VSL
Dutch
Metrology
Institute

Final report Euramet 800 project

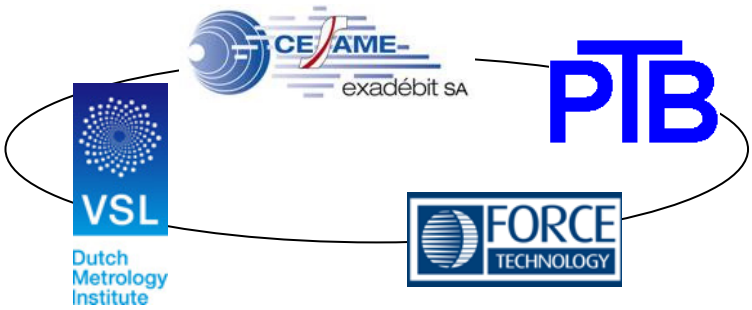

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Table of Abbreviations

HRV	Harmonized Reference Value, (comparable with KCRV)
KCRV	Key Comparison Reference Value
MuT	Meter under Test
TRM	Travelling Reference Meter

1 Project information

Project type	Collaboration in research
Starting date	2004-09-01
Coordinating Institute	VSL (Netherlands)
Participating Partners	LNE (France) PTB (Germany) FORCE (Denmark) since 23rd September 2013
Proposer / Coordinator	Mijndert van der Beek (VSL)

2 Introduction

Since the seventies an increasing use of Natural Gas as energy source and in Europe a vast network (gas-grid) has been realized. In this expanding gas grid more and more points of transfer of ownership are installed, leading ultimately to an increasing demand for reliable and stable reference values for high-pressure gas-flow measurements. The principle of Third Party Access, supported in the future by direct invoicing of energy-shipment, makes it of vital importance that Gas-transport organizations have at all times a clear knowledge about the contents of their transport-grid.

Hence, long term stability of reference values is gaining importance. Although small (insignificant) changes in (national) reference values are accepted by metrologists, the impact of variations on e.g. invoicing will probably never be understood nor accepted. The drive for one equivalent reference value in this working field of Natural Gas resulted in an extensive cooperation between three NMI's holding test facilities for High Pressure Natural Gas in Europe.

Key-comparisons are used by National Metrology institutes to verify results of independent realizations of standards of measurement (directly traceable to SI-units) and differences in results to the KCRV are observed and regarded 'as is'. However the harmonization process is combining the information from the independent (national) to a new , more accurate value in a sound statistical way. In 1999 on agreement, the harmonization in the field of HP Gas volume was established with two partners NMi VSL and PTB and on 4th May 2004, BNM joined also. Main advantages: Dissemination of the same reference values, a better long term Stability, smaller uncertainties and the transfer of knowledge amongst the participants.

3 The purpose of the project

The purpose of Euramet #800 collaboration in research project is:

- to inform the flow community on a regular basis and to get feedback
- to invite interested in this field to either actively join the project e.g. bringing their independently realized reference values as information into the harmonization process or to implement the harmonized reference values into their traceability chain.

4 Achievements of the cooperation so far

The next table depicts the achievements of the Harmonization group in Europe

Year	Achievement, event
1996	Observations of differences between Dutch and German traceability chains, Although non significant in metrological sense, annoying for the trade of natural gas between the countries.
1999	Contract undersigned by PTB and NMi to harmonize reference values for High Pressure NG volume. BMN (France) indicated interest to join as well at later stage. First cycle of realization of HRV completed.
2004	BMN, (now as partner LNE) undersigned the contract as well, HRV could be based on three partners from that day on. Second cycle of realization of HRV completed.
2008	Third cycle of realization of HRV completed.
2011	Efforts of HRV seem to pay off, stability of several traceability chains improved dramatically in the past 10 years. Gas distribution companies show better results in their mass balance of the pipeline grid. PTB demonstrated the equivalence of the KCRV determination with HRV in the results of the worldwide CCM-KC5a Key comparison.
2013	The 'EUREGA' consortium is the upgrade of 14 successful years of 'Harmonizing Reference Values of natural gas volume' in Europe and the way to open up for more partners. Eurega is being established by 4 partners: PTB, VSL, LNE and FORCE (Denmark), 23 September, Paris
2014	Preparations for 4th cycle of HRV determination. Project 800 finalized. Euramet 1301 project on harmonization is initiated (Eurega-1)

5 Information regarding the partners

In the next sections the specific traceability chains of the today's partners of the HRV will be discussed.

5.1 The traceability chain of VSL (The Netherlands)

The traceability chain of NMi VSL-Flow starts with the Gas Oil Piston Prover system. It is a closed circuit with a reciprocating piston connected to oil at one side and gas at the other side. Individual rotary gas meters are being calibrated at the GOPP up to 230 m3/h. Since the system is pressurized all sided and hardly no pressure drops are present the uncertainty of the super compressibility of the gas does not play a role of importance in the uncertainty budget.

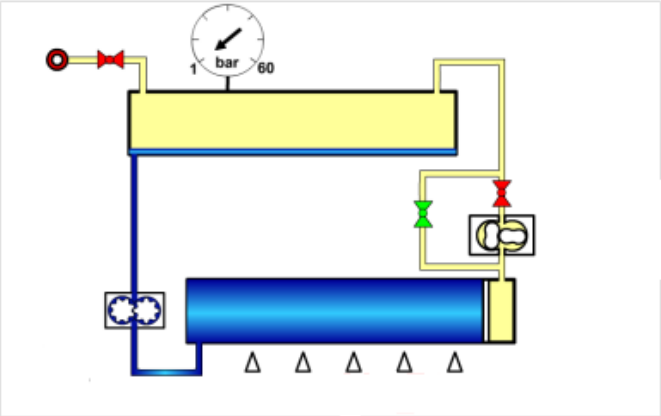

Figure 1 Gas Oil Piston Prover

The higher flow rates are achieved by 'bootstrapping' 5 rotary meters into one to get 5 times higher flow rates and so on. This procedure is performed at the mobile VSL-Tra(ceability) Sys(tem), or TraSys at which the flow rate can be boosted up to 4000 m3/h when two Trasys skids are put into parallel operation. The traceability chain is depicted in the adjacent figure.

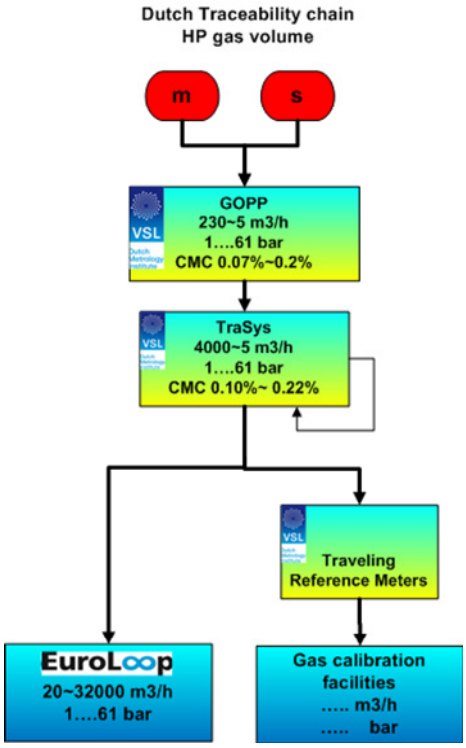

Figure 2 Traceability chain VSL HP

5.2 The realization of traceability at *pigsar* under responsibility of PTB (Germany)

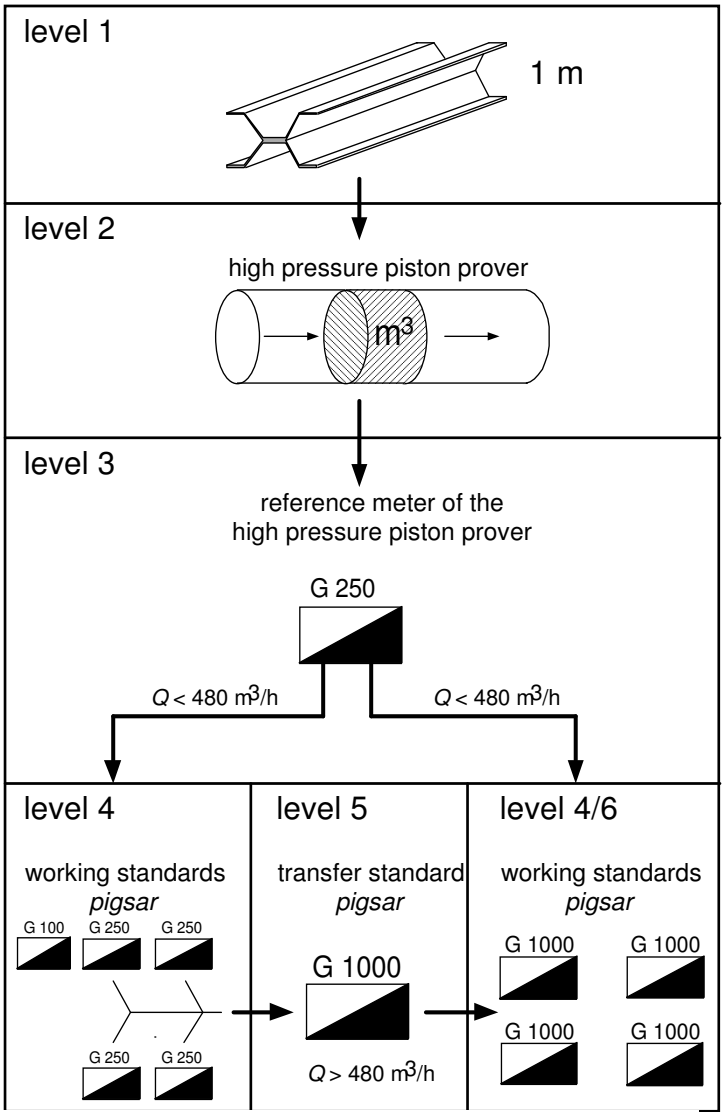

Figure 3 The high pressure traceability chain of *pigsar*

The high-pressure Reference Values at *pigsar* (shown in Figure 3.) are realized in only a few steps and refer to the basic SI-unit "meter" (level 1). At level 2 a piston-prover is built up and is geometrically measured. Therefore the piston-prover represents the unit "cubic meter". In the next step (level 3) the prover's reference standard (a turbine meter G 250) has been calibrated at three discrete pressures. This prover's reference standard can be used up to a flow rate of 480 m^3/h. Uncertainty and differences arising from the transfer of the statically determined cubic meter in the piston-prover and the volume under dynamic conditions are taken into consideration and are accounted for. Up to this range all the reference standards (turbine meters) of *pigsar* of all sizes were calibrated directly (level 4). Then, to reach higher flow rates, a transfer standard G 1000 has been calibrated using four working standards G 250 (level 5). At the last level (level 6) the working standards "*pigsar*" with size G 1000 have been adjusted in the higher flow rate using the transfer standard. In this way Reference Values at three operating pressures are established. A Reynolds comparison is executed to verify that the Reference Values at the three operating pressures are in agreement.

5.3 Traceability chain of LNE LADG (France)

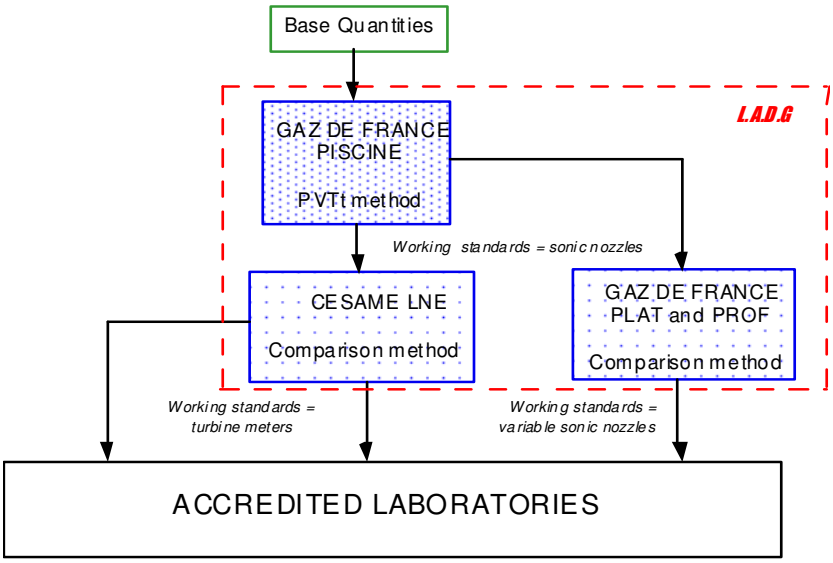

Figure 4 Traceability chain of the French accredited laboratories for gas flow measurements

The L.A.D.G. traceability chain involves the primary test bench PISCINE and all secondary test benches on which sonic nozzles are used as reference meters (see Figure 4). These benches are situated in Poitiers and are using a comparison method to calibrate the flow meters.
The gas flow rate traceability chain is presented in Figure 4. The chain is slightly different depending on the size of the sonic nozzle used as reference i.e. there is another stage when a throat diameter is higher than 20 mm.

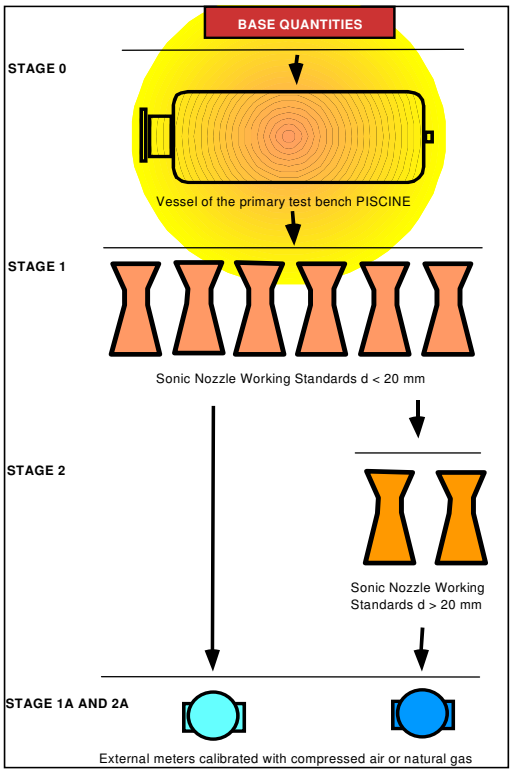

Figure 5 The gas flow rate traceability chain

The meter under test is calibrated in the stage 1a or 2a.
The stages are as follows:
Stage 0: The volume of the primary bench vessel is calibrated by the Laboratoire National d'Essais (LNE) by a weight measurement, using water.
Stage 1: Each small sonic nozzle (d < 20 mm) is individually calibrated under pressure on the primary test bench PISCINE using a PVT time method. The discharge coefficient of each sonic nozzle, CD, is determined on the complete Reynolds number working range from 0.6 up to 5.5 MPa.
Stage 2: Each big sonic nozzle (d ≥ 20 mm) is calibrated against a set of smaller sonic nozzles on the secondary test benches. The discharge coefficient of the sonic nozzle is determined on the complete Reynolds number working range too.
Stage 1a and 2a: The flow meter under test is calibrated against a set of sonic nozzles. The fluid used for the tests can be compressed air or natural gas. The error of indication is determined between the sonic nozzle reference mass flow rate and the mass flow rate calculated in the meter conditions.

5.4 Traceability chain of FORCE (Denmark)

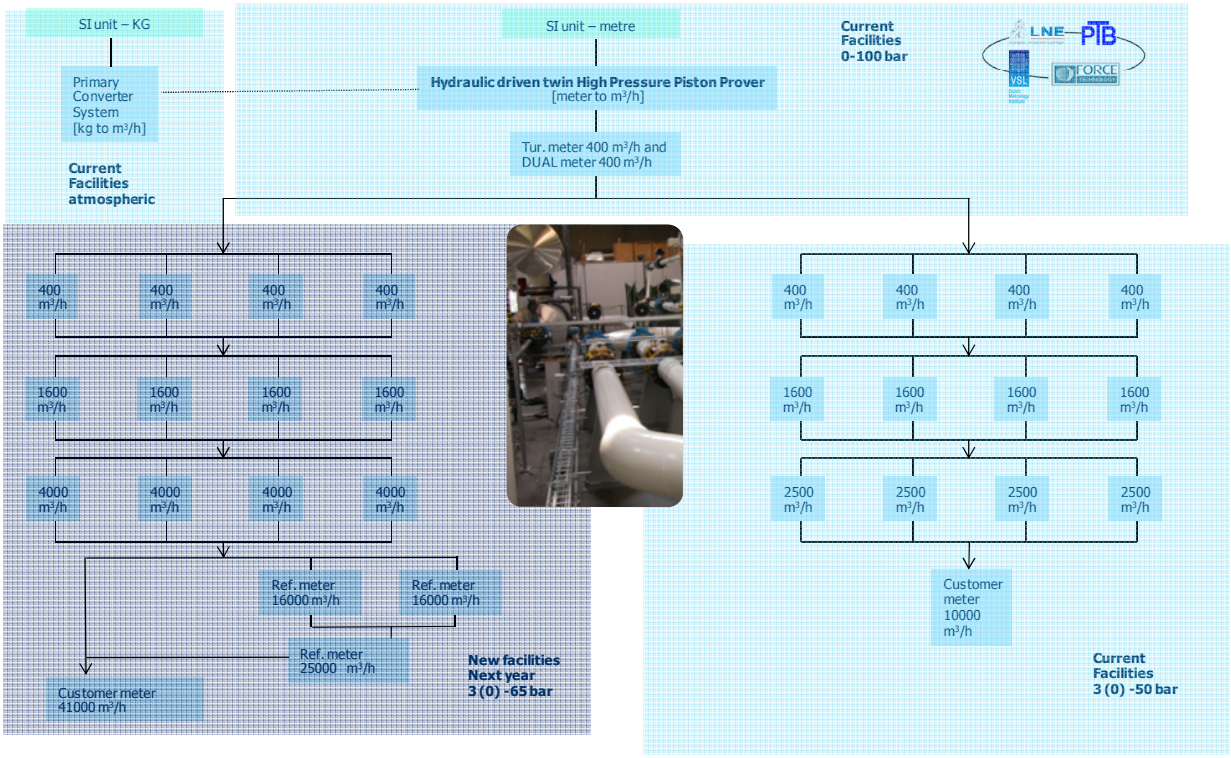

Figure 6 Traceability chain of FORCE

The realization of the Danish reference value for HP Natural is based upon a double set of piston provers in a closed circuit. Both pistons are driven by a hydraulic rod that is fixed on a yoke with the two piston driver rods. The seal leak tightness is realized by a small oil-overpressure between the seals. The cardinal flow meters (may be turbine- or rotary-) are being calibrated up to max. 400 m3/h. Traceability of the higher flow rates is based upon a three step further bootstrapping. The facilities will be expanded in the next future up to 41000 m3/h, pressure range from 3 to 65 bar.

6 Establishment of 'European Reference for Gas measurements' (Eurega)

On 23rd of September 2014 a memorandum of understanding was undersigned by PTB, VSL, LNE and FORCE. In this section, the view of different European metrological institutes and gas parties are being reflected.

6.1 Opening speech by LNE as host for the Eurega ceremony, Jean-Pierre Vallet

Ladies and Gentlemen, on behalf of the four member organisations who have worked together on this project, FORCE, LNE, PTB and VSL, as Chairman of Flomeko and as a signatory of the previous Harmonisation agreement, I am honoured to be the person to who welcomes you here today for this very special ceremony of the signature of the new Memorandum of Understanding on collaboration to facilitate a European Reference for Gas Metering – EUREGA.

After 14 years of experience and the success of the previous Harmonisation agreement, we have decided to give it a new international character as well as

1. better readability in Europe and worldwide
2. a clear social purpose showing its real interest for Society
3. to give the opportunity to open it to worldwide NMIs.

I would like to add that before being a Frenchman or a European, I am above all a citizen of the world, and I have always liked, since the very beginning, the spirit of this agreement (and I was the first Frenchman who wanted to join the agreement) for

- its great scientific or transparent quality and its objectivity
- the progress that it brings for the benefit of society
- the degree of independence that is left to each partner.

I appreciate also its spirit of openness towards other participants (whether European or not, from big or small countries) and, with the development of these colossal exchanges of "gaseous fuels" which are going to constitute the greatest source of much-needed energy for a very long time, I predict a very great future for EUREGA.

6.2 Rationales from point of view of the Metrological institutes

6.2.1 PTB, Roman Schwarz

Dear colleagues and distinguished guests,
On behalf of the Physikalisch-Technische Bundesanstalt and – particularly - its Presidential Board, I convey my congratulations to the members of the EUREGA consortium for having made this next, important step towards a closer European collaboration in the field of high-pressure natural gas measurement.
The PTB is proud to be a signatory of this renewed and extended Memorandum of Understanding, herewith expressing our commitment to continue the successful cooperation that started in 1999.
The European cooperation in the field of gas metering is part of a global harmonization process, where an increasing cross-border trade of goods and services puts increased demands on an internationally organized metrology.
The CIPM MRA from 1999, the MoU between the CIPM and ILAC from 2001 and 2012, the Joint Declaration of BIPM, OIML, ILAC and ISO from 2011, and the OIML MAA from 2006 are most prominent examples of this development.
The mutual recognition of calibration and test results requires a solid, internationally agreed basis. That is the International System of Units, the SI, which was adopted 53 years ago, in 1960. But it also requires harmonized requirements for measuring instruments, and harmonized calibration and test procedures which are developed in European and international organizations such as the

metre convention, the consultative committees of the BIPM, EURAMET and the OIML, where PTB plays a very active role.
From the economical point of view natural gas and its accurate measurement across the borders is of extraordinary importance. Therefore it was a big step when the first contract for harmonizing the reference for gas metering was signed in June 1999 by PTB and the Dutch NMI, followed by the French LNE in 2004.
Germany has 9 neighbouring countries and is an important transit market in Europe for pipeline-connected gas transport. It is obvious that all partners in trade and transport of natural gas require and benefit from a reliable, high-level, harmonized European metrological infrastructure – particularly with regard to the far-reaching liberalization of the European gas-market as we have seen in the past 10 years.
It was a big step for PTB, and we entered unknown territory, when we started our first harmonization activities - together with the colleagues from The Netherlands - in 1999. We did that, because we saw the need and wanted to fulfil our mission as a responsible metrology institute.
The starting point for PTB was a public private partnership with the company Ruhrgas, today operating as "Open Grid Europe", which started in May 1999 and turned out to be a typical win-win situation.
For PTB the infrastructure that is necessary to maintain a high-pressure natural gas reference test stand such as "pigsar" without having a commercial partner would economically and technically not be feasible.
On the other hand, for a natural gas transport company such as Open Grid Europe the operation of a "national reference for gas metering" under the supervision of the PTB as the National Metrology Institute offers different advantages, not least an increase in prestige.
This successful cooperation between a commercial partner and a National Metrology Institute was transferred already in other fields. For instance, the company WindGuard, being the market leader for calibration of anemometers used in the wind energy sector, operates a couple of wind tunnels, where one of which is used as a reference wind tunnel with PTB-owned and operated equipment serving as a national reference standard for the calibration of high-precision and bigger sized anemometers
Maybe that is an encouraging example also for other institutes in Europe or even outside Europe.
Finally let me wish the four partners of the EUREGA consortium much success for the next step towards a closer cooperation in the field of high-pressure natural gas measurement.
May your cooperation be so attractive for others, that new partners will join EUREGA in the near future!

6.2.2 VSL, Marc Pieksma

This is the summary of the presentation that was held by Dr Marc Pieksma, scientific program manager of VSL.

VSL: the Dutch metrology institute
-Maintain and develop the national measurement standards
-Make measurements directly traceable to international standards
-Contribute towards the reliability, quality and innovation both in business and society at large

Natural gas in the Netherlands
The importance of natural gas in the Netherlands:
- Is huge at present, will remain so in the future
- Transition to sustainability
- Flexibility (different energy sources)

Harmonisation of the cubic metre for natural gas:

- Is essential for fair trade
- Leads to well-known reference standards
- With low uncertainties
- VSL is a proud to be a partner of EUREGA, together with PTB, LNE and FORCE

Flow facilities and standards
VSL operates:
- Low-pressure flow laboratory (Delft)
- Laboratory for liquid flow (Dordrecht)

EuroLoop operates:
- At high pressures (up to 61 bar)
- Closed loop
- Separate company
- Has 'VSL inside' (traceability) on the basis of a contract

Metrology in Energy new developments
Current EMRP projects:
- Primary standard for LNG
- Energy gases (energy, carbon & moisture content)
- Biofuels (physical & chemical properties)

Possible future projects:
- Power to gas (hydrogen enriched natural gas)
- Biogases (impurities, content, properties)
- Multiphase flow metrology
- Rheology (non-Newtonian viscosity)
- LNG mid-scale, composition & caloric value
- Carbon Capture and Storage (CCS)
- Industrial emissions (stack monitoring and flow)

Concluding remarks
- VSL is proud to be part of EUREGA together with its partners PTB, LNE and FORCE
- VSL is proud of its contribution to the harmonisation
- VSL is very happy to sign the new MoU
- VSL will continue to contribute to the harmonisation, including such issues as:
  - Stability of the reference value
  - Lowest possible uncertainty

6.2.3 LNE, J.L. Laurent

It is with great pleasure to sign this memorandum; it is the culmination of many years of cooperation. This signature is intentionally put the day before the opening of an international conference 'Flomeko' that will take place in this same location.

I would first highlight the economic importance of this event. Europe bought a large fraction of the gas consumes on his territory and gas exchanges in Europe are very important. The precise knowledge of the amount transported, bought and sold is crucial for large parts of our economy. Difference on boundary is critical (boundary between company and country. Tools to increase fair trade and trust between partners are welcome.

Flow measurements in this range (above 5 bars if you allow me the use of the "vulgar unit " but commonly used in the industry and 650 m³ per hour) involves heavy equipment. The original

character of the metrological background of this agreement is to be based on a close cooperation to gain uncertainties in establishing harmonized values.

It is an open agreement and defined very clearly the opening to preserve the excellence of the team.

I sign this agreement as responsible for the network of French metrology, but I would emphasize the part taken by Jean-Pierre Vallet in charge of LNE LADG (one of our of designated laboratory) in the construction of this agreement. My only merit is to have give my support in the construction of this agreement for several years.

I would also highlight your efforts to involve the beneficiaries of this industrial progress closely and in particular your largest gas company.

6.2.4 FORCE, Nils Linde Olsen

First of all I would like to thank the three present participants of Eurega for the invitation for FORCE Technology to be part of the cooperation.

I can assure you that we at FORCE Technology will do our outmost to fulfil the goals and intensions in the cooperation agreement.

Calibration of gas meters is very important to FORCE Technology and as Jesper Busk told you we're just about building a large calibration loop in Vejen in Denmark. It'll be ready for use in the spring 2014.
So at FORCE Technology we hope and expect to be a significant provider of calibration services in the future.

Again thank you very much for the opportunity to become part of the Eurega cooperation.

6.3 Harmonization concept valued by large European gas distribution companies

6.3.1 Open Grid Europe GmbH, Dr Martin Uhrig

Ladies and Gentlemen
I would like to begin by sending you the best greetings from Open Grid Europe.
Open Grid Europe, this company name may sound unfamiliar to you. In fact, we are a very "young" company, but at the same time we have more than 85 years of competence and tradition. How is that possible?
Open Grid Europe has its roots in the former large German gas company Ruhrgas, which does no longer exist.
The name may have changed, but not our competence. Today Open Grid Europe is Germany`s largest gas transmission system operator. With around 1800 employees with decades of experience in design, construction, operation and marketing in the gas transmission sector we stand for reliability and competence dedicated to the benefit of our customers.
During the last years the European gas industry has undergone major changes and lot of major challenges on the agenda.

Regulation and unbundling have changed the gas industry dramatically. And there is still much to be done to create a regulatory environment of legal security and predictability providing incentives to invest for enterprises and investors.
In Germany the Energiewende, the Energy Turnaround, has led to an enormous growth of regenerative energies. Consequently a greater coherence between gas and power grids could be necessary, where the gas grids will be used to store excess green electricity from wind power or photovoltaics e.g. as synthetic natural gas produced by means of electrolysis and methanation.
Gas trading has changed significantly in the last years. It is becoming more and more international. As an example I would like to mention the new Platform for European Gas Capacity Booking PRISMA, which is a major step towards an integrated European gas market.
Opening up to international gas trading and ensuring security of supply for the whole continent require a functioning gas infrastructure. Here the focus of planning will have to be expanded to the European horizon, after being confined to local supply or a national perspective.
Gas measurement and meter technology plays a central role in this context as integral part of the gas infrastructure. It is more at the heart of the gas industry than any other technology. And in a way, it is the bridge between the commercial and technical sides of our business.
Accurate measurement is the basis of fair and reliable gas trading in Europe.
The accuracy of gas meters is of particular importance in practical operations. European standardization therefore requires calibration of high-pressure gas meters, if possible, exclusively with natural gas in a high pressure test facility.
The German high pressure test facility pigsar started operation in 1993 in Dorsten.
In 1999 the German Institute of Physics and Metrology, PTB, confirmed the facility's high measurement accuracy. Since then the "German National Standard for High-pressure Natural gas" is operated by PTB at pigsar. The national standard is imbedded into pigsar's metrological infrastructure, which gives pigsar the opportunity to serve the world with calibration services with lowest uncertainties.
It was also in 1999 that the first harmonization contract between NMI and PTB was signed.
Five years later, in May 2004, I had the honour – at that time on behalf of Ruhrgas - to give some greetings on the occasion of the signature of a new contract, with France becoming a new member.
Now we welcome a new member from Denmark, joining the "club" with an independent traceability chain, which I think is a very strong symbol for further stability in high pressure gas metering.
Looking back on nearly 15 years of Harmonized Reference Value in Europe we can clearly state that here European integration is well underway.
Harmonization in natural gas measurement is of outstanding importance for the liberalized European energy market. It allows us at Open Grid Europe – and certainly at all other European TSOs – to operate our network in a transparent and well balanced way and to provide our customers with accurate and reliable energy data.
We are very pleased, that now the Danish Metrological Institute "FORCE" has joined this harmonization process as the fourth partner. And we are looking forward to welcoming more partners to the project in future.
I would like to take this opportunity on behalf of Open Grid Europe to wish PTB, NMi, LNE and the new Danish partner "FORCE" a fruitful cooperation and every success on their way towards further harmonization.
Thank you very much.

6.3.2 GRT GAZ, Frédéric VULOVIC

Ladies and Gentlemen,
I am delighted and honoured to be here with you today for the signature of Eurega and for several reasons.
Firstly as I was personally involved in the signature of the previous agreement in Paris nearly 10 years ago, I'm pleased to see the continuation of this cooperation between four European metrology institutes among the most active in the service of the industrial needs. Particularly, I would like to thank the efforts of Jean-Pierre Vallet who was in France the brain of this agreement.
Indeed, the situation of the French gas transmission operators continues to change. Ten years ago, France was essentially a country of gas consumption: many inputs and few outputs. Current projects for the development of transport capacity, especially in the north and east of the France brings GRTgaz export duty of natural gas, at short and medium-term, primarily to Belgium. This very important development for GRTgaz involves determining large amounts of energy, and thus the metering qualities. You know the sensitivity of European transmission operators about their balancing. The work of harmonization of gas meter calibration are an important benefit for us because it helps us to handle the risk of unbalancing and its devastating financial impact.
On behalf of Anne-Sophie Decaux, director of the technical and expertise centre of GRTgaz, and on behalf of the Executive Committee of GRTgaz, we want to give you our support in the agreement signed today.
Finally, I wish life long life and success in this cooperation and hope that the name Eurega is a good omen for the coming years.
Thank you for your attention!

6.3.3 Gasunie Transport Services, the Netherlands, presented by G. Blom (VSL) on behalf of GTS

'Gasunie Transport Services' of the Netherlands is a main user of the Harmonized Cubic Meter since 1999. The harmonisation issue can be compared to the European currency of the Euro. By linking the national currencies to one-another a stable, and traceable reference is present enabling and stimulating fair trade.
It is important however to have a transparent system which can deal with any questions for the market, whether it be shippers or gas clients.
Therefore it is important that the implementation of the harmonised reference and its control are well-documented and that the rules and guidelines are correct and unambiguous.
The mission of Gasunie Transport Services is to offer an independent manner and implementation of gas transmission services for a well functioning liberalized gas market.
From that perspective, in agreements with the several connected parties, custody transfer metering must always and only be based upon gas meters calibrated at facilities traceable to the European Harmonized Reference Values, as per today continued as Eurega.

6.4 Memorandum of Understanding and undersigning

6.4.1 Introduction

LNE (French Associated Laboratory for Gas Flow Measurement –LADG), PTB (German national metrological institute), VSL (Netherlands national metrological institute) and FORCE (Danish national metrological institute) will sign the "Memorandum of Understanding on collaboration to facilitate EUropean REference for GAs metering (EUREGA)". The signing of this Memorandum

represents the next consequent step with the cooperation in the field of high pressure Gas Flow measurement in Europe, which will be the future basis for so called "Harmonized Reference Value". This new memorandum succeeds and replaces the very successful cooperation "Agreement on establishing harmonized reference values for the dissemination of the unit of volume for high pressure Natural Gas" of the National Metrology Institutes PTB, VSL and LNE which is in FORCE since June 1999.
A very huge, complex and well-operated pipeline transmission grid has been established during the last 40 years here in Europe to supply all European countries with Natural Gas energy. Due to the enormous energy consumption and consequently high economic importance we are living in an environment which requires very stable and reliable measurements. For high pressure gas flow measurements, a procedure has been agreed among the leading NMIs to establish common reference values, based on different independent national traceability chains of each country which leads finally to a higher degree of stability of measurements associated with smaller uncertainty. Due to the increasing level of integration in Europe not only in economic but also in political field with all related consequences, the cooperation among international partners needs also higher level of flexibility and compatibility with the surrounding economic and political areas. Therefore, after 14 years of successful application the actual "Agreement on establishing harmonized reference values …" will have to be adapted to the new requirements and needs in the field of metrology: This Agreement will be replaced by the new "Memorandum of Understanding", which reflects the changes of situation in that past 14 years.
Moreover, this new concept of harmonization should be considered as a very progressive method to achieve progress in metrology for the benefit of gas trading in Europe (and worldwide) up to the end-user and the realization of Harmonized European Standards for other units as well.

6.4.2 Summary of the differences of the Memorandum related to previous contracts

The main improvements between the 1999 based contract between PTB, VSL and BNM(later LNE) and the new Memorandum of Understanding 'Eurega':

- The memorandum has a more open structure to enable other participants to joint more easily;
- The consortium has overgrown the status of just a 'harmonization project between a few NMI's'
- The structure of the consortium is formalized, i.e. the team of experts are giving responsibility to the board of directors;
- The consortium holds a secretariat for managing the actions, financial book keeping, quality and documentation;

The full text of the memorandum can be downloaded at the Euramet database under the TC FF project 800.

6.4.3 prerequisites to join the EUREGA

In the technical procedure attached as Annex 2 to the "*MoU signed 23 September 2013 between PTB, VSL B.V., LNE and FORCE Technology on collaboration to facilitate a European Reference for gas metering EUREGA*", the prerequisites will be defined.

6.4.3.1 Equivalency of the Traceability Chains

1. Stability of each of the realization methods needs to be demonstrated. Stability refers to the reproducibility of the Reference Values over the years.
2. The uncertainty-budget of each of the systems must be fully known, understood and mutually accepted.

3. The level of confidence that the differences between the three systems are not significant has to be established and accepted.
4. Degree of Equivalency based on historic performance and uncertainty-level, has to be established and accepted.

6.4.3.2 Schematic diagram of the work process

In the next flowchart, the complete harmonization procedure concerning the organization, relations and cyclic character is depicted.

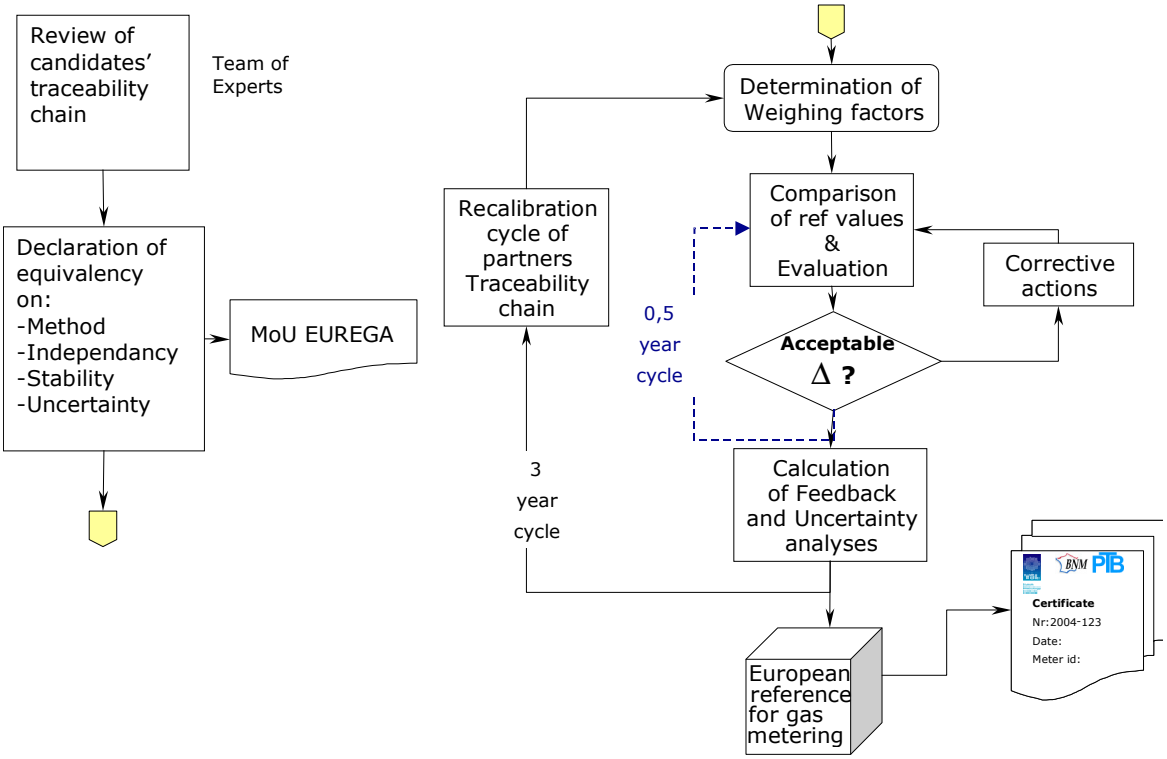

Figure 7 Schematic diagram of the process

6.4.3.3 Equivalency

A new participant shall demonstrate the independency and equivalency of this traceability-chain in operation to the members of the laboratory that have harmonized their reference values in a satisfactory way.

6.4.3.4 Reproducibility

A new participant shall demonstrate adequate reproducibility of its traceability-chain at least three times before taking part of this procedure.

6.4.3.5 Acceptance for participation

The members of the existing board shall form a technical assessment team to evaluate the results with respect to the candidate participant. The results of the comparison prior to the harmonization process shall meet the criteria in section **Error! Reference source not found.**. Consensus shall be reached with respect to acceptance of the candidate.

7 Conclusions

The ongoing cooperation between the European harmonization partners has reached a more mature status by undersigning of a Memorandum of Understanding.
Several working procedures are being formalized and the consortium 'Eurega' is open for more participants to join.
The positive effects of harmonization of reference values was demonstrated in several journals, key comparisons and conferences. The principle is highly valued by the gas trading and distribution companies in Europe and abroad. The flow community will be informed on a regular basis and a new project in Euramet is initiated with the id number #1301 'Eurega-1'. In this project, a new HRV cycle will be initiated, timeframe of this project will be 2014-2016.

8 References

D. Dopheide, B. Mickan, R. Kramer, M. P. van der Beek, *The Harmonized high-pressure Natural Gas cubic meter in Europe and its benefit for the user and metrology*, 12-16 January 2004, MSC conference

M.P. van der Beek and I.J. Landheer B. Mickan, R. Kramer, D. Dopheide, *Unit of Volume for Natural Gas at Operational Conditions, PTB and NMi VSL Disseminate "Harmonized Reference Values"*, 2003

Iman J. Landheer, Mijndert P. van der Beek, Gudrun Wendt, Thomas Kurschat ,*'The Harmonization of Reference Values for high-pressure Gas-Flow Measurements'*, 2 June 1999, Dordrecht, The Netherlands