

RAMSYS SYSTEMS

IN-PLANT AND SAFETY MONITORING SYSTEMS



MIRION
TECHNOLOGIES

A LEGACY OF DISCOVERY

For over 60 years, Mirion Technologies has provided recognized solutions in the design and manufacturing of equipment and services to detect, measure and analyze ionizing radiations in nuclear industry, civil and military defense, healthcare and other specialized industries.

Mirion is divided into 2 groups **Medical** and **Industries**. Industries group is comprised of 3 divisions:

- The **Detection & Measurement Division (DMD)** offers radiation measurement, personnel protection, advanced safety and search, and decontamination and decommissioning solutions for a variety of worldwide applications, from research to high-temperature cameras.
- The **Sensing Systems Division (SSD)** specializes in conduit systems used to pass cables through reactor containment structure and detector systems for plant safety and control
- The **Radiation Monitoring Systems Division (RMSD)** offers a complete range of safety related radiation, neutron flux, detection of tritium gas and specific monitoring solutions for nuclear energy production, nuclear research reactors, the fuel cycle industry, nuclear marine propulsion and other specialized industries, as well as maintenance, engineering and services for products from off-the-shelf equipment to large scale bespoke projects.

A photograph of a nuclear power plant with several large, white, conical cooling towers. The image is partially obscured by a blue geometric shape at the bottom. The text is overlaid on the right side of the image.

**TO PROVIDE THE NUCLEAR INDUSTRY WITH THE HIGHEST
QUALITY INSTRUMENTATION & CONTROL SOLUTIONS
TO PROTECT PEOPLE, PROPERTY & THE ENVIRONMENT**

A PIONEERING COMPANY WITH A RICH HISTORY

Mirion Technologies nurtured a radioprotection department from the early 1960's in order to provide installed radiation monitoring systems (RMS) for the 1st generation of Nuclear Power Plants.

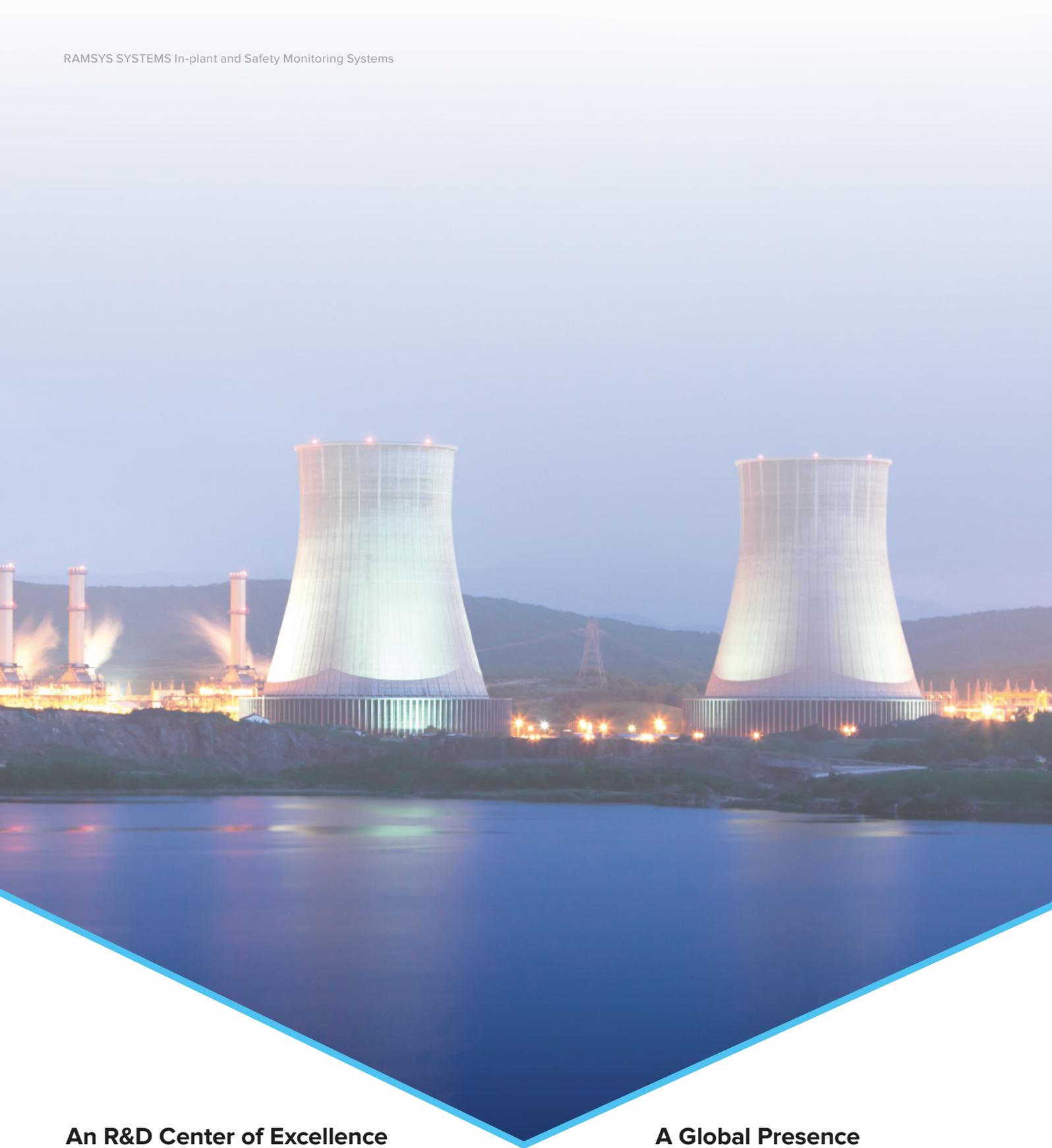
With continued success, we are now recognized as the world leader in providing field-proven monitoring instrumentation throughout the nuclear industry with RMS supplied to over 80% of the world's 2nd generation nuclear power plants.

Nuclear Revitalization is now upon us and Mirion Technologies state-of-the art engineering design expertise continuously provides unrivalled team support that exceeds 3rd generation nuclear power operator expectations including newly developed EPR™ and AP1000™ RMS systems.

Mirion Technologies continues to commit its skills and expertise in support of all nuclear industry stakeholders to assist in providing CO₂-free energy.



More than 250 nuclear centers around the world trust our equipment.



An R&D Center of Excellence

Our experienced engineering teams design and manufacture complete radioprotection systems tailored to customer specifications that:

- Meet all required ranges and sensitivities
- Meet all necessary codes and standards
- Have modular components with human-factors design built-in
- Consider future parts availability and supply

A Global Presence

With 2500 employees, Mirion has units in Europe, Asia and Americas and operates a sales network covering 50 countries.

An Exhaustive Range Based on Standard Products Built to the Strictest Standards

The standard products comprising the RAMSYS system, i.e. detection sub-systems, electronic sub-systems with associated software and processing and display instrumentation, are developed according to a thorough certification program, incorporating RCCE, IEC, ISO and IEEE standards.

Test analyses and results are systematically documented. Many RAMSYS products are also IEEE323 and IEC 60780-certified (nuclear qualification, thermodynamics, seismic aging), making them suitable for use in 1E and Safety

Product upgrades to replace obsolete components or incorporate functional improvements are done in real time improvements are done in real time.

They are documented to ensure if compatibility is maintained, and systematically accompanied by analyses plus additional tests if necessary, to ensure their continued compliance with certification criteria. All qualified and sold products benefit from full and documented traceability.



Over 30 000 ionizing radiation measurement channels installed worldwide.



RAMSYS, a Highly Upgradable Product Range

Designed for optimum upgradability, the RAMSYS range benefits from long-term efficiency, excellent continuity and continual improvement.

RAMSYS offers the following functions for nuclear installations:

- Reactor control and protection
- Containment systems
- Effluent release monitoring
- Operational process monitoring
- Area monitoring
- Post-accident facility management

Instrumentation Designed for Customer Satisfaction

A team of experienced engineers study and implement the realization of personalized systems based on technical specifications.

Our services range from the on-site installation supervision to the commissioning, preventive and corrective maintenance, repairing, training and remote support (hotline).

A Pertinent Analysis of Customer Requirements

Standard products represent 80% of our sales. In order to satisfy the remaining 20% demand, our dedicated project teams tailor this standard range to supply turnkey systems which are fully compliant with customer specifications in terms of both functional and certification requirements.

Unequaled Competitiveness

The excellent productivity, reliability, longevity and maintainability of our RAMSYS range, coupled with our numerous lessons learned, mean we can offer our customers the very best value for money, in terms of both investment and operating & maintenance costs.



APPLICATIONS

To provide the Nuclear Industry with the Highest Quality Instrumentation and Control Solutions



Area Monitoring

For on-site solutions, Mirion Technologies offers radiation monitoring systems (RMS) that can use different types of detectors to measure site-specific levels of alpha and beta particulates or gamma and neutron radiations (low, wide, high, dual/mixed) with variations of processors and displays, depending upon the location, human factors, and space requirements needed. Along with this instrumentation are all-inclusive software packages that facilitate the configuration, maintenance, management, or simulation of the RMS equipment.

No matter what conditions exist, individual and collective occupational exposure to ionizing radiation must be kept below the limits prescribed by regulatory requirements and As Low As Reasonably Achievable (ALARA). With the main objective to limit internal and external exposure of personnel, cost-effective and reliable products include a selection of a wide range of radiation monitors including variation in types, configurations, and sensitivities.

Mirion Technologies is firmly committed alongside our customers to implement the most innovative detection technologies; to improve the quality and reliability of monitors in all types of operating conditions; and to provide cost-effective solutions within budget and on-time.

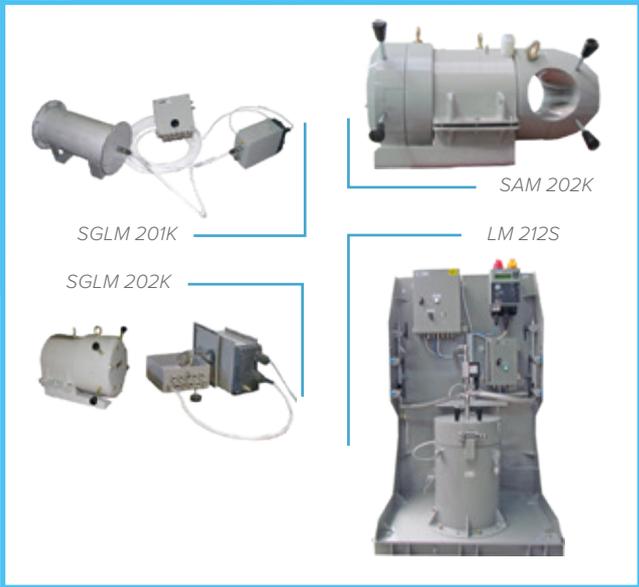
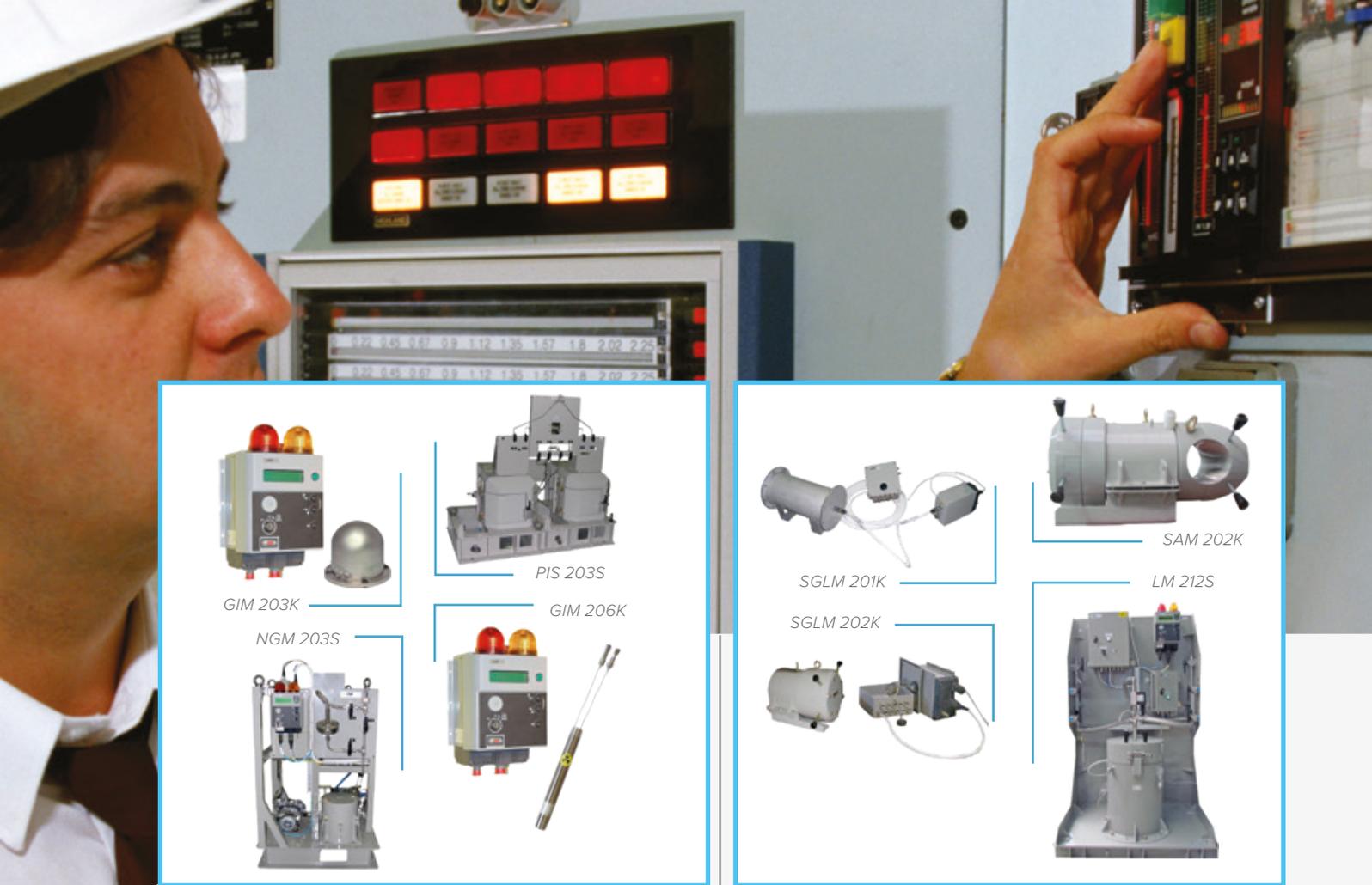
Effluent Release Monitoring

A full array of effluent air monitors is offered that can be comprised of safety/non-safety, fixed/mobile/portable, and/or seismically qualified instrumentation and can include particulate, iodine, and/or noble gas monitors. Various types of liquid monitoring systems are also provided that can be configured for in-line, off-line, or adjacent-to-line applications.

All instrumentation systems contain integrated software. Protecting the environment around nuclear facilities is paramount and monitoring any release of liquid effluents into the surroundings and/or gaseous effluents into the atmosphere is crucial. Some of these effluents could contain extremely low levels or radioactive materials (radionuclides) in which after treatment of gaseous and liquid effluent discharges, only a fraction is detectable. These releases, however small they may be, are subject to increased scrutiny and are strictly controlled through precise regulations.

Faced with such challenges, Mirion Technologies provides field-proven safety and non-safety systems that can accommodate various space and configuration challenges enabling an effective radiation monitoring system that meets site-specific needs. The range of monitors, both the gaseous emissions as well as for liquid waste, can also provide an accurate assessment of the activity for each radionuclide released through spectrum analysis.

In addition, instrumentation is provided for turn-key solutions to sample aerosols, iodine, tritium or carbon-14 to bring a nuclear facility in-line with its existing regulatory requirements.



Post-accident Facility Management

Three Mile Island, Chernobyl and Fukushima... These three accidents have led NPP operators worldwide to equip themselves with increasingly high-performance systems built to ever-stricter and higher standards, capable of managing their facility in post-accident situations. The use of ionizing radiation monitoring systems in the event of this type of accident is particularly critical to limit its scope of impact.

Responding to these requirements is a genuine technological challenge in that the physical values (temperature, pressure, integrated dose, time, etc.) influencing the various hypotheses at play never cease to increase.

Ultimate management procedures require the use of post-accident monitors:

- Gamma high flux monitors (GIM 206K), aimed at avoiding or delaying core damage.
- Gamma monitors, further to damage to the 1st or 2nd barrier.
- So-called «sump» monitoring (GIM 205K), further to accidental loss of primary coolant.
- Containment pressure relief vent monitoring, further to damage to the 3rd barrier.

Containment Systems

Acknowledged worldwide for delivering cost-effective Steam Generator Leak Monitors (SGLM) to nuclear power plants, Mirion also enjoys success in providing radiological spectrum analysis monitors, processing and display instrumentation, and comprehensive software for nuclear power plant radiation monitoring containment systems.

To avoid release into the environment of radioactive substances, nuclear power plants are designed with safety in mind and in some cases are built on the principle known as «triple containment barrier» in which the reactor is comprised of three main components including:

- The fuel cladding
- The primary circuit envelope
- The reactor building

The failure of any one of these barriers can lead to incidents or accidents affecting the availability factor of the plants' protection systems; technicians, engineers and operators; and more generally, the acceptance of nuclear power by the public. Monitoring of all three of these critical components is crucial to safe operation. Mirion Technologies has unparalleled experience to overcome these issues which includes:

- Monitoring steam generator tube breaks through N16 detection.
- Discovering primary leaks (tank cover, tank bottom) through the detection of N13.
- Determination of leaks in ductwork.
- Monitoring containment atmosphere through particulate and noble gas monitors.

In doing so, Mirion Technologies provides the highest levels of qualification and reliability required for such applications.



Operational Process Monitoring

Determination of radioactive levels in nuclear operational processes may require the measurement of volumetric activity of radioactive gas containing particulates, iodine, and/or noble gas. Mirion Technologies offers a broad range of solutions and configurations to meet site-specific requirements and variations can be fixed, mobile, or movable, as well as safety-related or non safety.

Cost-effective solutions for measuring the neutron flux at research reactors or nuclear power plants are also provided. Nuclear power facilities are faced with many challenges including equipment reliability, plant availability, personnel safety, compliance costs and deadlines, quality of products and services, and protection of the environment, amongst others. Alongside reactor operators, Mirion Technologies is committed to providing a very high level of safety and availability for nuclear power plants, the fuel cycle industry, research reactors, and waste treatment facilities.

This commitment is backed up by a full array of reliable monitoring systems that meet regulatory requirements to measure radioactivity in drums, filters, tanks, areas, or (for example) concentrated activity in pipes, tarpaulins or ventilation ducts.

Our technical staff can assist in determination of the proper measurement system depending on site-specific ambient conditions as well as space and qualification requirements.

Reactor Control and Protection

From Ultrasonic level measurements to safety critical control, protection and monitoring systems in operational nuclear power plants; Mirion Technologies provides safety and non-safety-related monitoring systems that meet or exceed today's regulatory requirements.

Included in this wide range of instrumentation are boron monitors and digital safety-shutdown Neutron Flux Monitoring Systems (NFMS).

When it comes to Reactor Control and Protection, it is essential to be confident in a reliable product of technical competence, experience and sustainability.

Mirion Technologies supplies reactor control systems for nuclear power plants worldwide, including:

- Neutron Flux Monitoring Systems for key containment safety monitoring which are qualified as Class A of the IEC61226 standard.
- Instrumentation for measuring hydrogen concentrations under normal and/or post-accident conditions.
- Boron meters to measure the boron concentration of the primary fluid in the reactor.
- Ultrasonic level measurement devices for monitoring things such as the water level in the primary circuit during outage.

In addition to very high levels of reliability, Mirion Technologies reactor control and protection instrumentation can accommodate any level of qualification according to the most demanding requirements.

CONFIGURATIONS

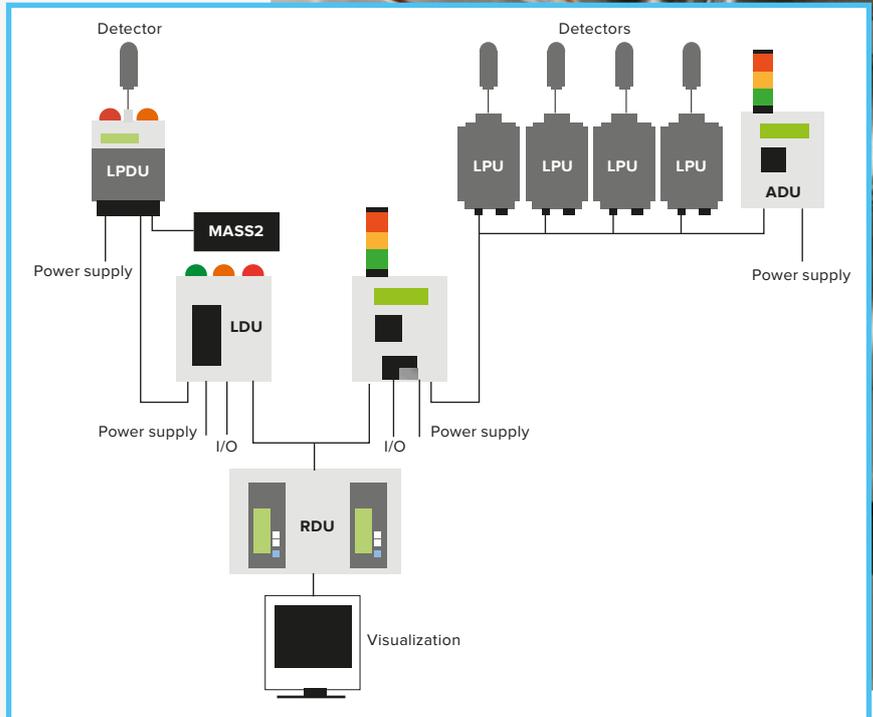
Modularity of the System

The RAMSYS system is very modular. It can be composed of different sub-assemblies, stand alone or integrated in the same network.

A RDU (Remote Display Unit) and LDU (Local Display Unit) can communicate up to 1,200 m (3,900 ft) through a data link.

A LDU and/or RDU can be used to display measurements, status, alarms of 1 to 8 LP(D)U (Local Processing and Display Units).

An ADU (Alarm Display Unit) can be used to display measurements, status, alarms of 1 to 24 LP(D)U. A second ADU can be added to the network and operate in spy mode: in this configuration, the ADU would have access to all the data from the LP(D)U without disturbing the network.



Inputs/outputs on a LP(D)U:

- 1 analog input 0/4-20mA
- 2 analog outputs 0/4-20mA
- 2 RS485 data link outputs
- 1 RS232 data link output (only for LPDU with display)
- 3 relay contacts

Inputs/outputs on a DU:

- 1 analog input 0/4-20mA
- 2 analog outputs 0/4-20mA
- 3 RS485 data link outputs
- 1 RS232 data link output (only for LPDU with display)
- 5 relay contacts
- 16 digital inputs for LDU, 8 digital inputs for RDU
- 16 digital outputs for LDU, 8 digital outputs for RDU

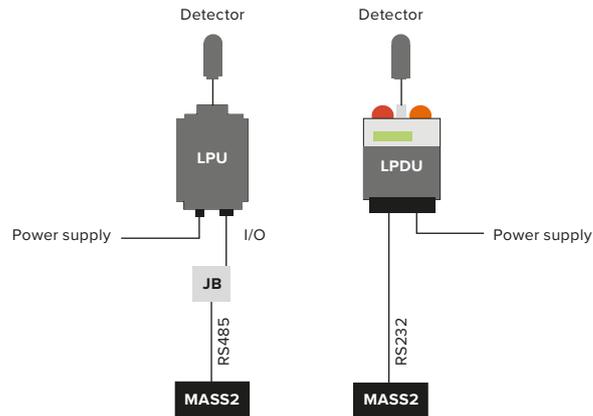
Inputs/outputs on an ADU:

- 1 analog input 0/4-20mA
- 2 analog outputs 0/4-20mA
- 2 RS485 data link outputs
- 1 RS232 data link output (only for LPDU with display)
- 5 relay contacts
- 5 digital inputs
- 3 digital outputs

MASS2 software uses of a portable PC for setting parameters, troubleshooting, calibration, visualization of the status and measurements.

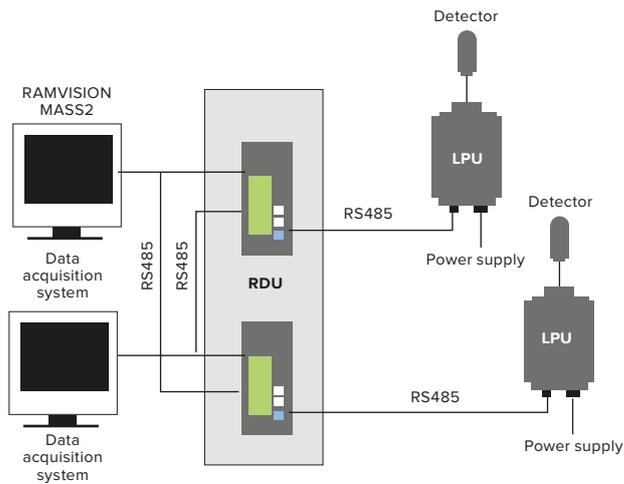
Standard Configuration

Local processing units can be «customized» to perform specific tasks, by simply loading application software (MASS2) from a maintenance PC. The simplest way to communicate with a LP(D)U is to hook up a portable computer using one of the RS485 serial links. The second serial link of the LP(D)U can also be used to connect a Local Display Unit LDU or a Remote Display Unit (RDU).



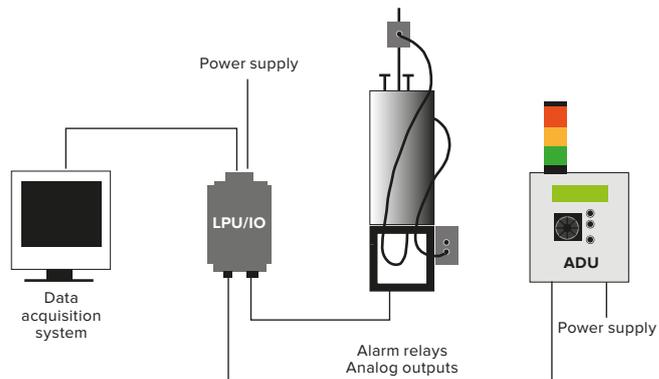
Example of Configuration with Full Redundancy

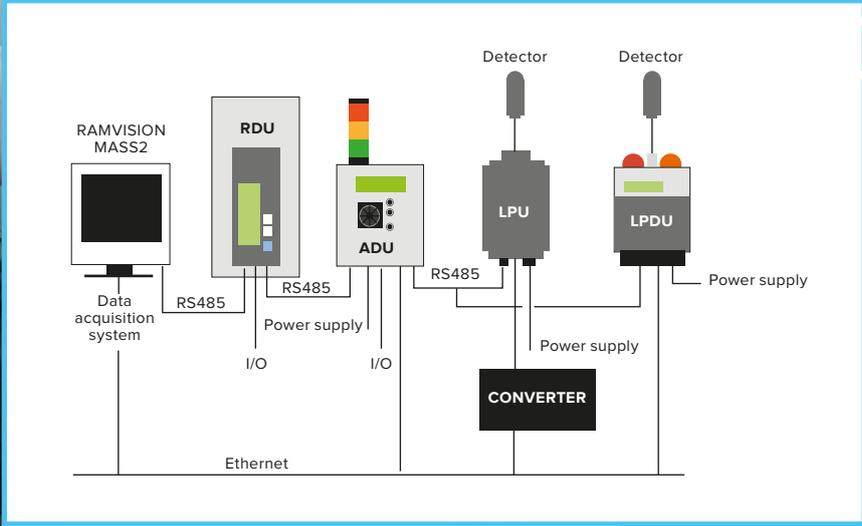
Since there are three RS485 serial links available for each RDU, a separate network can be connected to achieve a redundant configuration.



Compatibility with Existing Monitors

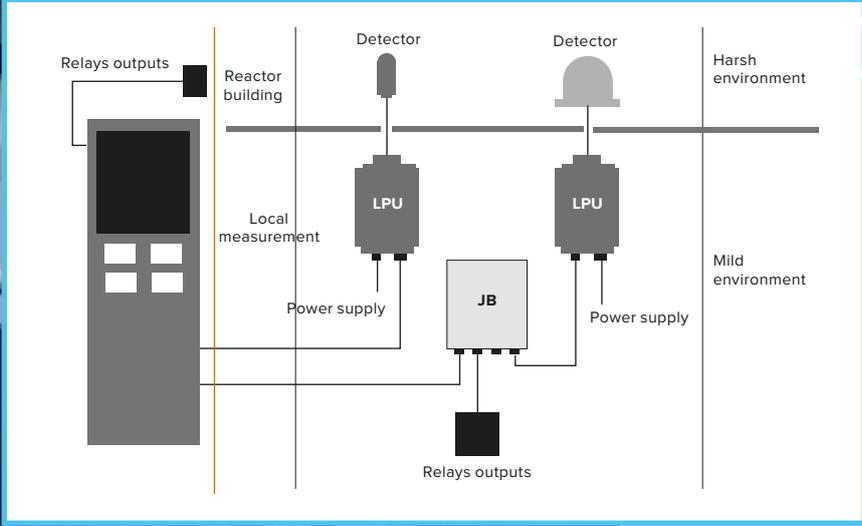
A RAMSYS network can integrate analog and digital signals from existing monitors via the LPU/IO (Input/Output) for data integration, processing control and transmission. Therefore, these monitors can be seen on the network, as any other monitors of the RAMSYS family.





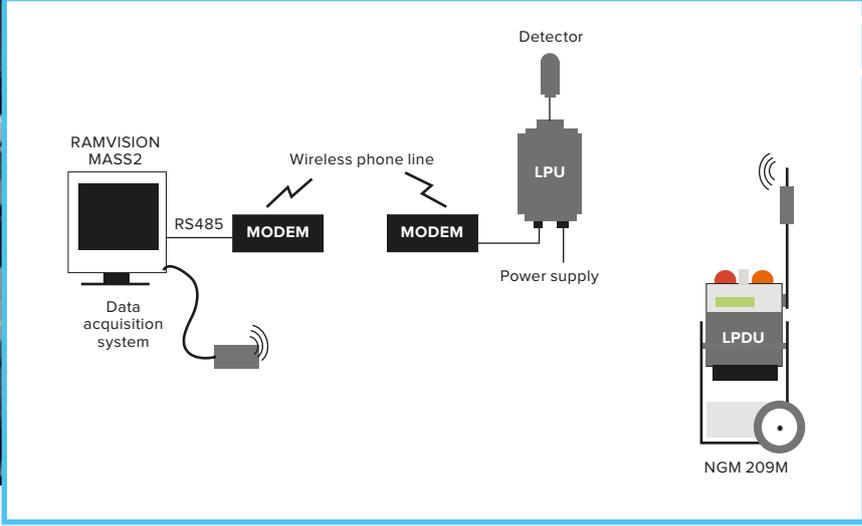
Example of Configuration with Ethernet Option

The ADU and the LP(D)U can communicate through an Ethernet link. The RDU and the LPU can also be connected to the Ethernet network thanks to a converter. In both cases, the data from the Ethernet network are the same than those from the RS485 data link.



Example of Configuration for 1E Applications

RAMSYS can be used for safety related applications. The LP(D)U, LDU, RDU, cabinets, as well as a large range of detection sub-assemblies are 1E qualified.



Example of Configuration with Wireless Communication Option

A remote control on a standard phone line can be done via a modem. Maintenance or On-line support can be provided through operator assistance facilitated by one of Mirion's customer service agreements.

The customer agreement is obviously required for this type of assistance. These solutions are ideal for temporary installation (maintenance, investigation tests, complementary measurement channel...).

SPECIFICATIONS



Area Monitors			
Model Number	Detector Type	Range	Application
GIM 201K	Ionization chamber	10 ⁻⁶ to 10 Sv/h (10 ⁻⁴ to 10 ⁺³ rem/h)	Low range
GIM 202K	Ionization chamber	10 ⁻⁷ to 10 ⁺² Gy/h or Sv/h (10 ⁻⁵ to 10 ⁺⁴ rad/h or rem/h)	Wide range
GIM 203K	Ionization chamber	10 ⁻⁶ to 10 ⁺³ Sv/h (10 ⁻⁴ to 10 ⁺⁵ rem/h)	Wide range
GIM 204K	Silicon diode	10 ⁻⁶ to 100 Gy/h or Sv/h (10 ⁻⁴ to 10 ⁺⁴ rad/h or rem/h)	Very wide range
GIM 205K	Ionization chamber	10 ⁻⁵ to 10 ⁺³ Gy/h (10 ⁻³ to 10 ⁺⁵ rad/h)	Medium range, waterproof, high temperature
GIM 206K	Ionization chamber	10 ⁻³ to 10 ⁺⁵ Gy/h (10 ⁻¹ to 10 ⁺⁷ rad/h)	Very high range for harsh environment
BIM 201K	Plastic scintillator	3.7 10 ⁺³ to 3.7 10 ⁺⁹ Bq/m ³ (10 ⁻⁷ to 10 ⁻¹ μCi/cc)	Wide range (beta irradiation monitor)
Neutron Monitors			
NIM 201K	Helium	10 ⁻⁶ to 0.1 Sv/h (10 ⁻⁴ to 10 rem/h)	Neutron Irradiation Dose Rate Monitor
Particulate Monitors			
ABPM 201S	Dual large area silicon	Alpha: 10 ⁻² to 3.7 10 ⁺⁶ Bq/m ³ (2.7 10 ⁻¹³ to 10 ⁻⁴ μCi/cc) Beta: 1 to 3.7 10 ⁺⁶ Bq/m ³ (2.7 10 ⁻¹¹ to 10 ⁻⁴ μCi/cc)	Duct or stack, off-line alpha beta monitor particulate or also work area
ABPM 203M	Dual large area silicon	Alpha: 10 ⁻² to 3.7 10 ⁺⁶ Bq/m ³ (2.7 10 ⁻¹³ to 10 ⁻⁴ μCi/cc) Beta: 1 to 3.7 10 ⁺⁶ Bq/m ³ (2.7 10 ⁻¹¹ to 10 ⁻⁴ μCi/cc)	Work area, mobile monitor, optimized for high energy (Pu ²³⁸ and Pu ²³⁹)
ABPM 204M	Dual large area silicon	Alpha: 10 ⁻² to 3.7 10 ⁺⁶ Bq/m ³ (2.7 10 ⁻¹³ to 10 ⁻⁴ μCi/cc) Beta: 1 to 3.7 10 ⁺⁶ Bq/m ³ (2.7 10 ⁻¹¹ to 10 ⁻⁴ μCi/cc)	Work area, mobile or portable monitor, optimized for low energy (U ²³³ , U ²³⁵ , U ²³⁸)
ABPM 205L,M	Dual large area silicon	Alpha: 10 ⁻² to 3.7 10 ⁺⁶ Bq/m ³ (2.7 10 ⁻¹³ to 10 ⁻⁴ μCi/cc) Beta: 1 to 3.7 10 ⁺⁶ Bq/m ³ (2.7 10 ⁻¹¹ to 10 ⁻⁴ μCi/cc)	Duct or stack, off-line monitor or also work area
PM 205S	Plastic scintillator	Beta: 3.7 10 ⁻² to 3.7 10 ⁺³ Bq/m ³ (10 ⁻¹² to 10 ⁻⁷ μCi/cc)	Duct or stack, off-line monitor or also work area
Iodine Monitors			
IM 201L,S,M	Nal 1.25 x 1 in.	3.7 to 3.7 10 ⁺⁶ Bq/m ³ (10 ⁻¹⁰ to 10 ⁻⁴ μCi/cc)	Duct or stack, off-line iodine monitor or also work area
IM 203M	Nal 1.25 x 1 in.	3.7 to 3.7 10 ⁺⁶ Bq/m ³ (10 ⁻¹⁰ to 10 ⁻⁴ μCi/cc)	Duct or stack, off-line mobile iodine monitor or also work area
Noble Gas Monitors			
NGM 202L	Ionization chamber	10 ⁺⁴ to 3.7 10 ⁺⁹ Bq/m ³ (2.7 10 ⁻⁷ to 10 ⁻¹ μCi/cc)	Duct or stack, off-line monitor or also work area (low range)
NGM 203S	Ionization chamber	Kr ⁸⁵ : 4 10 ⁺⁶ to 10 ⁺¹⁶ Bq/m ³ (1.08 10 ⁻⁴ to 2.7 10 ⁺⁵ μCi/cc) Xe ¹³³ : 10 ⁺⁶ to 3.7 10 ⁺¹⁵ Bq/m ³ (2.7 10 ⁻⁵ to 10 ⁺⁵ μCi/cc)	Accident range off-line monitor, harsh environment (high range)
NGM 204L,S	Dual large area silicon	Kr ⁸⁵ : 3.7 10 ⁺⁴ to 3.7 10 ⁺¹⁴ Bq/m ³ (10 ⁻⁶ to 10 ⁺⁴ μCi/cc) Xe ¹³³ : 3.7 10 ⁺⁴ to 1.8 10 ⁺¹³ Bq/m ³ (10 ⁻⁶ to 5 10 ⁺² μCi/cc)	Duct or stack, off-line monitor or also work area (low range)
NGM 209M	Dual large area silicon	Kr ⁸⁵ : 10 ⁺³ to 3.7 10 ⁺⁹ Bq/m ³ (2.7 10 ⁻⁸ to 10 ⁻¹ μCi/cc) Xe ¹³³ : 10 ⁺³ to 10 ⁺¹⁰ Bq/m ³ (2.7 10 ⁻⁸ to 2.7 10 ⁻¹ μCi/cc)	Work area mobile monitor, duct or stack (low range)
NGM 216S	Plastic scintillator	3.7 10 ⁺³ to 3.7 10 ⁺⁹ Bq/m ³ (10 ⁻⁷ to 10 ⁻¹ μCi/cc)	Duct or stack, off-line monitor or also work area (low range)
Liquid Monitors			
LM 211S	Nal 1.25 x 1 in.	3.7 10 ⁺³ to 3.7 10 ⁺⁹ Bq/m ³ (10 ⁻⁷ to 10 ⁻¹ μCi/cc)	Off-line gamma liquid monitor, 4 π/5 cm shielding
LM 212S	Nal 1.25 x 1 in.	3.7 10 ⁺³ to 3.7 10 ⁺⁹ Bq/m ³ (10 ⁻⁷ to 10 ⁻¹ μCi/cc)	Off-line gamma liquid monitor, 4 π/10 cm shielding
Samplers			
PIS 203S		3.7 10 ⁺⁷ to 3.7 10 ⁺¹² Bq/m ³ (10 ⁻³ to 10 ⁺² μCi/cc)	Shielded aerosols and iodine sampler (RG 1.97 compliance)
PIS 204L			Low activity particulate and/or iodine sampler
PIS 205L			Low activity, with sampling flow rate control (particulate and/or iodine)

Combination Monitors

Model Number	Detector Type	Range	Application
PING 206S	Particulate Iodine Noble gas	See ABPM 201S See IM 201S See NGM 204S	Stand alone skid
PNG 206S	Particulate Noble gas	See ABPM 201S See NGM 204S	Stand alone skid
PIM 206S	Particulate Iodine	See ABPM 201S See IM 201S	Stand alone skid
PINGM 207S	Particulate Iodine Noble gas	See PM 205S See IM 201S See NGM 216S	Stand alone skid

Steam Leak Monitors

SGLM 201K	Nal 3 x 2 in.	Leak rate: 0.1 to 5 000 l/h (0.6 to 31700 GPD)	Steam generator leak rate monitor (N ¹⁶) detector with thermal insulation
SGLM 202K	Nal 3 x 2 in.	Leak rate: 0.1 to 5000 l/h (0.6 to 31 700 GPD)	Steam generator leak rate monitor (N ¹⁶) detector with 2 in. lead shield

Spectrum Analysis Monitors

SAM 201K	Nal 1.25 x 1 in.	6 decades between 3.7 10 ⁺² and 3.7 10 ⁺¹² Bq/m ³ (10⁻⁸ to 10⁺² µCi/cc)	
SAM 202K	Nal 3 x 2 in.	6 decades between 3.7 10 ⁺² and 3.7 10 ⁺¹² Bq/m ³ (10⁻⁸ to 10⁺² µCi/cc)	
SAM 203K	Nal 2 x 2 in.	6 decades between 3.7 10 ⁺² and 3.7 10 ⁺¹² Bq/m ³ (10⁻⁸ to 10⁺² µCi/cc)	
SAM 204K	Nal 3 x 3 in.	6 decades between 3.7 10 ⁺² and 3.7 10 ⁺¹² Bq/m ³ (10⁻⁸ to 10⁺² µCi/cc)	

Software

MASS2	Maintenance and setup software
RAMVISION	Supervisory control and data acquisition software
SIMS2	Algorithm simulation software

Qualifications

References and Guidelines

RAMSYS has been developed for normal AND specific applications. For instance, it can meet the most demanding standards that are requested for NPPs Safety Related applications.

In this case the following norms are mandatory:

- 10CFR50B, 10CFR21, NQA-1
- IEC 61513,
- IEC 61226
- IEC 62138, ANSI/IEEE std 7-4.3.2
- IEC 60987
- HAF 604

RAMSYS has been «1 E » qualified according to the IEEE 323 and IEC 60780 standards, that rely on the specific following norms:

EMI/RFI tests:

- IEC 61000-6-2
- IEC 61000-6-4
- EPRI TR 102323
- RG1.180
- MIL STD 461E

Seismic tests:

- IEEE 344IEC 60980
- IEC 60068-3-3

Other tests:

- MTBF: MIL HDBK 217F
- TID: IEC 60544-2

Nuclear References and Guidelines

For each monitor, qualifications include nuclear tests.

These tests have been performed by specialized laboratories, based upon the following international standards:

- Gamma, X: **IEC 60532 or IEC 60846**
- Neutron: **IEC 61005 or IEC 61322**
- Particulate: **IEC 60761-1 & 2, IEC 61171**
- Gas: **IEC 60761-1 & 3**
- Iodine: **IEC 60761-1 & 4, IEC 61172**
- Tritium: **IEC 60761-1 & 5**
- Liquid: **IEC 60861**
- Accident and post-accident: **IEC 60951**



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