresh and dried fruits, nuts, oilseeds and pulses, or phytosanitary (quarantine) treatment for insect pests infesting fresh fruits and vegetables	0.15-1
Delay of ripening of fruits	0.2-1
Shelf-life extension of fruit and vegetables, meat, poultry, fish and ready meals by reduction of micro-organisms that cause spoilage	0.5-3
Inactivation/destruction of various food-borne parasites	0.3-6
Prevention of food-borne illness by destruction of non-sporeforming pathogenic bacteria (e.g. Salmonella, Campylobacter, Listeria) in fresh or frozen foods	3-7
Shorten drying and cooking times of vegetables and fruits	3-10
Reduction in viable counts of microorganisms in spices and other dry ingredients to minimize contamination of food to which the ingredients are added	5-10

- Heating, drying, & cooking cause **higher nutritional losses**
- **Optimum dose is a balance (EFSA, 2011)**
  - Needed vs tolerated
- Some salad vegetables could resist up to **4000 Gy** without physical-chemical damages & quality loss (Nunes et al., 2008)
- Mushrooms irradiated at a dose of **1.5 to 2.0 kGy** soon after harvest had a **shelf-life of 11 days** at 5° C (IAEA, 2001)
  - As opposed to a few days at most w/o treatment
- D10 values for various **Salmonella** strains in orange juice were between **0.6 & 0.8 kGy** (Niemira & Lonczynski, 2006).

Ahari, Hossein, et al. “The potential of food irradiation: Benefits and limitations.” *Trends in Vital Food and Control Engineering*, 5 Apr. 2012, https://doi.org/10.5772/34520.

BACKGROUNDER: Food Irradiation

By Doris Stanley

December 10, 1997

- Published just after FDA approved irradiation treatment of fresh/frozen meats
- **The process has little effect on the food itself**
  - No cellular activity in the food
  - Canning, cooking, or freezing food
- **Minimally affect some very sensitive vitamins**
  - B1 in pork – 3.2%.
- **Equally usable form**
  - "Irradiation converts small amounts of vitamin C in fruit to another equally usable form, so nothing is lost."

- "Multigenerational studies of animals fed irradiated foods show that not only is it safe, but the **nutritive value remains virtually unchanged**."
- Irradiation increases the **shelf life** of very perishable sweet onions to three months and not only extends the **shelf life** of tomatoes but also allows them to be picked when fully ripe.

Stanley, Doris. *Backgrounder: Food Irradiation : USDA Ars*, Oct. 1997, www.ars.usda.gov/news-events/news/research-news/1997/backgrounder-food-irradiation/.

Microbial Decontamination of Food by Electron Beam Irradiation

By Hsiang-Mei Lung, et. al. 2015

Food Industry Research and Development Institute

- The Joint Expert Committee on Irradiation **(FAO, WHO IAEA)**, stated "it is safe to appropriately use radiation for food decontamination;"
- "food irradiated at a dose lower than **10 kGy** has no toxic hazards and only a minor effect is posed on the nutrition"
- More resistant strains:
  - *Listeria monocytogenes* **(D10 = 1.09 kGy)**
- **(1.0 – 3.0 kGy)** is believed to be suitable for delaying the maturity or senescence of fresh fruits and vegetables and for **eliminating microbial contamination**

Table 1. Research investigating the use of EBI in the decontamination of vegetable and fruit products.

Product	Dose	Observation	Reference
Cabbage	0, 1.0, 2.3, and 4.0 kGy	• At a dose of 2.3 kGy, <1.0 log of microflora was detected (a decrease by >4.0 log). • At a dose of 4.0 kGy, K-12 *E. coli* decreased by >7 log; in fresh cut cabbage irradiated at 0.564 kGy, K-12 *E. coli* displayed 90% decrease (D10 value).	Grasso *et al.*, 2011
Ready-to-eat baby spinach leaves	0.20, 0.5, 0.75, 1, and 1.25 kGy	• A low-dose (below 1 kGy) e-beam radiation under modified atmosphere packaging (100% O_2 and N_2:O_2 [1:1]) may be a viable tool for reducing microbial populations or eliminating *Salmonella* spp. and *Listeria* spp. from baby spinach. • A suggested treatment to achieve a 5-log reduction of the test organisms would be irradiation at room temperature under 100% O_2 atmosphere at a dose level of 0.7 kGy.	Gomes *et al.*, 2011
Tuber aestivum	1.5 and 2.5 kGy	• EBI can reduce the loss of sensory quality and the occurrence of dominant bacterial colonies (Pseudomonadaceae and Enterobacteriaceae) in postharvest *Tuber aestivum*. • A combined use of modified atmosphere packaging with P-PLUS micro-perforated plastic material plus 2.5 kGy of irradiation successfully extended the shelf life of summer Tuber aestivum to 42 days at 4 °C, without having to cultivate mycelium or grow yeast.	Rivera, Venturini, *et al.*, 2011; Rivera, Blanco, *et al.*, 2011
Tomato, cantaloupe and lettuce seeds	7 kGy	• Initial load of pathogenic bacteria on seeds was ~6 log CFU/g. Results demonstrate that all treatments significantly reduced the initial load of pathogenic bacteria in seeds ($p < 0.05$). • ClO_2 and e-beam treatments were noticeably more effective against Salmonella in contaminated tomato seeds, where 5.3 and 4.4 log CFU/g reductions were observed, respectively. • EBI did not affect the seed germination rate.	Trinetta *et al.*, 2011
Iceberg Lettuce and spinach	0, 1.5, 2.0, 3.0, 4.0, and 5.0 kGy	• The results highlight the value of employing E-beam irradiation to reduce public health risks. In addition, the study outlines the critical importance of adhering to good agricultural practices that limit enteric virus	Espinosa *et al.*, 2012

Lung, Hsiang-Mei, et al. "Microbial decontamination of food by electron beam irradiation." *Trends in Food Science & Technology*, vol. 44, no. 1, July 2015, pp. 66–78, https://doi.org/10.1016/j.tifs.2015.03.005.

CIRMS 2026 — Need

Annual Meeting · April 13–15, 2026

Progress in **raising the maximum dose limit (1 kGy) for the treatment of produce** is currently blocked because we lack **full application knowledge and experimental data in 1986**, which prevents **pathogen reduction and shelf life extension level doses**.

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LAWS, LIMITS, & REGULATIONS

CODEX STANARD 106-1983 – FAO/WHO Codex Alimentarius Commission

GENERAL STANDARD FOR IRRADIATED FOODS

CODEX STAN 106-1983, Rev.1-2003

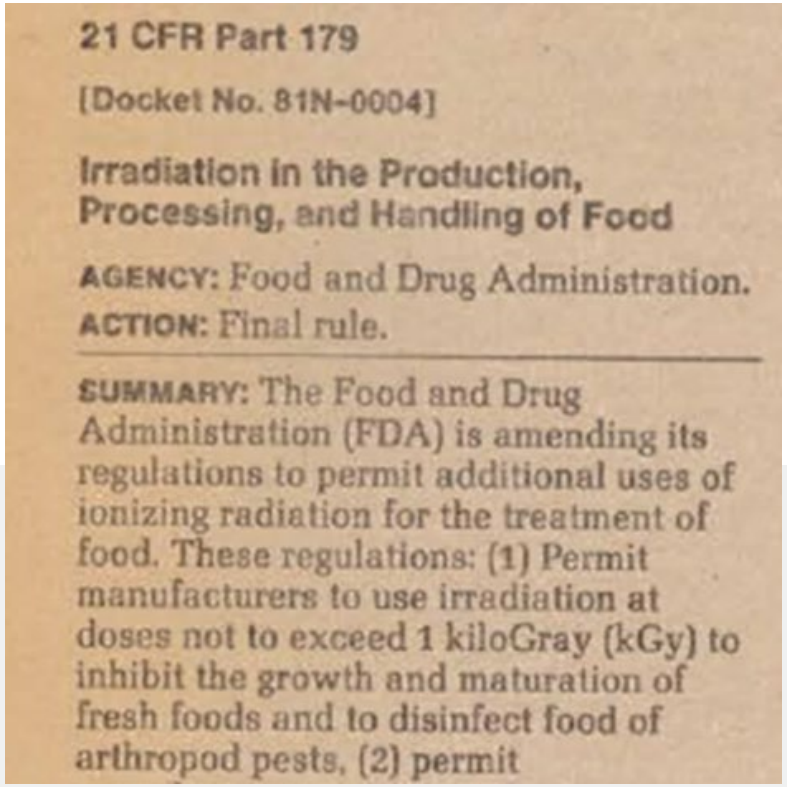
c) Electrons generated from machine sources operated at or below an energy level of 10 MeV.

2.2 Absorbed Dose

For the irradiation of any food, the minimum absorbed dose should be sufficient to achieve the technological purpose and the maximum absorbed dose should be less than that which would compromise consumer safety, wholesomeness or would adversely affect structural integrity, functional properties, or sensory attributes. The maximum absorbed dose delivered to a food should not exceed 10kGy, except when necessary to achieve a legitimate technological purpose.[1]

https://www.fao.org/fao-who-codexalimentarius/sh-proxy/ar/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXS%2B106-1983%252FCXS_106e.pdf

Federal Register Vol. 51, No. 75



21 CFR Part 179

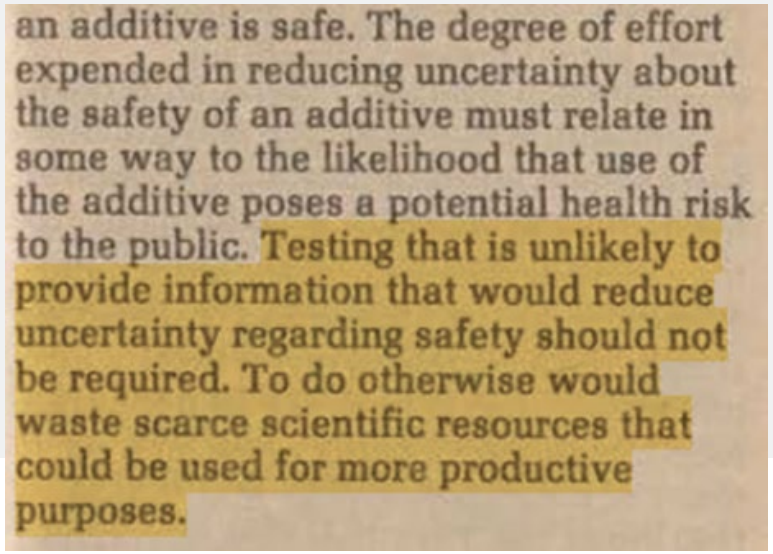
[Docket No. 81N-0004]

Irradiation in the Production, Processing, and Handling of Food

AGENCY: Food and Drug Administration.

ACTION: Final rule.

SUMMARY: The Food and Drug Administration (FDA) is amending its regulations to permit additional uses of ionizing radiation for the treatment of food. These regulations: (1) Permit manufacturers to use irradiation at doses not to exceed 1 kiloGray (kGy) to inhibit the growth and maturation of fresh foods and to disinfect food of arthropod pests, (2) permit



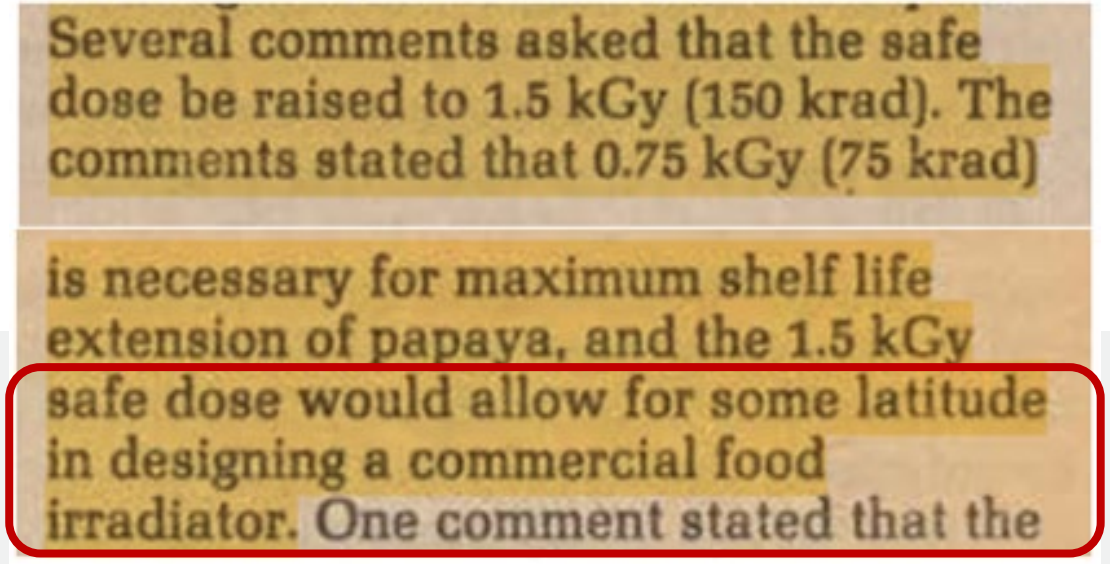
an additive is safe. The degree of effort expended in reducing uncertainty about the safety of an additive must relate in some way to the likelihood that use of the additive poses a potential health risk to the public. Testing that is unlikely to provide information that would reduce uncertainty regarding safety should not be required. To do otherwise would waste scarce scientific resources that could be used for more productive purposes.

- **Published in <u>1986</u>**
  - Haley's Comet
  - Top Gun
  - Oprah
- Implemented in 21 CFR Part 179
- **Has never been updated since**
- Scarce scientific resources and lack of uses (at the time) fueled an **arbitrary maximum limit**
  - Conservative due to **<u>available data</u>**

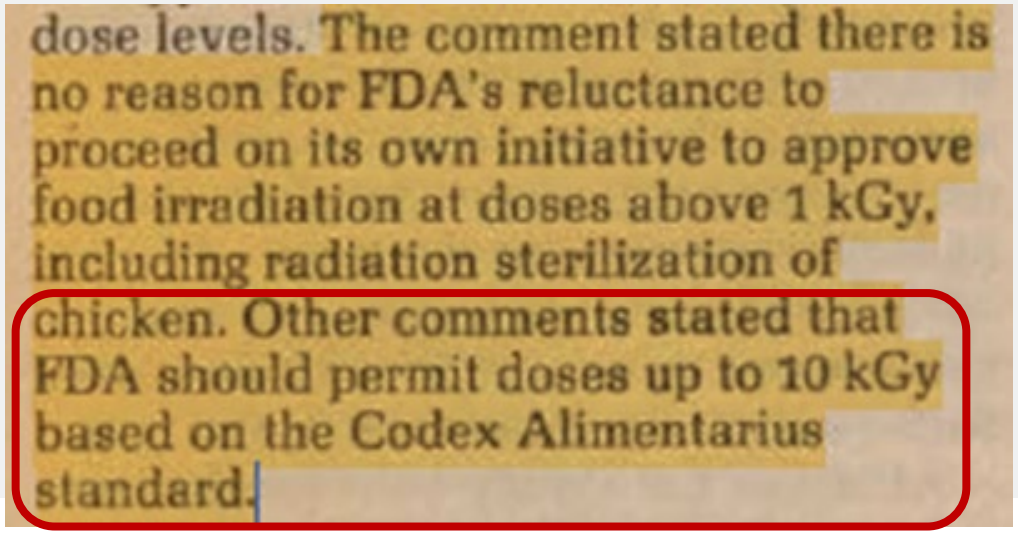
https://www.govinfo.gov/content/pkg/FR-1986-04-18/pdf/FR-1986-04-18.pdf

Federal Register Vol. 51, No. 75

- Comments published in this Register
- Shelf-life extension was **grouped in** with “inhibit the growth and maturation of fresh foods and to disinfect food of arthropod pests”
- More conservative than **international standards**
- Lack of **applicable facilities**



Several comments asked that the safe dose be raised to 1.5 kGy (150 krad). The comments stated that 0.75 kGy (75 krad) is necessary for maximum shelf life extension of papaya, and the 1.5 kGy safe dose would allow for some latitude in designing a commercial food irradiator. One comment stated that the



dose levels. The comment stated there is no reason for FDA's reluctance to proceed on its own initiative to approve food irradiation at doses above 1 kGy, including radiation sterilization of chicken. Other comments stated that FDA should permit doses up to 10 kGy based on the Codex Alimentarius standard.

https://www.govinfo.gov/content/pkg/FR-1986-04-18/pdf/FR-1986-04-18.pdf

Maximum Dose Limits for Other Foods – No Consistency

21 CFR Chapter I, Subchapter B, PART 179—IRRADIATION IN THE PRODUCTION, PROCESSING AND HANDLING OF FOOD

9. For control of *Salmonella* in fresh shell eggs.	Not to exceed 3.0 kGy.
10. For control of microbial pathogens on seeds for sprouting.	Not to exceed 8.0 kGy.
11. For the control of Vibrio bacteria and other foodborne microorganisms in or on fresh or frozen molluscan shellfish.	Not to exceed 5.5 kGy.
12. For control of food-borne pathogens and extension of shelf-life in fresh iceberg lettuce and fresh spinach.	Not to exceed 4.0 kGy.
13. For control of foodborne pathogens, and extension of shelf-life, in unrefrigerated (as well as refrigerated) uncooked meat, meat byproducts, and certain meat food products	Not to exceed 4.5 kGy.

https://www.ecfr.gov/current/title-21/chapter-I/subchapter-B/part-179

A Phased, Evidence-Based Path Forward

01

Raise the Limit to 4.0 kGy —
Align with the current maximum dose limit for iceberg lettuce and baby spinach: 4.0 kGy for fresh, non-frozen produce — the effective pasteurization threshold.

02

Adopt Codex Standards —

Update U.S. regulations to reflect the 2003 Codex Alimentarius revision removing the outdated 1 kGy upper limit ceiling.

03

Species-Specific Dose Studies —

Fund targeted FDA research on optimal dose ranges for key high-risk produce categories (leafy greens, berries, melons).

04

Modernize Labeling Rules —
Reform Radura labeling to reduce consumer stigma — framing irradiation as 'cold pasteurization' where scientifically appropriate.

IN CONCLUSION

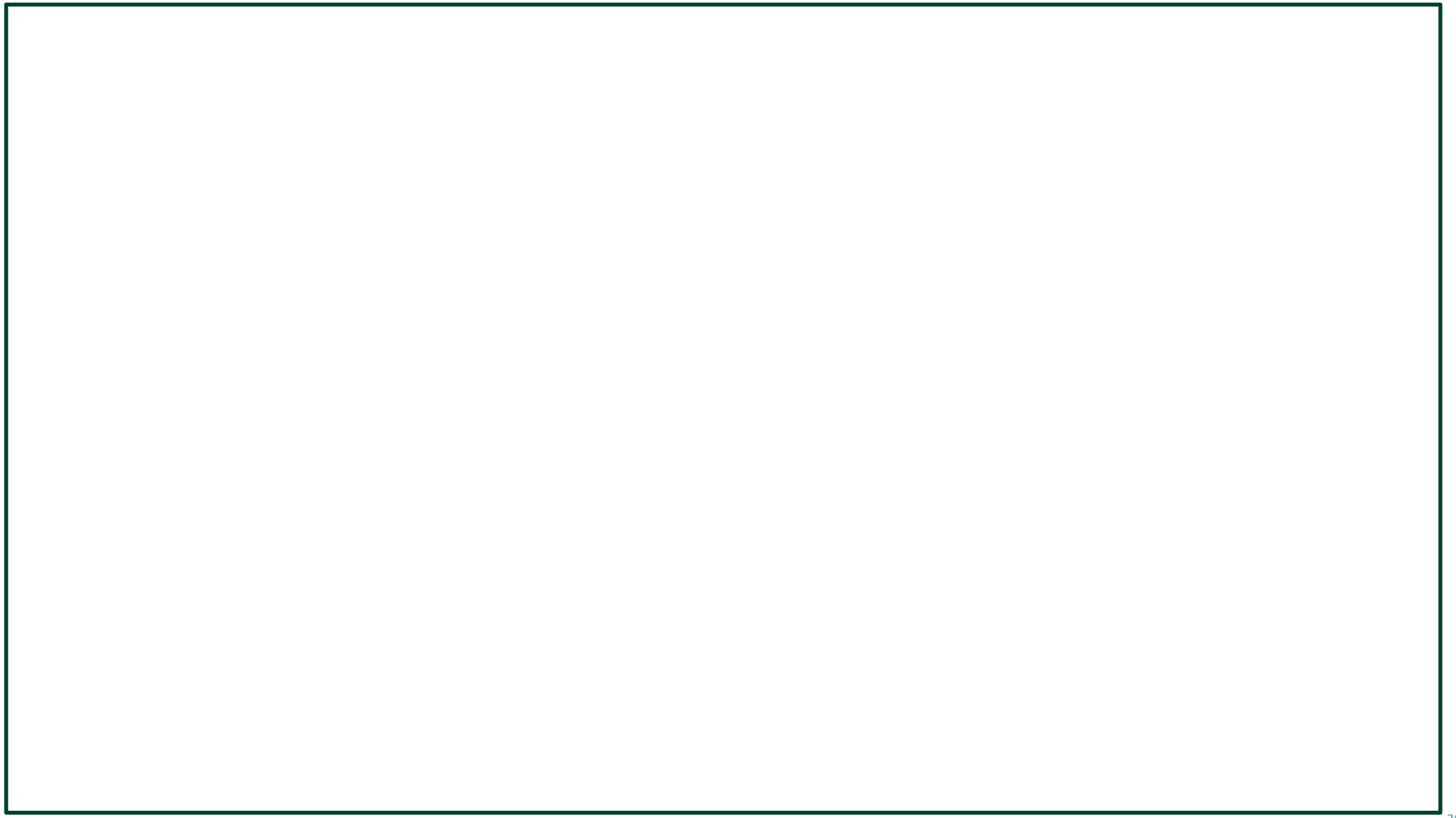
- 1 kGy limit was set conservatively and reflects older science
- International consensus established limits 10x as high
  - WHO, FAO, IAEA, Codex Alimentarius Commission
- Real petitions for higher limits have passed for other products
  - Meat, Poultry, Lettuce/Spinach
- Fresh produce outbreaks continue to sicken thousands of Americans annually
  - 48 Million/Year according to CDC
- Food waste continues to cost billions/year

These are all problems that higher-dose irradiation could meaningfully address while remaining well within established international safety thresholds.

OTHER NEEDS IN FOOD PROCESSING

- Radura Label Requirement
- In-line Diagnostics & Acceptance Qualifications
- Radiation Being Considered an Additive
  - Classifies fruit as “inorganic”

VIDEO OF THE RGV ECPTM CENTER IN MCALLEN, TEXAS



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