Health & Safety

Ionizing Radiation: Safety Precautions for the Conservator

Ionizing radiation is a concern for conservation professionals because it is both emitted by some instruments used to conduct analysis and because some collection items are themselves radioactive. Collections and instruments can emit varying kinds of radiation. These radiations present different dangers, can be blocked by different materials, and require different detectors for monitoring. Safety consideration must be given to the use of ionizing radiation-producing equipment, radiation monitoring equipment, and radioactive collection objects.

In 2020, a survey was distributed to the conservation community via the AIC Global Conservation Forum inquiring about these topics. After the survey, two posters were created that present general information for reference, with additional information regarding available monitoring technology. The broad topics are discussed here with links to the posters for reference.

Radiation Monitoring

When assessing radiation risks it is important to know which types of radiation you may encounter. Alpha and beta are particle forms of radiation that can be emitted by collection objects. Alpha radiation, while dangerous if the emitting material is inhaled or ingested, cannot penetrate paper or skin. Beta radiation has the ability to penetrate deeper than alpha but can be shielded with easily obtained materials, such as acrylic sheeting. Gamma and x-ray are high energy photon forms of radiation and are more difficult to block. While gamma rays can be released from collections directly, x-rays are more likely to be found in scientific instrumentation. Neutron radiation is the most dangerous, but unlikely to be stumbled upon by a conservation professional in a work setting. Multiple units of measurement related to radioactivity, exposure, and dose exist, but a good reference number to know is the US federal limit for the public and untrained employees, which is 100 millirem (100 mrem) or 1 millisieverts (1 mSv) per year, as determined by the Nuclear Regulatory Commission (NRC).

Many conservation labs have survey meters with Geiger-Mueller (GM) tube detectors, or "Geiger counters." Geiger counters can be used to check for radioactivity of a collection item, the effectiveness of shielding equipment, and leakage from instrumentation. Geiger counters detect the presence of radiation, but most cannot differentiate between

Types of commonly used personal radiation detectors (dosimeters):

- Film: Film badges are an older technology that use a combination of photographic film and filters. These have mostly been replaced by alternative technologies.
- Thermoluminescence (TLD): In TLD badges, the detector is a series of crystals. When heated, the amount of light indicates the amount of radiation absorbed by the crystals. They need to be sent into a company to be read. Extremity/ring dosimeters are also often TLDs.
- Optically Stimulated Luminescence (OSL): These function similarly to TLD badges, except the detecting crystals are activated through light rather than heat.
- Ionization Chamber/Direct Ion Storage (DIS): As radiation ionizes gas in a sealed chamber with an anode and cathode, the ions move to the electrodes and the charge that is produced is measured. In DIS dosimeters, this is combined with a memory cell, which stores the charge.
- Silicon Semi-conductor: Charges (freed electrons and the gaps they leave behind) are created in the semiconductor material as radiation travels through the crystal lattice. That energy is collected by an electrode and read.

types of radiation. They must be calibrated if they are to be of any quantitative value and maintained to be sure of sensitivity for qualitative work. Different models detect different radiations and have different sensitivities. The basic Geiger counters commonly found in conservation labs cannot be used to determine dose.

Dosimeters can provide an accurate reading of radiation dose received. There are various types of dose monitoring equipment and detectors available. Personal dosimeters are dose monitoring equipment that are worn by the user. They each have varying sensitivities, costs, and flexibility of use. No commonly used dosimeters detect alpha radiation, and different models detect varying combinations of beta, gamma, x-ray, and neutron. Some are considered passive and need to be read by a second machine in order for the wearer to obtain a result. Others are active and can give the wearer a real-time reading of exposure.

See the reference table on the poster "Ionizing Radiation in Conservation Labs Part 1: Monitoring Equipment" (www.conservation-wiki.com/w/images/f/f6/Dosimeters.pdf) summarizing commonly used dosimeter models for details on each.

Radioactive Objects

Although generally accepted that the radiation emitted by most radioactive art objects is low enough as to not be a concern, the dose from working on radioactive objects repeatedly for long periods of time is not well understood in the field.

Over half of survey respondents reported that they are aware of radioactive objects in their collections, but slightly fewer than half have a good awareness of the extent of these objects' radioactivity. Reported types of radioactive materials (often thorium, uranium, radium, and tritium) in their collections include decorative arts, industrial objects, historic medical and scientific laboratory equipment, military artifacts, musical instruments, and scientific specimens.

Radioactive objects might not always be what you expect. If you are unsure if an object has radioactive components, do a basic survey with a Geiger counter. Keep in mind that many Geiger counters cannot give dose numbers. If you want to calculate dose before working on an object or know the precise levels of radiation emitted by an object, you need specialized equipment such as a scintillation detector, ion chamber detector, or energy-compensated Geiger Mueller tube. An instant read-out dosimeter could also be used.

The legal aspects of having radioactive collection objects may differ depending on local, state, and national regulations. Make sure you are in compliance with these regulations; they may require surveys, safety training, and protocols for treatment, display, storage, labeling, packing, and shipment. Different working protocols depend on the level of risk. For example, intact uranium glass does not pose the contamination and inhalation risk of friable radium paint. See the poster "Ionizing Radiation in Conservation Labs Part 2: Radioactive Objects" (www.conservation-wiki.com/w/images/5/54/Radioactive_Objects.pdf) for more details. While everyone accrues some radiation from naturally occurring sources and medical procedures, it is important to aim to receive an annual dose that is As Low As Reasonably Achievable (ALARA). If you are working with radioactive objects, consult published articles for detailed protocols. If you are uncertain about any aspect of working with radioactive objects, it is best to consult a specialist.

—Cassia Balogh, Project Assistant Conservator, Philadelphia Museum of Art, cbalogh@udel.edu, and Haddon Dine, Objects Conservation Fellow, Straus Center for Conservation and Technical Studies, Harvard Art Museums, haddon_dine@harvard.edu

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