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A practical guide to radiation safety during nuclear power plant decommissioning

ThermoFisher SCIENTIFIC

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Overview

What is decommissioning

A decommissioning project is a process involving both the administrative and technical steps aimed to clean up a nuclear facility in a safe, secure, and environmentally friendly manner.

Decommissioning can be a labor intensive and dirty job, as well as a dangerous one. Some sites have more than just radiation to worry about. At government sites, chemicals, munitions, and explosives may also be present.

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Closure requirements

The permanent closure of a nuclear power plant involves:

1. Its safe removal from service
2. Dismantlement of the facility to the point that it no longer requires measures for radiation protection; i.e the radioactivity level is residual.

Advanced, integrated radiation detection and radioactivity measurement instruments, as well as chemical analyzers, help mitigate the threat and keep workers safe.

The USNRC offers a map on its website that depicts the locations of sites that are currently decommissioning, accompanied by an **Alphabetical list of sites undergoing decommissioning** which provides links to their descriptions. Included are site status summaries, any major technical or regulatory issues, and the estimated date for closure of each site.

Resources:

- The USNRC frequently asked questions about reactor decommissioning
- Radiation detection for decommissioning technology
- Backgrounder on decommissioning nuclear power plants

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3 ways to decommission

DECON (Decontamination)	SAFSTOR (Safe storage)	ENTOM (Entombment)
Dismantling or removing all radioactive materials above acceptable limits. This step reduces the radiation level in the plant and minimizes the potential exposure to workers during subsequent decommissioning operations.	Leaving the reactor intact but in a safe state. Highly radioactive components such as spent fuel are removed and placed in on-site storage while the surveillance and monitoring continue. This low initial cost process allows time for decay of radioactivity and the plant is dismantled in future years following steps like the DECON ones.	Permanently enclosing the facility on site into a condition that will allow the remaining radioactive material to be on-site without ever removing it.

Often used together

Rarely used option

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11 tasks for DECON and SAFSTOR

1. Pre-decommissioning actions
2. Facility shutdown activities
3. Procurement of general equipment and material*
4. Dismantling activities*
5. Waste processing, storage, and disposal*
6. Site security, surveillance, and maintenance
7. Site restoration, cleanup, and landscaping*
8. Project management, engineering, and site support
9. Research and development
10. Fuel and nuclear material*
11. Other

**Radiation monitoring and measurement needed*

Radiation monitoring and measurement

The radiological properties of the waste (e.g. activity and composition of radionuclides, dose rates from the waste) are measured using radiation monitoring instruments. These radiation monitoring instruments include personnel contamination monitors and personnel dosimeters as well as general-purpose instruments. Their use is highly critical since the decommissioning of facilities is conducted in a safe and environmentally acceptable manner in accordance with regulatory practices. Here are some of the tasks from the previous page where instruments are used.

TASK 1	Upgrading general radiological protection systems and health physics equipment every 10-15 years, depending on instrument type, wear, and age, is generally advised.
TASK 2	Periodic radiation and environmental surveys are needed, but the frequency and scope of inspections currently are not regulated in most countries.
TASK 3	It is fair to skip the R&D activity since all technologies and equipment that are necessary to decommissioning an NPP are currently available and could be purchased on the market.

Compliance

Overview

The USNRC states that both worker and public safety are considered in decommissioning planning. Thus, there is continued environmental monitoring of the site and the offsite areas to measure release of radioactive material during the decommissioning process.

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Protecting workers

Radiation exposure to the human body, contamination of skin, clothes, plant surfaces, air, or nearby water should be monitored.

Personnel dose monitoring:

Dosimetry services offer accurate measurement of radiation dose exposure in the workplace, ensuring personnel safety in any environment where radiation exposure is a concern. There are **electronic dosimeters** that are used for active monitoring of employee exposure that feature a built-in telemetry option.

Site entry and exit screening:

There are several monitors that help detect radioactive material on personnel, clothing, and objects to ensure contamination is not spread beyond the radiation control boundaries of a nuclear facility. **Personnel contamination monitors** identify surface contamination on the body, hands, and feet. **Personnel gamma portal monitors** provide simplified but advanced internal and external monitoring of workers well below clearance levels.

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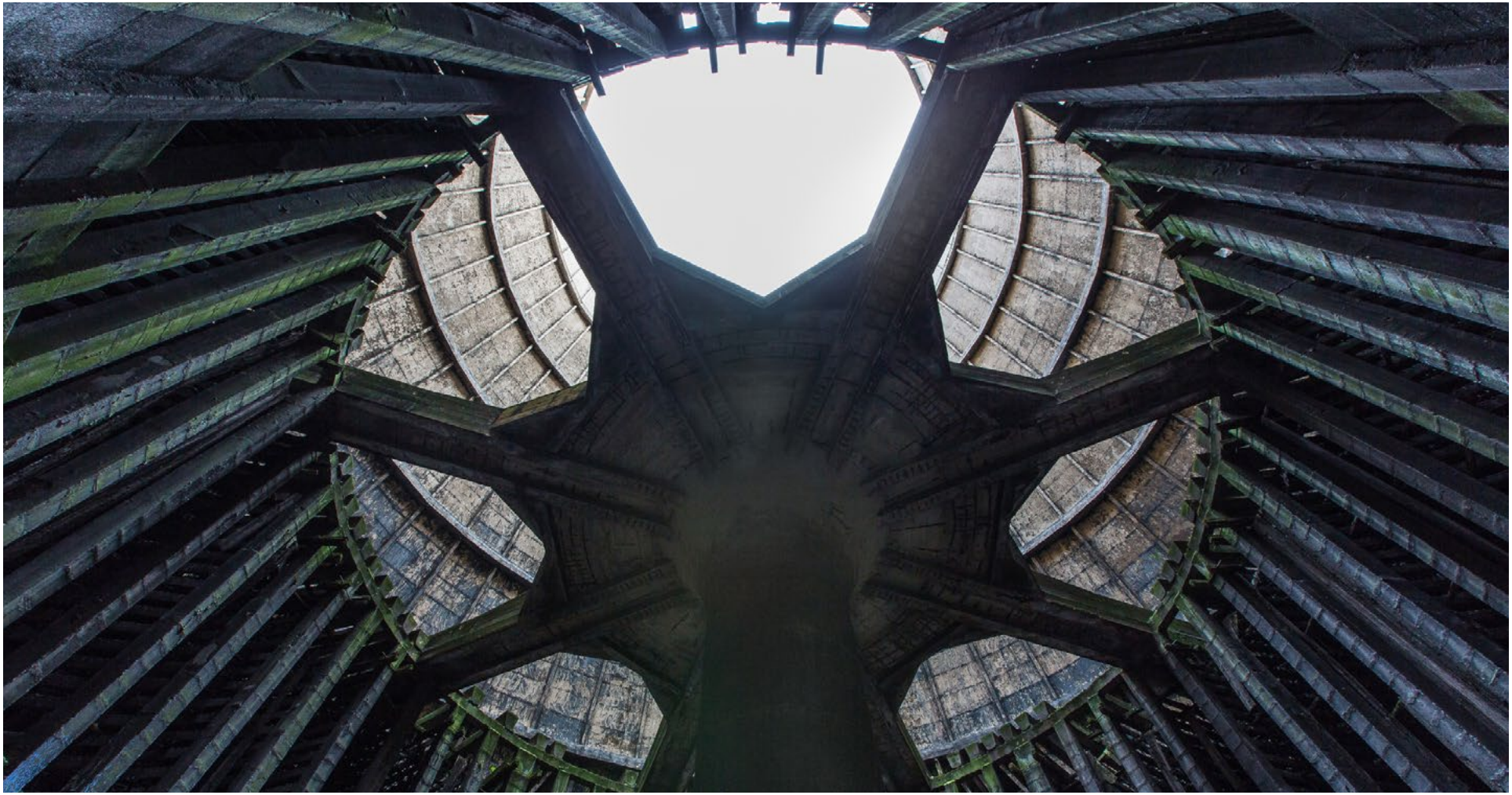
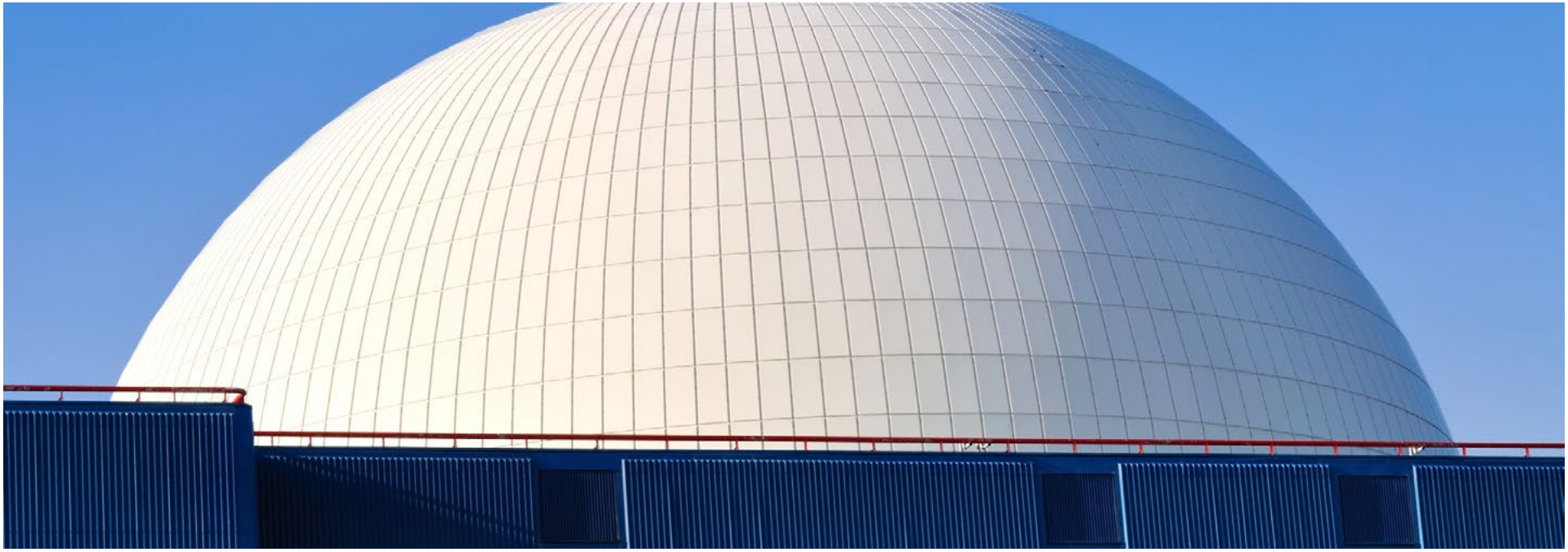
Monitoring air

Air monitoring systems give early warning to workers of airborne alpha and beta radiation. Alpha air monitors and beta air monitors are excellent solutions for monitoring stacks and ducts, as well as monitoring work areas.

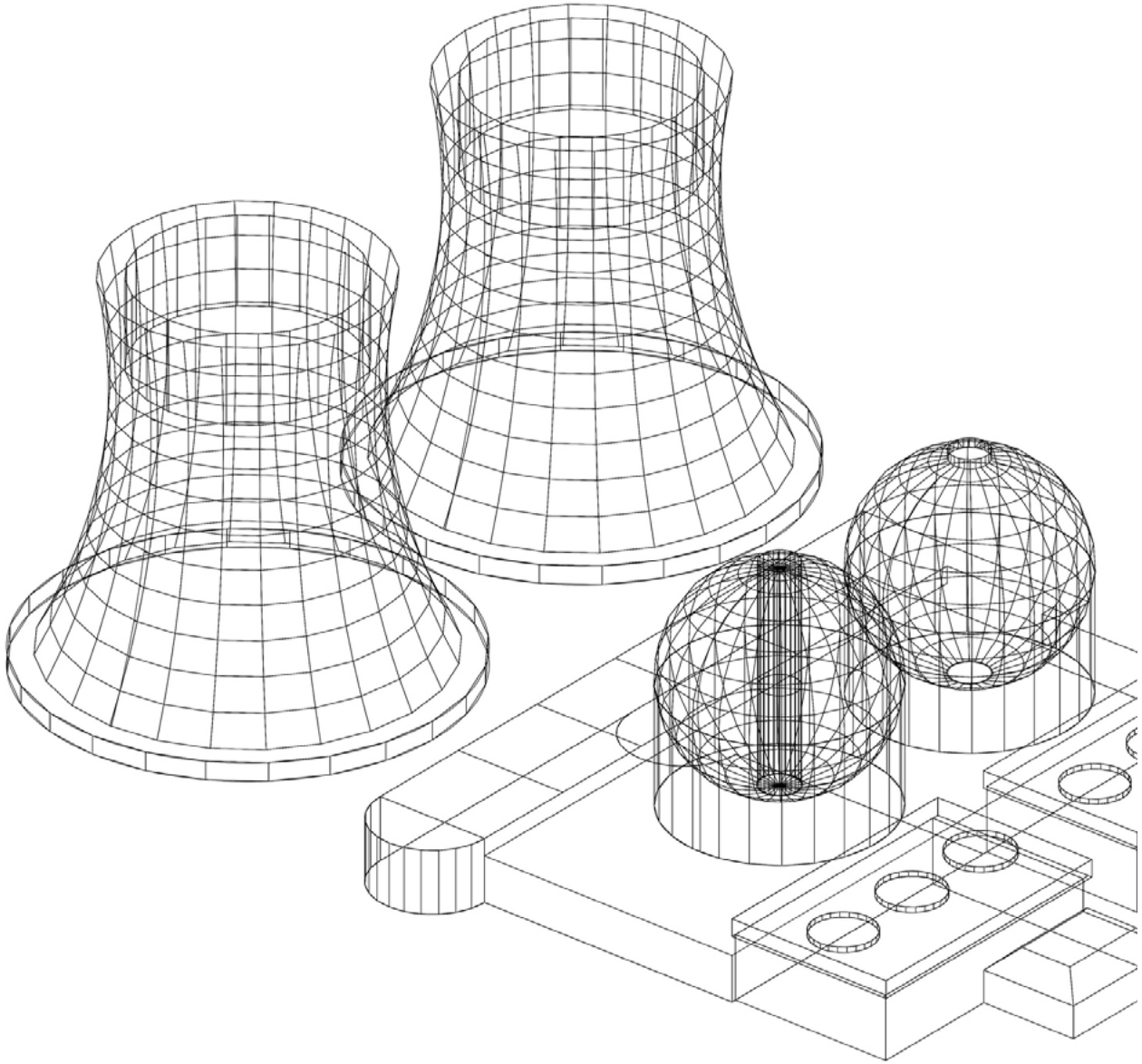


Survey instruments

There are portable survey meters that detect and measure very low levels of alpha, beta and gamma isotopes; even the smallest change in radiation rates are displayed immediately, while coincidentally occurring fluctuations are suppressed. Micro rem/sievert tissue-equivalent survey meters are ideal in applications where accurate dose rate measurements of low radiation levels are required. Ion chamber survey meters are vented to atmospheric pressure and specifically designed to have a flat energy response x-rays. Geiger-Muller, scintillation and gas proportional detectors are suited for a wide range of applications such as contamination assessment and reducing personnel risk radiation exposure.



Frisking and identifying unknowns



Frisking:

Multi-purpose survey meters help to quickly identify mixed radioactive surface contamination in facility and field environments.

Identifying unknown isotopes:

Spectroscopic personal radiation detectors detect and identify neutron and gamma radiation, while **handheld radiation isotope identifiers** are well suited to support identification of specific gamma isotopes.

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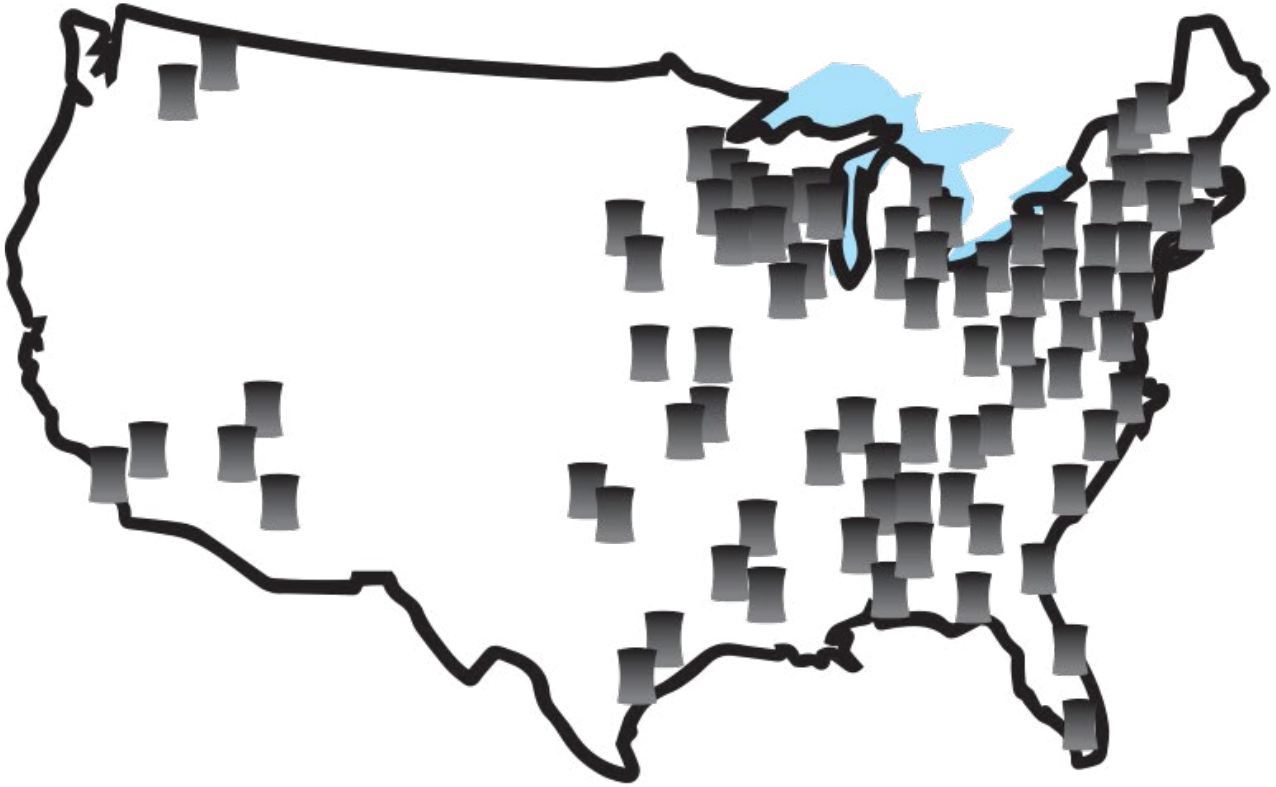
Radiation FAQs

Location of U.S. nuclear power plants

Nuclear power plants



- 60+ sites operating throughout US
- Significant risk for terrorism or accident resulting in radioactive release
- High level spent radioactive fuel stored on site
- Low level waste transported to disposal sites
- Uranium fuel transported to site each year for refueling

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PDF For more information, download: **U.S. Map of Radiation Threats**

Radiation detection frequently asked questions

Q. What is radiation?

Q. Where can you find radiation?

Q. How can radiation be detected?

Q. What's the difference between a Geiger counter and a personal radiation detector?

Q. Are there different personal radiation detectors for different purposes?

Q. How can I tell the difference between natural and artifical radiation?

Q. Are you trying to scare us with all this radiation talk?

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Click here to get the **answers**

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Equipment & services

Active monitoring of employee exposure

Electronic dosimeters monitor, inform, and improve worker safety in environments where radiation exposure is a necessary and unavoidable part of the job.

Thermo Scientific™ EPD TruDose™ Electronic Personal Dosimeter

Unparalleled real-time reliable dose reading of both gamma and beta radiation with a sensitivity as low as 0.005mrem/h. The added warning thresholds enable users to react before an alarm condition arises.

Product details ›

Click here to watch the EPD TruDose electronic personal dosimeter in action

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Site entry and exit screening

Decommissioning facilities maintain the highest safety standards to assure the health and safety of workers by the use of reliable radiation protection services based on sensitive, real-time monitoring instruments and easy-to-use procedures supported by professional data management tools.

Thermo Scientific™ IPM96 Whole Body Personnel Contamination Monitor

Efficient and accurate scanning for beta/gamma contamination on the entire surface of the body using 96 independent detection zones.

Product details ›

Thermo Scientific™ iPCM12 Whole Body Personnel Contamination Monitor

Personnel contamination monitor utilizes 21 detectors in monitoring the body, head, hands, and feet. The alpha/beta detectors are split into four detection zones to minimize the background during monitoring, and achieve the best detection limits.

Product details ›

Thermo Scientific™ PM12 Gamma Portal Monitor

Gamma portal monitor utilizes eight identical large gamma-sensitive plastic scintillation detectors to monitor personnel passing through the portal. Traffic flow can be either direction.

Product details ›

Click here to watch the PM12 personnel gamma portal monitor in action

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Site entry and exit screening

Thermo Scientific™ SAM12 Small Article Monitor

Small article monitor is used to measure tools and other hand carried objects for gamma contamination before leaving a radiological controlled area.

Product details ›

Thermo Scientific™ HFM11-SC Hand and Foot Monitor

Monitors alpha and beta radiation simultaneously, minimizing the risk of detector contamination.

Product details ›

Thermo Scientific™ FHT65QC Quick Internal Gamma Counter

A recurrent, quick, but sensitive scan of a worker's chest helps radiation protection officers to detect internal activity so that next step safety measures can be applied in a timely manner.

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For additional resources, including white papers, application notes, brochures, videos, comparison charts, and FAQs, visit our **Radiation Detection for Decommissioning** pages.

Air monitoring

Early warning to workers of airborne alpha and beta radiation.

Thermo Scientific™ ALPHA-7A Alpha Air Monitor

Continuous air monitor provides faster, more powerful algorithms for the identification and quantification of airborne releases of alpha-emitting radionuclides, primarily transuranics such as 238Pu and 239Pu.

Product details ›

Thermo Scientific™ AMS4 Beta Air Monitor

Provides an early warning to workers exposed to potential airborne releases of beta-emitting particulates.

Product details ›

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For additional resources, including white papers, application notes, brochures, videos, comparison charts, and FAQs, visit our **Radiation Detection for Decommissioning** pages.

Radiation survey instruments

Thermo Scientific™ RadEye G Personal Dose Rate Meter

The RadEye G personal dose rate meter detects and measures very low gamma energies; even the smallest change in radiation rates are displayed immediately, while coincidentally occurring fluctuations are suppressed.

Thermo Scientific™ RadEye PRD Personal Radiation Detector

The RadEye PRD personal radiation detector provides teams with high-performance detection for any scenario.

Thermo Scientific™ MicroRem/Sievert Tissue-Equivalent Survey Meter

The MicroRem/Sievert tissue-equivalent survey meter is ideal in applications where accurate dose rate measurements of low radiation levels are required.

Thermo Scientific™ RO-20 Ion Chamber Survey Meter

Provides an early warning to workers exposed to potential airborne releases of beta-emitting particulates.

Thermo Scientific™ NRD Neutron Ball with BF3 Tube

The NRD neutron ball with BF3 tube measures neutron dose rate from Thermal through Fast.

Geiger-Muller detectors

Thermo Scientific™ RadEye GX Survey Meter

Geiger-Muller/scintillation detectors

Thermo Scientific™ RadEye SX Survey Meter

Gas proportional detectors

Thermo Scientific™ RadEye PX Survey Meter

Frisking

Thermo Scientific™ B20 Multi-purpose Survey Meter

For more information, view our **selection guide**

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Identification of unknown isotopes

Detect and identify gamma and neutron radiation

Thermo Scientific™ RadEye™ SPRD-GN Spectroscopic Personal Radiation Detector

The RadEye SPRD-GN spectroscopic personal radiation detector delivers outstanding neutron performance and reliable gamma IDs.

Product details ›

Thermo Scientific™ RIIDEye™ X/M Series Handheld Radiation Isotope Identifiers

The RIIDEye X series handheld radiation isotope identifier is well suited to support contamination monitoring and remediation.

Product details ›

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Remote real-time monitoring & data management

Thermo Scientific™ FHT 6020 Area Monitor Display and Alarms

Nuclear facilities need accurate, reliable, sustained early warning of radiation leaks. The FHT 6020 area monitor display and alarms offers maximum reliability for permanent operation within nuclear facilities or environmental networks with up to 16 measurement channels that can process and display data from Thermo Scientific intelligent dose rate probes, FH 40 G series probes as well as analog or digital input. All channels can be operated simultaneously, along with audible and visible alarms, to measure and assess the level of gamma and neutron radiation.

Product details ›

Thermo Scientific™ RadEye™ Area Monitor

Extend the application range to convenient and cost-effective gamma and neutron area monitoring with the RadEye area monitor. The enclosure adapts several different types of RadEye instruments for area monitoring applications.

Product details ›

Thermo Scientific™ ViewPoint™ Enterprise Remote Monitoring System

Protect first responders and the public with the ViewPoint enterprise remote monitoring system, a comprehensive, customizable solution for real-time monitoring and data management. Early warning of potentially hazardous radiation is critical, and an effective response depends on having complete information about the environment. The ViewPoint enterprise remote monitoring system centrally processes and analyzes data from radiation, environmental and general purpose detectors to give a complete picture of radiation levels during normal and outage operations at nuclear power plants, industrial settings or security checkpoints.

Product details ›

Complex scenarios

Many sites have more than just radiation to worry about. At some government sites chemicals, munitions and explosives may also be present. Metal analyzers as well as chemical and explosive identification equipment may also be needed.

Chemical identification

Rapidly identify unknown chemicals and explosives with the Gemini Analyzer.

Product details ›

Metal analyzers

Scan a broad range of materials and identify and verify pure metals and alloys with portable XRF analyzers.

Product details ›

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Radiation dose monitoring services

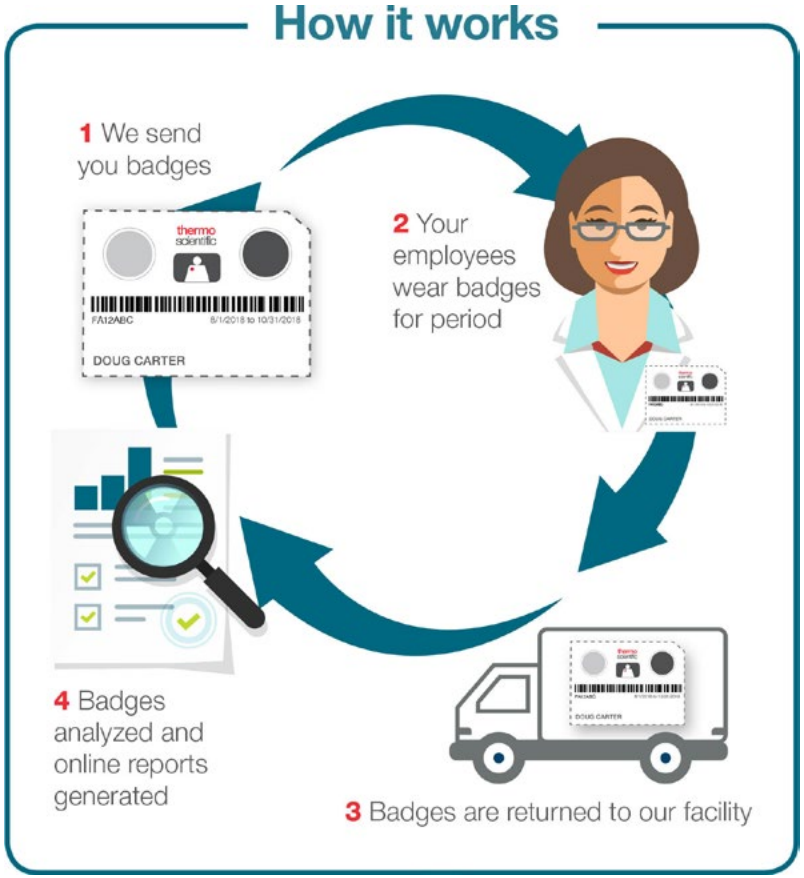
Radiation exposure in the workplace must be accurately measured and monitored to protect employees and employers alike. When worker safety can't be comprised, rely on our radiation dose monitoring services.

Your partner for safety

- Access to in-house, customer care experts
- Access to Dosimetry Consultants
- Access to Thermo Scientific MyRadCare – Free on all of your electronic devices
- NO maintenance fees
- NO cancellation fees
- NO fees to add, delete or make changes to wearers

Get started today by visiting **MyRadCare** or by completing **this form**.

Click here to watch a video on our dosimetry services.



For more information, download the brochure: **Dosimetry Services**

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About Thermo Fisher Scientific

Thermo Fisher Scientific is the world leader in serving science. Our mission is to enable our customers to make the world healthier, cleaner and safer. We help our customers accelerate life sciences research, solve complex analytical challenges, improve patient diagnostics, deliver medicines to market and increase laboratory productivity. Through our premier brands – Thermo Scientific, Applied Biosystems, Invitrogen, Fisher Scientific and Unity Lab Services – we offer an unmatched combination of innovative technologies, purchasing convenience and comprehensive services.

For additional information or to request a quote, please click below.

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