DOSIMETER COMPARISON CHART

MIRION TECHNOLOGIES
Dosimetry Services

	Instadose®+ Dosimeter	Instadose® Dosimeter	TLD Dosimeter	OSL Dosimeter	EPD or APD Dosimeter
Cost	$	$	$	$	$$$$
Measurements	Photon DEEP - Hp(10) SHALLOW - Hp(0.07)	Photon DEEP - Hp(10) SHALLOW - Hp(0.07)	Photon Beta Neutron DEEP - Hp(10) SHALLOW - Hp(0.07) EYE - Hp(3)	Photon Beta Neutron DEEP - Hp(10) SHALLOW - Hp(0.07) EYE - Hp(3)	Photon Neutron DEEP - Hp(10) SHALLOW - Hp(0.07)
Read Out	Accumulated (On-Demand)	Accumulated (On-Demand)	Accumulated (Lab Processing)	Accumulated (Lab Processing)	Accumulated & Dose Rate
Unlimited On-Demand Dose Reads	✓	✓	✗	✗	✓
Re-Calibration Required	✗	✗	✓	✓	✓
Wearer Engagement	High	High	Low	Low	High
Online Management Portal (Website)	✓	✓	✓	✓	✓ Provider Dependent
NVLAP Accreditation	✓	✓	✓	✓	Highly manual process
Immediate Online Badge Reassignment	✓	✓	✗	✗	✓ Provider Dependent
Archiving Dose (Wearer)	✓	✓	✓	✓	✓
Meets Legal Dose of Record Requirements	✓	✓	✓	✓	Highly manual process for meeting accreditation
NO Collection/ Redistribution Required	✓	✓	✗	✗	Must be collected to meet legal dose of record requirements
Read/View Dose Data on Your Smartphone	✓	✓	✗	✗	✗
Automatic (Calendar-set) Dose Reads	✓	✓	✗	✗	✗
Wireless Transmission of Dose Data	✓	USB plug-in to PC	✗	✗	Radio Communication
Immediate High Dose Alerts	✓ Upon Successful Communication	✓	✗	✗	✓
Descriptions	**Instadose Dosimeters** use direct ion storage (DIS) technology to measure ionizing radiation through interactions that take place between the non-volatile analog memory cell, which is surrounded by a gas filled ion chamber with a floating gate that creates an electric charge enabling ionized particles to be measured by the change in the electric charge created.		**TLD (Thermoluminescent Dosimeter)** measures ionizing radiation exposure by assessing the intensity of visible light emitted by a crystal inside the detector when the crystal is heated. The intensity of light emitted is dependent upon the radiation exposure.	**OSL (Optically Stimulated Luminescence Dosimeter)** measures ionizing radiation exposure when radiation energy deposited in the material causes electrons to move from the valence band to the conduction band. The greater the radiation energy absorbed (dose), the greater the number of trapped electrons. These electrons are freed by exposing the dosimeter to light and the intensity of the emitted light is measured and used to calculate the dose.	**EPDs (Electronic Personal Dosimeter) or APDs (Active Personal Dosimeter)** makes use of a diode (silicon or PIN, etc.) to detect "charges" induced by ionizing radiation, which can be measured as electric current and constitutes the measure of the dose rate.

IONIZING RADIATION & PERSONAL DOSIMETRY MONITORING

What Does It All Mean & Why Should I Care?

WHAT IS IONIZING RADIATION?

Ionizing radiation is used in a wide variety of fields such as medicine (to diagnose and treat diseases), nuclear power (to produce energy), research (to understand and harness its power), manufacturing (of consumer products), construction (of buildings and bridges), oil and gas (to generate energy/power), and many other areas.

While the benefits of using and harnessing the power of ionizing radiation may be numerous, so are the risks. Exposure to ionizing radiation causes damage to living tissue, and can result in radiation burns, cell damage, sickness, cancer, and in severe or long-term exposure cases even death.[1-6] Because ionizing radiation is not detectable by human senses (see, smell, hear, taste, touch), radiation detection devices must be used to indicate its presence and measure its power/potential hazard.

Occupational exposure to ionizing radiation can be safe when proper measures against undesired exposure are followed. Safeguarding occupationally exposed staff from the health hazards associated with unintended radiation exposure begins with knowing when and how much exposure they receive, on a cumulative basis.

WHAT IS A DOSIMETER? WHY DO SOME PEOPLE NEED TO WEAR THEM?

Personal radiation monitoring devices (or badges) are dosimeters that detect and measure an individual's cumulative dose of exposure to various forms of radiation (x-ray, gamma, neutron and beta).

Due to the potential health consequences associated with too much exposure to ionizing radiation,[1-6] industry regulations and guidelines[7-13] often require that:

- Employers provide employees exposed to radiation as part of their occupation with an appropriate and approved dosimeter when using radioactive substances and radiation equipment.
- Employers record and monitor all occupationally exposed persons in their employ who are involved in the use of ionizing radiation to ensure that the employee's work practices result in exposures well below their effective dose limits.
- Employees issued a dosimeter by their employer are required to wear the dosimeter while at work.
- The accredited dosimetry service provider must validate the dose results then report them to the employer.

WHAT'S THE DIFFERENCE BETWEEN A PASSIVE, ON-DEMAND & AN ACTIVE DOSIMETER?

A passive dosimeter (like a TLD or OSL) detects/measures radiation dose information for a specified wear period (typically 1-6 months) and must be returned to the dosimetry service provider for processing (to read, record, and archive the dose data in the individual wearer's record). In addition to processing the dosimeter, the dosimetry service provider also quality checks and validates the dose data before issuing the dose report. And, because its ability to capture dose is independent of a power source (like a battery), a passive dosimeter offers high reliability and immunity against operator errors like forgetting to turn it on. However, passive dosimeters can only report out the accumulated dose for that wear period, which makes it difficult to pinpoint (or alert the wearer or employer) exactly when a high or abnormal dose was received.

An on-demand dosimeter (like the Instadose dosimeter) detects and measures radiation dose information in the same way that a passive dosimeter does, but employs innovative SmartMonitoring™ and Bluetooth technology that enable onsite readings with the push of a button, remote/online processing (including quality checks and dose validations) and electronic transmission (also recording and archiving) of dose data. This eliminates the need to return dosimeters to the provider for processing and reporting, as well as the time-consuming task of collecting and redistributing dosimeters every wear period. Wearers keep their dosimeters and have the ability to manually read their dosimeter (with the push of a button) any time they want, as much as they want—resulting in a richer dose data stream offering more dose data points and insights. Additionally, on-demand Instadose+ and Instadose 2 dosimeters offer automatic dose reads according to a set calendar schedule, which ensures dose reads are captured and transmitted on a regular schedule without wearers having to perform manual dose reads.

An electronic personal dosimeter (EPD) or active personal dosimeter (APD) is a direct reading dosimeter that has a digital display for viewing realtime dose results. Typically offered as stand-alone systems (devices, displays, software), some EPDs or APDs may lack the quality and dose validation checks and balances (performed in-house or online by the dosimetry service provider) that are part of the passive and on-demand dosimetry models. Unlike passive and on-demand dosimeters, some EPDs and APDs may require a principal power supply to detect and store dose. Loss of the principal power supply (wired or battery), in some cases, renders them unable to function/operate and data may be lost. Currently, there are no EPDs and APDs accredited for legal dose of record radiation monitoring "off-the-shelf" by the manufacturer and the end user facility must obtain accreditation.

1. National Research Council, Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII – Phase 2 (2006). www.philrutherford.com/Radiation_Risk/BEIR/BEIR_VII.pdf
2. A. Roguin, et al. Brain and neck tumors among physicians performing interventional procedures. 111 American Journal of Cardiology 9: 1368-72 (May 2013).
3. S. Yoshinaga, et al., Nonmelanoma skin cancer in relation to ionizing radiation exposure among U.S. radiologic technologists. Int J Cancer. 2005;115:828-34.
4. E. Vano, et al. Radiation-associated lens opacities in catheterization personnel: results of a survey and direct assessments. 24 Journal of Vascular Interventional Radiology 2: 197-204 (2013).
5. E. Ron, E, Brenner, Non-malignant thyroid diseases after a wide range of radiation exposures. Radiation Research, 174:877-888 (2010).
6. R. Rola, Indicators of hippocampal neurogenesis are altered by 56Fe-particle irradiation in a dose-dependent manner. Radiation Research, 162:442-6 (2004).
7. International Atomic Energy Agency (IAEA). Radiation Protection of Staff in Dental Radiology. www.iaea.org/resources/rpop/health-professionals/dentistry/staff
8. Occupational Safety and Health Administration (OSHA) Standards 29 CFR 1910.1096. www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10098
9. Environmental Protection Agency (EPA). Federal Guidance Report No 14: Radiation Protection Guidance for Diagnostic & Interventional X-Ray Procedures. www.epa.gov/sites/production/files/2015-05/documents/fgr14-2014.pdf
10. NRC Regulatory Guide. www.nrc.gov/docs/ML1023/ML102350460.pdf
11. Patient Safety Network. Radiation Risks Associated with Diagnostic Imaging. psnet.ahrq.gov/primers/primer/27/radiation-safety
12. American Dental Association & U.S. Department of Health and Human Services, Food and Drug Administration. Dental Radiographic Examinations: Recommendations for Patient Selection and Limiting Radiation Exposure. www.ada.org/~/media/ADA/Member%20Center/FIles/Dental_Radiographic_Examinations_2012.ashx
13. American Veterinary Medical Association. www.lowerthedose.org

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