

NuWM MUM

ADVANCED FULLY AUTOMATED
LOW LEVEL WASTE ASSAY SYSTEM



MUM is advanced fully automated low level waste assay system based on four high performance HPGe (high purity germanium) detectors for comprehensive low-activity container radioactive waste characterisation and free release measurement. Monitored radioactive waste is freely stored in measuring containers. The system capabilities are enhanced using especially designed shielding blocks. System is designed to measure large quantities of radioactive waste, primarily dedicated to measure of metal radioactive waste, but easily adjustable and calibrated to measure other types of radioactive waste occurring in nuclear facilities.

Benefits

- Waste content declaration and hot-spot identification
- Low-background measuring tunnel with air-conditioning and filtration unit
- Composite shielding construction material
- Slight overpressure and temperature stabilisation inside the chamber
- Automatic feeder for loaded container, measured container and already measured container ready to unload
- Automatic weighing system

Key Figures

50 Kev - 3 Mev
→ Gamma energy range

3 tons per hour
→ Measurement capacity

4 HPGe
→ Interchangeable detectors

Product Description

Measurement is performed using 4 pc of integrated semiconductor detectors systems placed below (2 pc) and above (2 pc) the measured object (perpendicular to the longitudinal axis of the measuring container). The charge is measured in three positions (three measuring segments - 400 x 400 x 400 mm) with variable measurement time (12 spectra are acquired in total). The measurement is automatically adjusted according to the activity of the charges in the container.

System parts

- Automatic feeder system - the first segment includes weighing module.
- Low-background measuring chamber with automatic shielded sliding doors. The tunnel is constructed of lowbackground concrete blocks.
- Measurement and evaluation part including housed, shielded and collimated spectrometric measuring apparatus equipped with evaluation PC with management, analysis and evaluation software.
- Control terminal for system diagnostics and parameters settings.
- Optional: remote control, camera system, etc.

Product Applications

- Radioactive waste decommissioning
- Waste monitoring in nuclear power plants

Qualifications

- Waste-packages activity measurement (ISO 14850)
- Determination of the characteristic limits (ISO 11929)
- Electromagnetic compatibility (EMC) - EN 61000-4 (corresponding parts and levels)

Control Software

The device management software is used for setting of the parameters of measurement, processing of analytical results, the presentation of current measurements, the online component equipment diagnostics, communication with the PLC (programmable logic controller) control unit to manage all of system components and the measurement data storage and archiving.

- **GAMSControl** dedicated for management of the whole process of measuring and checks (PLC, sensors, steppers, power supply, communication, spectrometric route, scale, etc.). It allows to configure and manage all the system settings (geometry, measurement time, background check, energy stability check) and controls automatic feeder and barcode ID system. Comfortable diagnostic and control procedures and routines, graphical presentation functions, user configurable outputs and reports are the parts of the GAMSControl software. Measurement process can be fully automatic or manual, in which case the operator defines all the parameters.
- **WebRAOS** is dedicated for registration of measurement results (data recording from GAMSControl) and management of application data database, data review and visualisation (measured charge and performed checks, code lists, user rights and levels, interface from/to external application (XML), reports, etc.). Selected application data are shared with GAMSControl software (code lists and measuring settings). WebRAOS software also include statistical functions dedicated for displaying and reviewing of measured charge balance under defined time period and it also enables to carry out other functions used for data evaluation and presentation. WebRAOS is also dedicated for creation and/or modification of user profiles within the system applications.
- **RDBMS database ORACLE (XE)** is intended for storage of the measurement records and application data.
- **NuSOFT GAMWIN** - comprehensive spectroscopy analysis software package that is dedicated for the routine processing of results of gamma spectrometric measurements (spectrometric data acquisition, processing, analysis and evaluation).

Operational Information

Identification of the material is performed according to the assigned identification code (barcode). The measured material is placed inside the measuring boxes. For handling with measuring containers is recommended use of forklift with appropriate ancillary handling equipment.

Measurement process is initiated after the system stability and background check. After loading of the container to the measuring chamber on the measuring position (shifting on the automatic feeder from the store position to the measuring position) and its identification and registration the system starts the measurement according to the settings (measurement time, type of charge, counting geometry, etc.).

Measurement process can run in manual or in a fully automatic mode. The measuring system has an internal diagnostics of the state of individual subsystems. After introductory initialisation and start of the measuring the operator has the possibility to observe current measured data (spectra) and diagnostic status during the measurement and to control the measurement output data sets, results and reports after completion and evaluation of the measurement.

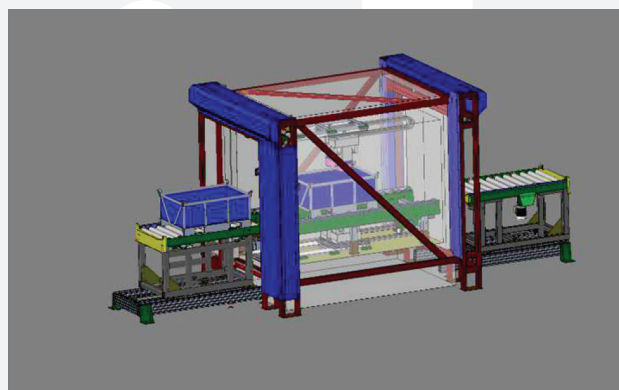
After initiating of the measurement the system sets the container to the first measuring position (the assay system measures the charge in three default positions - the measuring container is divided to three measuring segments - 400 x 400 x 400 mm). Positioning system is equipped with a position sensor with an accuracy of 2.5 mm. The measurement is completed in each segment after the measurement time or if the spectrum is acquired. In case of detector overloading the measurement is automatically elongated.

Activities of particular radionuclides are determined using NuSOFT GAMWIN and GAMSControl software packages. Based on measured spectrum the gamma spectrometry software performs analysis according to settings and calibration parameters. Measured values from individual lines and segments (radionuclides activity distribution in the charge) are compared and assessed. Individual and averaged MDA (minimum detectable activity) values are also calculated. The results of each measurement analysis are stored in a local database on the evaluation PC.

The low level assay system allows measuring of the radionuclides emitting gamma photons in the energy range from 40 keV. The photons generate electric pulses that are amplified in a pre-amplifier, and subsequently processed and

digitised in a digital signal processor. Digital signal is stored in a multichannel analyser (MCA) as gamma-ray spectrum. Measured spectra are transferred to a computer, and using NuSOFT GAMWIN software displayed, analysed and evaluated. The final measurement result is transferred and stored in WebRAOS database using application interface.

The result of the measurement is a registration record in WebRAOS software and output protocol which comprises an identification of the load, radionuclide composition, total mass activity, MDA, combined measurement uncertainty and other necessary information. Minimum measurement time for a load is approximately five minutes.



Product Specification

Detectors and MCA	4 HPGe interchangeable detector modules (IDM) with lead collimators; all-in-one integrated HPGe detector, cooler (Stirling-cycle), cryostat, and signal processing electronics, internal battery for ~2.5 hours following power failure; large HPGe detector (85 mm x 30 mm HPGe crystal), coaxial construction, P-type high-purity germanium; relative efficiency >50% typical (ANSI/IEEE 325-1996), energy resolution ≤ 1400 eV at 122 keV and ≤ 2.3 keV at 1332 keV, peak shape ratio ≤ 1.9 for full-width tenth-maximum to the full-width half-maximum at 1.33 MeV Integral dose rate monitor and multichannel analyser allows direct spectrometric digitisation of the output signal from the detector, 16k channels, digitally stable, Loss Free Counting (ZDT), Ballistic Deficit Correction, Low Frequency Rejector and USB 2.0 connectivity Adapted for quick swapped out / change of IDM in case of failure
Collimator	To focus only to the measured segment (400 x 400 x 400 mm) is used lead collimator with slot angle of 90 degree Lead side shielding 40 mm, 1 mm of stainless steel casing, inner copper liner, weight <50 kg
Measuring chamber	Low background measuring cell (tunnel) with air-conditioning and filtration unit shielded by special composite low background shielding material (low background concrete segments with density >2300 kg/m ³) with shielded sliding doors Heavy shielded sliding door with optical safety sensors and electrically controlled Inner chamber dimensions: height 2000 mm, width 1200 mm, depth 3000 mm. Shielding thickness: bottom 600 mm, side 400 mm, top 500 mm and doors 200 mm
Distance between container and detector	350 mm (from the axis of the measuring container)
Evaluation PC	Evaluation PC including NuSOFT GAMWIN, GAMSControl, WebRAOS and RDBMS ORACLE XE
Automatic feeder	Automatic feeder system - through direct open conveyor (three segments) for automatic shifting of the measuring containers to/from measuring cell, maximum loading capacity 500 kg Capacity for automatic changing up to 3 measuring containers (loaded container, currently measured container and already measured container ready to unload). First segment of the automatic feeder system (loading part) include certified tensometric scale for the weighing of the charge - weighing range up to 500 kg with accuracy of 0.2 kg
Containers	Measuring containers for freely stored material - dimensions 1200 x 800 x 400 mm, weight 60 kg, load capacity 300 kg, construction: low background stainless steel frame with plastic walls
Local control unit	Compact terminal for in-site manual control of system components, system diagnostics and setting of the system parameters with LCD operator touch panel and emergency stop switch
Controls and shifts	Electric control of mobile parts of the instrument, programmable logic controller (PLC) used for measuring unit, automatic feeder and measuring chamber, sensors signal processing and motion control of each engines, shifts and steppers, signaling and control elements, emergency and safety sensors and barriers, stop switches, circuit breaker protection devices, anti-collision sensors and proximity switches, power supply and communication modules
Charge identification	Barcode ID system including handheld barcode reader and barcode labels printer
System calibration	Factory efficiency calibration for measuring container and selected sample density (Monte Carlo techniques). MUM automatically selects appropriate efficiency calibration based on container weight, or based on the description in the waste package database
Printer	Laser printer for output protocol
Construction	Steel profiles frame partially sheathed with steel plates, conveyor of steel profiles. Construction materials are carefully selected to minimise influence of naturally occurring gamma emitters
Maximum dimensions	Height 3400 mm, width 8200 mm, depth 2750 mm
Weight	40 tons
Start-up time	<10 min (without detector cooling time)
Operating/storage temp.	From 5 °C up to 40 °C (operating), from -10 °C up to 50 °C (storage)
Relative air humidity	<80% (non-condensing)
Power supply	3 NPE 50Hz 230/400 VAC TN-S
Power consumption	9.4 kVA (max total)
Backup power supply	AC 230 V / 6 A, time coverage of power interruption: 10 min (measuring part)
IP protection	32
Power surge protection	Type 3
MDA	IDM with 50% efficiency HPGe detector, 90 s assay time, material: gravel, weight: 490 kg, density: 1.5 g/cm ³ , volume: 100% (0.33 m ³); ⁵⁴ Mn: 0.002 Bq/g, ⁵⁷ Co: 0.003 Bq/g, ⁵⁸ Co: 0.001 Bq/g, ⁶⁰ Co: 0.002 Bq/g, ¹³⁷ Cs: 0.003 Bq/g, ¹⁵² Eu: 0.006 Bq/g, ²⁴¹ Am: 0.02 Bq/g
Measuring range	Up to 1E8 Bq
Energy range	From ~50 keV up to ~3 MeV
Max. activity limit	¹³⁷ Cs 1E6 Bq/kg - ⁶⁰ Co 1E8 Bq/kg - ²⁴¹ Am 1E4 Bq/kg
Key radionuclides	⁵⁴ Mn, ⁵⁷ Co, ⁵⁸ Co, ⁶⁰ Co, ⁶⁵ Zn, ⁹⁰ Sr, ¹²⁵ Sb, ¹³³ Ba, ¹³⁷ Cs, ¹⁵² Eu, ²¹² Bi, ²⁴¹ Am, ²³² Th, ²³⁷ Np, ²³⁸ U, ²³⁹ Pu, ²⁴⁰ Pu
Accuracy	Typically better than 10% (uniform source and matrix distributions)
Measur. capacity	Up to 3 tons of metal material per hour - depends on the preset time of measurement and speed of exchanges of measured containers
Min. measuring time	1 minute (depends on material and density)
Charge loading time	2 minutes
Spare part kit	Spare HPGe interchangeable detector modules (IDM) with mounting kit
Conveyor	Automated conveyor line / feeder for selectable number of the measuring containers. Conveyor line shape: through direct open, semicircle open or circular closed
Application interface	Application interface from/to external application (XML)
System calibration	Factory efficiency calibration for selected types of materials and density (Monte Carlo techniques)
Verification source/kit	Reference source for energy and efficiency calibration checks (selected mix)
Camera system	The camera system allows monitoring of the entire space with a measuring apparatus and automatic feeder