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Continuous Air Monitoring

Regulations, Alpha & Beta Detection, and the Mirion CAM Portfolio

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**Scan QR code to log your
attendance for today's
(Thursday, June 18th)
breakout session**



Agenda

- *The Regulatory Landscape*
- *Why Alpha and Beta*
- *The Mirion CAM Portfolio*
- *Discussion*

The Regulatory Landscape



Why Continuous Air Monitoring Matters

PROTECTING WORKERS – IN REAL TIME

Inhalation of airborne alpha/beta particulates is the dominant internal-dose pathway in fuel cycle, D&D, accelerator, and isotope facilities.

- *Real-time detection enables immediate evacuation, ventilation response, and dose minimization – sample-only methods cannot.*
- *CAMs directly support ALARA, respiratory-protection decisions, and DAC-based exposure tracking.*
- *Confidence in compliance requires the right instrument, the right placement, and defensible data – not just a meter on the wall.*

10 CFR Part 20 – Standards for Protection Against Radiation

Scope & Authority

- *Applies to all NRC-licensed activities: power reactors, fuel cycle, byproduct material, research.*
- *Subpart C – Occupational dose limit: 5 rem (50 mSv) TEDE / year.*
- *Subpart F (§20.1501-1502) – Surveys and monitoring required to demonstrate compliance.*
- *Subpart H (§20.1701-1705) – Respiratory protection and intake controls in restricted areas.*

The DAC Concept

- *Derived Air Concentration: the airborne concentration that, inhaled over 2,000 working hours, delivers the annual stochastic limit.*
- *DAC-hours (DACH) are the unit of internal exposure tracking – 2,000 DACH = 5 rem CEDE.*
- *CAMs are how licensees demonstrate compliance with §20.1502 monitoring obligations in real time.*
- *Appendix B lists DAC values for ~750 radionuclides in three lung-clearance classes (D, W, Y).*

10 CFR 20 Appendix B – Alpha vs Beta DACs

Alpha emitters – extremely low DACs

- *Pu-239 (Class W): $2E-12$ $\mu\text{Ci/mL}$*
- *Am-241 (Class W): $2E-12$ $\mu\text{Ci/mL}$*
- *U-234 / U-238 (Class Y): $2E-11$ $\mu\text{Ci/mL}$*
- *Po-210 (Class D): $3E-10$ $\mu\text{Ci/mL}$*
- *Very small intakes can exceed annual limits – fast alarms matter.*

Beta emitters – wide range

- *Sr-90 (Class Y): $2E-9$ $\mu\text{Ci/mL}$*
- *Cs-137 (Class D): $6E-8$ $\mu\text{Ci/mL}$*
- *Co-60 (Class Y): $1E-8$ $\mu\text{Ci/mL}$*
- *I-131 (Class D): $2E-8$ $\mu\text{Ci/mL}$*
- *Note: DACs differ by 3-4 orders of magnitude – instruments must handle both regimes.*

Evolving Guidance: EPRI Alpha Guideline (2025 Revision)

- *EPRI revised Alpha Area classification from a DAC-ratio basis to a surface-contamination–threshold basis (Report 3002031477)*
- *New tiering structure based on alpha surface contamination:*
 - *Non-Alpha Area: < 20 dpm/100 cm²*
 - *Level 1: 20 – 200 dpm/100 cm² (< 0.3 DAC)*
 - *Level 2: 200 – 2,000 dpm/100 cm² (0.3 – 3 DAC)*
 - *Level 3: > 2,000 dpm/100 cm² (> 3 DAC) – continuous RP coverage*
- *PAS/PID monitoring triggers retained for β - γ : α ratio $\leq$ 50:1*
- *Drives need for sensitive alpha-capable CAMs in MORE areas than before*
- *Presented at Mirion Connect 2025*

10 CFR Part 835 – DOE Occupational Radiation Protection

Scope & Key Subparts

- *Applies to all DOE and DOE-contractor activities (non-NRC).*
- *Subpart C – Internal & external dose limits, ALARA program.*
- *Subpart E (§835.403) – Workplace air monitoring required where intake could exceed 0.02 ALI / week.*
- *Subpart K (§835.1002-1003) – Design and engineered controls to confine radioactive material.*

Appendix A – DOE DAC Values

- *Independent table of DACs distinct from NRC Appendix B.*
- *Covers transuranics, uranium, fission products, and activation products.*
- *Required where annual stochastic intake >0.02 ALI is plausible – Pu, Am, U facilities almost always.*
- *DOE-STD-1128 (Pu) and DOE-STD-1136 (U) provide good-practice guidance on CAM placement & sensitivity.*

Evolving CAM Regulations & Guidance

WHAT'S CHANGING – AND WHAT'S COMING

Continuous-air-monitor expectations are tightening through technical amendments, supervision-software integration, and new isotope-facility build-outs.

- *10 CFR 20 amendments through 2026 – clarifications to recordkeeping/reporting and continued alignment with ICRP dose terms.*
- *10 CFR 835 – last amended May 2026; technical amendments continue to refine air-monitoring expectations at DOE sites.*
- *ANSI/HPS N13.1 (sampling stacks) and N42.17A / N42.18 (CAM performance) remain the consensus standards inspectors reference.*
- *Industry trend: real-time alarming plus networked supervision (Vital®, Horizon®, Ramvision) is the de facto compliance baseline.*
- *New facilities (Pu-238, Ac-225, theranostics) are driving demand for low-DAC alpha sensitivity and isotope-specific ROI analysis.*

Why Alpha AND Beta?



Alpha Emitters – The High-Consequence Problem

The Hazard

- *Pu-239, Am-241, U-isotopes, Po-210, Th-232 – high LET, ~20× quality factor on inhalation.*
- *DACs are 10^{-12} to 10^{-10} $\mu\text{Ci/mL}$ – among the most restrictive in any regulation.*
- *Internal dose dominates; external alpha is stopped by skin.*
- *A single particle resuspension event can challenge limits.*

Detection Challenges

- *Short range (~4 cm in air) – particles must reach the detector face.*
- *Natural radon/thoron progeny (Po-218, Po-214, Po-212) produce alpha background that swamps low-level signals.*
- *Solution: alpha spectroscopy with ROI windows + dynamic radon/thoron compensation.*
- *Mirion iCAM uses 256-channel MCA; ABPM 203M uses 1024-channel for higher-resolution Pu-238/Pu-239 discrimination.*

Beta Emitters – Wide Range, Wider Backgrounds

The Hazard

- *Fission/activation products: Cs-137, Sr-90, Co-60, I-131, H-3 (separate trit. monitor), Cl-36.*
- *Energies span 18 keV (H-3) to >2 MeV – instrument energy range matters.*
- *Pure beta emitters (Sr-90/Y-90) and low-energy betas (Ni-63, S-35) are the hardest to detect.*

Detection Challenges

- *Ambient gamma raises the beta detector baseline – requires gamma compensation.*
- *Mirion iCAM/D uses a dual-PIPS arrangement: main detector + close-mounted compensation detector for dynamic gamma subtraction.*
- *ABPM 203M uses a dual large-area silicon (PIPS) with a radial fin grid for static compensation plus algorithmic dynamic compensation.*
- *iCAM beta energy window: 50 keV – 2.5 MeV (excellent low-energy performance).*

Single-Channel CAMs Leave Compliance Gaps

Alpha-only monitors

- *Miss Sr-90, Cs-137, Co-60 and most fission-product releases.*
- *Cannot support 10 CFR 20 Subpart H respiratory decisions for mixed-isotope work.*

Beta-only monitors

- *Miss Pu, Am, U, Po – the most restrictive DACs in the rule.*
- *Cannot demonstrate compliance in transuranic-handling facilities.*

Bottom line: simultaneous alpha + beta on a single filter is the only defensible answer for mixed-source workplaces – and is what Mirion CAMs deliver natively.

The Mirion CAM Portfolio



Two Product Lines, One Mission

CAMSYS™ — iCAM Family

- *iCAM™ — fixed or moving filter alpha/beta CAM.*
- *iCAM-RH™ — remote-head version for ducts, stacks, hard-to-reach areas.*
- *iCAM GA™ — gross alpha firmware variant for isotope production / pharma.*
- *iCAM-HD™ — high-flow (up to 120 L/min) for stack and effluent monitoring.*

RAMSYS™ — ABPM Family

- *ABPM 203M™ — mobile alpha/beta particulate monitor, near respiratory tract.*
- *ABPM 203P — portable version.*
- *ABPM 204M — uranium-optimized variant.*
- *Both lines: silicon PIPS detection, radon/thoron compensation, Ethernet/RS-485 connectivity, Vital® / Horizon® / Ramvision supervision.*

iCAM™ – Intelligent Alpha/Beta Continuous Air Monitor

Function

- Continuous monitoring of airborne alpha & beta particulate activity in the workplace.
- Dynamic radon/thoron compensation enables low false-alarm operation.
- Acts as a simple alarming monitor for operators; sophisticated under the hood.
- Connects to Vital® Supervision and Horizon® for networked data.

Configurations

- iCAM/S – single PIPS, fixed filter (basic).
- iCAM/D – dual PIPS, dynamic gamma compensation.
- iCAM/MF – moving filter (autonomous, up to 6 months).
- Bench, trolley, or wall mount; acid-resistant detector option.
- Source online ordering available for U.S. customers.



iCAM™ – Detailed Technical Specifications

Detection & Range

- *Detector: PIPS large-area silicon; single or dual.*
- *Alpha range: 1E-3 to 9E3 Bq/m³ (1 hr avg).*
- *Beta range: 1 to 3.6E5 Bq/m³ (1 hr avg).*
- *Alpha efficiency: 24% up to 5.7 MeV.*
- *Beta efficiency: 24% for Cl-36 / Sr-90; 15% for Co-60.*
- *Alpha energy window: 3 – 10 MeV (256-ch MCA).*
- *Beta energy window: 50 keV – 2.5 MeV.*

Operational Specs

- *Airflow: 15 – 60 L/min (typical 37 L/min).*
- *Filter: FSLW, GFA, or FMLB; fixed or moving.*
- *Three alpha + three beta alarm levels (configurable in DAC, Bq, CPS, Ci/cc).*
- *Default alpha L1: 12 DAC; beta L1: 2 DAC (V2.10.9+).*
- *3-6 months data archive, IP54, 5°C-50°C.*
- *RS-485, RS-232, Ethernet; iConfig setup; battery backup 30 min.*
- *Standards: IEC 61172, 60761-1 & -2, 61578*
 - *Real Pu & Cs137 aerosol test at CEA Saclay*
 - *Type tested to ANSI 42.17B*
 - *Certified to SIL1 IEC 61508 for reliability*

iCAM™ Configurations & Variants

Filter & Detector Options

- *Fixed filter — periodic manual change.*
- *Moving filter — automatic, ~3-6 months autonomy.*
- *Single PIPS (iCAM/S) or dual PIPS (iCAM/D) for gamma compensation.*
- *Acid-resistant detector option (iCAM/DAR).*
- *Optional G64 silicon detector for ambient gamma alarm function.*

Specialized Variants

- *iCAM-RH — remote head for ducts & stacks.*
- *iCAM-HD — high flow (up to 120 L/min) for stack/effluent monitoring; 75,000-entry archive.*
- *iCAM GA — Gross Alpha firmware ($\geq$ v2.20.0) for radon-progeny inclusive measurement; ideal for pharma, isotope production, government labs.*
- *Mobile trolley (M240) and portable (P240) form factors.*

ABPM 203M™ — Mobile Alpha/Beta Particulate Monitor

Design Philosophy

- *Small, lightweight, mobile — operates close to the worker's breathing zone.*
- *Extendable sensor head (1.5 / 3 / 10 / 20 m hose options).*
- *Dual silicon (PIPS) detector with radial fin grid for static + dynamic radon/thoron compensation.*
- *Optimized for high-energy alphas (Pu-238, Pu-239).*

Where It Excels

- *Containment atmospheres, control room air, glovebox vicinity.*
- *High-radon backgrounds where iCAM may struggle.*
- *Uranium-facility variant: ABPM 204M.*
- *Real-time alpha spectrometry — 1024-channel MCA.*
- *Up to 6 months autonomy with moving or fixed filter cassette.*



ABPM 203M™ – Detailed Technical Specifications

Detection & Range

- *Detector: dual large-area silicon (PIPS).*
- *Alpha range: 1E-2 to 3.7E6 Bq/m³.*
- *Beta range: 1 to 3.7E6 Bq/m³.*
- *Alpha energy window: 2 – 10 MeV.*
- *Beta energy window: 80 keV – 2.5 MeV.*
- *Gamma window: 80 keV – 2.5 MeV (compensation).*
- *Real-time alpha spectrometry, 1024-channel MCA.*

Physical & Operational

- *Flow rate: 35 L/min standard.*
- *Dimensions: 1270 × 360 × 303 mm; ~26 kg.*
- *Temp limit: -5°C to +55°C; MTBF >20,000 hr.*
- *Power: 230 VAC / 50 Hz or 120 VAC / 60 Hz.*
- *Comms: 1× RS-232, 2× isolated RS-485, Ethernet.*
- *Standards: IEC 60761 / 61172 / 61578; 100 Gy TID.*
- *Software: Ramvision supervision + SAMS spectrum tool.*

iCAM™ vs ABPM 203M™ — How to Choose

Choose iCAM when...

- *Fixed workplace monitoring (bench, wall, trolley).*
- *Mixed alpha/beta with moderate radon backgrounds.*
- *Networked supervision via Vital®/Horizon® is required.*
- *Stack/duct monitoring (iCAM-RH or iCAM-HD).*
- *Low-energy beta detection (down to 50 keV).*
- *Faster lead time (4-6 months) and lower cost.*

Choose ABPM 203M when...

- *Mobile monitoring near worker breathing zone is needed.*
- *High-radon environment — radial fin + dynamic compensation excels.*
- *High-energy alpha discrimination (Pu-238 vs Pu-239) is required.*
- *1024-channel spectrum analysis (SAMS) is valuable.*
- *Uranium-facility version (ABPM 204M) is needed.*
- *Higher qualification level matches your site spec.*

Mirion Guidance – Compliance with Confidence

FROM SELECTION TO LIFECYCLE SUPPORT

Mirion supports the full compliance lifecycle – from application engineering through calibration, training, and global field service.

- *Application engineering – instrument selection mapped to your isotope inventory, DAC values, and ventilation design.*
- *Installation & qualified calibration – Mirion service engineers commission and perform on-site / in-plant source calibrations.*
- *Training – classroom and on-site programs for operators, maintenance staff, and health physicists.*
- *CSA service contracts – predictable maintenance, parts, and obsolescence management across the instrument life.*
- *Software & data – Vital® Platform, Horizon® (iCAM) and Ramvision (ABPM) for real-time supervision, archiving, and reporting.*
- *Global field service – North American and worldwide FSE coverage to keep monitors on-line and audit-ready.*

Survey for:

Continuous Air Monitoring: Regulatory Guidance & Best Practices



*Please take a moment
to fill out a short survey
on this session.*

Thank You

