Fact Sheet

United States Nuclear Regulatory Commission
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Commercial Irradiators

Background

Irradiators are facilities that expose products such as food, food containers, spices, medical supplies and wood flooring to radiation to eliminate harmful bacteria, germs and insects or for hardening or other purposes. The gamma radiation does not leave any radioactive residue or cause any of the treated products to become radioactive themselves. The source of that radiation can be radioactive materials, an X-Ray tube or an electron beam.

The NRC and "Agreement States" regulate those irradiators using a radioactive source, typically cobalt-60. With some exceptions, the NRC does not specify the types of products that may be irradiated nor does it have a position on the irradiation of food. The U.S. Food and Drug Administration and other agencies have approved the irradiation of meat and poultry, as well as other foods, including fresh fruits and vegetables.

There are generally two types of irradiators which use radioactive material in operation in the United States: underwater and wet-source-storage panoramic models. In the case of underwater irradiators (Figure 1), the sealed sources that provide the radiation remain in the water at all times, providing shielding for workers and the public. The product to be irradiated is placed in a water-tight container, lowered into the pool, irradiated and then removed.

With wet-source-storage panoramic irradiators (Figure 2), the radioactive sealed sources are also stored in the water, but they are raised into the air to irradiate products that are automatically moved into the room via a conveyor system, then lowered back to the bottom of the pool. For this type of irradiator, thick concrete walls or steel provide protection for workers and the public when the sources are lifted from the pool.

To avoid worker overexposure to radiation, the sealed sources used in all irradiators must be carefully controlled and handled at all times. All of the U.S. commercial irradiators regulated by the NRC currently use cobalt-60. The amount of the material in the devices can range up to 10 million curies, with most large commercial irradiators using more than 1 million curies of radioactive material.

Irradiators have been in use in this country for about 40 years. There are approximately 50 commercial irradiators nationwide that are licensed by the NRC and "Agreement States," which are states that have entered into an agreement with the NRC that permits them to regulate, within their borders, most radioactive materials that would otherwise be overseen by the NRC. Currently, there are 33 "Agreement States."

Safety Reviews and Requirements

With proper design and operating procedures, commercial irradiators can be operated safely and without posing any significant radiation risk to workers or the public. Indeed in most cases the radiation exposure to workers is so low that it cannot be detected or distinguished from natural background levels of radiation. Because of the significant structures built to shield these operations, members of the public in the vicinity of an irradiation facility receive little, if any, radiation exposure from the irradiation sources.

Licensing and Inspection

Under the Atomic Energy Act of 1954, all irradiators using radioactive material must be licensed and meet all applicable safety requirements. Among the requirements:

- A license must be obtained from the NRC or an "Agreement State" prior to beginning construction of a new irradiator.
- Design and performance criteria must be met for irradiator facilities and the sealed sources used in them.
- Irradiator facilities must undergo construction monitoring and acceptance testing.
- The operation of an irradiator must adhere to regulations pertaining to such areas as worker training, operating and emergency procedures, and inspection and maintenance.

When reviewing an irradiator application, the NRC assesses the integrity of the sources to be used, the design of the safety systems, the training and experience of personnel, and the facility's radiation safety program. The NRC conducts periodic inspections -- usually every other year -- to ensure compliance with agency regulations. If a facility is not in compliance, the NRC can take appropriate enforcement action, up to and including revocation of its license.

Accidents and Contamination Events

There have been no fatalities resulting from overexposure to radiation from irradiators in the United States. However, there have been two serious radiation-related injuries at irradiation facilities in the U.S. The first overexposure occurred in June 1974 in Parsipanny, N.J., when an irradiator operator walked into a room containing an exposed source, saw it and quickly left. He received a dose large enough to cause clinically observable symptoms of radiation sickness, but the dose was not large enough to be fatal. The entrance to the room lacked the modern automatic access control systems now used, plus an alarm system had been turned off.

The other event occurred in September 1977 in Rockaway, N.J., when an operator entered an irradiation chamber following a shift change while a source was unshielded. This occurred because the facility management had decided to allow the source to be raised with both interlock and safety devices inoperable. Like the worker involved in the earlier event, he received a dose large enough to cause clinically observable symptoms of radiation sickness, but the dose was not large enough to be fatal.

Worldwide, there have been five fatalities in other countries, specifically El Salvador, Italy, Norway, Israel and Belarus. Most, if not all, of the occupational worker deaths or serious overexposures occurred because safety systems were intentionally bypassed or procedures were not followed. Although there have been no radiation-related deaths at irradiators in the U.S., two deaths occurred when individuals were trying to move materials to be irradiated on a conveyor and were crushed. The radiation-related deaths in other countries involved individuals who ignored safety features built into the systems.

There have been no irradiator events in the United States that resulted in groundwater contamination, but there have been two instances of soil contamination. One occurred in 1988 in Decatur, Ga., due to a leaking irradiator source utilizing cesium-137 in the form of cesium chloride, which is highly soluble and similar to ordinary table salt. The leakage caused significant contamination of the facility and some contamination of the soil surrounding the building. Extensive cleanup work was required, at considerable expense to the facility's operator as well as the U.S. Department of Energy, which had supplied the source. However, there was no exposure to members of the public.

Another event occurred in Dover, N.J., in 1982. That situation involved a damaged cobalt-60 source and resulted in the contamination of water that was released to the facility floor and soil immediately surrounding the facility. As in the Georgia event, an extensive cleanup was required, but there was no groundwater contamination or exposures to members of the public.

The NRC has, over the years, reviewed the causes of various incidents at irradiator facilities. In response, it has developed a set of very prescriptive regulations to ensure that irradiator facilities include safety features and redundancies to minimize the possibility of radiation exposures for workers and members of the public. These regulations are embodied in a portion of NRC regulations that was implemented in 1993 and is known as 10 CFR (Code of Federal Regulations) Part 36.

Shipment and Disposal of Radioactive Sources

Radioactive source suppliers are required to ensure that shipping packages containing sources are sufficiently robust and meet all applicable NRC standards. They must also transport radioactive materials in accordance with U.S. Department of Transportation regulations.

The sources are typically returned to the supplier once their radioactivity levels have dropped to the point where they can no longer efficiently irradiate product material. Again, NRC and Department of Transportation requirements on the shipment of such materials must be met when they are returned to suppliers.

Security of Radioactive Sources

The NRC recognizes the public's concern about a possible terrorist attack on an irradiator facility. Although there have been no specific credible threats against any U.S. nuclear facilities, the NRC required, via orders, increased security measures at irradiation facilities in response to the 9/11/01 attacks.

Following the issuance of an irradiator license, the NRC issues an order to the facility's owner requiring that certain very specific actions be taken to enhance security of the irradiator and its sources. Those security measures must be in place before radioactive sources are loaded into the irradiator. While there has been concern expressed about the possibility of a terrorist obtaining a radioactive source and using it to build a so-called "dirty bomb," the NRC has considered a number of scenarios and preliminarily determined that it would be extremely difficult for someone to explode a cobalt-60 source in a way that could cause widespread contamination.

Emergency Procedures

The NRC requires that irradiator operators have emergency procedures that include coordination with local and state emergency response agencies. Companies that operate irradiation facilities are required to have emergency procedures for a variety of emergencies, including leaking sources, low water or leakage from the storage pool and fires. No license for operation is issued unless satisfactory emergency procedures have been developed.

Decommissioning

As with other facilities licensed by the NRC and "Agreement States" to use nuclear materials, irradiation facilities are required to properly clean up the site once they are permanently shut down. At that time, any remaining radioactive sources must be safely disposed of and any residual contamination above acceptable levels must be removed. Confirmatory surveys must be conducted to ensure that the decommissioning work is consistent with applicable safety and health standards.

In September 2003, the NRC announced that it was amending its regulations to require companies that use substantial amounts of nuclear materials to increase the amount of financial assurance provided to cover decommissioning costs. The change was designed to bring the amount of financial assurance required more in line with current decommissioning costs and provide adequate assurance that timely decommissioning can be carried out.

Under that change, many large irradiation facilities that previously used specific dollar amounts in the NRC's regulations as the basis for financial assurance for decommissioning are required to base their funding on site-specific decommissioning cost estimates. The revisions did not alter the approved methods of providing such financial assurance. They are: prepayment; a surety (in the form of a bond, letter of credit or line of credit), insurance or other guarantee method, such as a parent company guarantee if that company meets certain financial tests; or an external sinking fund in which deposits are made at least annually, coupled with a surety method or insurance.

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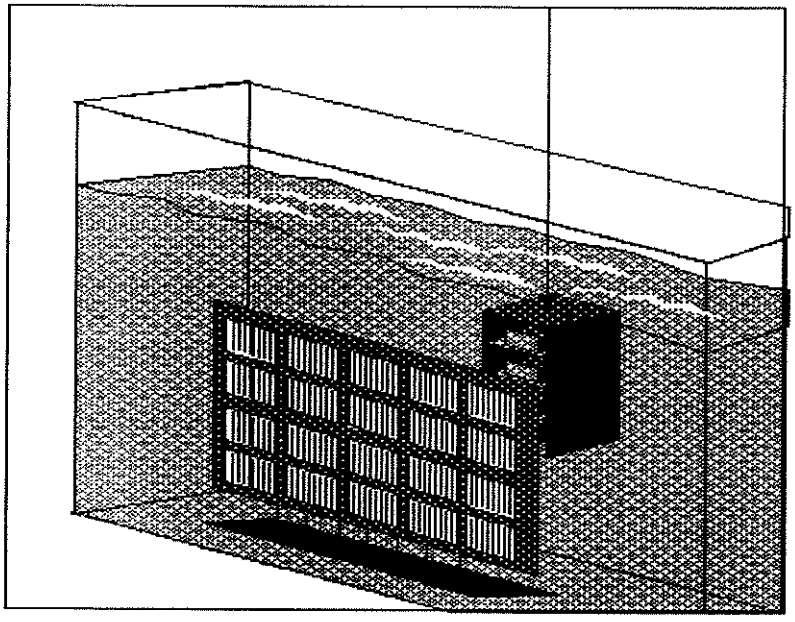

Figure 1 Underwater Irradiator. *The sealed sources remain in the water at all times. The product to be irradiated is placed in a water-tight container and lowered into the water.*

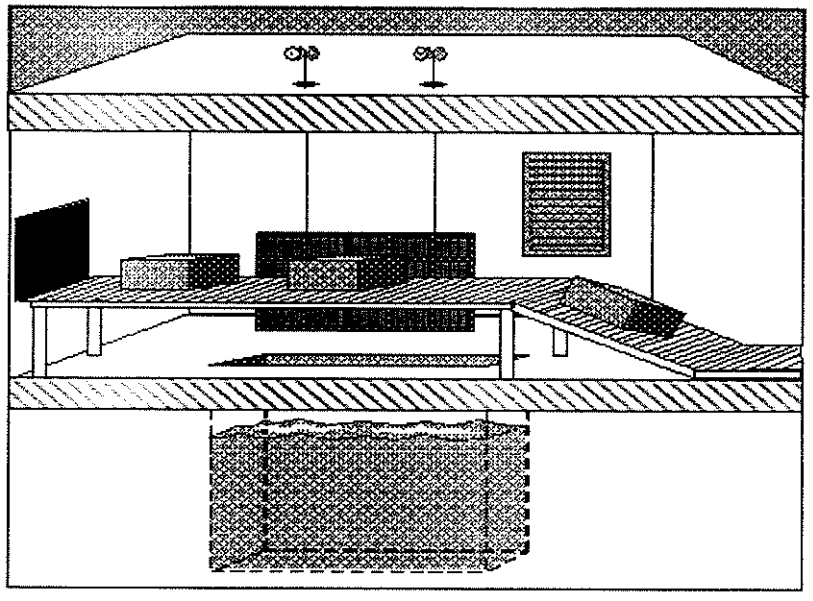

Figure 2 Commercial Wet-Source-Storage Irradiator. *The sealed sources are stored in water and raised into the air*

to irradiate a product that may be moved into the irradiation room on a conveyor system. This is an example of a panoramic wet-source-storage irradiator.