Government Chemist

Review 2011

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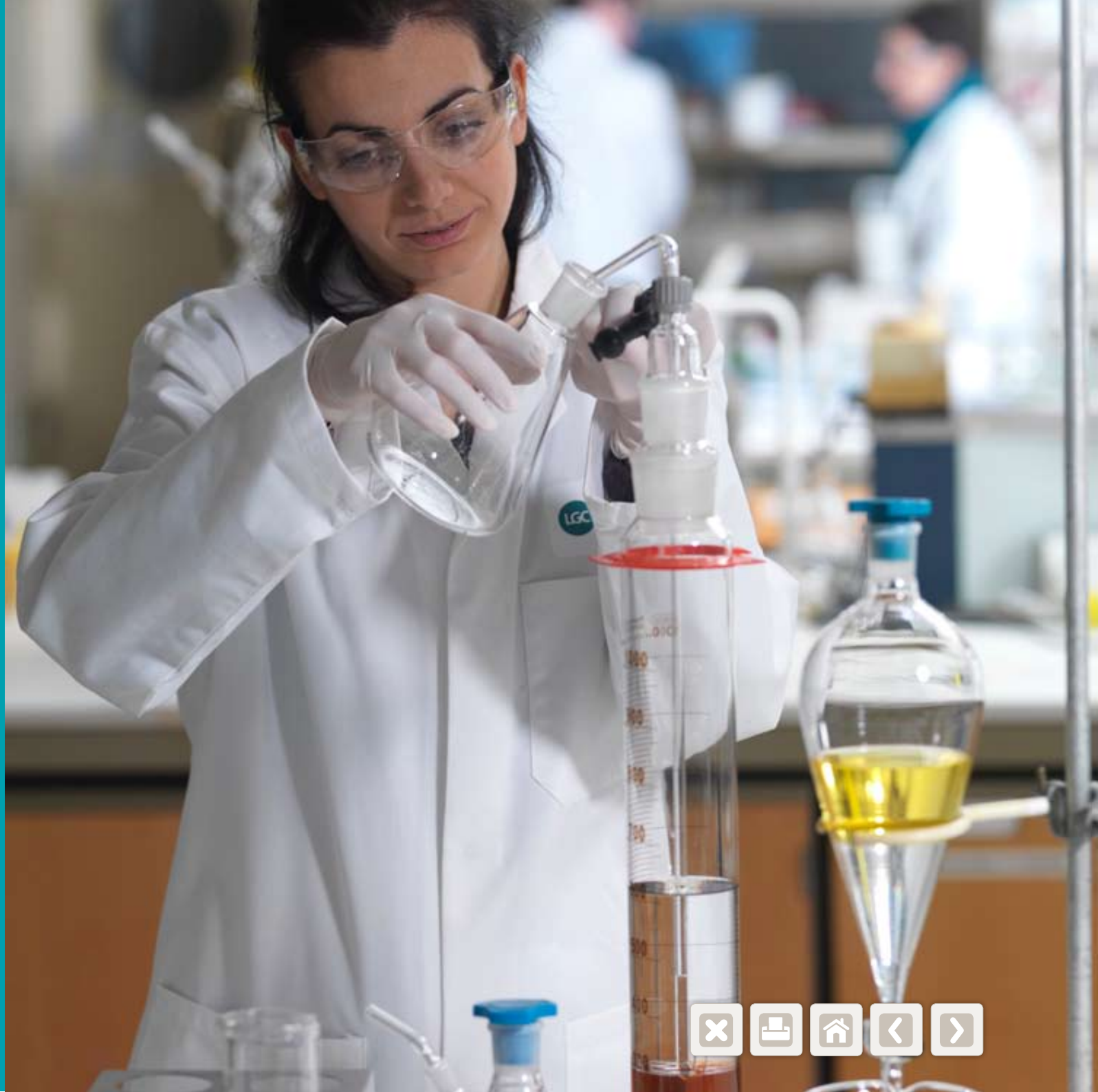


Foreword

The Function of the Government Chemist was defined more than a century ago as a safe guard to industry, Government and the legal system for the fair and practical implementation of food and agricultural laws. In the intervening years Government and my predecessors have maintained the Function and the underpinning skills necessary to deliver this, to match the issues of the day. Continuous evaluation and evolution are critical to ensure relevance. In this respect I am particularly pleased with the input I have received from the National Measurement Office and the Government Chemist Working Group which provided governance and excellent feedback and advice on our work.

An important political and economic issue of today is the need for efficient regulation that is not burdensome on industry but still provides the public with appropriate levels of protection. Section 2 of this review covers the role of the Government Chemist as a source of technical appeal. Over the course of the year our interventions provided a quick and cost effective mechanism for resolving differences of opinion over the legal status of a wide range of products. Included in this have been issues like the presence of nitrofurans in seafood that required particularly complex interpretation. As referee analyst and advisor to Government my staff frequently contributed to efficient regulation by advising on the need to perform, and the requirements for, good measurement. An example of this was our continued input to industry on the implementation of the EU REACH directives described in section 3 of this review.

Global food safety is a further area of political and social concern. Complex supply chains and innovation in practices present new challenges for the measurement community in developing and enforcing regulation and responding to unforeseen incidents. Section 3 of the review also covers some of the areas, like molecular biology and allergen detection, where we contributed towards scientific developments to provide potential solutions to emerging measurement issues. I am also pleased that our partnership with the University of Kingston continued to develop and address the tracking and analysis of global food alerts that should enable us to respond more quickly to future food incidents. It is through this mix of intelligence gathering and analysis, science development, technical appeal and advice that the Function will remain contemporary.

I end this foreword by acknowledging the input of the skilled individuals at LGC that delivered the analysis, research, advice and dissemination over the course of the year, and to my colleagues at the National Measurement Office who continue to support our work.

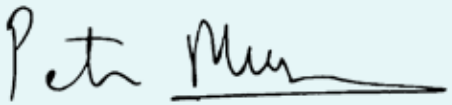
I hope you find this review interesting and informative.

Derek Craston
BSc PhD FRSC
Government Chemist

Note from the National Measurement Office (NMO)

The work of the Government Chemist is an important component of the portfolio of activities within the National Measurement System that provide a strong underpinning for the quality of life and economic prosperity in the UK. The Government Chemist provides an authoritative source of technical appeal and advice, and the UK is well placed to implement and enforce better regulation and to provide industry with appropriate channels to ensure that it is fairly treated. The contribution is broad, encompassing the successful resolution of disputes under various Acts of Parliament as referee analyst, the conduct of research and development in support of the referee function and in the provision of advice to Government on many aspects of chemical and bioanalytical measurements.

The Government Chemist's team have consistently demonstrated their ability to predict what analytical developments will be needed in the future and to discharge the legislative requirements of the function with independence, scientific excellence and value for money. Given the role of the National Measurement Office as guardian of the National Measurement System, which includes providing support and governance to these activities, I am very appreciative of the contribution of both the Government Chemist's staff and the Government Chemist Working Group and their dedicated input over the past twelve months.



Peter Mason
Chief Executive, National Measurement Office

1 Remit

Over its long history, the Government Chemist has employed the latest measurement technologies and practices to resolve potentially costly disputes, protect the public and to contribute to effective and efficient regulatory enforcement in industrial sectors where chemical measurements are important. The measurement techniques used are frequently developed in our laboratories and are based upon our understanding of the likely future problems where the Government Chemist may be called on.

The Government Chemist fulfils two functions, funded by the Department of Business, Innovation and Skills (BIS).

Statutory function

The Government Chemist has a science-based statutory function comprising duties prescribed under seven acts of Parliament. These duties (Box 1 on page 6) centre on public protection, safety, health, value for money, and consumer choice. Much of our work relates to scientific dispute resolution – 'referee analysis'. Based on independent measurement and expert opinion we resolve disputes between regulators and businesses. In these cases, the stakes can be high, so the credibility of the referee rests on first-class science, which is underpinned by the assignment of our home laboratory, LGC, as the UK's designated National Measurement Institute for chemical and bioanalytical measurement.

Legislation covering the food, agriculture and medicinal products sectors, where the safety of the consumer is of prime importance, contains equivalent provisions for the taking of official samples and subsequent analysis.

There are several routes for referral to the Government Chemist. For example, the Food Safety (Sampling and Qualifications) Regulations 1990 are invoked for many of the dispute resolution activities we undertake. These regulations state that test samples are divided into three parts by an authorised officer. The enforcement authority and trade party each receive one of these samples to perform independent analyses, while the third part of the sample is retained in case the referee – the Government Chemist – is called upon to act.

A trader may in some circumstances ask for a referral to the Government Chemist without having their own portion of the sample analysed (a procedure known as 'supplementary expert opinion' - described on our website). For businesses, a successful appeal to the Government Chemist may avoid the effects of penalties prescribed under criminal law, potentially expensive compliance actions and, most seriously, loss of reputation and goodwill. Lastly, the referral sometimes comes from the court itself, with proceedings suspended pending the outcome.

Of course, when the Government Chemist's findings confirm those of the enforcement authority, the appropriate action to protect the public can proceed with all the more authority. But, whatever the outcome, the scientific outputs of the case can be disseminated to all parties and the lessons of these learned to help reduce the possibility of recurrence. Dissemination of referee cases also takes place through scientific publications, seminars, workshops and training events.

► **Section 2** of this review looks at the year's completed referee cases.

Unsurprisingly, the need for referee analysis often arises in novel or complex areas. Consequently, we need to carry out horizon scanning to identify emerging issues and by targeting our R&D in these areas, we hope to be able to respond to demands much better, as well as making the appropriate analytical measurements in shorter timescales. Dissemination of the measurement capability developed to stakeholders can also lead to the prevention as well as the resolution of disputes.

► **Section 3** for an overview of R&D activities

Advisory function

The Laboratory of the Government Chemist was founded in 1842 to detect adulteration of tobacco on behalf of HM Customs & Excise. It developed significantly from that point and became established for nearly half the 20th Century as a free-standing central department, with the responsibility and capability to investigate and analyse a varied range of samples and problems on behalf of other government authorities.

On privatisation in 1996, an agreement between the Secretary of State for Trade and Industry and LGC was signed which underpinned the continuity of the broader public functions by appointing the Government Chemist 'as a source of advice for HM Government and the wider analytical community on the analytical chemistry implications on matters of policy and of standards and of regulations'. This agreement recognised the importance of chemistry and related sciences in underpinning many sectors and products within the modern UK economy.

The advisory function is delivered principally by responding to government calls for advice or published consultations, where analytical science plays an important role. These responses provide relevant information to a broad range of stakeholders who have an interest in regulatory compliance and developing trends in policy, legislation, standards and the measurement science relevant to them. They are published through the Government Chemist website or at dissemination events. The advisory function also looks at emerging issues combining new regulation and analytical measurements and seeks to highlight appropriate paths to be taken in the future as these issues emerge into the mainstream.

► **Section 3** for more about the wider advisory function.

Governance

The Department for Business, Innovation and Skills (BIS) funds a programme to enable delivery of statutory casework, scientific advice and any work and research necessary for the ongoing effectiveness of the Government Chemist's functions. Within BIS, responsibility for both the Government Chemist and the wider UK National Measurement System rests with the National Measurement Office (NMO).

Arrangements are in place to ensure that the Government Chemist programme is delivered competently, and that scientific standards, impartiality, transparency and integrity are maintained. The Government Chemist Working Group (GCWG) meets twice a year to oversee and discuss the delivery, planning and quality of the programme. The GCWG also has oversight of the scientific standards of the programme. The GCWG comprises representatives of regulatory and enforcement bodies, industry, trade associations and academia, with a broad range of backgrounds, skills and interests. The group provides the necessary independent scrutiny of the programme and offers advice to the NMO regarding future priorities.

The current Government Chemist programme

The current Government Chemist programme, covering 2011-14, commenced in April. The programme reflects the prioritisation exercise carried out by the GCWG, and is similar in structure and themes to the 2008-2011 programme:

- Intelligence gathering: horizon-scanning projects on the scientific implications of policy development, emerging legislation, changes to existing legislation and enforcement trends
- Capability building: innovative R&D which aims to reflect potential needs for future casework under the Government Chemist's statutory role
- Statutory activities: work carried out in relation to individual cases that are referred to the Government Chemist under his statutory function as defined in Acts of Parliament
- Knowledge transfer: improved dissemination of regulatory and analytical developments to a wide range of stakeholders, with the aim of improving standards of measurement, understanding of the regulatory environment and of helping industry generate innovation in products and processes.

The GCWG ranked proposals that had been developed over the course of the year by expert Government Chemist staff in liaison with key stakeholders. The key areas of capability building work are allergens, food fraud, vitamins, illegal dyes, mycotoxins, and real-time horizon scanning.

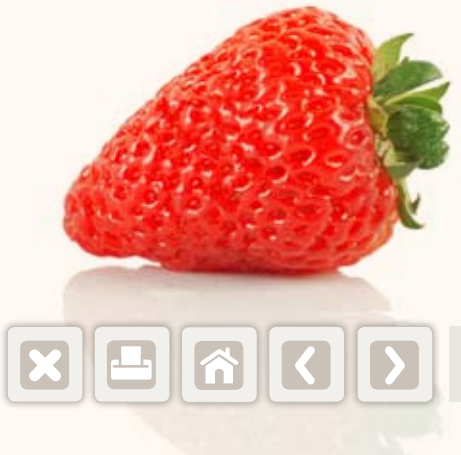
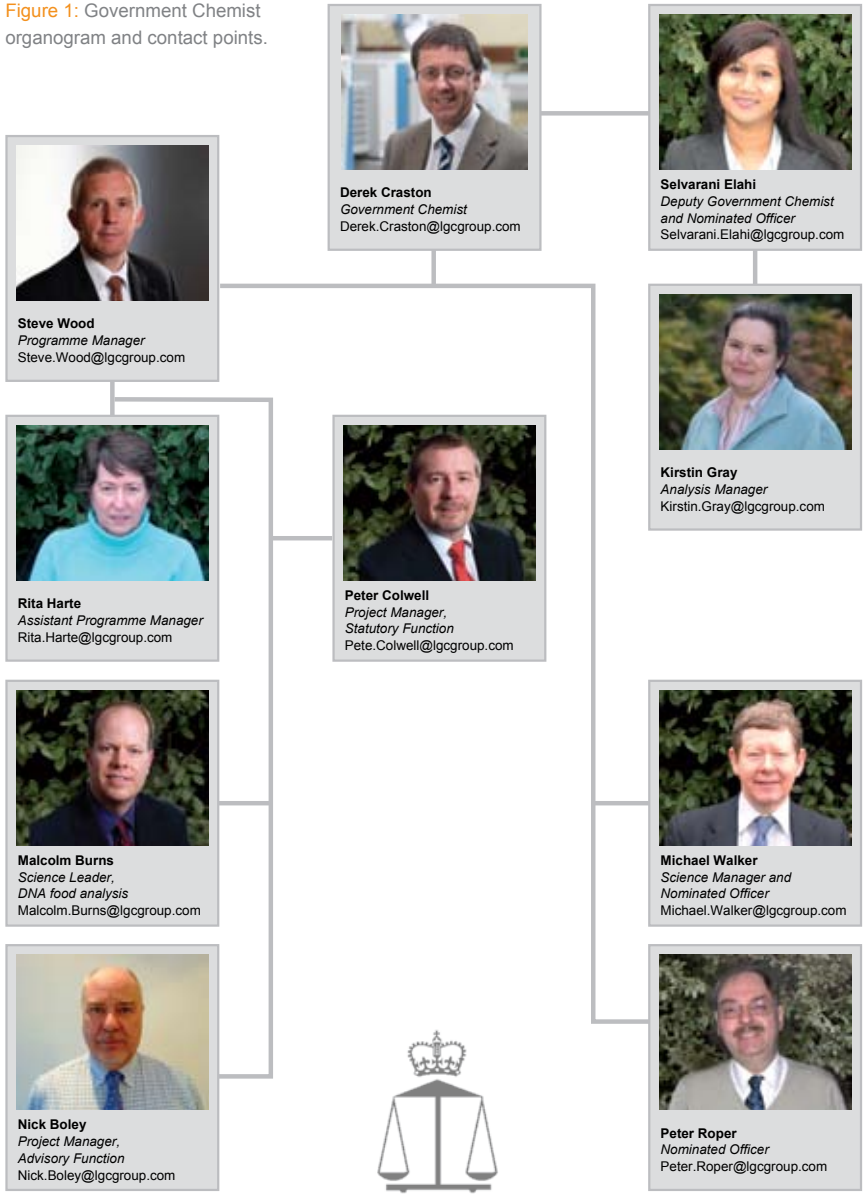


Figure 1: Government Chemist organogram and contact points.



People

LGC staff who directly support the Government Chemist function have clearly and independently defined roles (Figure 1). Within this framework, there are particular requirements for the management of statutory casework:

- Nominated officers, one of whom holds requisite statutory qualifications[1], have overall responsibility for case supervision. They prepare and sign Government Chemist certificates of analysis
- Only the Government Chemist or Deputy, once satisfied that the case has been properly completed, may countersign.

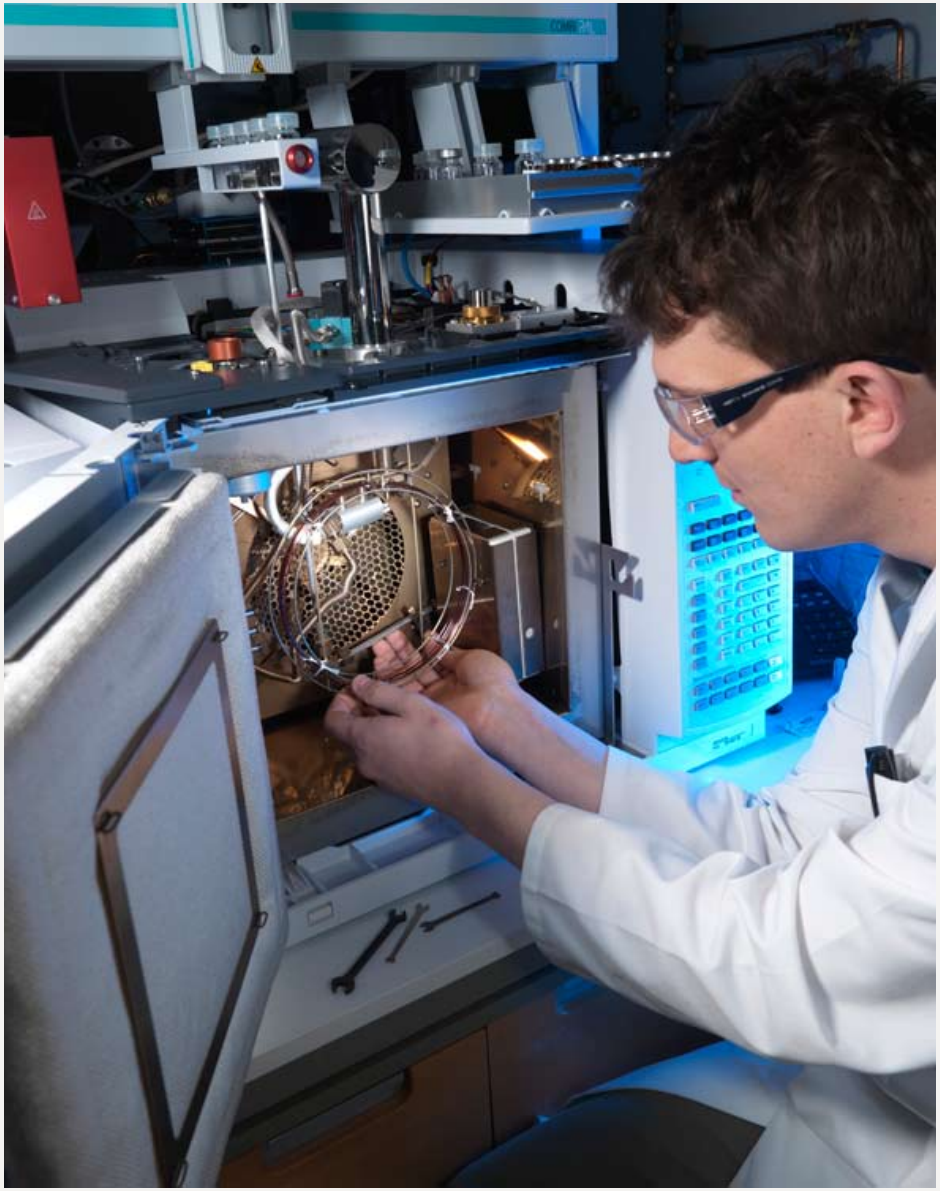
Staff carrying out work under the Government Chemist's statutory function continually demonstrate their competence through participation in an extensive variety of appropriate proficiency testing schemes and collaborative studies. The diverse nature of LGC's scientific activities therefore leads to a wide range of skills and specialisms being available in-house. Many of the staff involved in delivering the programme have carried out research and development work, often of an internationally-collaborative nature, which gives them the capability to contribute positively and efficiently to their work.

Collaboration

Within the Government Chemist programme we are always seeking to collaborate with a wide range of stakeholders and to expand the range of stakeholders involved in our work so that we can better respond to the future challenges of potential casework. Our work on allergens is a good example of this. Our research projects aim to develop scientific capabilities which will benefit public health, safety and well-being, and the wider scientific community, including those UK manufacturing industries which depend on sound analytical measurement and understanding of regulations.

If you would like to get involved with any aspect of our work, or for more information on our work, please contact us at Government.Chemist@lgcgroup.com or go to the website (www.governmentchemist.org.uk).

[1] All work is overseen by a nominated officer holding the MChemA qualification



Box 1: The Government Chemist in legislation

The duties of the Government Chemist as referee analyst are defined in or under:

Food Safety Act 1990

Food Safety (Sampling and Qualifications) Regulations 1990

Food (Northern Ireland) Order 1989

Food Safety (Northern Ireland) Order 1991

Food Safety (Sampling and Qualifications) Regulations (Northern Ireland) 1991

Poultry Meat (Water Content) Regulations 1984

Natural Mineral Water, Spring Water and Bottled Drinking Water Regulations 2007

Materials and Articles in Contact with Food Regulations 2010

Plastic Materials and Articles in Contact with Food Regulations 2009

Agriculture Act 1970

Feed (Hygiene and Enforcement) Regulations 2005

Genetically Modified Animal Feed Regulations 2004

Medicines Act 1968

Farm and Garden Chemicals Act 1967

The Government Chemist is named and has other scientific responsibilities under:

Merchant Shipping Act 1995

Hydrocarbon Oil Duties Act 1979

Poisons Act 1972

The status and territorial extent of the Government Chemist are understood with reference to:

Freedom of Information Act 2000

Scotland Act 1998 (Cross-Border Public Authorities) (Specification) Order 1999

Administrative Provisions Act (Northern Ireland) 1928

Government Chemist Regulations (Northern Ireland) 1928

2 Science underpinning sound dispute resolution

Referee casework arises most frequently under the Food Safety Act 1990 or the Agriculture Act 1970.

Formal samples taken under statutory enforcement provisions are divided into parts for analysis on behalf of the authorities, the food and feed business operator (FBO) and, when required, the referee. During 2011, 14 cases were referred to the Government Chemist – 9 in connection with the Food Safety Act and 5 in accordance with the provisions of the Agriculture Act. Further information about some of these cases is presented later in this section.

The Referee function

Referee casework is the core of the Government Chemist's function, guaranteeing fair treatment for industry and enforcement alike by authoritative adjudication. We maintain the even-handed credibility of this referee role by stringent governance of the function and painstaking analytical rigour. Our aim is to safeguard consumers, regulators, the agrifood sector and the courts from unwitting errors in measurement science.

Analytical results must be interpreted in increasingly complex scientific legal and policy contexts. Recognising this we explain our findings by expert opinion in our reports. As our understanding of the issues arising in disputes grows we share this with stakeholders by posting advice on our website. Thus we aim to derive wider benefits for all stakeholders from our casework.

When a referral is received we begin with a case meeting; the default analytical strategy is multi-replicate analyses on each of three days to provide a case specific measurement uncertainty. Analysis of certified reference materials, blanks and spiked blanks is performed to provide a high level of analytical confidence. All significant analytical steps are witnessed by a second scientist, the resulting dataset is independently evaluated by professional statisticians, a certificate is drafted and reviewed by a qualified person and finally the case file is brought to the Government Chemist for peer review. If all steps are satisfactory the Government Chemist will allow the certificate to be released. Along with the high-end equipment deployed these measures are aimed to give the food business owner, the courts and regulators the necessary assurance that the appellate function is discharged to the highest possible professional standards.

Regulation of chemical food safety and standards in the UK is a multifaceted landscape[2] and the Official Food and Feed Control Laboratory system (OCL) maintained by Public Analysts, often doubling as Agricultural Analysts, faced continuing funding challenges during the year. Similarly the financial climate impacted upon laboratories serving the agrifood trade. Analytical results tend to be disputed in the more complex cases or where there are recognised scientific uncertainties. Hence the resource deployed by the Government Chemist to resolve referrals authoritatively is often far greater than that available to OCL or trade sides. The fact that each continue to deliver high quality measurement science is a tribute to the sophisticated and advanced measurement science infrastructure in the UK.

[2] Single integrated national control plan for the United Kingdom - January 2007 to March 2012, Food Standards Agency, 2012, http://www.food.gov.uk/multimedia/pdfs/uknationalcontrolplan.pdf

Mycotoxins

Aflatoxins are a chemically related group of genotoxic carcinogens derived from *Aspergillus* moulds, which pose a high risk to the safety of food produce. They remain prominent in casework although referrals have diminished from their high point in 2008 (Figure 2). Of the two cases related to food for human consumption that have been received, our findings upheld those of the OCL in one case and overturned them in a second. As well as food for human consumption wild bird feed comes under investigation recognising that avian species are very susceptible to these toxins. Two cases in 2011 addressed this and again our findings upheld those of the OCL in one case and overturned them in a second.

Nitrofurans

Once widely used as veterinary antibiotics, these compounds are now prohibited in food in the EU because they can cause cancer. Nitrofurans are unstable in animal tissue, but give rise to carcinogenic metabolites, which are measured as marker compounds. Law that requires the absence of an illegal substance in food raises a problem for analytical chemists when reporting results but a pragmatic solution has been adopted by the European Commission. Food of animal origin is prohibited from entering the food chain if it contains nitrofurans above a reference point of 1.0 microgram per kilogram (μg kg^{-1}). Where the results of analysis confirm the presence of a nitrofuran metabolite (above the detection limit of the method) but below the reference point an investigation is required on the part of the competent authority. For readers interested in these chemico-legal aspects further details are available on the Government Chemist website.

Moreover, whereas aflatoxin measurement is a mature science with widespread analytical capability, nitrofuran marker compound analysis presents many pitfalls and is confined to relatively few laboratories owing to the complex nature of the equipment needed. Metabolites are determined by validated extraction and derivatisation procedures followed by liquid chromatography with tandem mass spectrometry, LC-MS/MS, with deuterated standards. There is a need to measure free and bound metabolites and one in particular; the semicarbazide (SEM) presents problems of interpretation. SEM has been found in breadcrumbs and other bread products arising from the presence of azodicarbonamide, a flour treatment agent also banned in the EU but still used in Asia. Azodicarbonamide can also migrate from plastic gaskets, where it is known to be used as a blowing agent, from carrageenan, and through hypochlorite treatment of nitrogen containing foods. SEM occurs naturally in the shells of crustaceans, and consequently referrals in 2011 were of prawns, shrimp and crab. A solution, difficult to put into practice routinely, is to excise and test the inner core flesh of the animal.

Lastly, procedures for sampling food of animal origin to test for antibiotic residues such as nitrofurans differ from those for contaminants such as mycotoxins in food of non-animal origin. For practical reasons and to guard against loss of analyte the homogenisation of food of animal origin prior to division of the sample into three portions cannot be as comprehensive. Thus any inhomogeneity in the distribution of antibiotic residues may be reflected in the results obtained by each laboratory carrying out an analysis.

Three of our four nitrofuran cases in 2011 came directly from importers as Supplementary Expert Opinion (SEO) referrals[3] and one as a result of conflicting results from the OCL and trade laboratories. In each case we overturned the OCL findings although in two of the cases we reported a metabolite present albeit below the reference point.

As a consequence we published on our website a comprehensive advice note on nitrofuran analysis which is being used by OCLs as a useful guide to best practice.

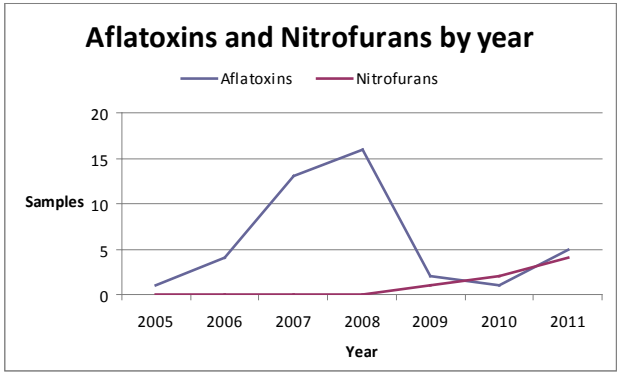


Figure 2: Volume of activity on two significant casework areas, aflatoxins and nitrofurans.

[3] SEO, Supplementary expert opinion – see glossary

Aluminium

Spanning three centuries of food safety regulation the question of the safe amount of aluminium in food was raised again as a new topic for referral in 2011 illustrating that nothing ever really goes away in food chemistry. Two cases arose in 2011 regarding imported noodles.

The use of alum[4] as an adulterant to whiten wheat flour and bread was a cause célèbre in the 19th century. Aluminium in food was the focus of a great deal of attention for a time in the late 20th century when a link between aluminium intake and the development of Alzheimer's disease was postulated and parenteral exposure to high aluminium concentrations by patients undergoing dialysis has led to neurotoxicity. However the link with Alzheimer's disease is no longer considered relevant. But in November 2008 elevated concentrations of aluminium in imported noodles were discovered in Germany. These and other findings suggested the illicit use of aluminium based additives. As a consequence, EU law to require enhanced surveillance of noodle imports was enacted.

Importers in the UK voiced concerns that there may be laboratory bias in the measurement of aluminium in noodles and that wheat grown in China may naturally contain higher concentrations of aluminium than that grown in Europe and North America. Hence the two cases in 2011, one SEO and the other disputed findings. There is no domestic or European statute setting out a maximum concentration for aluminium in noodles and in this situation in the past the Government Chemist might have confined himself to stating an analytical result. However, recognising that it would be more helpful to propose expert interpretation, we assessed the evidence. Our starting point was our own findings gathered over the years on aluminium in food. There have also been recent toxicological findings from the European Food Safety Authority (EFSA) that in animal studies aluminium has the potential to produce neurotoxicity, embryotoxicity and reproductive toxicity. EFSA and the Joint Expert Committee on Food Additives (JECFA) have also stated that aluminium intake may exceed recommended tolerable weekly intakes. We also had regard to the view taken by the European Commission supported by the Standing Committee on the Food Chain and Animal Health[5]. The relevant minute of the Standing Committee meeting reads as follows:

> *"Following requests for clarification as regards the proposed listing of noodles from China under Annex I to Regulation (EC) No 669/2009, the Commission clarified that, based upon available data, the level of 10 mg/kg could be used to distinguish noodles with acceptable unavoidable background presence of aluminium from noodles presenting unacceptable levels. Vote: qualified majority by 338 votes in favour, 7 votes abstained."*

Since there is no legislative limit the Government Chemist needed to arrive at a view with which we could advise a court. Thus our certificates of analysis carefully rehearsed the evidence in support of a limit for aluminium in noodles of 10 mg kg^{-1}. This was exceeded in both cases, our opinion accepted and the consignments were refused entry into the UK.

However, in order to explore the issues and prompt further debate we published an advice note on aluminium in noodles on our website and are in the process of gathering evidence for a peer reviewed paper on the topic to inform policy makers and the analytical community.

Nitrite

There is a long tradition of preservation of bacon and ham with salt, and it was noticed centuries ago that certain batches of salt produced a pink colour and a special flavour in meat. These changes were thought to arise from reaction with nitrate (saltpetre), present in some salt. But food chemists later pinpointed nitrite, formed from nitrate by bacterial action, as the true precursor of the beneficial flavour and colour changes, as well as contributing a preservative function. Today the nitrite used in meat curing is produced commercially as sodium nitrite. But caution around the toxicity of excess nitrate and nitrite has led to strict limits on the concentration of these compounds in cured meat, and analytical surveillance of food for nitrate and nitrite has a long history but, again, problems persist. We were asked for sampling advice to produce three equivalent portions of the official sample in the special case where hand cured ham was being produced with concomitant uneven distribution of nitrite throughout the meat. Having taken our advice, there still remained significant differences in the analytical results obtained by the OCL and trade laboratories. We therefore followed up with our own analyses that seemed to confirm the OCL results but highlighted that the analytical chemistry in this area may not be fully resolved and we are currently pursuing studies that we trust will be of benefit to all parties.

[4] Alum, hydrated potassium aluminium sulphate

[5] Directorate-General Sanco D – D(2010) 658863 Summary Record of the Standing Committee on the Food Chain and Animal Health, Held in Brussels on 14 July 2010, (Section Controls and Import Conditions)

Liquid extracts of vitamins from animals feeds.

Animal Feed

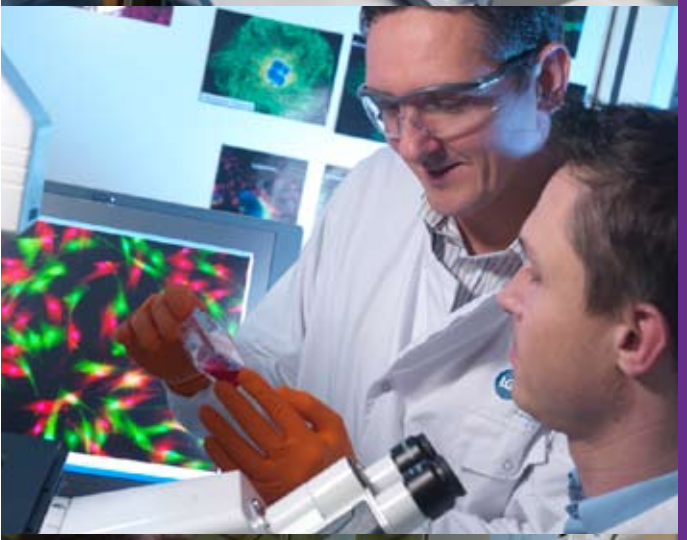
There have been many examples of food safety incidents originating from animal feed, hence regulation of feed continues to be an important facet of enforcement activity and referee casework inevitably arises. Two cases involving four official samples were referred in 2011, a common feature being the determination of vitamins A and E. This work combines the very traditional image of a chemist – manipulation of solutions in elaborate glassware on the bench – with the very latest instrumental techniques. It is thus both labour-intensive and technically demanding and, perhaps unsurprisingly, controversy remains between trade and enforcement interests on the techniques and their results. Our painstaking analyses upheld OCL findings but also prompted further work to see if we can resolve some of the issues arising and provide more facile and efficient approaches to these important analyses.

Professional standards

Lastly, in this brief review of the year's work, at the request of a trader, we conducted a desk top review of the format and content of OCL certificates on lead in food supplements. Appraised against professional standards we found the certificates fit for purpose but suggested improvements for the future.

Conclusions

The referee function remains a demand led service clearly required in the UK. Going beyond the particular resolution of each case, we have engaged actively in dissemination of the issues for the benefit of stakeholders both through information on our website and our increased output of peer reviewed papers. In 2011, drawing on collaboration with Professor Duncan Thorburn Burns, emeritus in the Queen's University of Belfast, we published papers on such diverse topics as Nitrogen Factors choking hazards and morpholine in apples. Continuing dialogue with regulators and trade interests has demonstrated the usefulness of this approach. The next section includes further details of our publications.



3 Impact

The impact of the work of the Government Chemist programme is broad and the effects can be seen in a number of ways.

Research projects are carried out to support the future work of the Statutory Function by looking at measurement topics which are likely to become more important. These are not just aimed at the referee analyses carried out by the Government Chemist, but also for the wider measurement community to prevent disputes by promoting best measurement practice in these emerging areas. This is disseminated through knowledge transfer activities, and a list of publications is given later in this section. The advisory function of the Government Chemist provides advice on analytical measurement subjects to Government and the wider community of stakeholders.

All these activities are aimed firmly at predicting future regulatory issues within the chemical and biochemical measurements sphere, whilst providing a secure base for more efficient and cost-effective regulations.

Biofuel sustainability

Debate around competition for land use for biofuels production versus food and feed production is long standing, and a clear indicator for the need for sustainability of new energy sources. Development of methods for the determination of the geographical and biological origin of biofuels is therefore timely and important for ensuring both sustainability and commercial aspects of first generation biofuels.

Origin discrimination of biofuels

LGC's designated National Measurement Institute's work has focused on investigating of the feasibility of methods based on bulk and compound-specific carbon isotope ratio measurements to discriminate between biofuels of different origin. This builds on LGC's previously developed and validated methodology for carbon isotope ratio analysis of forensic ethanol and steroids in urine by gas chromatography-isotope ratio mass spectrometry (GC-IRMS) and, more recently, methodology for the SI traceable carbon isotope amount ratios by multicollector inductively-coupled plasma mass spectrometry (ICP-MS). LGC is now applying these capabilities to biodiesels and their raw materials and intermediate production products.

The relative isotopic composition of a material can be affected subtly by its geographical origin or how it has been processed or manufactured. Using a range of raw sample materials, with known geographical origin and production chain, methods are being developed to evaluate the feasibility of both bulk and compound-specific carbon isotope ratio measurements as tools for discrimination of different origin. Combining LGC's measurement capability with that of other European Metrology Institutes, the aim is to determine which analytical tools are required to achieve accurate origin discrimination of biofuels.

To date, LGC's data for bulk carbon isotope ratio measurements using elemental analyser-isotope-ratio mass spectrometry (EA-IRMS) demonstrates that this is not a suitable tool to discriminate between biofuels of different geographical origin. However, use of LGC's new gas chromatography combustion isotope-ratio mass spectrometry (GC-C-IRMS) method for compound-specific carbon isotope ratio for the determination of fatty acid methyl esters (FAMEs) and major fatty acids may prove to be a more successful tool. Five FAMEs, analysed by EA-IRMS to determine their isotopic compositions and associated uncertainty, are being used to assess the performance of the GC-C-IRMS system. Once fully developed, the methodology will be validated in terms of uncertainty and traceability.

This collaborative research will result in the identification of tools for accurate and precise determination of the geographical and biological origin of biofuels. This will impact on sustainability requirements, improve biofuel trade and regulation, and ultimately lead to wider quality of life benefits.

GC-C-IRMS for determining compound specific isotope ratio measurements of FAMEs

Quantification of biofuels

Biodiesel is produced by transesterification of the triglycerides in oil or fat with an alcohol, in the presence of a catalyst, to yield FAMES and free glycerol, a by-product which is separated from the final product at the end of the production process. However, incomplete reaction results in the formation of glycerol intermediates including mono- and diglycerides. These, or traces of free glycerol left in the final product can cause severe engine operational problems. The European EN 14214 standard specifies a maximum content of total glycerol and free glycerol.

Industry has high throughput methods in place to determine biofuel quality. However it is important that the accuracy of these industry methods are understood. In order to do that, National Measurement Institutes are collaborating, internationally, to develop reference methods to produce a rapeseed biofuel reference material produced by IRMM.

As part of this collaboration, LGC is developing reference methods by applying exact matching isotope dilution mass spectrometry (EM-IDMS) on multidimensional GCGC in order to accurately determine levels of diglyceride in biofuels. In conjunction with the other National Measurement Institutes (NMIs) who are developing reference methods for monoglycerides and triglycerides, the reference methods will be used to certify a rapeseed biofuel reference material, which can, in turn, be used by industry to validate their methods.

Making chromium supplements safer

LGC's National Measurement Institute laboratories are helping to ensure the production of safe and effective food supplements by developing new methods for the accurate measurement and identification of chromium species.

Chromium supplements are increasingly popular for the prevention of type 2 diabetes, stress reduction and weight loss, making up almost 6 % of all mineral supplements sold in stores and online. However, some chromium products on the UK market are poorly characterised and, there have been cases where their safety has been questioned. Chromium (VI), even at very low levels, is a known genotoxic carcinogen. However chromium (III) was thought to be an essential mineral, until a report by the European Food Safety Authority[6] expressed concerns about the safety of dietary chromium (III) on the basis of DNA damage in vivo, and suggested it may need to be re-evaluated.

However, the diversity of chromium species at different concentrations in complex 'solid' matrices present measurement challenges. In addition, the lack of pure calibration standards and reference materials required for method validation needs to be addressed. Currently, the only available certified reference material (CRM) for chromium is for inorganic chromium in solution, and there are no 'speciated' chromium CRMs. Furthermore, there is no information on the presence of other toxic elements (e.g. Cd, Pb, Hg) or elemental species in existing chromium supplements. This means that reference methods for the accurate quantification and identification of chromium species will provide essential information in order to ensure the safe development of food supplements. LGC's reference methods will be essential tools in the future development of 'speciated' chromium certified reference materials (CRMs).

This research builds on previous speciation capabilities developed at LGC, specifically in the accurate measurement and characterisation of selenium and selenium species in complex matrices, which has led to the development of a range of speciated reference materials to enable accurate assessment of the selenium content in selenium enriched food supplements.

LGC's new HPLC-ICP-MS method for the accurate quantification of chromium (III) and chromium (VI) using species-specific isotope dilution mass spectrometry (IDMS) has been developed and validated. Such methodology can be used as a reference by field laboratories to characterise chromium-containing food/supplements. In addition, novel sample extraction and purification methods from complex matrices, combined with methodologies to enhance the sensitivity of detection of chromium species are being developed at LGC in order to enable quantification of chromium species at low concentration levels. The IDMS method will also enable LGC to participate in forthcoming studies to demonstrate capability to accurately quantify chromium species in complex matrices and to produce food/supplements speciated chromium reference materials, which are urgently needed to validate existing methods.

New reference methods, such as these, are essential to enabling UK industry enter new markets and derive more efficient production processes. Accurate measurement of product characteristics will enable development of safer and more efficacious products, promoting potential quality of life gains through the use of chromium supplementation.

The results of LGC's research will be beneficial to the pharmaceutical industry, health service providers and the wider diabetes research community, as well as being applicable to chromium species determination for environmental monitoring.

[6] EFSA Journal (2009) 1112, 1-20; Scientific Opinion of the Panel on Food Additives and Nutrient Sources added to Food

Developments in nanotechnology call for improved measurement

Nanotechnologies are increasingly being used to overcome scientific, commercial and industrial challenges through the engineering of application specific nanoscale materials.

- Nanotechnologies are incorporated into over 1300 commercial products
- Global market is currently worth £6 billion and expected to reach £10.5 billion by 2015.

As the impact of nanotechnologies on human life becomes more prevalent, it is becoming increasingly important to be able to characterise nanomaterials, for example for their potential effects when they contact biological systems and their size distribution in consumer products.

Detecting nanoparticles in sun screens

Of the family of separation methods, field flow fractionation (FFF) is the most used and appropriate for separation of nano-objects in complex matrices. LGC's National Measurement Institute laboratories are developing new methods which involve coupling of FFF to ICP-MS in order to provide size-resolved data on the elemental composition of nanoparticles.

The problem

Titanium dioxide is used predominantly as a white pigment in a variety of consumer products, including coffee creamers, tooth pastes and sunscreens. In sunscreens its high refractive index protects the skin from UV radiation from sunlight. Initially, titanium dioxide was considered to be an inert mineral, non-toxic to human beings and the environment. However, following its broad application range, concerns have arisen that the toxicological risk has not been investigated sufficiently.

The solution

LGC's novel method for the characterisation of titanium dioxide particles in sunscreens involves an improved extraction method for nanoparticle isolation. Previous research carried out by academics has demonstrated the applicability of coupling FFF to ICP-MS in order to characterise nanoparticles. However, the results obtained on the analysis of similar samples were not comparable and quality control using a titanium dioxide reference material or spiking experiments was not undertaken.

LGC's research addressed this by sample spiking with aluminium-labelled titanium dioxide reference particles of known size to study the effect of extraction and separation conditions on particle size distribution. The analyses of the sun screens were compared for titanium extraction efficiency, particle size distribution and titanium dioxide recovery from the FFF channel. Using FFF-ICP-MS, the simultaneous detection of aluminium and titanium was proven, for the first time, to be very useful for tracking the spiked titanium oxide particles due to their much higher content of aluminium when compared to native titanium oxide particles in the sunscreen.

This research goes some way to addressing the emerging need for new validated methodology capable of reliably determining size and size-based elemental composition of nanoparticles, and in particular, the development of extraction methods able to preserve the size and composition of nanomaterials in the original sample. Future work will study the feasibility of applying these methods for accurate size-based elemental speciation analysis in food and investigate the production of standards and reference materials which are essential for standardisation and comparability of toxicity tests, as well as for quality control of existing products.

Standardising measurements for toxicity testing

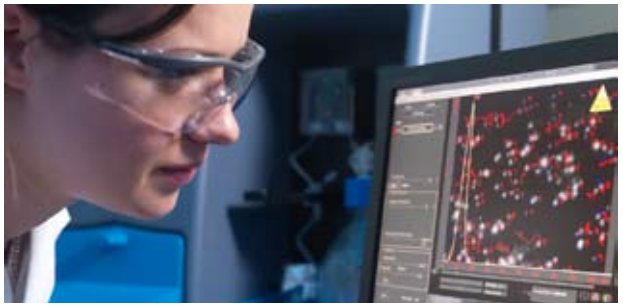
LGC's designated National Measurement Institute laboratories are investigating the possibility of developing a standardised panel of reference nanomaterials to enable the development of traceable methods for improved *in vitro* toxicity measurement for safety assessment. The potential for nanotechnology to improve human health and aid diagnostic and medical procedures can only be realised if nanomaterials, particularly those for use in nanomedicine applications and consumer products, are shown to be non-hazardous to human health.

The problem

Current *in vitro* screens which mimic the physiological environment of the human body offer one of the fastest methods to measure the toxicity of nanoparticles. However there is poor comparability between laboratories, due, in part, to the fact that when nanomaterials interact with biological systems, their physical and chemical properties can change significantly affecting their functionality and behaviour. This makes their potential toxicity difficult to predict. Highlighted as critical in a number of reports is the need for a bank of nanomaterial reference materials to enable standardised measurement across laboratories.

Currently there is only one certified reference nanomaterial available – 60 nm mono-dispersed gold-citrate (NIST RM-8013). This inert reference material, whilst used widely for calibration of equipment, is not suited for *in vitro* nanotoxicology due to its lack of toxicity. Recently, the Institute for Reference Materials and Measurements (IRMM) produced a series of nanomaterials in powder-form, characterised for their physical characteristics. These materials are now being used by LGC to form the basis of a standardised panel of prototype reference materials.

However, development of these nanomaterials as reference materials for *in vitro* analysis requires their characterisation in biologically relevant systems. This presents challenges due to artefacts caused by assay conditions, a lack of standardisation in sample preparation methodology and the low resolution of traditional sizing techniques for heterogeneous nanoparticles in complex matrices.



Nanoparticle Tracking Analysis in combination with FFF-ICPMS characterises particles for size, distribution and elemental composition

The solution

Researchers at LGC need to modify the surface of the particles to control their behaviour enabling consistent toxicity measurements. LGC's newly acquired Nanoparticle Tracking Analysis (NTA) system, enables analysis of particle size and size distribution by relating the rate of Brownian motion to particle size. This offers a unique method of visualising and analysing particles. By combining this technique with FFF-ICPMS, particles in complex suspensions can be characterised in terms of size, distribution and elemental composition.

Once completed, it is anticipated that this research will produce a prototype panel of reference materials characterised for their properties (size, agglomeration state, elemental composition and toxicity) in physiologically relevant systems so that they can be applied as calibration standards in testing procedures for regulatory processes and public acceptance of nanomaterial safety.

Technical guidance on nanotechnology

Dr Heidi Goenaga-Infante, Principal Scientist for Inorganic Mass Spectrometry, was recently involved in the development of Publicly Available Specification (PAS) 139 on detecting and characterising nano-objects.

Commissioned by the Department for Business Innovation & Skills and developed by the British Standards Institution (BSI), the document entitled 'Detection, characterization and identification of manufactured nano-objects in complex matrices' provides technical guidance on this topic ensuring users have access to the relevant information.

The PAS will be of value to policy makers and regulators who need to recognise the issues surrounding nanotechnology, and researchers who need to address the issues for analysis and metrology.

The document is available to download from the BSI website.

Improved toxicity testing for regulatory risk assessment

LGC's designated National Measurement Institute laboratories have published the results of a study to determine the reproducibility of *in vitro* toxicogenomics data, which indicate that these methods are sufficiently robust and reproducible to allow their further investigation in regulatory risk assessment.

In vitro studies offer quicker, cheaper and more ethical alternatives to animal testing than conventional *in vivo* studies. Driven by the introduction of legislation such as REACH, as well as an amendment to the Cosmetics Directive banning the marketing of cosmetic products containing ingredients tested on animals from 2013, there has been a concerted effort to develop *in vitro* assays for regulatory toxicity risk assessment[7].

Working in collaboration with the Fund for the Replacement of Animals in Medical Experiments (FRAME), Unilever, Agilent and the Institute for Health and Consumer Protection of the European Commission's Joint Research Centre, LGC has designed an inter- and intra-laboratory study to assess whether the current generation of microarray technology is capable of generating robust, reproducible data of sufficient quality to show promise as a tool for regulatory risk assessment.

Whilst microarray platforms have been evaluated over the past 10 to 15 years in the pharmaceutical and chemical industries, recent improvements have made the technology more robust, thereby potentially offering a suitable alternative to costly animal testing.
As a case study, three of the collaborating laboratories analysed a human liver cell model (HepG2) for gene expression, following exposure to the genotoxic carcinogen benzo[a]pyrene (B[a]P). Exposure of HepG2 cells to B[a]P has been used as an archetypal model for research into the mechanisms of genetic toxicology and forms the basis for many standardised testing studies. The abundance of existing data from previous toxicogenomic studies enabled direct comparisons with results from this research.

Mimicking a real-life regulatory testing environment and incorporating a well controlled standard operating procedure, the inter-laboratory study produced reproducible datasets, with each laboratory identifying the same key biological responses characteristic of a B[a]P response. This provides further evidence that toxicogenomics can predict chemical toxicity *in vitro*, but importantly, shows that the technology can produce data of sufficient quality to show promise as a tool for toxicity testing in a regulatory setting.

As a result of these findings, research in this field is now focused on identifying the optimal cell system for generating reproducible data of the quality required for regulatory testing. This will hopefully lead to developing robust cell models that are predictive for a range of toxic chemicals of different toxicological mechanisms of action.

LGC's research on toxicity testing was described in a recently published paper 'Inter- and intra-laboratory study to determine the reproducibility of toxicogenomics datasets'.

[7] D.J. Scott *et al.*, Toxicology, 2011, 290, 1, 50-58

Knowledge Transfer

The wide dissemination of knowledge to regulators, academics, policy makers, the food industry, and professional bodies is fundamental to the function of the Government Chemist. Here we highlight how we are transferring knowledge along traditional channels including scientific papers, but also through specialised working groups, collaborative events, training and web–based media.

2011 was designated the International Year of Chemistry (IYC), an entire year devoted to the celebration of chemistry. Under the unifying theme “Chemistry – our life, our future” IYC 2011 was a worldwide initiative to increase public appreciation of chemistry in meeting world needs, to encourage interest in chemistry among young people and to generate enthusiasm for the creative future of chemistry.

The Government Chemist realises the importance of engagement with the wider scientific community and the public. 2011 has been a successful year at LGC, and to support IYC 2011, we have made substantial steps in developing new and exciting dissemination routes for our science. In a bid to not only raise the awareness of IYC 2011, but also to emphasise that developments in chemistry are essential for sustainability and improvements in every human being’s life, we have built a twitter page, under the name @LGCGroup and a blog called LGC Science, in order to communicate developments in science with a wide audience.

In 2011, Dr Selvarani Elahi was appointed as Deputy Government Chemist and became the first female scientist to hold the title. 2011 also marked the 100th anniversary of the Nobel Prize awarded to Madame Marie Curie so presenting an opportunity to celebrate the contributions of women to science. In a supplement dedicated to the IYC 2011, the ‘Independent’ newspaper highlighted the need for female role models in chemistry. Dr Elahi was interviewed for the article and commented:

> *“I’m pleased to be a positive role model. I have a three-year-old daughter and it can be inspiring for other mothers to see women with young families getting ahead.”*

Advice

We continue to offer advice to a wide range of stakeholders on analytical chemistry specifically of food and feed. As a trend we have noted that there are fewer avenues available to people searching for sound advice, and as a result we have seen a rise in demand for advice.

The enquires we receive are of a diverse nature including advice of sampling procedures of nitrates and nitrites in bacon, informal limits for milk allergens in food, decontamination procedures for arsenic, and methods for authenticating the geographical origin of meat.

This diversity, coupled with the range of sources of the enquiries continues to confirm the Government Chemist as a trusted and authoritative source of information.

Training

The expertise acquired by the Government Chemist through the referee function is put to good use in providing training for practising analysts.

The successful annual ‘Association of Public Analysts (APA) Educational Trust Annual Postgraduate Course’ held at Reading University continues to form the cornerstone of our training activities. This year 15 delegates from 12 Public Analyst laboratories serving 108 Local Authorities (25 % of those in the UK) attended the course which, in a two year cycle, touches on most of the syllabus for the Mastership in Chemical Analysis, the statutory qualification required to practice as a Public Analyst. The MChemA is awarded by the Royal Society of Chemistry following a three part series of examinations. The week long intensive course included lectures given by Public Analysts currently in practice as well as experts outside the profession. This enabled mutually beneficial contact to be made and, once again, networking was a much valued informal aspect of the event. All delegates recorded that they enjoyed the course and considered that it met their expectations to a high degree.

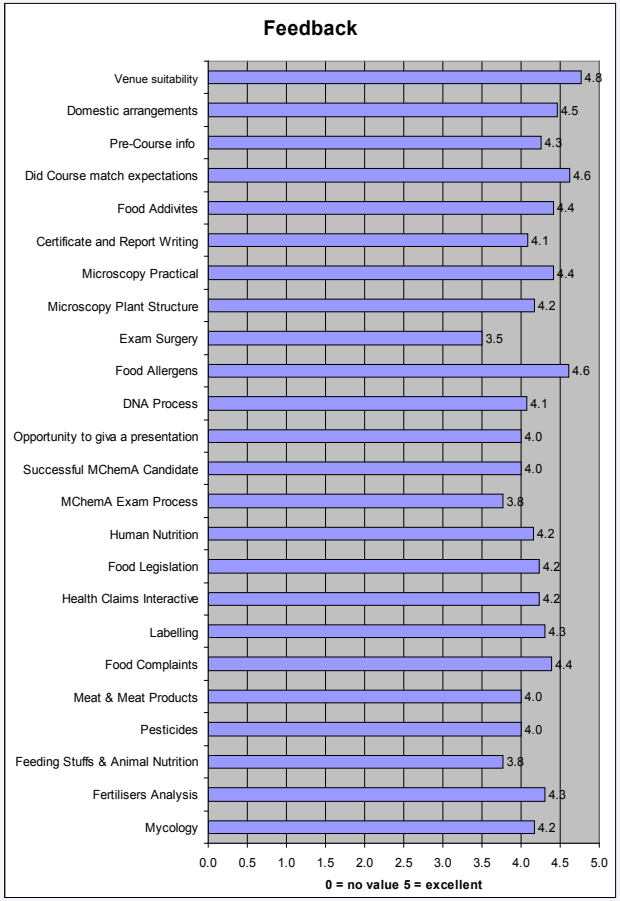


Figure 3: Positive feedback from delegates of the APA Educational Trust Annual Postgraduate Course

Real-time PCR used in the analysis of GMOs

Malcolm Burns, Science Leader in Food Analysis hosted two courses for Edinburgh and Dundee Public Analysts on real-time PCR analysis of Genetically Modified Organisms (GMOs). The courses were in direct response to requests from Public Analysts from the network of UK Official Control Laboratories who had recently acquired real-time PCR instrumentation.

These courses mark the continued assistance and training that LGC is able to offer UK Official Control Laboratories in support of their molecular biology capability. As part of LGC's position as the UK National Reference Laboratory for GMO analysis, awarded by the Food Standards Agency in 2009, LGC takes an active role in supporting the UK enforcement capability for detecting GMOs in food and feed.

> *"I found the course very informative and very easy to understand, a refreshing change from previous courses I have attended. The course provided a very useful, relevant insight in to what should be recorded and implemented for the real-time PCR, and as a beginner in this field I found LGC's course was ideal for what I was looking for." – Course attendee.*

Publications

Publishing peer-reviewed papers is integral to our work enabling transparency to the analytical community. The number of research and technical papers produced by LGC (48 overall in 2011 see list below) compares well with university chemistry departments. Much of this output stemmed from the NMI and Government Chemist functions and covered topics in analytical, bioanalytical and forensic science, including food authenticity, toxicology, protein chemistry and molecular and cell biology. This illustrates the broad range of expertise available 'in-house' and the synergies that can be exploited in support of the Government Chemist function.

This year, for example, following requests from stakeholders we published two papers on nitrogen factors; one reviewing nitrogen factors as a proxy for the quantitative estimation of high value flesh foods[8] (Thorburn Burns D *et al.*) and the other detailing the reappraisal of nitrogen factors for farmed salmon and for salmon frame mince[9] (Colwell P *et al.*).

A paper entitled 'Analytical Strategy for the Evaluation of a Specific Food Choking Risk, a Case Study on Jelly Mini-Cups'[10] (Walker M *et al.*) was published illustrating a recommended analytical strategy to determine if dome-shaped jelly sweets represent a potential choking risk. This work was prompted by the Directive 2006/52/EC prohibiting the use of a range of gel-forming additives in jelly mini-cups. The paper caused much interest and consequently, a centre double page spread article entitled 'Sweet but not so innocent' was published in the September issue of Laboratory News[11].

A referee case in 2010 which identified Morpholine – a carrier and emulsifier for fruit glazing – in an imported consignment of apples crystallised concerns that no official method of analysis existed for its determination. The Government Chemist published a paper entitled `Forensically Robust Detection of the Presence of Morpholine in Apples – Proof of Principle'[12] (Walker M *et al.*) which addressed this need.

Government Chemist reveals link to Captain Scott's 1901 Antarctic Discovery expedition

A highlight of 2011 was Dr Derek Craston's public lecture at the Royal Society of Chemistry headquarters at Burlington House, London, which aimed to raise public awareness of the work undertaken by the Government Chemist and explain how we address modern food safety challenges.

In addition Dr Craston revealed how Captain Scott's preparations for his 1901 Discovery Expedition to the Antarctic included a personal request to the Government Chemist to analyse his planned food supplies, specifically one of the key foodstuffs, Pemmican.

Pemmican was supposed to be a highly nutritious concentrated dried meat product containing 60 % ox fat, supplying 549 kcal per 100 g, the balance being protein with little starch and virtually no moisture. The low moisture content would have prolonged its storage. On examination by the then Government Chemist, the Pemmican samples to be used by Scott were found to contain only 19.6 % ox fat, and 38 % starch and 8 % moisture. Manhauling sledges requires about 4600 kcal per day and since fat supplies over twice the energy of protein or starch on a weight for weight basis the energy value was reduced by about a third. Some suggest even with adequate energy intake the polar explorers were slowly starving to death. It was also reported that the samples analysed contained pieces of broken metal. On seeing these results, Scott chose an alternate supplier of Pemmican which, after further analysis, showed a nutritional content that was 'rather more satisfactory'.

Dr Craston's lecture was accompanied by an exhibition depicting a Christmas dinner display with authoritative details on how the Government Chemist ensures food safety. The lecture received positive feedback from the delegates and generated a lively question and answer session. A link to the video of this lecture can be found here.

[8] Thorburn Burns D et al, Anal. Methods, 2011, 3, 1929-1935
[9] Colwell P *et al.*, JAPA, 2011, 39, 44-78
[10] Walker M *et al.*, Food Anal. Methods, 2011, 5, 54-61
[11] Walker M *et al.*, Laboratory News, 2011, August
[12] Walker M *et al.*, Food Anal. Methods, 2011, DOI: 10.1007/s12161-011-9324-z

The Wider Advisory Function

As well as the statutory function of the Government Chemist, we are tasked to provide advice on analytical measurement subjects to Government and the wider community of stakeholders. We carry this out by providing specific measurement-based advice on a broad range of policy and regulatory developments, and also by the provision of more proactive scientific and measurement-based support to those industries where chemical measurements are key to their business.

Addressing scientific issues with stakeholders

We have continued to follow developments of both the UK Chemical Stakeholder Forum (UKCSF) and the Advisory Committee on Hazardous Substances (ACHS) by attending meetings of these bodies and, where possible, making contributions to relevant discussions. We have provided advice by responding to a wide range of official consultations (see Box 2). Official consultations are carried out by the Government, or the European Union, to obtain the input of interested stakeholders on proposed new legislation or regulations, prior to enactment. They are considered to be an important part of the process of developing new legislation and regulation. The Government Chemist, who provides expertise in matters of analytical science pertaining to regulation and legislation, is well-placed to respond to appropriate consultations which refer explicitly or implicitly to chemical or bioanalytical measurements.

We were in general agreement with the proposals in the consultations which we considered were appropriate for us to respond to. We did note that these consultations covered subjects where high quality measurements were considered essential to underpin their implementation. However, the importance of these measurements was absent or significantly downplayed in some of these consultations, and so we sought to raise the profile of good quality measurements in our responses.

Specific questions which we addressed included:

- How to use both novel and established measurement practices in effective regulation
- The need to ensure that proposed regulation and legislation are compatible with existing analytical capability, including state-of-the-art capability, to enable effective implementation where measurements play a potentially key role
- The need to highlight areas where chemical measurement may be necessary to help effective implementation of new regulation and legislation
- The use of existing regulatory frameworks, including third-party accreditation and certification, as a means of carrying out more effective and cost-effective regulation in certain sectors
- The importance of high quality analytical measurements across different sectors, and how they should be highlighted to all stakeholders in order to optimise the adoption, enforcement and compliance with new regulations.

Box 2: Our public consultation responses

Department of Business, Innovation and Skills	Transforming Regulatory Enforcement: Freeing Up Business Growth
Department of Environment, Food and Rural Affairs	Wine Regulations 2011
Department of Health	Proposal by the European Commission for a regulation of the European Parliament and of the Council on Foods intended for infants and young children and on food for Special Medical Purposes
Department for Transport	Renewable Transport Fuel Obligation (RTFO) Guidance following Renewable Energy Directive (RED) Implementation
Environment Agency	The Treatment of Waste by Thermal Desorption
Environment Agency	Proposed revised methodology for the determination of hazardous substances for the purposes of the Groundwater Daughter Directive
European Food Safety Authority	Guidance on risk assessment concerning potential risks arising from applications of nanoscience and nanotechnologies to food and feed
Food Standards Agency	Revised Food Standards Agency Strategy for 2010 to 2015
Local Better Regulation Office	Priority regulatory outcomes: a new approach to refreshing the national enforcement priorities for local authority regulatory services
Ministry of Defence	Equipment, support, and technology for UK defence and security
National Measurement Office	Considerations for a Law on metrology (Revision of OIML D1:2004: Elements for a Law on metrology)

Taking Our Advice into New areas

We were aware that some specific industries within the UK were having some issues in getting to grips with REACH for their own situations, and consequently we held a seminar on REACH and CLP compliance in the construction and vehicle sectors at the Heritage Motor Museum in Warwickshire. These industrial sectors have many similar technical and measurement issues, and are both dependent on quite complex supplier chains for materials. This seminar was aimed at addressing the specific issues that confront all players in these supply chains regarding REACH and CLP compliance.

Over 50 delegates registered for the seminar. The talks were well-received and delivered a wide range of information from the speakers' differing perspectives, whilst highlighting the technical, legal and political difficulties of implementing REACH in a sector with long and complex supply chains.
The seminar opened with a presentation by the European Chemical Agency's (ECHA) Johan Nouwen who explained the legal situation for producers of articles under REACH, and the definition of an article producer. He also covered the need for communication with the supply chain (see Figure 4) for SVHCs in articles, and how the 0.1 % threshold guidance applies to all finished articles and, once an article has been disassembled, all component parts.

The Government Chemist's address outlined the role of LGC in measurement science, covering both the Government Chemist and NMI functions. He went on to highlight the importance of chemical measurements to the economy and the complex nature of the measurement process.

Timo Unger from ACEA (the European Automobile Manufacturer's Association) delivered a most entertaining talk about communication challenges for his industry under REACH. He explained the situation regarding extended Safety Data Sheets, and the possibility that some could be up to 900 pages long! He also highlighted that the phase-out of REACH candidate list substances could lead to increasing costs and a less competitive position for EU manufacturing.

Alan Handley of LGC presented a talk on the analytical toolkit available for measurements to support REACH. He stressed that full compositional analysis (particularly for organic compounds) for many articles could be extremely expensive, and that analyses should be targeted as much as possible.

Finally, Mark Selby of Denehurst Chemical Safety brought the topics of the day together in his talk. He highlighted the need for good communication and supplier-customer relationships. One specific point of interest he made was that the vehicle industry had tighter restrictions on some specific articles than the food and medical implant sectors have for the same articles. This illustrated the progress and co-operation in the vehicle industry in trying to tackle REACH, but also showed that their approach may be too strict.

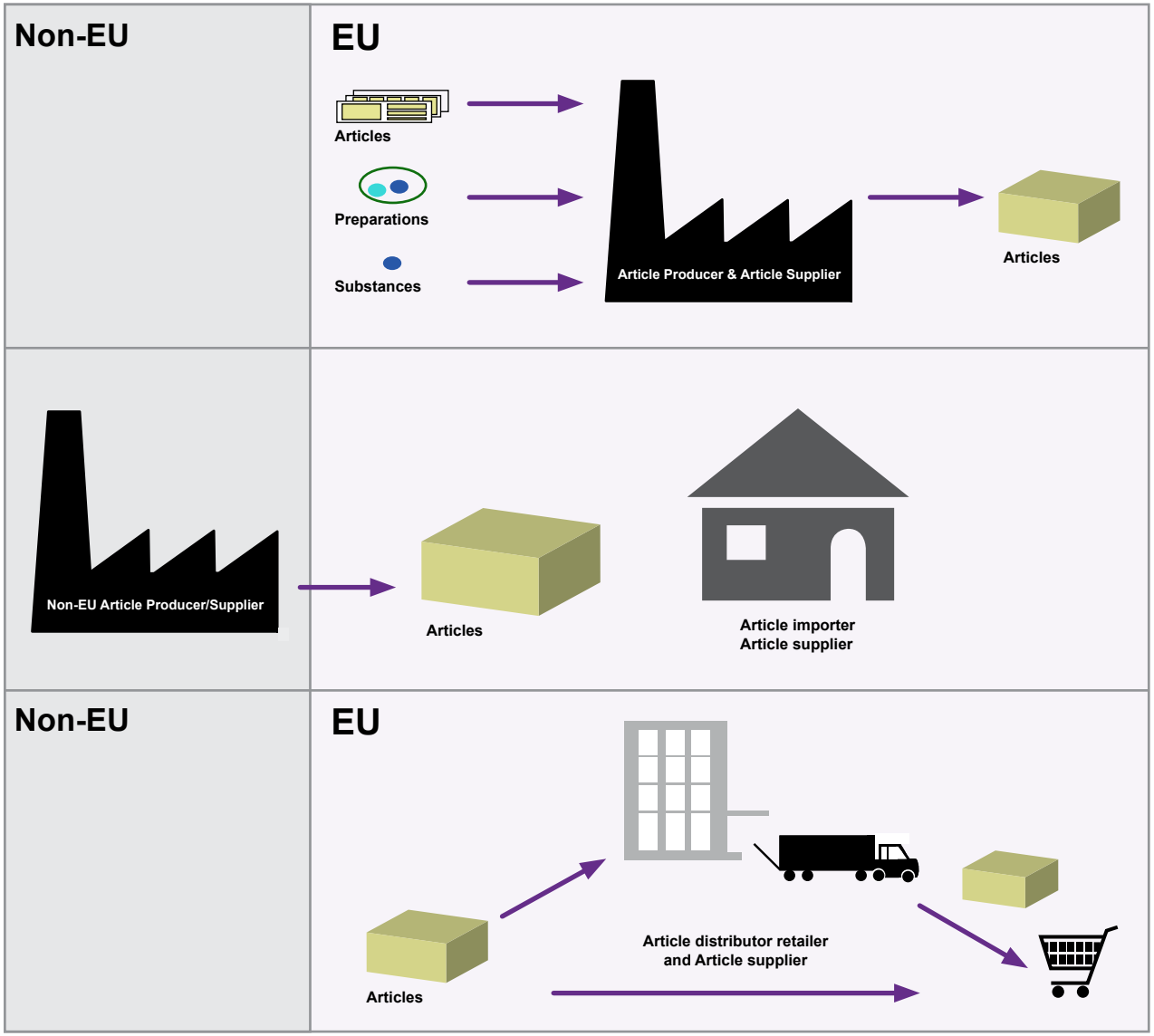


Figure 4: Producers, Importers and Suppliers of Articles (© European Chemicals Agency, 2012, Source: European Chemicals Agency, http://echa.europa.eu/)

Micro-funded Studies

The prioritisation process undertaken by the GCWG identified a number of proposed project areas which they felt were appropriate for small-scale funding, and might also lead to increased activity of industrial benefit. They considered that these smaller projects should be undertaken with a potential for further funding in the future, if appropriate.

- A new document "Questions and answers on measurement implications of REACH and CLP" (Version 2) has been prepared which updates the previous version for recent changes and developments in the application of REACH and CLP legislation across the chemical and allied sectors.
- An initial report on potential measurement issues relating to corrosive, waste, incidental or trace substances in carbon dioxide (CO_2) streams destined for geological storage has been produced and made available on the Government Chemist website. This report highlights the trace gases and other impurities which may be found in CO_2 streams for carbon capture and sequestration (CCS), particularly those which may have a potentially adverse affect on the storage and transport of the CO_2 streams in the United Kingdom. It also identifies measurement techniques which could be used in a future strand of the project to demonstrate determination of some of these contaminant species such as oxides of nitrogen and sulfur.
- The quantitative measurement of arsenic species in landfill leachate by inductively-coupled plasma-mass spectrometry (ICP-MS). A method is under development which should be of wider interest and benefit to laboratories in the environmental measurements sector, as well as the Environment Agency. This builds upon work in the previous programme to develop a qualitative method for arsenic species in landfill leachate.

Chemical Nomenclature

The Government Chemist is represented on both IUPAC's Advisory Committee to Chemical Nomenclature and Structure Representation Division (VIII) since its inception in 2002, and on the RSC's "Committee on Standards in Nomenclature, Terminology, Units and Symbols" (CSN) since 1991.

The RSC committee met once in the past year. Many members are from the education sector, but there are also representatives of BSI and scientific societies. Government Chemist input is appreciated as it has contributed an industrial and regulatory focus, more practical than theoretical, which has otherwise been absent from the committee.

Proposals for the names of element 114 (flerovium, Fl) and element 116 (livermorium, Lv) have been made. The proposed names were open to public comment, but we received a personal invitation to comment on the proposal.

The Forensic Drugs team at LGC has assisted the Department of Justice in the preparation of amendments to legislation. Input to this was provided on behalf of the Government Chemist by supplying accurate chemical names and descriptions so that legislation could deal with "legal highs". This is important so that the correct chemicals or families of chemicals are covered by new legislation, whilst allowing harmless chemicals, or legitimate medicines, to be freely and legally traded. Many "legal highs" are chemically very similar to legitimate products, so it would not be feasible just to ban anything which happens, for example to be structurally similar to 3,4-methylenedioxy-N-methylamphetamine (MDMA).

We have also provided advice on names for cosmetic ingredients, for legislative reasons to the Department of Business, Innovation and Skills via LGC's Consumer Safety team.

We strongly believe that chemical nomenclature is important – it underpins all analysis, as if you don't know what you are looking for, how can you measure it?

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Glossary

See the International Vocabulary of Metrology[13] for the current definitions of terms used in measurement science.

ACEA	European Automobile Manufacturer's Association
BIS	Department for Business, Innovation and Skills
BSI	British Standards Institution
CCS	Carbon Capture and Sequestration
CLP	Regulation (EC) No 1272/2008 on classification, labelling and packaging (CLP) of substances and mixtures, as amended
CRM	Certified Reference Material – Material with accurately known traceable concentration of one or more components for use in calibration or validation of methods of analysis
Defra	Department for Environment, Food and Rural Affairs
Derivatisation	Chemical modification of a substance, typically without changing its core structure, for example to facilitate measurement
DfT	Department for Transport
EA-IRMS	Elemental analyser linked to isotope-ratio mass spectrometry – a modern technique for separating and measuring species containing different isotopes of one or more elements to help trace sample history or origin
ECHA	European Chemicals Agency
EFSA	European Food Safety Authority
EM-IDMS	Exact Matching Isotope Dilution Mass Spectrometry; the amount of isotopically labelled internal standard added is equivalent to the amount of the measurand thought to be present
FAMES	Fatty acid methyl esters: components of biodiesel
FBO	Food or feed business operator
FFF	Field flow fractionation – separation technique which separates particles according to their mobility
FRAME	Fund for the Replacement of Animals in Medical Experiments
FSA	Food Standards Agency
GC-IRMS	Gas Chromatography linked to isotope-ratio mass spectrometry – a modern technique for separating and measuring species containing different isotopes of one or more elements to help trace sample history or origin
GCWG	Government Chemist Working Group
Gene expression	Production of a characteristic biomolecule (RNA) from the genomic sequence, which may be followed by translation into specific proteins
Genotoxic carcinogen	Substance which can damage genetic material and cause cancer; Regulation (EC) No 1881/2006 *setting maximum levels for certain contaminants in foodstuffs* implies that no level can be considered safe
ICP- MS	Inductively coupled plasma mass spectrometry – a modern technique for determining the chemical elements in a sample
in vitro	Performed with laboratory or industrial media and instruments, rather than in a living organism

[13] International Bureau of Weights and Measures, International vocabulary of metrology – basic and general concepts and associated terms (VIM), Third Edition, JCGM 200:2008, 2008, www.bipm/org/utils/common/documents /jcgm/JCGM_200_2008.pdf

Glossary

IRMM	JRC Institute for Reference Materials and Measurements
JECFA	The joint FAO/WHO expert committee on food additives
LBRO	Local Better Regulation Office
LC-MS/MS	Liquid chromatography-tandem mass spectrometry
MChemA	Mastership in Chemical Analysis – this Royal Society of Chemistry qualification is required for appointment as a Public Analyst
Microarray	Compact array of biomolecular probes - typically either DNA or protein - which can be used to acquire data simultaneously on the composition of a sample
MOD	Ministry of Defence
MRPL	Minimum required performance limit in animal products *(see Decision 2002/657/EC concerning the performance of analytical methods and the interpretation of results)*
Multidimensional GCGC	Gas chromatography carried out in more than one dimension. Components separated in one dimension are then separated in another dimension using different separation criteria.
NIST	US National Institute of Standards and Technology
NMI	National Measurement Institute
NMO	National Measurement Office
PCR	Polymerase chain reaction, a technique used to amplify DNA sequences so that they can be identified
Port Health Authority	Special type of local authority created to ease administration at seaports where the port area is covered by more than one local authority, responsible for carrying out checks on food and feed consignments
Public Analyst	Analytical scientist appointed under statute by UK local authorities to provide an official food or feed control function and scientific advice for the enforcement of many acts of Parliament
Quantitative analysis	Measurement, with results expressed as a number and a unit, of the quantity of a target substance in a sample, e.g. 10 mg/kg
REACH	Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals, as amended
RED	Renewable Energy Directive: Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources
Referee analysis	Impartial analysis by the GC to help resolve disputes relating to test results obtained on behalf of two independent parties
Referee function	Duty of the Government Chemist under acts of Parliament to provide impartial analysis in the resolution of disputes relating to the enforcement of regulation
RTFO	Road Transport Fuel Obligations
SEO	Supplementary expert opinion in the context of Regulation (EC) No 882/2004 on official controls, Article 11(5)
Toxicogenomics	Investigation of the toxic mechanism and potency of substances based on the way they affect the activity of genomic DNA
UKAS	United Kingdom Accreditation Service

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