CHAPTER – 10

Radioactive Biomedical Waste

DEFINITION

Healthcare facilities employ radioactive materials in both diagnostic (in vitro analysis of tissue and imaging) and treatment procedures.

Radioactive waste can come in many forms: medical equipment contaminated with trace amounts of certain isotopes, clothing, biological material (pathological waste), and the radiation source for radiation therapy (e.g. a cobalt block).

Describing the quantities of radioactive waste.

When we talk about quantities of waste, we most often express the quantities in terms of weight or mass (e.g. lb, kg, tons). In some cases we express it as a volume. Radioactive waste is described in these terms, but also in terms of how radioactive it is. either as mass or volume (as most waste is reported) or total radiation given off by the waste. The traditional unit of radioactivity is the Curie, although the newer S.I. unit is the becquerel. A Curie (abbreviated Ci) is 3.7 x 1010 decays per second. This comes from a simple count of atom decay rate. The metric unit for radioactivity is the becquerel (Bq) which is defined as atom decays per second.

Becquerels are quite small, and one Curie is 37 billion becquerels. One becquerel is 27 picoCuries, or 2.7 x 1011 Curies. Each isotope has a characteristic number of Curies or becquerrel per unit mass. For Cobalt-60, this is 44 TBq/g (about 1100 Ci/g). When we manage radioactive substances, we talk about number of Curies or becquerels present. If there is twice as much mass of a given isotope, there are twice as many Curies.

Storing radioactive waste on site

Like other waste, radioactive waste should be collected from around the facility on a regular schedule. The waste management company Daniels Health recommends "foot-operated disposal/collection bins lined with disposable polythene." Healthcare facilities send their radioactive medical waste off site for treatment and disposal. Storage on site is a concern for the waste manager and can pose risks and cause regulatory headaches. Try to keep the radioactive waste away from other waste (to avoid cross-contamination) and away from areas where people and animals frequent. Consider ventilation and ease of access when considering where to put waste.

Store waste in only approved bags and container.

- Bags – Yellow with Radiation label

- Boxes – Line with yellow bag
- Bottles – Attach Radiation label
- DO NOT use anything that can be mistaken for a ordinary trash container
- When full label with user's name and dept., isotope, activity, fill date and seal with a liquid tight tie-off

Old Symbol

New Symbol

Radioactive waste disposal

The cost of disposing of radioactive waste is on the order of ten times that of disposing of municipal solid waste. The design of radioactive waste disposal systems is guided by the philosophy of "confine and contain". Waste is treated to the point that, when placed in final disposal, it will not leak, leach, or fragment. Most radioactive waste from health care facilities ends up specially designated and permitted low-level radioactive waste landfills. In 2019, 4.2 million cubic feet of LLRW went to landfills in the US. In 2020, it was about 1 million cubic feet.

The other philosophy, which is less responsible, is called "dilute and disperse".

It results in release of radioactive material into the environment distributed over a large geographic area so that the final concentration of radionuclides is low. If you employ this method, be ready to answer questions to regulators and to the public. We strongly discourage anyone from intentionally releasing radioactive waste, even in small amounts.

All four types (Classes A, B, C, and GTCC) are disposed of by burial; GTCC cannot be put in most landfills where the waste is close to the surface, but must be buried deeper. In the US, the federal government is responsible for getting rid of GTCC, but the states have responsibility for disposal of Classes A, B, and C waste. Federal legislation has encouraged the states to join up to compacts to help each other take care of waste. Ten compacts have been formed.

About Radiation

Every radioactive isotope has a characteristic half-life - the time it takes for half of the atoms to decay to a different isotope. In some cases the isotope it decays to is stable (not radioactive) but sometimes the result is another radionuclide with its own half-life.

Half-lives range from fractions of seconds to thousands of years.

There are three kinds of radiation (this is a little oversimplified) - alpha, beta, and gamma. All can be dangerous to humans and animals. Alpha and beta particles are relatively easy to stop -separating the radioactive material from people with a piece of cardboard is enough.

Gamma radiation is stronger and can pass through concrete. Radiation specialists have methods for determining the hazards posed by materials and for designing shielding mechanisms.

Exposure to radiation can cause headache and nausea for light exposure to more serious symptoms (anemia, skin rashes, tissue damage) for heavy exposure. Even the radioactive material used in diagnostic instruments (e.g. Gallium 67) can pose a hazard if it gets out. Long-term radiation exposure (if the material becomes embedded in the body) can cause cancer and birth defects in offspring.

Mixed waste

The term mixed waste is used in the radioactive waste industry to refer to waste that meets the definitions for hazardous waste and for radioactive waste, Some landfills can take treated hazardous waste but not radioactive waste and vice versa, Only few places can accept mixed waste and it can be expensive to deal with, even when it is not particularly dangerous. This is another reason to segregate and avoid mixing waste streams, although sometimes the production of mixed waste cannot be dodged without disrupting medical operations.

WASTE CONTAINERS

Not This

But

WASTE CONTAINERS

THIS

Legal Methods of Disposing of Radioactive Waste

- Decay in Storage (DIS)
- Dump to Sanitary Sewer
- Only RSO may Ship to Disposal Site
- Dispose as if not radioactive

★ Decay in Storage (DIS)

👉Store waste in the laboratory if the half-life is no more than 120 days.

👉"DIS" Isotopes must be held for decay for at least 10 half-lives.

👉Survey monitoring of material must read close to background.

👉All radioactive labeling must be defaced.

👉Document in log.

Dump to Sanitary Sewer

👉Must be water soluble or readily dispersible biological material in water.

👉Concentration per month is limited by the regulations, check with the Radiation Safety Officer.

👉May obtain permission from the Radiation Safety Office prior to dumping - Only way to know if other people are dumping.

Dump to the Sanitary Sewer Cont.

👉Annual Limit per Facility

1) H-3 - 5 curies

2) C-14 - 1 curie

3) All other radionuclides combined - 1 curie

Legal Methods of Disposing of Radioactive Waste

👉Only Radiation Safety Office may Ship to Disposal Site.

👉Contact Radiation Safety Officer when you have a full container of dry or liquid waste

👉Disposal Site waste will be stored in the radiation shed until scheduled pick-up.

★Dispose as if not Radioactive

👉Scintillation medium containing no more than 0.05 microcuries per ml of H-3, or C-14 may be discarded as if it was not radioactive. If chemical solvent is disposed of properly the radioactivity will not pose a problem.

👉A record shall be kept of each such disposal for the life of the license; it may be sent to the RSO

High-Level Waste

High-level radioactive waste primarily is uranium fuel that has been used in a nuclear power reactor and is "spent," or no longer efficient in producing electricity. Spent fuel is thermally hot as well as highly radioactive and requires remote handling and shielding. Nuclear reactor fuel contains ceramic pellets of uranium 235 inside of metal rods. Before these fuel rods are used, they are only slightly radioactive and may be handled without special shielding.

During the fission process, two things happen to the uranium in the fuel. First, uranium atoms split, creating energy that is used to produce electricity. The fission creates radioactive isotopes of lighter elements such as cesium-137 and strontium-90. These isotopes, called "fission products," account for most of the heat and penetrating radiation in high-level waste. Second, some uranium atoms capture neutrons produced during fission. These atoms form heavier elements such as plutonium. These heavier-than-uranium, or "transuranic," elements do not produce nearly the amount of heat or penetrating radiation that fission products do, but they take much longer to decay. Transuranic wastes, sometimes called TRU, account for most of the radioactive hazard remaining in high-level waste after 1,000 years.

NRC Responsibilities

The NRC licenses and regulates the receipt and possession of high-level waste at privately-owned facilities and at certain DOE facilities. The DOE facilities subject to NRC regulation are defined by law to include facilities used primarily for receiving and storing high-level waste from activities licensed under the Atomic Energy Act and facilities other than Research and Development facilities authorized for the express purpose of long-term storage of DOE-generated waste. Facilities for permanent disposal will require a license from the NRC under these provisions.

By law, the Commission is not authorized to license:

- Receipt or possession of high-level waste used for or part of DOE activities in a DOE research and development facility;
- DOE facilities for the short-term storage of high-level waste from DOE activities (such as existing DOE high-level waste storage tanks);
- Operating DOE facilities for the storage or disposal of transuranic contaminated waste, foreign high-level waste not resulting from a licensed activity, and low-level wastes;

- Decommissioned DOE facilities, except those covered under Section 202 of the Energy Reorganization Act. (Section 202 authorizes NRC to license certain DOE facilities, including not only the high-level waste storage facilities noted above, but also certain demonstration reactors);
- DOE high-level waste processing facilities, such as those for solidification, strontium and cesium extraction, and waste crystallization.

Low-Level Waste

Low-level wastes, generally defined as radioactive wastes other than high-level and wastes from uranium recovery operations, are commonly disposed of in near-surface facilities rather than in a geologic repository. There is no intent to recover the wastes once they are disposed of.

Low-level waste includes items that have become contaminated with radioactive material or have become radioactive through exposure to neutron radiation.

This waste typically consists of contaminated protective shoe covers and clothing, wiping rags, mops, filters, reactor water treatment residues, equipment and tools, luminous dials, medical tubes, swabs, injection needles, syringes, and laboratory animal carcasses and tissues.

There have been eight operating commercial facilities in the United States licensed to dispose of low-level radioactive wastes.

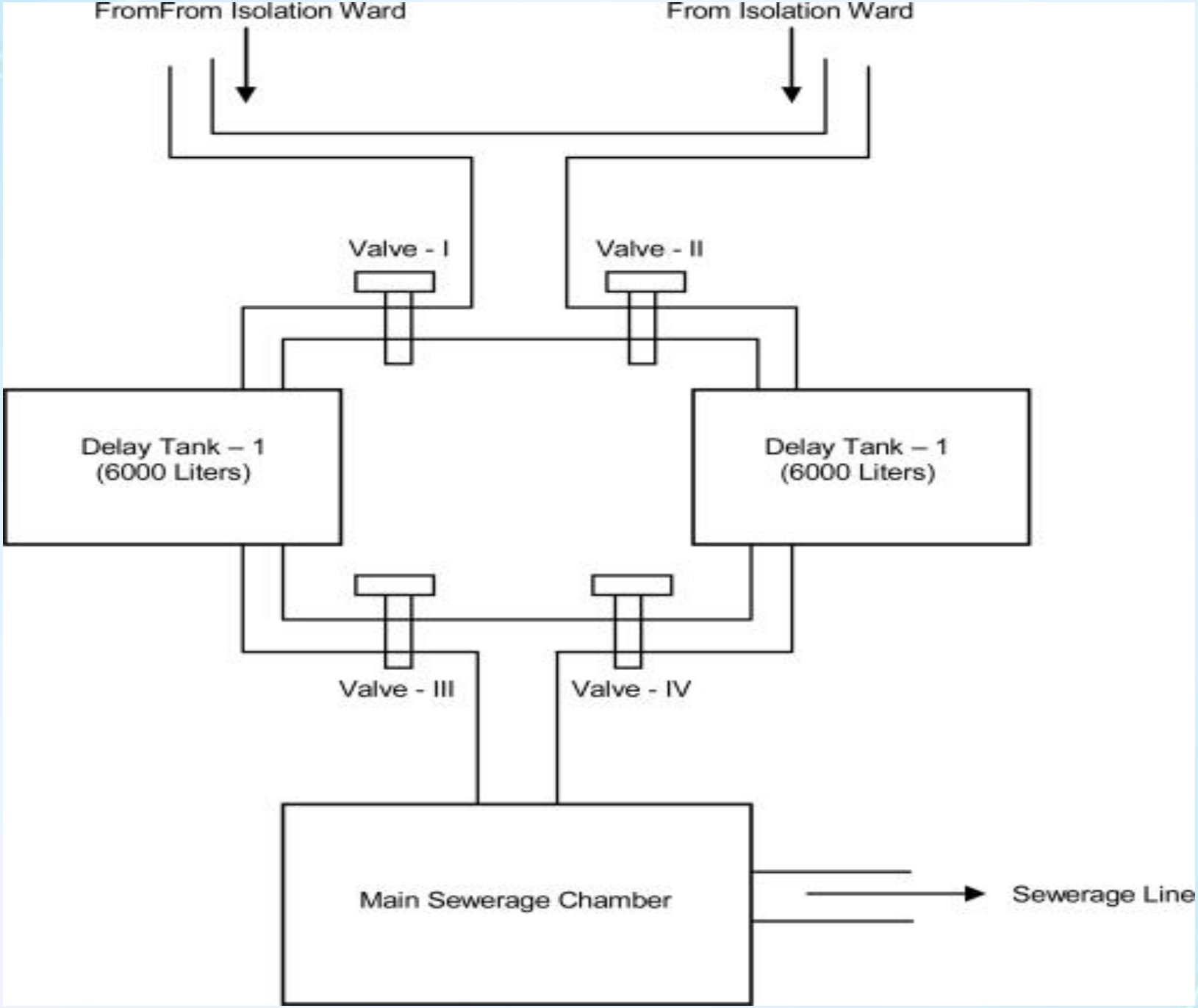
They are located at

(1) West Valley, New York; **(2)** Maxey Flats near Morehead, Kentucky; **(3)** Sheffield, Illinois; **(4)** Beatty, Nevada; **(5)** Hanford, Washington; **(6)** Clive, Utah; **(7)** Barnwell, South Carolina; and **(8)** Andrews, Texas.

At the present time, only the latter four sites

Disposal of excreta and urine of patients administered high doses of radioisotopes:

Patients administered high therapeutic doses of radioisotopes (e.g., Iodine-131 in thyroid cancer) are admitted in isolation wards until their radiation emission levels are within the minimum safe limits (3 mRoentgens per / Hour at 1meter distance). The excreta and urine of patients admitted in a high dose isolation ward (e.g. Iodine −131) after getting flushed passes the PVC pipes through the shortest route possible into customized storage tanks, called delay tanks for storage before dispersal into the sewerage system


FromFrom Isolation Ward
From Isolation Ward
Valve - I
Valve - II
Delay Tank – 1
(6000 Liters)
Delay Tank – 1
(6000 Liters)
Valve - III
Valve - IV
Main Sewerage Chamber
Sewerage Line

Advisory / Regulatory bodies and Record keeping

The usage of radioisotopes and disposal of radioactive waste is done in accordance to recommendations and guidelines issued by various international and national bodies. Institutional Head, Departmental Head, and Radiation Safety Officer of the institution have to co-ordinate their activities with the national regulatory body. Authorisation for procurement, usage and disposal of radioactive waste from the regulatory body is mandatory. The following bodies play key roles in ensuring safe use of radioisotopes and safe disposal of the radioactive waste.


Thank
you!