FOOD IRRADIATION - A FRESH CASE OF RADIATION PHOBIA ?

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INTRODUCTION

From the mid-1950's until the present day any activity with words such as atomic, nuclear or radiation has caused great concern in many members of the public. These concerns arose, quite properly, during the 1950's because of the levels of radioactive contamination produced by atmospheric nuclear weapons testing. The concerns have continued to be fueled by events such as the 1957 Windscale Reactor Fire, the three Mile Island accident of 1979, Chernobyl, as well as various other issues, of which the most potent is the potential impact of a nuclear war. Because of these public fears , often encouraged by various groups for their own normally laudable, ends, the potentially beneficial uses of radiation are often confused with those that are distinctly dangerous.

Such is the case with the proposal to irradiate various foodstuff to either extend their shelf-life or to control or kill pathogens and insects after harvesting.

Two arguments are being used by the opponents of food irradiation. One is that the process is hazardous to both plant operators and members of the public who live nearby. The second is that the irradiation process harms the eventual consumers of the food from either induced radiolytic products or substantially reduced nutritional loss and vitamin loss.

This paper argues that whether or not the second point is valid, the process itself is inherently safe and does not present any untoward radiological hazard.

FOOD IRRADIATION PROCEDURES

Preserving food by ionising radiation - either gamma rays from radionuclides, usually cobalt-60 or caesium-137) or machine generated Xrays or electron beams - works by killing microorganisms and insects in or on the food. Radiation can also delay the ripening of produce by modifying the metabolic processes of maturing fresh fruits and vegtables.

The most common form of irradiation plant is the static sterlizer housing the irradiation source in a pool of water from which it can be raised to irradiate products passing on some type of conveyor system. The lot being contained within a suitably thick concrete cell. One such plant using cobalt-60 operates in the State of Victoria and is used for the irradiation of a variety of non-food items such as syringes, gloves, bee hives etc.

The Victorian plant consists essentially of a 7 meter deep pool of water in which sits a metal frame containing 6 modules each capable of holding up to 42 Co-60 pencils. The frame is raised out of the water into the irradiation position. The controls for raising and lowering the sources and operating the product conveyor are all located outside the 1.6m thick concrete cell which houses the irradiation facility. The walls provide adequate shielding when the source is in the exposed position. The various holes for access etc. were monitored and the highest radiation levels detected were:

(a) at the main exit point - 5 μGyh^{-1}

(b) at the product exit point of the conveyor range - 9-10 μGyh^{-1}

This area is fenced off, the dose rate at the fence gate was about background.

The total amount of radioactive material present in the Dandenong plant at full loading is approximately 37 petabequerel (i.e. 10^6 Ci)).

The irradiation room is ventilated at the rate of 20 air changes per hour to avoid excessive ozone build up. The pool water is circulated continuously through a mixed resin bed demineraliser and activated charcoal filter.

RADIATION SAFETY

Radiation safety was considered under two headings - the safety of plant personnel, and the safety of the general public, particularly those living near the plant. Both routine operations and potential emergencies were assessed.

For plant personnel it was thought that there were two possible sources of exposure: external irradiation through inadequate shielding, emergence of a pencil from within the shielded area, inadverent exposure within the cell, possible exposures during loading and unloading procedures and possible high gamma dose rates at the ion-exchange column caused by a leaking capsule contaminating the water and internal irradiation from leaking cobalt contaminating the pond, then drinking water leading to unsuspected ingestion.

EXTERNAL IRRADIATION

As noted above there are no radiation leaks around the concrete cell and the maximum dose rate during routine work is 9-10 μGyh^{-1} at the exit point of the conveyor range - which is fenced off.

An even better indicator of radiation control procedures are the monthly and yearly exposure records of staff working in the area. Monthly doses are generally zero with occasional exposures of between 10 and 70 μSv.

During loading and unloading, plant personnel assist AECL staff, and the maximum dose received during such operations has been 180 μSv. The highest yearly dose recorded has been about 400μ Sv.

Emergency situations considered were;

(a) Inadvertent Exposure Within the Cell

The start up procedure requires that a safety key switch is activated in the irradiation room using the same key that activates the control consule. the key is attached to a radiation monitor. The procedures are that the operator has to enter the irradiation room, check that no-one is there, activate the safety key switch, leave the irradiation room at walking pace, lock the access door, and within 45 seconds activate the control console switch. It is considered that the procedure is completely adequate for preventing anybody inadvertently being left in the cell.

In the reverse procedure as noted above the access door cannot be unlocked except by the control console key by which can only be removed when the source is in the shielded position. The door itself has further safeguards, there is also the cable stretched across the access to the maze, and a radiation monitor is attached to the key.

Because of the various interlocks it was considered that the possibilities of anybody being in the cell with the sources in the exposed position to be nil, even though at least two such events have apparently occured overseas.

(b) Inadvertent Exposure Outside the Cell

The daily monitoring of the ion-exchange column, now changed to continuous monitoring, provides an early warning of any cobalt leakage and exposure to staff should be negligable.

Which leaves the possibility of a pencil emerging from the shielded area. There are three defence mechanisms. Firstly, the source pencils are slotted into channels at the top and bottom of one of the six modules. When full, the hinged end of the module is closed holding the pencils firmly in place. These modules in turn are held in the rack by sliding them into vertical channels at each end of the module. A cover is fitted to the conveyor structure such that should a pencil be dislodged from a frame it would fall to the bottom of the pond and not onto a product box. Thirdly, a gamma monitor, now duplicated, is installed in the product exit maze. This monitor sounds an alarm and shuts the plant down should the dose rate rise above a preset level.

INTERNAL IRRADIATION

The combination of the possibility of the cobalt-60 metal, the ion-exchange column monitor, and the fact that the rods are wipe-tested when being installed makes the likelihood of any contamination of drinking water negligable.

MEMBERS OF THE PUBLIC

It was thought that there were four possible sources of exposure to members of the public, other than visitors.

They are: external radiation during routine operation of the plant; loss of a pencil from the plant environs;

external exposure during transportation of sources to and from the plant;

contamination of water supplies leading to ingestion of cobalt-60.

The radiation levels at the perimeter of the plant are indistinguishable from background and do not change whether the source is in the exposed position or not. Thus members of the public do not receive a radiation exposure during normal operation of the plant.

All transportation is carried out using flasks designed to IAEA standards. These flasks are designed to withstand accidents of much greater magnitude than any that can be conceived as happening between the arrival port and the plant. The dose rates on the outside of the flask range from 50 to 400 μGyh^{-1}, well below the allowable limit. Consignments are accompanied by a radiation safety officer who travels in a separate vehicle. Thus in the event of accident causing the truck to be stopped members of the public could and would be kept away from any potential exposure zone.

ACCIDENTS

A comprehensive review of accidents at sterilization plants has not been undertaken. However the data that have been found suggests that the few fatalities that have occurred appear to have resulted from a failure to follow set procedures coupled with a component failure.

Typical was the fatality at the Norwegian Institute of Engergy Technology. A microswitch failed giving a source shielded signal releasing the barring of the door lock even though the positional display showed the source in an elevated portion. Comparison of the two signals would have shown the discrepency. There was not however a positive failure signal.

In addition the radiation monitor in the interlock system had been taken out of service for maintenance and the radiation dose/interlock system was out of action. Thirdly, the technician failed to use a monitor to check the radiation level before entering the irradiation room.

The prevention of any of these three mistakes would have avoided the fatality.

CONCLUSION

Radiation phobia, although not necessarily an identifiable disease, does exists in many countries. Professional radiation protection personnel have a responsibility to continue the process of public education so that there is a better understanding of the hazards, real and otherwise, of the uses of radiation.

One such current public issue is whether the irradiation of food is hazardous or not.

It is not appropriate to argue from the particular to the general but what can be stated is that the gamma sterilization in Victoria plant does not pose a hazard to plant personnel or public. Neither should plants like it, operated in a similar manner under a similar restrictive and policed regulatory regime, cause radiation problems.

Wherever debates and inquiries are conducted on the suitability or otherwise of radiation preservation of food the safety of the process should not be a significant factor.

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