



**An Easy to Use, Reliable and Robust Solution to Free Release  
Sentencing of Containerized Radioactive Waste**

- Ideal for low density waste characterization
- Detection limits easily meet free release levels resulting in cost savings
- Intuitively simple user interface with flexible reporting options
- Tried and tested analysis software algorithms
- High sensitivity LN<sub>2</sub>-Free HPGe detectors with advanced digital signal processing electronics
- Supports 208 liter (55 gal.) containers and smaller boxes
- Container weighing up to 725 kg (1600 lbs) via load cell
- Automatic Drum Handling Conveyor options

QED is a tool for radioactive waste generators and assay professionals with the task of identifying, quantifying, and sorting radioactive wastes. The high disposal cost of low-level waste makes QED the most cost effective tool to sort and demonstrate that 'non-radioactive' wastes are free release candidates. (The definition of what waste is non-radioactive varies, but for most facilities, QED can make the determination in a single count of a few minutes.)

## QED Benefits

- Rapidly and reliably verifies waste activity is at "free release" levels.
  - Ultra-low MDA (~10 nCi) for 'No Activity'
  - Performs TRU sorting at 100 nCi/g over a wide density range (0.1 to 1.5 g/cc)
  - MDA of less than 370 Bq for 208 liters of drummed low density waste for most nuclides
- Naturally occurring radioactive materials (NORM) activities may be excluded from results
- Determination of non gamma emitters by correlation.
- Corrects for matrix material density
- All new modular shield design:
  - Easy installation/reinstallation, especially in restricted spaces or waste storage areas
  - Easily decontaminated
  - Easily reconfigured from drums to smaller boxes

## Mechanical Description

QED features a unique, modular shield design. The shield is shipped as individual pieces, and can be easily installed by two people in a matter of hours. It is fabricated from 4 inches of low background steel checked for contamination by <sup>60</sup>Co. Each lot of low background steel is individually analysed before fabrication to ensure there is no extraneous contamination. An easily cleanable lacquered copper inner liner suppresses lead x-rays.

The drum is manually loaded with a conveyor and rotated on a platform inside the low background shield in order to average out matrix attenuation effects. Automatic conveyor options are available on request.

A high degree of attention has been paid to operator safety in the design of the QED. The heavy shielded door is electrically controlled. A "light curtain" coupled to an interlock system eliminates any possibility of an object or a person being injured by a moving door. Two emergency interrupt buttons are located on either side of the door and a third is located on the operator console.

For counting of 208 liter drums, the HPGe detectors are installed in the "top", "middle" and "bottom" positions. A fourth intermediate position, with removable plug, is provided between the bottom and middle positions to facilitate the counting of smaller waste packages, for example cardboard boxes.

Generally, smaller containers will result in lower detection limits than larger containers filled with the same material. QED handles small paper or plastic bags of waste as well as carboys containing liquids up to a standard 55 gallon (208 litre) drum weighing up to 1600 lb (750 kg).

## QED Spectroscopy Electronics

The latest generation ORTEC DSPEC jr 2.0 (Ref. 1) USB family DSP spectroscopy electronics provide ultra-stable operation over a wide range of count-rate and temperature.

Ethernet communications can be provided to allow the operator console to be located remotely from the measurement point, particularly useful in areas of high ambient radiation. The ORTEC *CONNECTIONS*<sup>™</sup> spectroscopy architecture means that the QED is easily interfaced with other systems, e.g. for record keeping/reporting; live spectral data and results may be viewed on other network PC's if required.

## QED Software

QED Waste assay software employs the tried and tested ORTEC GammaVision-32 (Ref. 2) algorithms to process the spectra and extract the peak areas. A unique interpolative attenuation correction method is used to correct for the effects of container and matrix.

## Low-Level Waste Assay and Segregation System Model 3400-210

### Standard QED HPGe Detectors

QED employs three ORTEC Large Area PROFILE Series GEM detectors that 'view' the drum in three vertical slices or segments without collimation. This method provides high-efficiency and high-resolution at high and low energies and maximizes sensitivity for reliable nuclide identification. All HPGe detectors are supplied as "SMART-1™", which monitor and store their own state-of-health (SOH) (Ref. 3). Use of the X-COOLER II cryo-cooler eliminates the need for liquid nitrogen (Ref. 4).

Standard HPGe detectors offered with the QED are ORTEC PROFILE GEM-F7040 (Ref. 5) with the following specifications:

Nominal Crystal frontal area: 36 sq cm, length 40 mm

FWHM resolution at 122 keV: 750 eV (Ref. 6),  
at 1.332 keV: 1.95 keV

Nominal Relative efficiency: 40% (Ref. 7)

Peak Shape FWTM/FWHM typical: 1.9  
FWFM/FWHM typical: 2.65

Peak To Compton ratio: 50:1

### Standard Performance Specifications

The following are typical performance data for the standard GEM-F7040 detector option. These are detection limits for a 55 gallon drum, with matrix densities as specified, in a 30 minute count according to the NUREG4.16 detection limit methodology. These detection limits assume homogeneous source and matrix distribution. NUREG4.16 is a very conservative detection limit formalism. It is not uncommon for vendors to specify detection limits using the simple "1-sigma Currie limit".

### High Performance QED Detector Option

For improved sensitivity, QED can be supplied with PROFILE GEM-FX8530 detectors which provide ~45% greater frontal area and an ultra thin entrance window for enhanced low energy response (recommended for <sup>241</sup>AM determination.) (Compatible with PC/FRAM (Ref. 8) for determination of Pu and U Isotopic ratios.)

GEM-FX8530 Specifications:

Nominal Crystal frontal area: 54 sq cm, length 30 mm

FWHM resolution at 14.4 keV: 600 eV (Ref. 6),  
at 122 keV: 650 eV (Ref. 6), at 1.332 keV: 1.90 keV

Nominal Relative efficiency: 50% (Ref. 7)

Peak shape FWTM/FWHM typical: 1.9  
FWFM/FWHM typical: 2.9

Peak to Compton ratio: 55:1

### High Performance Specifications

The following are typical performance data for the high performance GEM-FX8530 detector option. These are detection limits for a 55 gallon drum, with matrix densities as specified, in a 30 minute count according to the NUREG4.16 detection limit methodology. These detection limits assume homogeneous source and matrix distribution. NUREG4.16 is a very conservative detection limit formalism. It is not uncommon for vendors to specify detection limits using the simple "1-sigma Currie limit".

Nuclide	Energy keV	Detection Limit (pCi/g)				
		Matrix Density g/cc				
		0.1	0.2	0.3	0.8	1.8
CS-137	662	0.07	0.04	0.03	0.02	0.02
CO-60	1173	0.06	0.03	0.02	0.01	0.01
CO-58	810	0.08	0.05	0.04	0.02	0.02
Th-232	911	0.23	0.13	0.10	0.06	0.05
Th-228	583	0.10	0.06	0.04	0.03	0.03
TH-234	93	3.04	2.03	1.47	0.79	0.68
BI-214	609	0.22	0.13	0.09	0.06	0.05
U-235	185	0.14	0.09	0.06	0.05	0.04
U-238	1001	6.06	3.48	2.51	1.57	1.32
PU-239	414	4506	2737	2035	1483	1198

**Typical Performance Data, Standard HPGe Detector Option.**

To compare the performance data shown here with Currie limit data, divide the data here by ~2.83. For example, for a matrix density of 0.3 g/cc, the high performance detection limits for <sup>137</sup>Cs and <sup>239</sup>Pu become 0.01 and 720 pCi/g respectively.

Nuclide	Energy keV	Detection Limit (pCi/g)				
		Matrix Density g/cc				
		0.1	0.2	0.3	0.8	1.8
CS-137	662	0.05	0.03	0.02	0.01	0.01
CO-60	1173	0.05	0.03	0.02	0.01	0.01
CO-58	810	0.06	0.03	0.03	0.01	0.01
Th-232	911	0.17	0.10	0.08	0.04	0.04
Th-228	583	0.06	0.04	0.03	0.02	0.02
TH-234	93	1.60	1.07	0.77	0.41	0.36
BI-214	609	0.14	0.08	0.06	0.04	0.03
U-235	185	0.07	0.05	0.03	0.03	0.02
U-238	1001	4.84	2.78	2.01	1.26	1.05
PU-239	414	2575.11	1564.17	1162.64	847.22	684.49

**Typical Performance Data, High Performance HPGe Detector Option.**

To compare the performance data shown here with Currie limit data, divide the data here by ~2.83. For example, for a matrix density of 0.3 g/cc, the high performance detection limits for <sup>137</sup>Cs and <sup>239</sup>Pu become 0.007 and 410 pCi/g respectively.

## Low-Level Waste Assay and Segregation System Model 3400-210

### QED Ordering Information

QED is delivered, installed and commissioned following full factory testing.  
The system comes complete with operator station, ready to work.

Model No.	Description
3400-210-F70	QED equipped with ORTEC PROFILE GEM-F7040 detectors
3400-210-FX85	QED equipped with ORTEC PROFILE GEM-FX8530 detectors

### Contact the Factory for the following options:

Automated conveyor system

"In line" (pass through) systems with automatic conveyors

Additional detector configurations (including plastic and NaI(Tl) scintillators)

- 1) ORTEC DSPEC jr 2.0 spectrometers digitally process the signal from each HPGe detector. Ultra stable temperature and count-rate performance is the result. The patented LFR filter reduces the effect of low frequency environmental noise. The innovative "ZDT" Loss-free counting mode eliminates measurement bias, should hot spots produce wide fluctuations in count rate. High speed USB 2.0 data communications are provided. See [http://www.ortec-online.com/pdf/dspjr\\_20.pdf](http://www.ortec-online.com/pdf/dspjr_20.pdf).
- 2) See <http://www.ortec-online.com/pdf/a66.pdf>.
- 3) See [http://www.ortec-online.com/detectors/photon/a3\\_7.htm](http://www.ortec-online.com/detectors/photon/a3_7.htm).
- 4) X-COOLER, exclusive to ORTEC is the leading non-LN<sub>2</sub> refrigerator for HPGe detectors. Since 2000 it has been proven in many hundreds of installations, and is by far the pre-eminent cooler of its type. In combination with ORTEC patented PopTop detector capsules, the system is reliable and in the unlikely event of a failure, either the detector capsule or the cooler may be swapped out on site for easy repair. See <http://www.ortec-online.com/detectors/xcool.htm>.
- 5) See [http://www.ortec-online.com/detectors/photon/b2\\_1\\_1.htm](http://www.ortec-online.com/detectors/photon/b2_1_1.htm).
- 6) This specification may be relaxed by up to 10% because of the use of the X-COOLER refrigerator.
- 7) Specified according to IEEE-325. PROFILE F detector crystals are "over square" (diameter>length), leading to much improved sensitivity in applications such as drum scanning compared to conventional detectors of similar relative efficiency but closer to 1:1 d/l. For more detail see [http://www.ortec-online.com/pdf/best\\_choice\\_det.pdf](http://www.ortec-online.com/pdf/best_choice_det.pdf) page 5.
- 8) PC/FRAM is licensed form Los Alamos National Laboratory, more detail on request.

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Specifications subject to change  
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