## TC-MC perspective on European Metrology Networks

TC for Metrology in Chemistry
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## Introduction

EURAMET's vision is to be the leader in the development and application of measurement, enabling Europe to be competitive, prosperous, healthy and sustainable through innovation.

This vision will be achieved by developing and disseminating an appropriate, integrated and cost-effective metrology infrastructure, taking into account the needs of regulators, accreditation bodies, documentary standards organisations, international metrology community (CGPM, CIPM, BIPM) and end users in industry and society. To be effective this activity must be internationally recognised and based on robust and high-quality science, and must also support National Metrology Institutes (NMIs) and Designated Institutes (DIs) in meeting their own national targets through collaboration and via access to a balanced European measurement infrastructure.

## Challenges in Metrology in Chemistry

Metrology in chemistry is a rapidly growing field of metrology, strongly driven by societal needs for reliable chemical measurements as well as legislation and international agreements. The central aim in the field of chemical metrology is to establish measurement stability, comparability and coherence in all aspects of chemistry and biology, independent of space and time of measurement. This is particularly difficult for chemistry and biology because of the multi-dimensional nature of measurements. Physical measurements often deal only with the magnitude of the quantity considered, whereas in chemistry and biology the number of component-matrix combinations is vast, and there are added considerations of isotopic composition and additional nominal properties such as identity and viability.

Furthermore, unlike in physical measurement where primary standards may be established and then maintained and curated, the nature of chemical measurement implies that material carrying the relevant properties is consumed upon use, often being disseminated in the form of certified reference materials with limited stability. The implication of this is that primary measurement standards in chemistry and biology continually need to be renewed and disseminated at NMIs and DIs. Considerable effort is required, therefore, only for maintaining current capabilities and services.

Priority future activities for metrology in chemistry and biology have been identified in areas such as health care, environmental and climate protection and food safety. Particular needs are the development of reference methods and materials to meet emerging demands, metrology for the identification and analysis of nanoparticles, macromolecules and biomolecules, and capability to underpin traceable measurement at ultra-low concentrations. For the reasons described above, and with the continuing pressure on scientific budgets, it is evident that a more collaborative effort between NMIs, DIs, accreditation bodies, standardization organisations, legislative bodies, policy makers, national governments, industry, academics and end-users is urgently required to accomplish these ever more demanding tasks and expand the services of NMIs and DIs to customers. This engagement with key stakeholders is one of the objectives in the EURAMET 2020 strategy.



Metrology in Chemistry

To ensure high quality and uniform testing of food and feeds within the EU a legal network of European Reference Laboratories (ERL), National Reference Laboratories and Control Laboratories in the Member States have been established (see EC Regulation No 882/2004). Also the revised Medical Devices Directives foresee the implementation of ERLs for high-risk medical devices. These legally mandated measurement networks as other established networks ensure the comparability of measurement results and need to be supported by traceable standards for coherence and worldwide comparability.

## Current Situation

Measurement results and the assessment of their quality are increasingly demanded in European legislation in many fields of public interest. Many of these are related to chemistry, especially in areas that are considered to be “Grand Challenges” in the European research agenda “Horizon 2020” such as health care, environmental and climate protection or food safety. A central theme is ensuring the international comparability of measurement results. This is achieved by traceability to common standards - typically to the SI system. Quality assurance demanding traceability of this kind is described in internationally accepted standards such as ISO/IEC 17025. Hence, this standard is generally referred to in European directives demanding internationally comparable measurement results of a high quality. For end user laboratories, accreditation to ISO/IEC 17025 requires access to SI traceable reference materials and calibration standards, which must ultimately be provided by the international metrology infrastructure supported by the global network of NMIs and DIs.

On the national level, collaborations and interactions with the various stakeholders in these processes are already implemented and are proving successful. Two such examples are described in the appendices. In brief, DANIAmet in Denmark builds on a decentralised metrology infrastructure profiting from synergistic collaboration with academic institutions and industrial companies as well as from international collaborations. LNE, the national metrology institute of France, extensively collaborates with other national organisations in, so-called, national reference networks. Knowledge is exchanged within the networks and new methods are developed to meet the emerging requirements of European Legislation. Both schemes are models that could be developed further and adopted successfully on a European-wide level.

Different transnational infrastructures are already emerging in several areas in order to meet traceability demands and foster international comparability. An example in the health area is the Joint Committee for Traceability in Laboratory Medicine (JCTLM). A driver in this field is the In-Vitro Diagnostic Medical Devices Directive (IVD Directive, 98/79/EC) of the European Union, which requires traceability of values assigned to calibrators and control materials to reference materials of higher order. In response to this requirement the CIPM together with the BIPM created the JCTLM, supported by the International Federation for Clinical Chemistry (IFCC) and the International Accreditation Cooperation (ILAC). As a result of the work of the JCTLM, a regular proficiency testing scheme was established that can serve as the legally requested reference point for validation of laboratory performance of higher order reference laboratories such as accredited calibration laboratories according to ISO/IEC 17025 and ISO 15195. Also, a range of certified reference materials (CRMs) and reference methods for clinical chemistry are now available which constitute the reference framework for traceability in laboratory medicine, even on a global scale. It comprises CRMs of well-defined chemical entities whose property values are traceable to the SI and CRMs whose property values have been agreed upon by international convention and are not yet traceable to the SI. This reference system is under permanent review and further developed as required. The establishment and maintenance of SI traceability for a selected group of measurands of high priority is a key requirement for this system.

Another example is in the air quality area. The importance of the National Air Quality Reference Laboratories (NAQRLs) has been fostered by European air quality directives (originally Directive 96/62/EC and subsequently Directives 2004/107/EC and 2008/50/EC). These laboratories are in many cases legally responsible for the quality assurance and delivery of traceable air pollutant measurements in their respective Member States. The so-called AQUILA network was created and a Memorandum of Understanding has been signed between the JRC Ispra and most of the participating institutes. The network aims to provide coordinated QA/QC activities, method development and validation on a European level. The network collaborates in standardisation activities, on common research projects and pilot studies, and also offers a forum for information exchange in form of training courses, workshops and conferences. Several of these institutes are also NMIs or DIs, proving a direct link to the metrology infrastructure.

The independent evolution of structures for the quality assurance of measurement results in areas as different as health care and air pollution control highlights the different approaches currently to providing a European infrastructure for establishing, maintaining and disseminating measurement standards in the most important fields of chemistry. These have evolved to meet the needs of each area, recognising the different complexities of each topic, even within the chemical metrology area itself.

## Future European measurement infrastructure

Within Europe it is clear that TC-MC, as the guarantors of the robustness and coherence of the SI system for addressing chemical measurement in Europe, has a key role to play as a focal point for coordination of the collaborative efforts required to meet these requirements for traceability in any given area. For transversal topic such as health, environment, energy or new technologies close collaboration with other technical committee is envisioned.

The coordinating role of TC-MC would most sensibly be based around the existing core TC-MC sub-committee structure. Supplementary meetings of these committees with an expanded constitution are envisaged. These meetings could include, but are not limited to: accreditation agencies, standards organisations, legislative and regulatory bodies, policy makers, national governments, industry and end-users (especially those with special responsibilities: for instance air quality reference laboratories). The composition of this body facilitates a two-way dialogue, allowing policy makers to make the scientific community aware of what future developments may be, and allowing the scientific community to influence future policy and make policy makers aware of current technical capabilities when developing their policy. This would also be a forum for agreeing and coordinating best practice in chemical measurement across Europe.

Subsequently, the group could then decide the best way to address current and emerging needs for traceability in a specific area. For instance:

- the requirements can continue to be addressed within the current infrastructure,
- additional work is needed in the form of best practice guidelines to assure quality,
- an expanded committee involving relevant stakeholders is required,
- extra investment via collaborative R&D programmes, or

- a more radical approach needs to be considered, such as a distributed network of traceability.

Implementing any of these options to provide a co-ordinated approach to quality assurance and measurement traceability in a given area might be considered to constitute a ‘European Metrology Network’. The first four options build on the current strength of redundancy in the measurement system amongst NMIs to ensure best realisation of the units under consideration, strengthening this by engaging relevant stakeholder and end users in the process. The final option recognises that some chemical and bio-chemical measurement areas are so broad and specialised that there is not currently enough capacity amongst NMIs to produce useful measurement redundancy. In such cases a division of labour approach resulting in a distributed network of traceability may be more appropriate, where individual laboratories are charged with acting as the reference points for given measurement areas. This may or may not be a role enshrined in current legislation.

**Towards European Metrology Networks**

Chemical measurements cover a broad range of very different aspects of life that serve very different interests such as health care, environmental protection or food safety. These different stakeholder groups traditionally act independently and all address measurement quality needs individually. A goal of establishing European Metrology Networks would be to address the specific needs of each stakeholder group in Europe individually in a specific network in close collaboration with the stakeholder groups and, at the same time, establish and assure a congruent and scientifically sound metrological infrastructure across all networks and guarantee SI traceability.

It would be ideal to monitor and address the need for SI traceable standards on a European level for each stakeholder group as these are very often common European (and often global) needs and often driven by European legislation. These networks may also serve as a basis to address research and development needs via collaborative research activities. Such research activities are already ongoing within the framework of EMRP and EMPIR. This current scoping document builds on these activities.

Another big advantage of an European approach would be to combine the capabilities of the participating European NMIs and Dis, to provide a comprehensive set of SI traceable measurement capabilities that is greater than the sum of its parts and can serve the needs of each community much more comprehensively and potentially more efficiently. A “traceability pool” of this kind would also foster the long-term funding commitment for maintaining SI traceability in the fields desired by the international metrology system. This is particularly important in the chemistry sector because of the limited resources devoted to chemistry at NMIs as compared to physics.

The organic evolution of the above mentioned structures in a variety of forms currently is a demonstration for the need of such an infrastructure. The European Metrology Network is a method to create a more structured and effective governance on these processes.

The two examples below highlight European Metrology Networks at two ends of the spectrum. The first, a distributed network of traceability with the division of labour between participating laboratories, designated in law to perform these services. The second, an evolution of the current network of NMIs and DIs offering a robust source of traceability through measurement redundancy, to include relevant stakeholders and end users in strategy discussions.

## Example 1: Towards a European Metrology Network for Laboratory Medicine

A European Metrology Network for Clinical Chemistry aims to provide and maintain SI traceable reference points for the most important measurands in clinical chemistry on a sustainable basis. This includes the maintenance of measurement standards on a primary level and the provision of calibration services for reference laboratories in clinical chemistry. A central part of these services is the provision of SI traceable reference values in PT-schemes such as the above mentioned JCTLM comparisons on a regular and continuous basis. The results of the participating laboratories in the PT-scheme may then be used for the validation of the SI traceability of their measurement results within a known measurement uncertainty, for example, as evidence in laboratory accreditation processes.

Considering the size of the target and the resources available at the European Metrology institutes, it is evident that a dedicated collaboration on a European level is a prerequisite for accomplishing this task in a comprehensive manner. A coordination of this kind on a European level would considerably reduce the need to provide the whole range of priority measurands through every NMI/DI in Europe and, even more importantly, would significantly reduce the workload for the NMIs and DIs required for the regular organisation of PT-schemes.

Sharing the work in this way and providing a reliable and comprehensive metrological backbone on a long-term basis requires a clear commitment amongst the partners to participate in such a network and also regular consultations between the partners in order to assure the complementary character of their work and to achieve a common surveillance of the process. The commitment should be contractually assured. It would also be favourable if the status of such collaboration would be supported and affirmed by EURAMET as the legal body responsible for the collaboration of NMIs and DIs in Europe. This would also help to establish the status of the networks as contact points for quality assurance in their field of activity, for example, for the relevant regulators.

Similar to goals already discussed in other fields (AQUILA) such a collaboration of metrology institutes, designated institutes and expert laboratories also provides an ideal basis for discussing the future developments and needs in the field between all relevant partners and on a European level. Hence, the group may also generate and provide expert knowledge and input for legal processes, standardisation and also common research activities directly targeted to European requirements.

## Example 2: Towards a European Metrology Network for Gas and Particle Analysis

The aims mentioned in example 1 are mirrored in the gas analysis and particle measurement area where there are increasing requirements on metrology to assist industry and Member States to defensibly meet targets with respect to air quality, emissions and automotive legislation whilst also assessing exposure of European citizens to harmful pollutants.

Meeting these targets requires strong leadership within European gas and particle metrology which delivers European coordination and international collaboration and also acts as a focal point for interaction between the NMI communities and government, regulators, industry and end users.

The robustness of measurements made in these areas is often compromised at the top level by a lack of traceable measurement standards and at the end-user level by absence of appropriate quality control and standardisation of sampling and routine measurement procedures. The activities required to address these problems and also bridge the gap between the metrology and end user community are of a broader scope than the current technical arrangements under EURAMET and the CIPM allow. These activities would require a more flexible approach and, in particular, ability to work much more closely with end users to ensure the proper dissemination of metrological traceability and best practice at the routine measurement level in the field or factory. A European Metrology Network with a broader remit than traditional metrology, air quality reference and end user organisation would have more capabilities to answer these requirements.

The vision therefore is to establish a virtual European Metrology Network to assist in underpinning the metrological traceability in gas analysis and particulate measurement from the SI to the end user by providing coordination to deliver cost effective, fit for purpose measurement solutions to meet the needs of industry, funding organisations and the end user community. Such a virtual European Metrology Network for Gas and Particle Analysis would:

- Coordinate a best practice approach to underpin traceability and traceable measurements within each country and across Europe encompassing NMIs, air quality reference laboratories, standardization bodies, end users and for European proficiency testing schemes;
- Provide a contact point for NMIs and expert laboratories in Europe, for PT-scheme providers, calibration laboratories, standardisation bodies and risk assessors;
- As a community, ensure the provision of SI traceability for priority measurands in accordance with regulatory requirements within each country and across Europe;
- Support the metrology infrastructure in Europe at EURAMET TC-MC, AQUILA, CEN and, via a subset of members, worldwide at CCQM and ISO;
- Engage with key stakeholders and end users within and outside Europe to prioritise future activities and disseminate best practice and assist European policy makers and national governments to evidence-base regulation;
- Drive strategy development and co-operation in metrology and R&D activities across European NMIs & DIs;
- Provide a framework to allow for consistent and ongoing collaboration and research by attracting long term funding from pan-European programmes and coordinating such research projects.

Membership of the European Metrology Network would be based around the membership of the current EURAMET TC-MC sub-committee on gas analysis but could expand, as appropriate, to include subsets of relevant stakeholders, NMIs and DIs outside EURAMET, and European air quality reference laboratories.

The chain of responsibility from CCQM via EURAMET and European AQ reference laboratories to field measurement endeavours is clear and continuous, although spans many levels of activity. The coordinating laboratories in such a network would be those with the broadest range of relevant activities.

A good example of impact that such a European Metrology Network would be in the area of HCl and HF measurements in air and in emissions. Currently the legislation for the allowable emissions of these components has been imposed in a top-down fashion by the European Commission. This does not currently take account of the availability of traceable standards or validated methods to perform these measurements from stationary sources. This has resulted in unsatisfactory compliance with this legislation in many areas. The proposed EMN would have brought together all communities involved, in advance, to help shape the legislation, to ensure it worked within currently available technology and traceability routes, and where this was not possible to develop collaborative research projects and standardisation activities to address these deficiencies in advance.

Via the same inclusive approach the EMN would also be able to accelerate the development of technology in emerging areas, such as particle number concentration measurement, where there needs to be close cooperation between legislators, industry and measurement scientists to define and deliver measurement requirements to support the development of the next generation of cleaner vehicle engines.

## Example 3: Towards a European Metrology Network for Food Safety

Food and beverage ingested by humans represent a potentially proficient pathway of exposure to toxic and nutritionally important elements. Therefore, food metrology is a significant research topic in scientific, manufacturing and social fields. The development of SI traceable data obtained from advanced analytical methods is mandatory to determine the presence of food contaminants, toxic metals, pesticide residues, allergens, endocrine disruptors, mycotoxins, etc… Reliable information on the trace-element content of foods is necessary for food safety.

Food metrology is the discipline dealing with the development, application and study of analytical procedures for characterizing food properties and their constituents. Such analytical procedures are used to provide information to regulators and consumers about a wide variety of different characteristics of food, including its compliance with regulations and directives with respect to composition, structure and nutrition level and to allow consumers to make informed choices about diet. Advanced analysis methods, results of which are traceable to SI units, are needed to investigate food properties and the presence of residues and contaminants in low concentration, to help with certification of its biological origin and georeferencing of food, and to determine the impact of food on health. The main topics addressed by metrology in food science are: a) the determination of the concentration of heavy metals, antibiotic and pesticide residues, allergens, endocrine disruptors and mycotoxins in low concentrations in food matrices; b) to prevent food fraud related to, e.g., the biological origin of food or the use of genetically modified organisms and c) the use of nanoparticles in the food industry, in particular to determine their physical and chemical parameters to evaluate the impact on health. These topics investigate important challenges in food, nutrition and health sciences, for which metrology add fundamental insights and a decisive technological aid.

In particular, different soils have different composition in terms of types and amounts of mineral elements. Major and trace elements composition of food are a distorted reflection of the element composition of the soil in which the plant grows. Provenance means to identify and ensure the origin of a commodity and thereby the region where it was produced. Recent incidents have demonstrated the need for effective provenance systems. Proof of provenance has become an important topic in the context of food safety, food quality and consumer protection in accordance with European legislation and international standards and guidelines (EC regulations 178/2002 and 931/2011, COM(2015) 204 final). Isotopic and elemental finger-printing provides a robust analytical tool to determine the origin of food. Therefore, an independent and universally applicable analytical strategy to verify the declared country of origin of food can be an invaluable tool to enable regulatory authorities to trace contaminated foods back to their source.

In the European framework, the challenge of these activities is to create an infrastructure among national metrological institutes and stakeholders able to merge complementary competences and capabilities for developing and establishing the food quality and safety.
For these purposes it is important to focus on the development of:

- data traceable to SI units obtained from advanced analytical methods,
- hyphenated analytical methods for high sensibility measurements,
- standardised measurement procedures,
- robust sampling protocols,
- consolidated calibration procedures,
- proficiency testing,
- matrix certified reference materials,
- developing new methods of measurement among laboratories to study food provenance.

This metrology integrated infrastructure could ensure the highest standards of food safety, by developing new pathway for the establishing of measurement traceability, new CRMs, faster and more efficient methods of sampling for screening tests, in order to guarantee food quality and safety and food provenance. Strong interaction with the aforementioned legal network of European Reference Laboratories (ERL), National Reference Laboratories and Control Laboratories in the Member States is a prerequisite for success. Currently relevant laboratories in the field of food are planning to build European networks such as the METROFOOD RI initiative.

**Example 4: Other models using collaborative initiatives**

Similar approaches might also be possible in other fields of high priority such as water pollution. Initial efforts in the area of water analysis have already been made in the frame of regular EURAMET projects (EURAMET 924) and EMRP projects (ENV08, ENV51) and cover research work as well as inter-comparisons with more than 100 laboratories on all levels (NMIs, expert laboratories and monitoring laboratories) all across Europe and even beyond on a global scale.

Another emerging example is the action "european marine sensor calibration network" aiming to establish a permanent working group for calibration activities for essential climate variables in marine environments. It involves the research community, the National Metrology Institutes (PTB; SYKE; LNE; INRIM) and industry from the participating countries. One target of the initiative is to share the efforts to cover all the oceanographic needs in climate change activities

## Appendix I

The Danish metrology system is an example of a decentralised metrology infrastructure. Denmark has a national metrology institute (NMI) and six designated institutes (DIs)[1]. Of the five DIs two are private companies who see commercial interests in maintaining metrological standards. One DI is the Technical University of Denmark, which in some departments maintain metrological standards. The other three DIs as well as the NMI are members of the Danish Advanced Technology Group[2] meaning that they have contracts with the Danish Ministry of Higher Education and Science to *develop, transform and communicate new and existing knowledge and technology to companies and institutions. They can also focus on developing new technological infrastructure such as testing facilities and laboratories*[2]. For the NMI metrology is the main activity, but for the three DIs metrology is only a small part of their activity. The two private companies receive no funding from the government except that they are eligible to participate in EMPIR projects and thus indirectly receive funding for their participation in such projects.
The description above seems to indicate a high level of metrological activities in Denmark. However, although there are many parties working in metrology, a report from 2006[3] states that:

> *DANIAmet holds the most needed competences and has excellent connections to the international metrology system. However, approximately 80% of the needs for traceable measurements in Denmark are referred to foreign countries.*

It is possible that the situation is slightly better in 2015, but there has been no major change since 2006. The report from 2006 continues to say:[3]

> *Danish participation in the global knowledge transfer is a prerequisite for providing access for Danish companies, particularly SMEs, to foreign facilities.*

Although the degree of decentralisation of the metrology system in Denmark might be atypical, the situation that a significant part of the needs for traceable measurements must be covered by foreign countries is likely to be applicable to a significant number of the smaller European countries. It can be a time-consuming task to identify where to get the needed traceability. European Metrology Networks would make that task less time-consuming. Additionally, where smaller countries could make a useful and relevant (although probably not large) contribution to a European Metrology Network this would strengthen the participation.

[1] The Danish metology institutes (NMI + DIs) are organised in the organisation DANIAmet-MI. A list of members of this is found here: http://www.daniamet.dk/cms/site.aspx?p=8708.
[2] More information on this here: http://en.gts-net.dk/about-gts/who-is-gts/
[3] Kim Carneiro et al. *Strategic action plan for Danish Metrology* report no. DFM-2006-R09, DFM, 2006

## Appendix 2

In France LNE has long experience in environmental measurements and is member of two specific national reference laboratories: AQUAREF (The French national reference laboratory for water and the aquatic environment) and LSCQA (The French Central Laboratory for air quality monitoring). To strengthen and develop references in the environmental fields are strategic challenges, reliable measurements being needed to avoid any contests and critics from abroad. In France the eco-industries are word wide leaders in both sectors and it is a priority to support those industries.

*AQUAREF*
The French Water Law of December 2006 gave a new impetus to water quality monitoring policy, particularly with the creation of the French agency for water and aquatic eco-systems (ONEMA), which aims to promote the sustainable management of water resources and aquatic ecosystems. AQUAREF, French National Reference Laboratory in support of aquatic environment monitoring, was created in 2007 to enhance French expertise in the field of aquatic environmental monitoring, by improving synergies in expertise and research capability among the relevant existing public research institutes: BRGM (Bureau de Recherches Géologiques et Minières), IRSTEA (Institut de Recherche en Sciences et Technologies pour l'Environnement et l'Agriculture), IFREMER (Institut Français de Recherche pour l'Exploitation de la Mer), INERIS (Institut National de l'Environnement industriel et des Risques), LNE (Laboratoire National de Métrologie et D'essais).

AQUAREF has become a reference body in transferring methods and good practices to operators. Harmonizing good practices will ensure that physicochemical and hydro-biological measurement data are reliable and can be compared with one another. AQUAREF set up a strategic plan as well as a scientific and technical program around the following objectives:

- Define rules related to measurement, sampling and analysis procedures in order to optimise the quality of monitoring data;
- Have a proactive role in proposals for advanced monitoring;
- Represent France among European technical experts.

Some of AQUAREF key actions are:
Sustaining French ministry in the transposition and implementation of European Water Framework directive
Improving the quality of data by:

- Studying sampling methods, training field teams, organising on-site collaborative campaigns;
- developing fit for purpose analytical methods in conformity with European requirements which may be transferred to routine laboratories;
- Providing tools suited to support quality assurance over the entire measurement chain (PT Proficiency testing, CRMs Certified Reference Materials, etc.);
- Strengthening and transferring bio-indication techniques to operators;
- Supporting contractors in harmonising technical requirements through guidance, legislation or the measurement data exchange system.

Anticipating future monitoring processes by

- Validating innovative sampling or analytic devices (passive samplers, sensors, kits, bioassays…);
- Accelerating their transfer and acceptance by operators;
- Developing and validating methods to analyse pollutants of emerging concern.

- Promoting French expertise at the European level by leading French standardisation within LNEs field of activities in order to bring it to Europe;
- Exchanging views with European experts in technical groups devoted to the implementation of the Water Framework Directive.

Within AQUAREF, LNE is more particularly involved in the following activities:
Sampling
Implementation of Quality Controls in the field such as duplicate and blanks,
Organisation of collaborative trials on in situ physico-chemical parameters (e.g. Groundwater in 2009, Lake water in 2010),
production of guidance documents to help harmonise sampling protocols and in situ measurements and design of experimental plan to assess uncertainties arising from sampling.
Development and optimisation of chemical methods to comply with the QA/QC performance criteria. (pesticides, PAH, PBDE, TBT…)

Building expertise to support data quality LNE as French NMI has proposed a traceability chain to achieve comparability through metrological traceability and accurate measurements as prerequisite to ensure good decision making. Furthermore, LNE is leading the topic of uncertainties estimation (organization of workshops on uncertainty (2 x 1 day), testings and workshop of free software for easy evaluation of the uncertainties). LNE is contributing to the maintenance and the improvement of the data base for water quality data (Sandre).
Scientific and technological development in areas of emerging concern
Evaluation of performances of innovative devices (passive samplers, sensors, continuous measuring devices etc.), recommendation on Quality Controls tools and best practice for implementing those devices, development of methods and approaches to analyse emerging pollutants (e.g. non target screening).

*LCSQA*
To support the Ministry of Environment on the application of the air quality supervision policy, and ensuring quality and coherence of the data delivered by the approved monitoring networks, a Scientific Interest Group has been created in 2005 and is called the French Central Laboratory for Monitoring Air Quality (LCSQA): the LCSQA composed of 3 relevant existing public research institutes, INERIS, Mines de Douai and LNE ensures the technical coordination of the monitoring networks in ambient air.

The objectives of the National Reference Laboratory are:
- To support the Environment Ministry on implementing its air quality supervision policy;
- To represent the Ministry of Environment on air quality at a European level;
- To build a national data repository on air quality;
- To anticipate air quality issues.

In this National Reference Laboratory, LNE is more specifically in charge of the traceability of the measurements performed in ambient air by the monitoring networks. Therefore, LNE has a long experience in the field of gas metrology, and in particular in the preparation of gravimetric gas mixtures and in the analysis of gas mixtures: these activities are accredited COFRAC since 2001.

LNE develops and maintains Reference Materials, which are primary standard gas mixtures (PSM) obtained by using gravimetry as preparation technique. The gravimetric principle, which is described in the International Standard ISO 6142, is a powerful tool to produce accurate gas standards.

Its expertise lies also in the certification of gas mixtures (from nmol/mol to µmol/mol) used by the networks to calibrate their analyzers in the monitoring stations.
Owing to its experience, LNE set up and is now responsible for traceability chains for gas pollutants such as nitrogen oxides, ozone, carbon monoxide, volatile oxygenated compounds, sulphur dioxide. Periodically, LNE calibrates the reference gas mixtures of the monitoring networks which are then implemented to calibrate the analyzers used in the monitoring stations to measure the pollutants in ambient air. In this way, the measurements performed by the networks are traceable to the primary reference standards and are comparable among themselves and over the time.

In the directives 2008/50/CE and 2004/107/CE, quality objectives in terms of uncertainties on the measurements (for example $\pm$ 15 % for the gas pollutants) are defined by the European Commission. To fulfil the requirements, LNE wrote methodological guides to estimate the uncertainties on all mandatory pollutants measurements performed in ambient air. These methodological guides have been published by the French standardization body (AFNOR) as technical specification composed of eight parts to cover all mandatory pollutants. Each year LNE organizes and/or participates in International and European interlaboratory comparisons to demonstrate the accuracy of its reference standards and methods. Moreover LNE organizes annual comparison exercises at the national levels with the 27 French monitoring networks: in this scheme LNE sends unknown gas mixtures which are then directly calibrated by the networks with their analyzers in the monitoring stations and the measured values are compared with the true values determined by LNE. In this way LNE ensures the reliability of the traceability chains set up in the field of ambient air.

Apart from its role to ensure the accuracy and the reliability of measurements in the field of ambient air for the LCSQA, a big issue concerns the development of new methods for gas and particles metrology. For example, in the field of particles, the TEOM-FDMS (Tapered Element Oscillating Microbalance with Filter Dynamics Measurement Systems) is a common measuring instrument used by the French air quality monitoring network. This instrument is currently calibrated with calibration weights traceable to SI while having values and masses differences between each of them that are not representative of real atmospheric particle mass measurements. Moreover, these calibration weights do not allow detecting any technical problem of the TEOM-FDMS sampling system upstream the mass measurement and of the intrinsic TEOM-FDMS filtration system. In this way, LNE is developing a calibration method using a portable particle generator system producing known and stable particle mass concentrations over time. The results showed the good technical performances of the portable particle generator system in terms of repeatability and reproducibility; moreover the tests performed directly in monitoring stations show that the design of LNE's generator may be suitable for a direct use in the monitoring stations.