

# **DrumScan® LRGs Mk II**

## **Drum, Package & HEPA Filter Monitor**

- Rapid, reliable and cost-effective assay of drums up to 200 litres (55 US gallons), packages up to 90 litres (25 US gallons) and HEPA filters by a single monitor.
- Ideally suited to measurement of solid waste contaminated with fission products, activation products and uranium (including  $^{235}\text{U}$  enrichment) for categorisation and sentencing.
- Simple to use, Microsoft® Windows® driven operator interface requiring no specialist radiometric or computing knowledge.
- Customised results reporting for single waste item measurements and waste consignments (including automatic generation of approved Drigg D4 form for UK LLW consignment).
- Wide operating range for waste items with contact gamma dose rates up to 5 mSv/hr (500 mrem/hr).
- Flexible physical arrangement, wide range of pre-set configurations and supplied pre-calibrated to meet customer's specific measurement needs.
- Remote PC control up to 10 metres (33 feet) away to minimise operator dose uptake
- Inference of activity for all 'difficult-to-measure' radionuclides (e.g. pure beta emitters or low energy/intensity gamma emitters) from multiple, directly measured, reference radionuclides via customer-defined wastestream fingerprints (scaling factors or nuclide vectors).
- Low resolution gamma spectroscopy with high integrity gain stabilisation.



- Matrix correction based on mean waste density using turntable's integral weigh platform.
- Results stored automatically in a Microsoft® Access database, with provision for easy back-up.
- Optional bar code reader to enable automatic input of each waste item's unique details.

The DrumScan® LRGs Mk II Drum, Package & HEPA Filter Monitor has been designed and manufactured by BIL Solutions Ltd. following extensive operating experience and customer feedback of existing low resolution gamma spectrometry (LRGS) assay systems. The result is a highly versatile instrument which enables customers to achieve rapid, reliable and cost-effective assay of drums, packages and HEPA filters for waste storage and disposal categorisation.

The DrumScan® LRGs Mk II is a non-destructive assay system for the measurement of solid radioactive waste.

The well established and reliable LRGs measurement technology results in a robust, simple and easy to use instrument suitable for industrial plant environments.

### **Applications**

The DrumScan® LRGs Mk II is ideal for use in process plant applications requiring the measurement of fission products, activation products and uranium, including the determination of  $^{235}\text{U}$  enrichment, for waste categorisation and subsequent sentencing for storage or disposal. It is suitable for solid, radioactive wastes in drums up to 200 litres (55 US gallons) and weighing up to 300 kg (660 lb), packages up to 90 litres (25 US gallons) and most HEPA filters, with a contact gamma dose rate up to 5 mSv/hr (500 mrem/hr).



The DrumScan® LRGS Mk II is more cost-effective to use than high resolution gamma spectrometry (HRGS) systems, but generally requires more knowledge of and confidence in the wastestream fingerprints (scaling factors or nuclide vectors). In particular it requires the presence of one or more dominant gamma radionuclides, known as reference nuclides, in each wastestream which can be measured directly.

Key applications include the assay of solid wastes arising from the operational activities and decommissioning programmes of nuclear power stations and reprocessing plants where wastestream fingerprints are well characterised, and uranium wastes from fuel fabrication and processing.

### System overview

The DrumScan® LRGS Mk II comprises two or three vertically aligned NaI(Tl) scintillation detectors and associated gamma pulse-processing electronics located within a temperature controlled measurement cabinet. This is mounted on a platform facing an integral rotating turntable. Each detector is shielded and collimated to view the waste item when placed on the adjacent turntable. During measurement the waste item is simultaneously rotated, weighed and a gamma spectrum acquired from each detector.

On completion, each spectrum is analysed to determine and report the isotopic inventory of the waste item. This analysis is performed by an industrial PC and all results are presented to the user via a Windows® driven operator interface. This simple and easy to use operator interface is readily adopted by waste management teams. It can be located up to 10 metres (33 feet) from the temperature controlled measurement cabinet if necessary to reduce dose uptake to operators when assaying waste items having high contact dose rates.

### Measurement procedure

The DrumScan® LRGS Mk II is simple to use requiring no specialist radiometric or computing knowledge. The waste item is placed on the turntable and the measurement initiated by clicking a button on the interface. The operator is prompted to enter information which will be used to link the waste item being monitored to the measurement results stored; for example, the waste item type (drum, package or HEPA filter), wastestream and unique waste item identification code. This can be achieved either manually through the keyboard and pull-down menus or via an optional bar code reader. Once entered the measurement begins and the turntable rotates for a pre-determined period. The measurement is complete when the turntable stops at which time the total radionuclide inventory of the waste item is displayed on-screen.

At pre-determined intervals, or at any time the gamma background conditions change, the operator is required to perform a background measurement. This background information is subtracted from each waste item measurement to give a more accurate assay of the waste item's contents. Again, this is achieved via a single button on the operator interface.

### Results reporting

For each waste item the activities and specific activities of all directly measured and inferred radionuclides are reported in the form of a 'Waste Assay Measurement Report'. This includes the total alpha, total specific alpha, total beta and total specific beta activities. When configured for uranium assay, the <sup>235</sup>U enrichment is also reported. In addition, all non-radiometric data specific to the waste item are reported such as the waste item's unique identification code, measured mass and operator's unique identification. The Waste Assay Measurement report can be viewed on-screen or printed.

To create a waste consignment the operator selects a variable number of measured waste items. In this case DrumScan® LRGS Mk II automatically generates the approved D4 form containing the total combined radionuclide inventory for UK LLW consignments to Drigg. Customer specific consignment reports can be produced as an option.



## Inference of activity for 'difficult-to-measure' radionuclides

The directly measured activity of a pre-defined reference radionuclide is used to infer activities for all 'difficult-to-measure' radionuclides which cannot be measured directly (e.g. pure beta emitters or low energy/intensity gamma emitters). The reference radionuclide and the corresponding radionuclide fingerprint are defined uniquely for each wastestream implemented on the system using data supplied by the customer. At least 15 different wastestreams, each having a unique fingerprint, can be implemented on DrumScan® LRGS Mk II.

Where the generation mechanisms for different radioactive species differ significantly within a single wastestream fingerprint, several directly measured, reference radionuclides may be used to infer the activities of 'difficult-to-measure' radionuclides; one for each species. For example, the direct measurement of  $^{137}\text{Cs}$  activity may be used to infer the activities of all 'difficult-to-measure' fission products in a waste item, whilst all 'difficult-to-measure' activation products may be inferred from the direct measurement of  $^{60}\text{Co}$ . This approach ensures the activities of all 'difficult-to-measure' radionuclides are inferred optimally, thereby resulting in the highest possible accuracy of total waste item activity.

## System gain stabilisation

Effective and reliable system gain stabilisation is most important in achieving accurate radionuclide measurements for LRGS based assay systems, especially when environmental conditions vary widely. DrumScan® LRGS Mk II performs gain stabilisation automatically and continuously throughout all measurements by monitoring an 'alpha' peak that is permanently present in the gamma spectrum of each detector.

This is achieved through the use of a radioactive source within each detector which is low enough in activity to be exempt from regulatory control.

The use of a temperature controlled measurement cabinet to house the LRGS detectors further ensures a highly gain stabilised system capable of operation in a wide range of environmental temperatures.

## System calibration

Each DrumScan® LRGS Mk II system is supplied pre-calibrated to meet the specific measurement needs of each customer. The specifics of each calibration are agreed with the customer prior to the commencement of factory-based commissioning.

The day-to-day check of system calibration and operational stability is confirmed by the routine measurement of a waste item, supplied with the instrument, in to which a source(s) of known activity is placed at a pre-determined location.

## Correction for waste matrix attenuation

Calculated activities are corrected for the effects of gamma attenuation by the waste matrix using correction factors. These vary with the weight of the waste item (mean density) and gamma emission energy. They are pre-determined and configured for a number of defined waste item mass ranges and gamma energies before the system is dispatched.

## Safety and security features

The DrumScan® LRGS Mk II incorporates two important safety features; a turntable with a clutch-slip mechanism to prevent injury



from a trap hazard when rotating, and an emergency stop button in the top panel of the measurement cabinet which cuts all electrical power to the turntable. Physical security of the measurement cabinet is ensured via two lockable doors.

Operational, software and data security is controlled by the system's design. Prior to enabling measurements, a log-in procedure requires an operator's identification and password.

There are two levels of authorisation; Operator(s) and Supervisor. The Operator status allows only the basic functions required for the routine measurement of waste items, background conditions and checks of system calibration. Supervisor status replicates these facilities but enables additional functions such as the ability to create more operators, delete operator(s) and change passwords.

The operator's identification is reported on each printed Waste Assay Measurement Report.

All software system constants are held in a Microsoft® Access database which is password protected. This password is different from the Operator(s) and Supervisor passwords.

## Specification

Measurement system size:	1400 mm long, 700 mm wide, 1260 mm high
Measurement system mass:	375 kg
Deployment method:	Fork lift truck or manually operated hydraulic pallet truck
Deployment orientation:	Any avoiding high background in detectors' field of view
Maximum waste item size:	Drums up to 200 litres (55 US gallons)
Maximum waste item mass:	300 kg (660 lb)
Detector type:	NaI(Tl) scintillator with photomultiplier tube
Computer:	Compact industrial PC
External data storage:	CD-RW, other options available
Operating system:	Windows® 2000
Monitor:	15" colour TFT
Printer:	Colour inkjet
Operating voltage/current:	110 or 230 V AC, 50/60 Hz, configured at shipment; 10 A at 110 V
Electromagnetic compatibility:	Emissions to EN61000-6-3:2001, Immunity to EN61000-6-1:2001

## Performance

Detection limits:	Assuming a uniform distribution of activity in a relatively homogeneous waste matrix in 5 minutes in a gamma radiation background of $>1 \mu\text{Sv/hr}$ ( $>100 \mu\text{rem/hr}$ ) $^{60}\text{Co}$ , 9 kBq; $^{137}\text{Cs}$ , 6 kBq for a 200 litre drum of typical power plant waste weighing 50 kg $^{60}\text{Co}$ , 6 kBq; $^{137}\text{Cs}$ , 7 kBq for a 90 litre bag of typical power plant waste weighing 8 kg $^{235}\text{U}$ , 150 mg for a 200 litre drum of operational waste contaminated with natural uranium oxide
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Systematic uncertainty:	$\pm 30\%$
Energy range:	$\sim 30$ to $\geq 1500$ keV
Dose rate envelope:	Waste items up to 5 mSv/hr (500 mrem/hr) contact gamma dose rate
Environmental rating:	Measurement cabinet to BS EN 50298, IP54 Industrial computer to BS EN 50298, IP54
Gamma radiation background:	Up to 5 $\mu\text{Sv/hr}$ (0.5 mrem/hr) without further external shielding
Operating temperature range:	0°C to 40°C
Remote operation:	Operator interface up to 10 metres (33 feet) from measurement cabinet

## Options

Two or three detectors in a range of sizes depending on waste item geometry and activity.

Longer or variable geometry between measurement cabinet and waste item turntable.

Bar code reader to enable automatic input of waste item's unique details.

Customised results reporting for single waste item measurements and/or waste consignments.

Product and residues monitoring through derivatives of DrumScan® LRGs Mk II.

Larger TFT monitor.

Colour laser printer.