



SOLUTIONS FOR CHALLENGING D&D PROJECTS



EVERY D&D PROJECT HAS DIFFERENT REQUIREMENTS AND CHARACTERISTICS

In July 2016 Mirion Technologies and Canberra Industries joined forces as Mirion Technologies to become a leading supplier of radiation measurement and imaging solutions to the nuclear industry. Our new Characterization Division is focused on supporting customers involved with Decontamination and Decommissioning (D&D) projects. Our world-class team of experts combines application know-how with a broad range of Mirion products and systems to deliver solutions that help customers address the complex challenges faced during all stages of the D&D project life cycle.

We develop advanced and innovative equipment, tools and methodologies that meet or exceed your needs, focusing directly on the success criteria of your D&D project. Whether it's acceleration of site clean-up, minimization of waste volumes or reduction in waste costs, we can help you achieve your objectives.

Our flexible offer ranges from the supply of off-the-shelf equipment, to customized equipment and support services, to dedicated on-site scientific and technical resources.

Regardless of the project scope, we will partner with you to identify the right combination of products and expertise to ensure a successful project outcome.



Visit our Measurement and Expertise (M&E) page.



MEASUREMENTS AND EXPERTISE SOLUTIONS

PARTNERSHIPS FOR MORE EFFICIENT AND COST-EFFECTIVE NUCLEAR MEASUREMENTS

Expert Support for Complex Systems

- Technical and feasibility studies to assist in waste management and D&D strategies, audit preparation and assistance, NDA system upgrade, system training.

Method Development

- Best approach and methodology to achieve the customer's objectives, best practice approach.

Measurement Procedures

- Operating instructions, documentation and training to provide QA approved methods for operators.

Onsite Measurement Services and Characterization Reports

- Large range of onsite services from dose rate and gamma imaging surveys to complex gamma spectroscopy and neutron measurements. Some of our instruments and systems are available for lease.

Assistance to System Operations

- Enhancing the operation of your NDA systems with the support of our Experts, providing assay systems for measurement campaign.

Expert Data Review

- Expert physics review of assay system results with QA and fingerprint reviews.

System Calibration Service

- Initial or Annual calibration for installed systems, system qualification and certification.

EXAMPLES OF OUR D&D SOLUTIONS

Decontamination and Decommissioning (D&D) is a major effort worldwide, covering everything from early R&D facilities to first generation nuclear power plants, weapons and fuel fabrication facilities and research reactors.

1 Site Characterization p 6



Prior to dismantling a nuclear facility, full site characterization may be performed to identify costs and hazards associated with D&D. At this time, initial modeling of various scenarios may occur in order to properly plan the operations that will be deployed during the D&D project. Mirion offers a wide range of tools for large outdoor area surveys, underwater measurements, concrete walls and floors, and large structures and components characterizations.

2 Operations Support p 12



During the dismantling process, materials and other objects will require radioactive quantification. Radiological mapping might also be required in certain areas during the demolition process. Mirion can provide radiological tools and procedures that enable efficient sorting and characterization of waste prior to shipment.

3 Environment p 16



Routine monitoring is required during all D&D phases to provide early warning and characterization of possible radiation release incidents. Monitoring programs maintain constant baseline information and variations are investigated. In the event of a radiological release, responders need to move immediately to protect the public and themselves. Mirion is a leader in providing measurement solutions and expertise for both real-time and sample-based Environmental Monitoring.

4 Worker Protection p 17



A proactive and comprehensive health and safety program is essential to safeguard the health of employees, to maintain ALARA principles and to avoid preventable and costly accidents during the whole D&D project. Mirion offers a wide range of field-proven solutions to safeguard personnel.

		1				2			3	4
		Large Outdoor Area Surveys	Underwater Measurements	Concrete Walls and Floors	Systems, Structures and Components	Soil Sorting	Laboratories	Waste Characterization	Environment Monitoring	Contamination Monitoring
Products & Systems	Imaging Cameras		✓	✓	✓					✓
	iPIX™ Gamma Imager	✓		✓	✓					
	TRACS / Aegis™	✓		✓	✓			✓		
	ISOCS™ In Situ Object Counting System	✓	✓	✓	✓	✓		✓		
	NDA Systems & Clearance Monitors				✓	✓		✓		
	Lab Gamma Spec			✓			✓			
	Low Background Alpha / Beta			✓			✓			
	Lab Alpha Spec						✓			
	Hand Held Dose Rate & Contamination	✓		✓	✓			✓		✓
	Personnel Contamination Monitors									✓
	Alpha Beta & Gamma Air Monitoring	✓		✓					✓	✓
Measurement & Expertise	Expert Support for Complex Systems	✓	✓	✓	✓	✓		✓		
	Method Development	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Measurement Procedures	✓	✓	✓	✓	✓		✓	✓	✓
	Onsite Measurement Services	✓	✓	✓	✓	✓	✓	✓		
	Assistance to System Operations	✓	✓	✓	✓	✓	✓		✓	
	Expert Data Review	✓	✓	✓	✓	✓				
	System Calibration Service	✓	✓	✓	✓	✓				✓

1

Site Characterization

LARGE OUTDOOR AREA SURVEYS

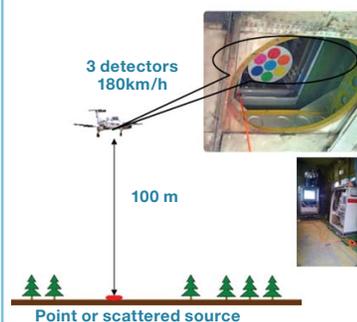
Mirion has developed solutions to survey large areas using GPS technology for mapping outdoor areas in real time. These solutions include high-efficiency clusters of HPGe capsules in helicopters, various gamma assay systems with ISOCS (In Situ Object Counting System) technology and handheld dose rate meters mounted in a mobile lab.

Dose Rate Mapping



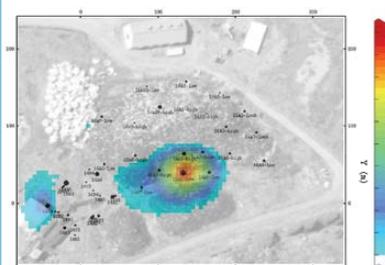
Dose rate data with Colibri® and Kartotrak® software by Geovariances

Aerial Survey



Air survey mapping with segmented HPGe detectors

In Field Spectrometry

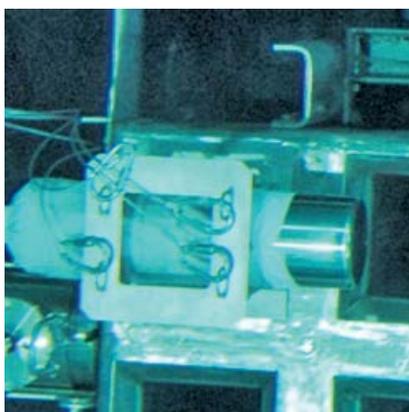


Mapping of ^{235}U contaminated area

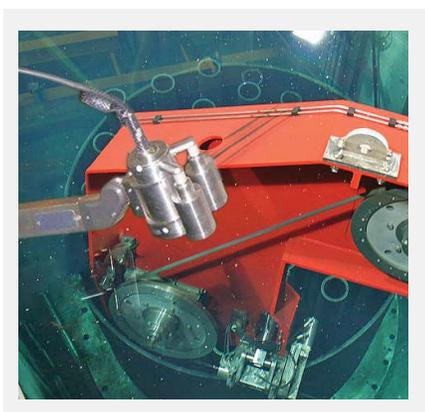
UNDERWATER MEASUREMENTS

Solutions can be deployed for underwater nuclear measurements.

To obtain accurate quantitative results, our sealed, electrically cooled HPGe detector can be used in ponds and rivers, whereas in fuel pools, our SMOPY Services Team can provide characterization for fuel rods as well. Our detectors come with the ability to be easily mounted in a Remotely Operated Vehicle (ROV) to survey large underwater areas.



Underwater measurement of activated waste with the SMOPY Probe



Radiation tolerant cameras used to monitor underwater cutting & dismantling of Reactor components



Sealed HPGe in water tank (25 m cable)

SURFACES AND FLOORS

Basic radiological detection is performed by gamma dose rate instrumentation, as well as surface contamination monitors.

Typical alpha beta measurements on surfaces and floors are executed by means of contamination monitors, whereby levels of 0.04 Bq/cm² (240 DPM/100 cm²) alpha and 0.4 Bq/cm² (2400 DPM/100 cm²) beta are applicable survey limits for discrimination (either averaged over 100 cm² or site specific limits can apply).

Mirion can supply the user with a range of instruments from swipe/smear testers to handheld detectors or larger floor contamination monitors with varying sizes of detectors, but where full discrimination between the alpha and beta (gamma) channels can be obtained.

Dose rate and alpha – beta/gamma area contamination monitors



Dose rate detection by **RDS-30**, **RDS-31**, **Radiagem™**, **Colibri** series for ambient to medium levels



α - β contamination probes **SAB(G)-100** (100 cm²)



External and Tele-STC dose rate probes for high range levels

Swipe testers and large area contamination monitors



iSolo®: α/β Swipe/Filter Counter with NORM rejection



Easy-Count™: CSP™ α/β Portable Smear Counter



Aegis™ Transportable HPGe Spectrometer



SABS-579 α/β (579 cm²) Floor Monitor

Site Characterization continued on next page

1 Site Characterization

continued

BORE HOLES AND CONCRETE WALLS

Where (beta) gamma contaminants are expected, surface and in-depth profiling of walls and floors are required to accurately evaluate the contaminated areas before dismantling operations commence. Once contaminated areas are identified a plan for waste segregation and contamination removal can be evaluated.

Mirion offers a broad array of products and turn-key solutions with support from our Measurement and Expertise Team, from on core sampling methods, to HPGe or CZT detectors inserted in drilled holes, and innovative gamma imaging coupled to spectroscopic detectors.

Non-invasive solutions are available using our ISOCS with HPGe or CZT detectors. Results can be processed using ISOCS, or with specialist support from Mirion using the Advanced In-Situ Gamma Spectrometry Services.

Spectrometry based measurements for depth profiling

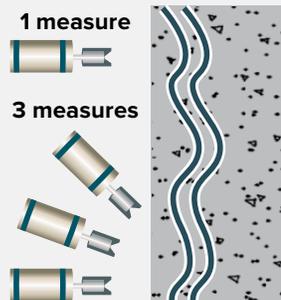


In core spectrometry for Bq/g determination using single sealed LN₂-free HPGe



GR1 compact CZT detector with optional shielding and collimator set

Non-invasive in-situ measurement using ISOCS, also using several ISOCS positions.



Wall or surface determination in Bq/cm² and in-depth profile detection using **ISOCS** HPGe

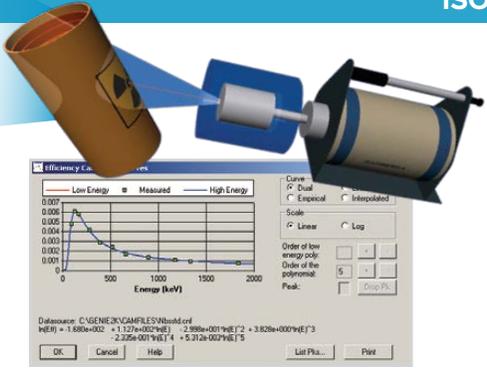


In-situ Measurement of Depth Tagged Dust Samples (TruPro® Technology)

SYSTEMS, STRUCTURES AND COMPONENTS

Mirion has over twenty years of experience characterizing contamination of nuclear components using ISOCS. Waste or in process components such as pipes, tubes, scrap, ventilation systems, and small irregular objects can be characterized using this approach. ISOCS is an excellent tool to evaluate the activity of these components for continued waste storage or disposal, without the need for radionuclide calibration sources. ISOCS can be deployed along with the iPIX Gamma Imager to locate a hot spot in real time.

ISOCS



Flexible geometrical models for efficiency determination using ISOCS



Characterization of heat exchangers for free release

Scheme of activity calculation

```

graph TD
    subgraph Legend
        M[Measurement]
        Model[Model]
        FR[Final Result]
    end
    GOS[Geometry of the scene] --> GACC[Gamma attenuation calculation code]
    GACC --> GE[Geometrical efficiency]
    GE --> Act[Activities]
    LS[Location of sources] --> GACC
    LS --> GS[Ge Spectrum]
    GS --> Act
    GD[Ge Detector] --> GS
    DE[Detector efficiency] --> Act
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    style GS fill:#ADD8E6,stroke:#000,stroke-width:1px
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ISOCS Uncertainties Estimator and multi-Geometry Calculator enables the testing of the sensitivity of model's parameters, such as geometry, material, shapes, etc.

1 Site Characterization
continued

SYSTEMS, STRUCTURES AND COMPONENTS
continued

Advanced Services with iPIX Gamma Imager



Passive neutron coincidence monitors for neutron characterization of Special Nuclear Material (SNM) in Fuel Cycle operations or D&D

For Fuel Cycle facilities, Mirion offers neutron slab counter solutions for inventory and D&D purposes



WM3400 Passive Neutron Slab Counter



WM3500 Curved Slab Passive Neutron Counters

IMAGING

Nuclear Inspection and Surveillance Systems – Cameras Hardened Against the Effects of Radiation

CCTV monitoring of nuclear generating, reprocessing, waste management and research facilities is of vital importance during the decommissioning and dismantling phases.

Mirion radiation tolerant inspection and surveillance systems, whether permanently located within the plant or used in portable or temporary configuration are designed to survive the hostile environments frequently encountered.

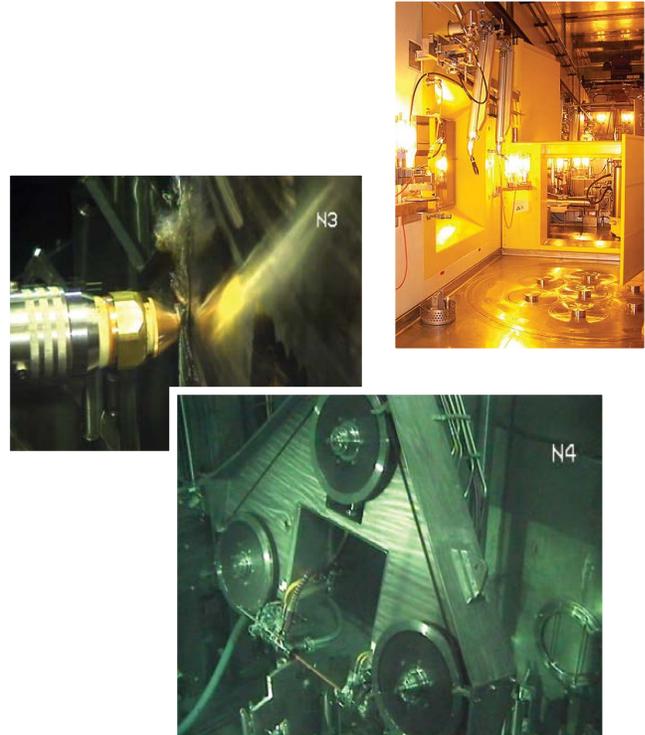
D&D Applications

- Pre-shutdown surveys
- Fuel removal and handling
- Visual monitoring of inaccessible areas
- In situ monitoring of D&D activities
- Fuel storage ponds
- Drum identification (machine vision)
- Waste retrieval and handling
- Robotics and remote tooling
- Welding and cutting
- Corrosion evaluation
- Waste encapsulation and vitrification
- Safeguards

These CCTV cameras can be equipped with a selection of lens and lighting attachments, allowing operators to carry out a variety of inspection tasks for both low and high radiation environments with a total gamma dose between 100Gy – 1MGy.

Major project experience with D&D programs and an in depth knowledge of the latest CCTV technology are crucial in our ability to meet the rigorous specifications that the nuclear industry demands. We employ professionally qualified System Design Engineers and Project Managers experienced in configuring and managing CCTV projects from initial concept to final on-site commissioning.

We have the ability to re-package our imaging systems to fit through legacy penetrations and cell/tank access paths not previously used for cameras to support your D&D needs while leveraging the latest IP technologies for data storage and remote/wireless viewing.



Cameras and Imaging Systems



RC-913 Mini PTZ Camera

RC720 HD-Rad Camera

C983 System Camera



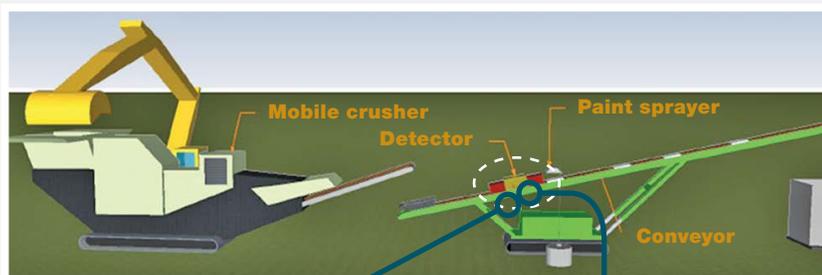
RC911 DOTCAM-HR Camera

2 Operations Support

SOIL SORTING AND BULK MATERIALS CHARACTERIZATION

The large volume of soil and sludge incurred in a D&D project requires an efficient and fast segregation of contaminated waste from the waste that can be free released. Mirion has designed and operated soil sorters to respond to these challenges in some major D&D sites around the world.

A variety of configurations are available to meet your unique needs



LABORATORIES

Samples are typically analyzed in radiochemistry laboratories with quantification of alpha beta and gamma emitting nuclides using our cost effective and easy to use solutions.

Maximize productivity in your laboratories and count rooms



Alpha Analyst™ for alpha spectrometry



Apex-Gamma™ Spectroscopy



iMatic™: Gasless
Automatic Alpha/
Beta Counter



TRACS: Transportable
Radiation Analysis
Counting System

*Operations Support
continued on next page*

WASTE CHARACTERIZATION

Mirion has significant experience and expertise in non-destructive assays for waste measurement. Gamma assay, neutron assay, and combined gamma/neutron systems are available to measure containers ranging from non-packaged waste to vehicles. We are committed to providing you a full range of measurement solutions to meet your site waste characterization needs.

The Measurement and Expertise Team can be deployed on site to provide a customized solution to fit your specific project.

Free Release Waste (VLLW)

Plastic scintillator based CLEARANCE monitors



Cronos® -1/-4/-11 family



CGO/CPO-SMART™
with spectrometry capability and
NORM reduction



RTM6xx series for large
volume screening

HP Germanium based FREE RELEASE monitors with nuclide identification



CLEA for 100 liter drums



Q² / AQ² / IQ³ family



Box counter

Non-exempt Waste (LLW / ILW)

ISOCS System Based Solutions for In Situ Measurements

SGS / TGS drum monitoring systems identification

NDA 2000 Non-Destructive Assay Software

TGS: Tomographic Gamma Scanner for improved accuracy (typically for SNM)

SGS: Segmented Gamma Scanner for Waste Characterization

Mobile Waste Assay Solutions

Mobile ISOCS Large Container Counter (MILCC)



Environment

ENVIRONMENTAL MONITORING

Routine monitoring is required around and in all nuclear D&D sites to provide early warning and characterization of possible radiation release incidents. To evaluate the real time contamination in nuclear sites, it is important to continuously measure releases of radioactive material in the environment strongly affected by wind direction and speed. Our solutions can be deployed on complex D&D sites using wireless secured connections in any situation.



EcoGamma™-g is an advanced, dual detector environmental gamma radiation monitor designed to operate in the most extreme conditions with unsurpassed accuracy, range and stability.

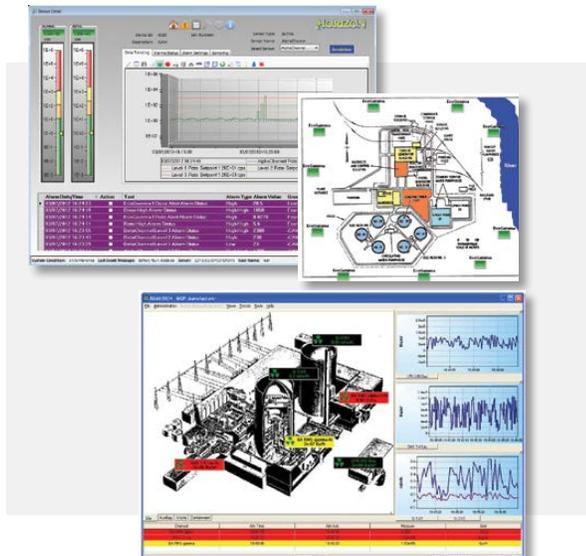


ABPM 203M Mobile Alpha/Beta Particulate Monitor

This monitor, with its small and lightweight extendable sensor, functions locally next to the respiratory tract of workers. It is perfectly adapted for the measurement of particulates in environments with high rates of radon.



Environmentally enclosed iCAM™ Continuous air monitor capability for D&D applications requiring remote monitoring of the D&D facility. Environmentally enclosed iCAMs can be placed around your D&D facility to monitor for any airborne release of radioactivity.



Horizon® Supervisory Software represents a real-time data acquisition and control system that provides supervisory oversight of your radiological instruments. It combines Mirion's radiological monitoring expertise with industry-leading technology for SCADA (Supervisory Control and Data Acquisition) applications.

4

Worker Protection

DOSIMETRY AND CONTAMINATION MONITORING

A proactive and comprehensive health and safety program is essential to safeguard the health of workers, to maintain compliance with ALARA principles and to avoid preventable and costly accidents in D&D operations. Mirion supplies a variety of instrumentation and equipment used to monitor worker health and assure that the working environment is safe.

Dosimetry:



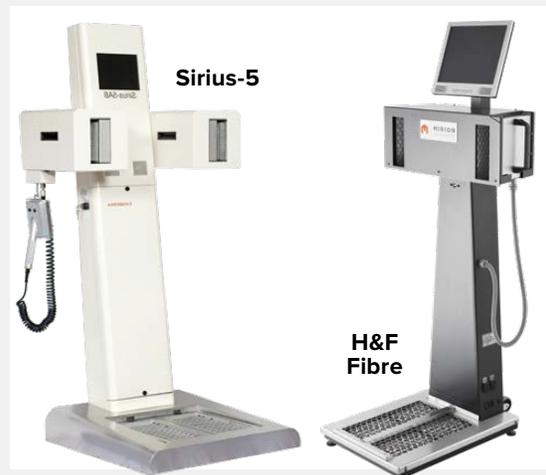
DMC 3000 family of dosimeters with optional beta, neutron or gamma sensitive PRD modules

Handheld Dose Rate and Contamination Monitors:



The **Radiagem** and **Colibri** family can accommodate a family of **CSP-Smart probes** for enhanced detection of gamma dose rate and α - β (γ) contamination monitoring

Hand and Foot Monitoring:



Sirius™-5 (gas or gasless) and **H&F Fibre** (gasless) for α - β contamination monitoring purposes

CONTAMINATION MONITORING

Personnel Contamination Monitors

α - β Contamination Monitors



Argos™-3/-5 series for gas and gasless α - β and optional **Zeus™** gamma detection



TSE-II Two step exit monitors for gasless operation

Gamma entry/exit Portals

Based on PVT plastic scintillation detectors



GEM™-5 gamma portal monitor



PGS (normal background) and **PGH** (high background) and **FastTrack Fibre** gamma portal monitors

In-Vivo Counters

Spectrometry based advanced nuclide specific monitoring



FASTSCAN™ NaI Whole Body Counter



ACCUSCAN™ II: Scanning HPGe Whole Body Counter

Who we are, where to find us

Mirion Technologies is a leading provider of innovative products, systems and services related to the measurement, detection and monitoring of radiation.

The company delivers high quality, state of the art solutions that constantly evolve to meet the changing needs of its customers.

With the addition of the Canberra™ brand in 2016, Mirion® expanded its portfolio and the breadth of its expertise to bring a new standard of solutions to the market. Every member of the Mirion team is focused on enhancing the customer experience by delivering superior products, exceptional service and unsurpassed support.

MIRION AT YOUR SERVICE



Headquarters

- Mirion Worldwide HQ – San Ramon, CA

International Offices

- Please visit the website for a complete listing.

Sales Offices

- Mirion sales and service capability exists in virtually every country in the world.

To learn more about Mirion's
D&D solutions, please visit
www.mirion.com





MIRION
TECHNOLOGIES

www.mirion.com

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OPS-759 - 02/2019