



# Radiation Monitoring Systems

**FOR A LIFETIME OF SERVICE**

Nuclear power plants worldwide rely on the quality and dependability of General Atomics Electromagnetic Systems' (GA-EMS) **Radiation Monitoring Systems (RMS)**. GA-EMS fields and continuously supports qualified monitoring and detection systems, providing plant operators with unmatched reliability, system sustainability, and performance to ensure safety while minimizing overall plant lifecycle costs. Since the first system installation in 1965, we provide customers with an unwavering commitment to keep our RMS systems running efficiently for the lifetime of the plant.

Process Monitors

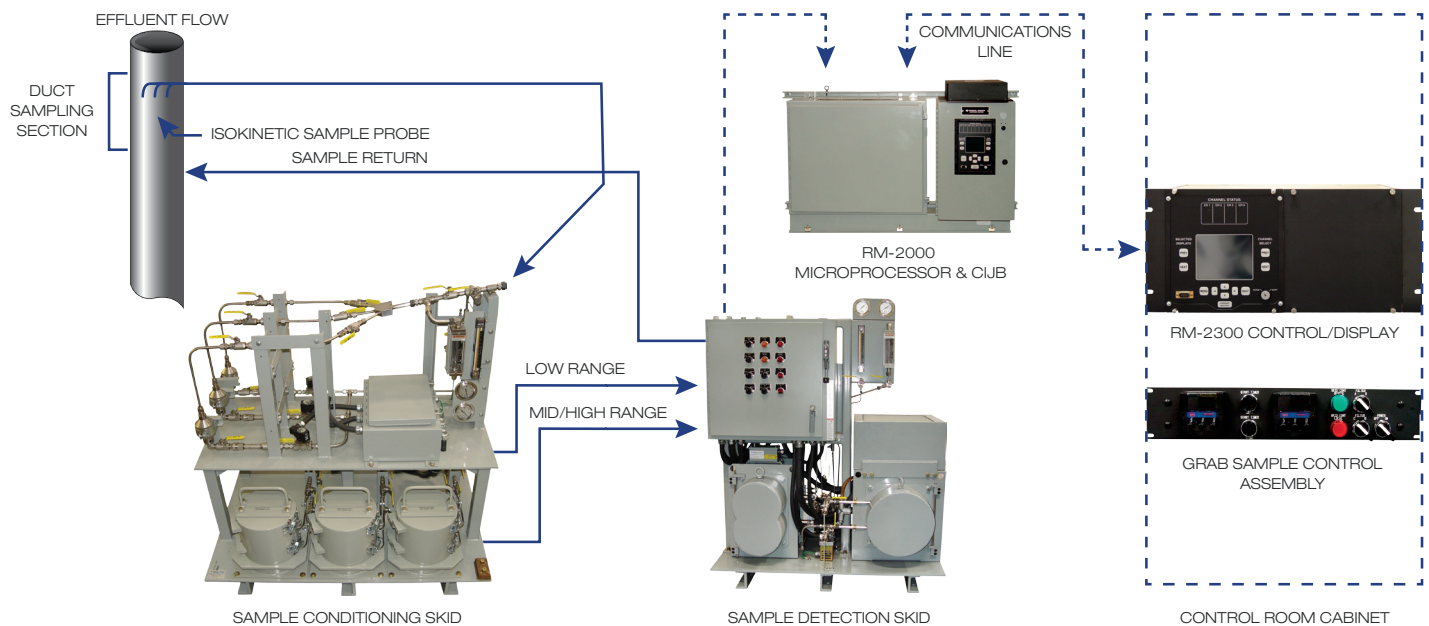
Area Monitors

Central Computer Systems

# Radiation Monitoring Systems

Designed and manufactured in the U.S.A., our flexible designs are customizable to meet site-specific requirements for new plant builds and to retrofit existing plant installations. GA-EMS builds radiation monitors with full qualifications and traceability, eliminating additional costs associated with qualification in place. We also provide diagnostic and system health monitoring capabilities to help operators keep system performance optimal.

GA-EMS has designed, manufactured, and fielded over 100 unique detectors and works closely with customers to customize systems to suit specific plant requirements. This brochure provides information on typical standard systems and parameters.



## COMPLIANCE

GA-EMS is an industry leader in meeting safety and non-safety requirements with a Quality Assurance Program that fully complies with:

- 10CFR50, Appendix B
- Reg.Guide 1.97
- NQA-1-2015
- ANSI N45.2, including applicable daughter standards
- Seismic – IEEE 344
- Environmental – IEEE 323
- ISO 9001:2015, AS9100:2016 Certified
- ISO 14001:2015

## CUSTOMER SUPPORT SERVICES

We provide outstanding customer support and obsolescence mitigation to ensure each system is sustainable over a plant's entire operating lifecycle. Our support services, access to unmatched technology expertise, and extensive on-site and off-site training help plant operators keep systems safely on-line, all the time.

- Complete Field Service
- Engineering Services
- Start-up Service
- Training Courses
- RMS Users' Group Conference

## SERVICE AGREEMENTS

RMS Service Agreements are available to provide customers with 24/7/365 access to our aftermarket, field service, and technical support teams. RMS Service Agreements are specifically aligned with the Nuclear Engineering Institute's Efficiency Bulletins to provide:

- Around-the-Clock Technical Support
- Expedited Field Service Support
- Professional System Health Check Evaluation
- Proactive Spare Parts and Obsolescence Planning
- In-Depth, Interactive Training Courses
- Priority Outage Coverage

# Area Monitors

GA-EMS offers a variety of area monitors designed to continuously monitor gamma radiation for areas inside a nuclear power plant. Systems are configured to monitor low radiation ranges for the protection of plant personnel, as well as high radiation ranges to detect breaches in process stream or containment boundaries. GA-EMS area monitors feature Geiger-Mueller (G-M) tubes for low range gamma radiation detection and ionization chambers for high range gamma radiation detection. Extended range configurations are available to monitor ranges that overlap between the G-M tube region and ion-chamber region. GA-EMS microprocessor unit processes the detector signals, calculates activity data, displays data, transmits data to plant computer systems, and activates local and remote audible and visual alarms.



High Range Containment Monitor with RM-2020 and RD-23 Detector



RD-14 Detector



RD-2A Detector

MODEL	TYPE	RANGE	DESCRIPTION
RD-2A, RD-2B	Ionization Chamber	$10^{-1}$ to $10^4$ R/hr	General high range area detector, or can be used to view a process line for measurement of radioactivity such as a hardened containment vent pipe.
RD-8	Ionization Chamber	$10^{-1}$ to $10^5$ R/hr	Energy compensated high range area detector, LOCA qualified.
RD-14 Low Range	G-M Tube	$10^{-3}$ to $10^4$ mR/hr	General area monitoring within the plant.
RD-14 High Range	G-M Tube	$10^{-2}$ to $10^5$ mR/hr	General area monitoring within the plant or adjacent to line applications.
RD-23	Ionization Chamber	$10^0$ to $10^6$ R/hr	Measures radiation level in the containment. Safety related R.G. 1.97 qualified for use in harsh environments and during a LOCA.

# Process Monitors

GA-EMS process radiation monitoring systems are designed to continuously detect and measure radioactivity in airborne and process gas, liquid, and steam lines. Our custom and standard designs can accommodate specific applications and requirements within a nuclear power plant. All GA-EMS monitors are manufactured with the highest standards of quality in the industry, with full qualifications and traceability.

GA-EMS radiation monitors include local processors, remote indicators, and integrated systems to perform data acquisition, analysis and display, monitor control functions, alarm relays, analog outputs, and digital communications. System databases contain operation and calibration constants, alarm set-points and history files, and are programmable for specific applications. The Control Room Display assembly provides easy menu-driven access to database items, monitor remote control and display, and continuous polling for radiation level and operation status. Operators can also perform control functions such as purge, checksource, and pump functions from the display to verify performance and status.



Heat Traced Particulate, Iodine, and Gas Monitor



Off-Line Liquid Monitor

TYPE	RANGE	DESCRIPTION
Gas Monitors	Xe <sup>133</sup> : $3.4 \times 10^{-7}$ to $3.4 \times 10^{-1}$ $\mu\text{Ci}/\text{mL}$	Off-line beta detector assembly designed for detecting activity concentration in a continuous gas sample. Attached to sample flow piping, the sample gas is drawn into the chamber at a set rate.
Liquid Monitors	Cs <sup>137</sup> : $7.8 \times 10^{-8}$ to $7.8 \times 10^{-2}$ $\mu\text{Ci}/\text{mL}$	Off-line gamma detector assembly designed for detecting activity concentration in a continuous liquid sample. Attached to sample flow piping, the sample liquid is pumped into the chamber at a set rate.
Wide Range Gas Monitors (WRGM)	Xe <sup>133</sup> : $10^{-7}$ to $10^5$ $\mu\text{Ci}/\text{mL}$	Detects and measures off-line beta-gamma activity concentration levels by drawing a representative sample from the plant vent effluent flow. The sample flow is directed either to the normal or accident sample flow path determined by the sample activity concentration level. Safety related R.G. 1.97 qualified monitor.
Particulate Monitors	Cs <sup>137</sup> : $2.5 \times 10^{-12}$ to $2.5 \times 10^{-6}$ $\mu\text{Ci}/\text{mL}$	Off-line particulate detector assembly measures particulate activity concentrations. Samples are drawn continuously through a local particulate filter (fixed or moving filter available).
Particulate and Gas Monitors (PG) (R.G. 1.45)	Particulate: Cs <sup>137</sup> : $2.5 \times 10^{-12}$ to $2.5 \times 10^{-6}$ $\mu\text{Ci}/\text{mL}$ Gas: Xe <sup>133</sup> : $5.4 \times 10^{-7}$ to $5.4 \times 10^{-1}$ $\mu\text{Ci}/\text{mL}$	Off-line PG monitor draws a representative sample from the plant containment atmosphere, provides sample flow through the monitor and measures the sample's radioactive level. Both channels utilize beta detectors to measure the activity concentration.
Particulate and Iodine Monitors (PI)	Particulate: Cs <sup>137</sup> : $2.5 \times 10^{-12}$ to $2.5 \times 10^{-6}$ $\mu\text{Ci}/\text{mL}$ Iodine: I <sup>131</sup> : $2.9 \times 10^{-11}$ to $2.9 \times 10^{-5}$ $\mu\text{Ci}/\text{mL}$	Off-line PI monitor draws a representative sample from process gas or atmosphere, detects and measures process beta and gamma activity concentration.
Particulate, Iodine and Gas Monitors (PIG)	Particulate: Cs <sup>137</sup> : $2.5 \times 10^{-12}$ to $2.5 \times 10^{-6}$ $\mu\text{Ci}/\text{mL}$ Iodine: I <sup>131</sup> : $2.9 \times 10^{-11}$ to $2.9 \times 10^{-5}$ $\mu\text{Ci}/\text{mL}$ Gas: Xe <sup>133</sup> : $5.4 \times 10^{-7}$ to $5.4 \times 10^{-1}$ $\mu\text{Ci}/\text{mL}$	Designed for sampling and measurement of process gas streams. The off-line PIG monitor draws a representative sample from process gas or atmosphere, detects and measures process beta and gamma activity concentration.

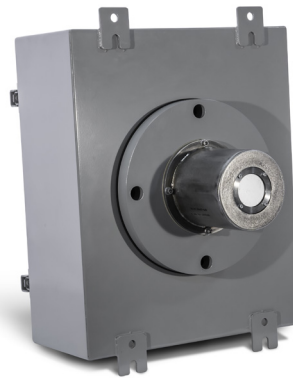
# In-Line Monitors and Adjacent-to-Line Monitors

Whether off-line, on-line, in-line or adjacent-to-line, GA-EMS monitoring systems continuously measure radiation activity in the process gas, liquid or steam lines. Each system provides real-time processing of activity data, and maintains monitor and channel databases, and multiple history files. In addition, monitors provide local detection, indicators, and alarms. Each system communicates directly with the digital radiation processor to produce measurement data for display and processing, and to transmit status, activity data, alarm status, and receiving status inquiries.

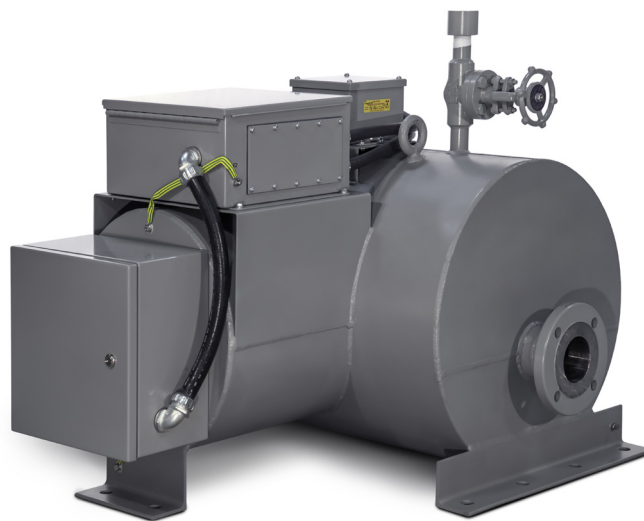
Depending on the system configuration, detectors are protected by a three or six inch lead shield assembly to minimize any background radiation from reaching the detector. A shielded door provides easy access to the detector. GA-EMS monitoring systems are configured to fit most pipe and cable sizes to eliminate the need for additional engineering costs and to simplify installation and maintenance.



**Adjacent-to-Line Detector  
in Lead Shield**



**In-Duct Noble Gas Detector**



**Stainless Steel In-Line Liquid Monitor**



TYPE	RANGE	DESCRIPTION
In-Line Liquid or Gas Monitors	Cs <sup>137</sup> : $6.7 \times 10^{-8}$ to $6.7 \times 10^{-2}$ $\mu\text{Ci}/\text{mL}$ Xe <sup>133</sup> : $2.1 \times 10^{-7}$ to $2.1 \times 10^{-1}$ $\mu\text{Ci}/\text{mL}$	Provides continuous measurement of gamma activity concentration levels in the process lines. Examples of applications include: service water blowdown, steam generator blowdown and condenser off gas.
In-Duct Gas Monitors	Xe <sup>133</sup> : $1.5 \times 10^{-7}$ to $1.5 \times 10^{-1}$ $\mu\text{Ci}/\text{mL}$	Continuously measures the level of beta activity concentration by directly interfacing with the air in a duct. Examples include fuel handling area exhaust, auxiliary building exhaust and control room vent.
Adjacent-to-Line Monitors	Cs <sup>137</sup> : $1.5 \times 10^{-7}$ to $1.5 \times 10^{-1}$ $\mu\text{Ci}/\text{mL}$ Xe <sup>133</sup> : $5.1 \times 10^{-6}$ to $5.1 \times 10^0$ $\mu\text{Ci}/\text{mL}$	Mounts adjacent to main process lines to measure activity concentration without removing the sample or interrupting the line.
Main Steam Line N16 Primary-to-Secondary Leak Monitors (R.G. 1.97)	N <sup>16</sup> : $3.7 \times 10^{-7}$ to $3.7 \times 10^{-1}$ $\mu\text{Ci}/\text{mL}$	An adjacent-to-line monitor that measures activity concentration of the main steam line to support leak rate calculations. Two different regions of interest (ROI) available for display and processing include the fission product and N <sup>16</sup> ROI.
Main Steam Line Monitors (R.G. 1.97)	Co <sup>60</sup> : $5.7 \times 10^{-5}$ to $1.0 \times 10^2$ $\mu\text{Ci}/\text{mL}$	Mounted in a lead shield adjacent to the main steam line to measure post-accident concentration of primary coolant in the main steam line. Lead shield minimizes the effect of the background radiation on the detector.



MODEL	TYPE	DESCRIPTION
RM-2000	Local Processor – Multi-channel	Performs data acquisition, analysis and display, monitor control functions, alarm relays, analog outputs, and digital communications. Includes application specific database, multiple history files, menu-driven interface, electronic calibration, automatic diagnostics/continuous self-test, and local status indication.
RM-2020	Local Processor – Single Channel	Provides local and remote activity and alarm status. Generates operate and alert alarms and digital display of dose rate and monitor status. Includes database for configuration, data/alarm setpoints, calibration constants, history files and control functions. Includes checksource operations and communications with external devices.
RM-80	Local Processor – Multi-channel	Performs data collection, data reduction, data analysis, data display, and alarm generation. Controls monitor functions and alarm relays, and maintains monitor and channel database information containing monitor operating parameters.
RM-2300	Remote Processor – Multi-channel	Provides database control, display, and inquiry of fielded monitor via communications to the RM-2000. Numerical and graphical display of data. Provides alarm relay outputs. Mounted in standard 19" rackmount NIM bin.
RM-11U	Central Computer System	Capable of maintaining multiple communication loops for all GA-EMS RM-80, RM-2000, and RM-2020 models. Monitors and displays data and log alarm messages from all processors in a given network via communication loops. Provides capability for the operator to control the monitor equipment including pumps, checksource, and purge. Provides the operator with display screens showing detector activity levels, status, alarms, trends, database information, and communication statistics. Maintains information for each monitor by polling each RM-80, RM-2000, and RM-2020 for activities, flow values, alarms, and status.
RM-1000	Remote Indicator – Single Channel	Single channel digital radiation processor/ rate meter module for use in various detector systems, both safety-related, Class1E, and non-safety related. Performs processing for both area and process monitor functions. Mounted in standard 19" rackmount NIM bin.

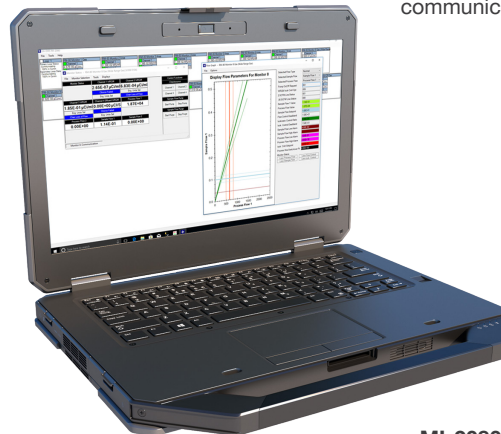
# Special Tools

MODEL	TYPE	DESCRIPTION
RT-10	G-M Tube Transfer Calibration Source	Allows performance of routine transfer calibrations of G-M tube area radiation detectors. Uses a C <sup>137</sup> source contained in a 4π lead shield for safe handling.
RT-11	Ion Chamber Transfer Calibration Source	Allows performance of routine transfer calibrations of ion chamber area radiation detectors. Uses a C <sup>137</sup> source contained in a 4π lead shield for safe handling.
Simulator - RM-2000	Simulator Software	PC-based software application simulates all features of the RM-2000 microprocessor for use in simulator systems and training systems.

MI-2080

Maintenance Interface Software Kit

PC-based remote software interface to RM-80 and RM-2000 monitors. Provides data analysis and maintenance functionality, is capable of querying data from individual monitors and displaying this data to the user as well as downloading data to a monitor in the form of database changes. The software provides a tabular database view, a user-controlled graph display, data-logging capabilities, and the ability to monitor a single radiation monitor. The software can display trends, channel-selection graph, flow graph, check-source trend, K-list display and verification, and communication statistics.



MI-2080



## CONTACT INFORMATION

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