

# ANTECH

A. N. Technology Limited ◦ ANTECH Corporation



*profile of ANTECH*  
*nuclear measurement solutions*



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## About ANTECH

ANTECH designs, develops, supplies, supports and maintains a wide range of non-destructive nuclear measurement technologies with applications in nuclear safeguards, nuclear waste assay and sentencing, and radiation detection. ANTECH instruments measure special nuclear materials (SNM) including uranium and plutonium as well as fission products and radiation in the environment. ANTECH consists of two companies; A. N. Technology Ltd. is the parent company in the UK and ANTECH Inc. (trading as ANTECH Corporation) is the child company in the USA. ANTECH has been established in the international nuclear measuring instrument supply chain since 1987.

Measurement technologies include passive and active neutron measurements for the determination of uranium and plutonium in waste and for safeguards and a wide range of gamma-ray measuring instruments for detecting, assaying and sentencing gamma ray emitting materials in cans, drums and boxes ranging from exempt and low level waste to high activity intermediate level waste (ILW). ANTECH is a world leader in the development, design and supply of radiometric calorimeters for the measurement of plutonium, tritium and other heat producing radionuclides. In addition ANTECH supplies robotic sample loading equipment for calorimeters and mechanical handling equipment such as conveyors for the automated handling and movement of waste drums and boxes. ANTECH also provides comprehensive on-site measurement services with associated measurement data review and validation. In addition to measurement supply and the performance of measurement services, ANTECH is involved in consulting and providing technical support to the nuclear industry.

## ANTECH Locations and Contact Information

ANTECH offices are located in Wallingford, UK (near Oxford) and in Westminster (Denver), Colorado in the United States. From these locations ANTECH supports customers around the world. Contact information for ANTECH is as follows:

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## ANTECH Global Customer Base

Our broad international customer base includes government nuclear laboratories, power stations and nuclear industry site operators and contractors around the world. In the UK, ANTECH customers include AWE, Dounreay Site, Magnox decommissioned nuclear power stations, Sellafield Site and the UK Ministry of Defence. In the United States ANTECH customers include laboratories and facilities of the US Department of Energy (Argonne, Carlsbad, Hanford, Idaho Falls, Los Alamos, Rocky Flats, Savannah River) and Nuclear Fuel Services. Elsewhere, we have waste assay and safeguards instruments supply contracts in countries including Argentina, Australia, Canada, China, Finland, Japan, Korea, South Africa, United Kingdom, and in Italy with the European Commission at ISPRA and the IAEA in Austria supplying safeguards instruments.



## Safety, Health and Environment Statement

Safety is an integral component of all the activities in which ANTECH is involved. It is not simply a policy or a set of procedures; it is an inherent aspect of everything we do. Safety awareness and safe practices of work are intimately bound up in all our operations – from design through all aspects of execution.

### Safety & Health

ANTECH is dedicated to providing safe processes for all of its activities and especially for the measurement of potentially nuclear materials. ANTECH operates a Health and Safety Policy in compliance with and exceeding Government legislation and Approved Codes of Practice on all company sites. This policy is implemented in the following way:

- ANTECH provides and maintains a working environment for employees, contractors and visitors that is safe and free from risks to health
- ANTECH provides such protective equipment as is necessary for the health and safety at work of employees, contractors and visitors
- ANTECH provides information, instruction, training and supervision as is necessary to ensure the health and safety at work of employees, contractors and visitors
- Arrangements are made for ensuring an absence of risks to health in connection with the use, handling, storage and transportation of articles and substances
- All individuals are encouraged to exercise responsibility and care in the prevention of injury and ill health to themselves and to others
- ANTECH Health and Safety Policy is subject to regular review

### Environment

ANTECH is dedicated to developing and operating systems that increase the efficiency of nuclear materials measurement to limit the environmental impact of nuclear energy. This ethos prompts ANTECH to minimize the environmental impact of company operations and the design, fabrication, installation and operation of all products and systems as part of our environmental management activity:

- A regular review of operations is conducted to ensure compliance with the requirements of environmental legislation
- A policy of environmental awareness is promoted and all staff are encouraged to use resources in a sustainable manner
- A recycling policy is in force in all company offices
- Suppliers are audited to ensure that they follow environmentally aware production methods
- ANTECH promotes a purchasing policy that gives preference to products and services that cause the least harm to the environment
- Environmental issues are considered in the selection of materials and treatments
- Reusable packaging is used, where appropriate, for all company products

## Quality Management System

The ANTECH Quality Management System (QMS) is formalised in line with current ISO standards in the United Kingdom and the United States. By utilising this system ANTECH aims to enhance customer satisfaction through the effective application of management and infrastructure processes relating to every aspect of company activity, from the receipt of a sales enquiry through to product delivery, support and maintenance.

In the UK the ANTECH QMS is registered and audited to ISO:9001-2015 by BSI (Certificate No. FM 36310). In the USA ANTECH is registered and audited to ISO:9001-2008 by BSI America (Certificate No. FM 61716). ANTECH Corporation also operates a QA system in compliance with NQA-1-2008 and has been audited to this standard by several customers.

## Capabilities and Activities

The following sections provide examples of ANTECH instruments and technology and the different measurement solutions where they are applied around the world.

### Radiation Detection and Environmental Monitoring

ANTECH radiation detection equipment includes gamma-ray measuring contamination portal monitors, mobile environmental laboratories, radiation detection monitors and automatic soil monitoring and segregation systems. Portal monitoring technology includes neutron and gamma-ray portals for homeland security based on new boron tube neutron detectors. Mobile laboratories are supplied by ANTECH for environmental and soil monitoring and for nuclear emergency responders. ANTECH also supplies automated instruments and systems for detecting, sorting and sentencing radiation in soil, building rubble and decommissioning waste.

Figure 1 shows a G5340 Series plastic scintillator based contamination portal monitor under test at the ANTECH facility in Wallingford. The G5340 Series employ on-board microprocessors and use the SPRT algorithm, which updates the statistical test for radioactive contamination every 200 milliseconds. This provides fast detection of gamma radiation even for vehicles moving at greater than 8 km/hr.



Figure 1

Figure 2a shows an ANTECH Model B6030-001 mobile environmental laboratory, several of which have been deployed in Europe. Figure 2b provides an interior view of the mobile lab showing a sample preparation area and a small sample alpha-beta counter and NaI gamma-ray well detectors.



Figure 2a



Figure 2b

Figure 3 shows RadSearch, a novel radiation detection device and Gamma camera. It can scan a surface or object and determine the distribution of radioactivity, identify the radionuclides present and determine both the activity (in Bq) of the scanned area and the dose rate (in Sv) arising from it.

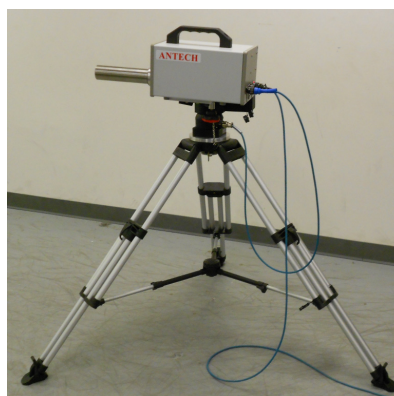


Figure 3



Figure 4

Figure 4 shows a deployed view of the Model G3107-1000 Soil Measuring and Segregation System. This automated instrument is intended for the on-site sorting and segregation of soil, gravel and rubble containing radioactive contamination. On-site soil sorting greatly reduces the amount of contaminated soil that must be transported for off-site disposition, saving both transportation and disposal costs.



## Exempt and Low Level Waste (LLW) Measurement

ANTECH provides instruments and services to support measurement and segregation of radioactive waste for the categories of exempt, very low level waste (VLLW) and low level waste (LLW). Both gross gamma-ray counting and gamma-ray spectroscopy techniques are employed.

Figure 5 shows the G3301 Series Segregated Waste Clearance Monitor (bag monitor) deployed at a UK nuclear power station. The G3301 Series, which uses 6 plastic scintillators to provide 4 Pi geometric coverage, achieves the highest detection efficiency in the industry of 21% for the detection of  $^{137}\text{Cs}$  in low density waste. This microprocessor based instrument can be used to free release low density waste in bags.



Figure 5

The Model G3400-220 Low Level Waste Segregation and Sentencing System (known as the QED) is shown in Figure 6 in use at a European nuclear power station. It employs three high efficiency electromechanically cooled high purity Germanium (HPGe) spectroscopy detectors to measure low and medium density LLW in 220 litre drums. The drums are loaded by roller conveyor into a 100 mm thick steel shielded measurement chamber, designed to reduce the radioactive background and thus lower the detection sensitivity. A density correction is performed by measuring the weight of the drum using internal load cells as the measurement is performed. Using gamma spectroscopy, this very sensitive instrument is able to subtract the radioactivity due to NORM in the waste as part of the assay process.



Figure 6

Figure 7 shows the Model G3700-B25 Waste Segregation Gamma Box Scanner, in the two HPGe detector version, in operation at a nuclear laboratory in Canada. The system is used to perform confirmatory measurements of LLW in B-25 boxes and other large waste containers. Density correction is provided by internal load cells and the process of making multiple measurements of the waste box is automated by moving both the box and the detectors to obtain different measurement configurations.



Figure 7

## Intermediate Level (ILW) and High Activity Waste Measurement

Intermediate level waste (ILW) and Class C LLW (USA) can arise due to the presence of high gamma-ray activity. The most widely used instrument for both LLW and ILW measurements worldwide is the Segmented Gamma Scanner (SGS). Typically, relatively homogeneous waste in drums is rotated and measured in vertical slices or segments and a gamma-ray transmission source is used to correct the assay result for variations in the average density from one vertical segment to another.

Figure 8 shows a view of the ANTECH Model G3200-340, which is a compact and transportable SGS for measuring 200 litre and 340 litre (85 gallon US) over-pack drums. This instrument is in use at several nuclear facilities in the United States and Europe.



Figure 8

Figure 9 shows the Model G3250-200 Wide Range SGS (WR-SGS). It is designed for automatic drum handling using roller conveyors and covers a very wide range of waste activity (from VLLW to highly active ILW) and high drum density. WR-SGS instruments are in use at a nuclear power station in Europe and at a nuclear facility in Australia. The measurement of spent fuel element debris (FED) represents the high activity end of ILW assay.



Figure 9

Figure 10 shows a FED measurement system to be deployed at a decommissioned nuclear power station in the UK. The unit contains an HPGe detector with an inverted trapezoidal tungsten collimator and significant lead shielding. It is used to measure  $^{137}\text{Cs}$ ,  $^{60}\text{Co}$  and in some cases  $^{152}\text{Eu}$  in order to characterize the waste prior to interim storage.



Figure 10

## Measurement of Transuranic and Intermediate Level (ILW) Waste Containing Plutonium

Transuranic waste and ILW containing alpha emitters, and especially plutonium, pose different measurement challenges. Three different measurement techniques are routinely applied for the measurement of plutonium depending on the container type, material concentration and waste matrix. Although the SGS, such as the Model G3200-340 (Figure 8) is widely used for transuranic waste assay and sentencing, large errors can arise due to matrix heterogeneity and high waste density. In response the Tomographic Gamma Scanner (TGS) was developed at Los Alamos for the measurement of heterogeneous waste and ANTECH produced the first commercial variant under license.

The ANTECH Model G3800-340 (see Figure 11) has been used widely for transuranic waste measurements at the DOE facilities at Los Alamos, Rocky Flats and Idaho Falls. In high-density waste matrices neutron measurements have some advantages.

Figure 12 shows the Model N2024-220 Drum Decommissioning Piece Monitor, which is used to determine the plutonium content of waste by measuring the spontaneous fission of  $^{240}\text{Pu}_{\text{effective}}$  in the UK. The instrument has sufficient sensitivity such that drums can be filled with waste to a predetermined plutonium content. Typically waste drums measured in a piece monitor will receive a final measurement for sentencing purposes in a higher efficiency Passive Neutron Drum Monitor such as the ANTECH Model N2221-220 (see neutron monitor in Figure 21).



Figure 11

For plutonium containing waste (PCM) and bulk plutonium, calorimetry is an effective assay technique based on measuring the thermal energy (heat) generated by alpha particle decay. The Model CP263-0420 P Series transportable calorimeter is shown in Figure 13. It has the advantage as an assay instrument that it can be calibrated electrically obviating the need for plutonium heat calibration standards. Over 25 of these instruments have been supplied by ANTECH and used to assay plutonium residues and waste at DOE sites in the US including Rocky Flats, Hanford and Savannah River.



Figure 12



Figure 13

## Safeguards and Accountancy Measurements of Special Nuclear Materials

Safeguards measurements are performed in order to ensure that the presence of Special Nuclear Material (SNM) including Uranium and Plutonium is verified and that SNM is not diverted for inappropriate use. Typically, safeguards measurements are performed on both fresh and spent nuclear fuel as well as bulk quantities of SNM. In some cases safeguards measurements are also performed on nuclear waste if warranted by the content of SNM. ANTECH supplies a range of safeguards measurement instruments to customers including the International Atomic Energy Agency (IAEA) in Vienna, DG TREN in Luxembourg and national safeguards authorities in different countries.

Figure 14 shows an ANTECH Model N2044 Neutron Coincidence Collar employed by the IAEA for measurements of fresh fuel bundles of BWR, PWR and VVER fuel. It is applicable both to low enriched uranium (LEU) and mixed oxide (MOX) fuel.



Figure 14

Figure 15 shows an Underwater Fork detector used by the IAEA for measuring both BWR and PWR spent fuel bundles in cooling ponds. In order to measure plutonium by either neutron methods or calorimetry, it is necessary to determine the isotopic ratios of the different plutonium isotopes.



Figure 15

The ANTECH G3501 Plutonium Isotopic Spectrometer (Figure 16) performs isotopic ratio measurements and is used at Los Alamos in conjunction with calorimeter measurements.



Figure 16

Calorimetry is widely employed for bulk material accountancy and safeguards measurements of plutonium, an alpha particle emitter and also tritium, which decays by beta decay. Figure 17 shows the Model CV364-1490 High Sensitivity Large Sample Calorimeter which is used at Los Alamos and Figure 18 shows the Model CHF400-5300 a large volume twin cell calorimeter employed in the UK for making precise measurements of tritium in large waste containers.



Figure 17



Figure 18

## Special Measurement Applications

ANTECH has a capability for developing and designing radiometric-measuring instruments and analysis software for special requirements and bespoke applications, based on employing a variety of radiation detectors and the use of imbedded microprocessor technology. Included are radiometric measuring and detection instruments with a safety critical function and instruments designed for a variety of special applications. ANTECH has further capabilities in the development of software for measurement process control, measurement data analysis and motion control and automation using microprocessor and PLC technology and in electronic circuit design.



Figure 19 shows an example of a special purpose printed circuit board (PCB) containing a number of single channel analysers, a high voltage power supply and with an embedded microprocessor and counting channels. Non-volatile firmware embedded in the microprocessor is developed under the control of the ANTECH ISO:9001-2008 certified Quality Assurance program which involves rigorous testing and validation. ANTECH employs similar PCBs to develop intelligent instruments, to imbed diagnostic functions and to automate measurement processes.

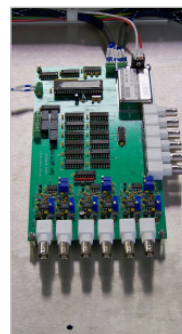


Figure 20

Figure 20 shows a novel screening instrument designated QuickSort. It is controlled by an embedded microprocessor and includes both scintillation detectors for gross gamma ray counting and  $^3\text{He}$  detectors for neutron counting. The instrument is designed to sort LLW from TRU for cases where the waste content is unambiguously LLW or TRU.



Figure 19

## Integrated Measurement Systems and Measurement Automation

For measurement and waste assay applications where more than one measurement technology is applicable, ANTECH has developed integrated measurement systems. A good example is illustrated in Figure 21, which shows the Model B2307-220 waste assay system implemented at the Sellafield MOX Plant (SMP) in the UK. The system consists of a gamma-ray spectroscopy instrument for determining plutonium and uranium isotopic ratios, a passive neutron coincidence counting system for determining the  $^{240}\text{Pu}_{\text{effective}}$  content of the waste and automation to rotate the drums and load drums into the neutron measurement chamber. The purpose of the combined measurement is to determine the total uranium and plutonium in the MOX waste.



Figure 21

Figure 22 shows the more comprehensive Waste Characterization System (WCS) Model B7703-440 implemented at the JRC Ispra site of the European Commission in northern Italy. This system incorporates a number of measurement technologies including drum weight, surface dose measurement, both SGS and TGS measurement, and both passive and active neutron assay. The WCS is designed to measure 20 drums in a 24-hour period automatically in un-attended mode. The system will accommodate both 220 and 440 litre drums (the latter weighing up to 1500 kg). The measured data for each drum, including radionuclide content and quantity of uranium or plutonium, is recorded in a measurement report and the WCS is interfaced to the site waste inventory database.



Figure 22

Figure 23 shows a different configuration of an automated waste assay system. Again the system incorporates a TGS Model G3850-200 and a Model N2240-200 Active-Passive Drum Monitor, both with parallel beam automatic drum loading. In addition to measurement instruments ANTECH designs and supplies radiation shielding and waste container and drum handling equipment including conveyor based drum transport and robotic systems for loading and unloading sample containers from counting instruments and calorimeters.

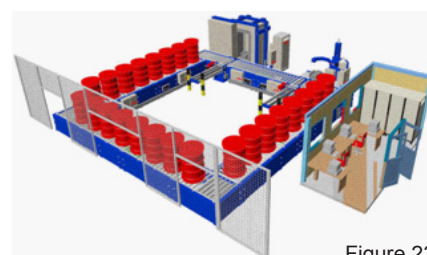


Figure 23

## Measurement and Decommissioning Services

ANTECH have extensive experience worldwide in providing Measurement Services at customer sites. These services may include the supply or lease of measurement and characterization equipment, waste container handling equipment, measurement instrument operation staff, data analysis and review (including result data certification to national standards), on-site technical and instrument calibration support and on-site maintenance.



Figure 24a



Figure 24b

Figures 24a, 24b and 24c show views of the ANTECH Mobile Gamma Ray Assay Lab Model G6434-3601-340, which has been leased to the US DOE and which is deployed to the Hanford site for LLW-TRU waste drum sorting and segregation and LLW drum characterization. The system has been deployed on three contracts over a period of over six years and has measured and sentenced in excess of 7000 waste drums. ANTECH provides a supervising operator and data analysis and review is conducted by ANTECH SME staff in Denver.



Figure 24c

For the most recent measurement service contract ANTECH have deployed a Mobile Neutron Assay Lab Model N6241-2940-2550 to the Hanford site, leased to the US DOE. The instrument, shown in Figure 25, is an Active-Passive Crate and Drum Counter and is used to sentence LLW drums with a high gamma ray background.



Figure 25

Figure 26 is a photograph of a Mobile TGS Assay Lab, Model N6231-3800-340, which was deployed by ANTECH at the Advanced Mixed Waste Treatment Plant (AWMTP) at Idaho Falls. It was used to sentence TRU waste in in both 220 and 340 litre drums for disposal at the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico.



Figure 26



## Consultancy with Physics Assessments and Technical Support to Customers

With a strong physics bias including a well-established MCNP radiometric modelling resource, as well as experience of international nuclear industry working practice, ANTECH provides a comprehensive nuclear consulting and technical support capability with an emphasis on measurement technology. In support of waste and safeguard measurements ANTECH are able to model a wide variety of detector and waste container configurations in order to determine the optimum measurement process.

Figure 27 shows the 24-processor computing cluster employed by ANTECH for modelling and simulation. Modelling is also used to estimate dose rates, detection limits and measurement errors and to determine the optimum configuration for radiation shielding both for neutrons and gamma rays.



Figure 27

Figure 28 is a plot of the dose-rate distribution due to gamma radiation arising from waste drums in the Model B7703-440 Waste Characterization System facility due to the presence of radioactive waste drums. An MCNP simulation was used to generate the dose-rate plot in order to assess the requirements for radiation shielding in the facility.

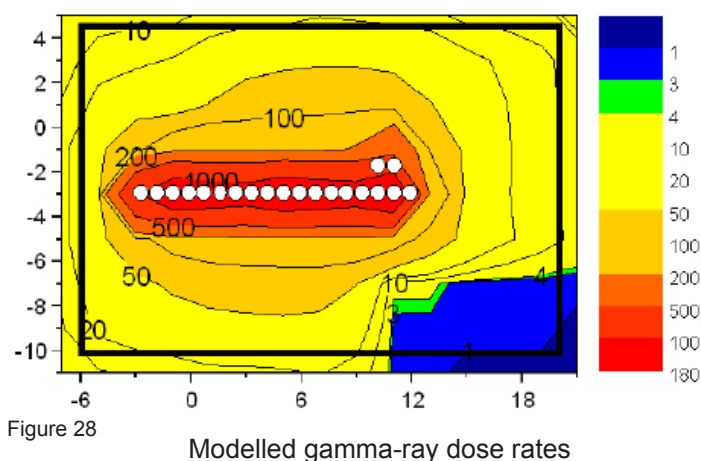


Figure 28

ANTECH is able to provide technical support to customers around the world. This may include measurement data analysis and review, support for instrument calibration and validation, maintenance, physics assessment related to measurement and technical assistance in a variety of other areas relevant to the nuclear industry where ANTECH has expertise. ANTECH staff have extensive experience working on-site in UK nuclear installations and in nuclear installations in both the US and Europe.