

*XVII IMEKO World Congress
Metrology in the 3rd Millennium
June 22–27, 2003, Dubrovnik, Croatia*

**Establishing the International Acceptability
of
Flow Measurements**

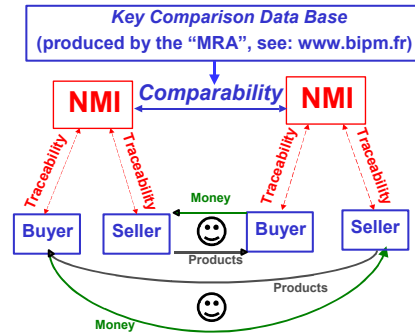
G.E. Mattingly
Chairman, CIPM* Working Group for Fluid Flow (WGFF)
and
Dep. Chf., Process Measurements Division
Chemical Science and Technology Laboratory
NIST
Gaithersburg, MD
gmattingly@nist.gov

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* International Committee for Weights and Measures

3. As today's market places expand from local and national to global and international, measurements need to be acceptable internationally; this can be achieved, via:



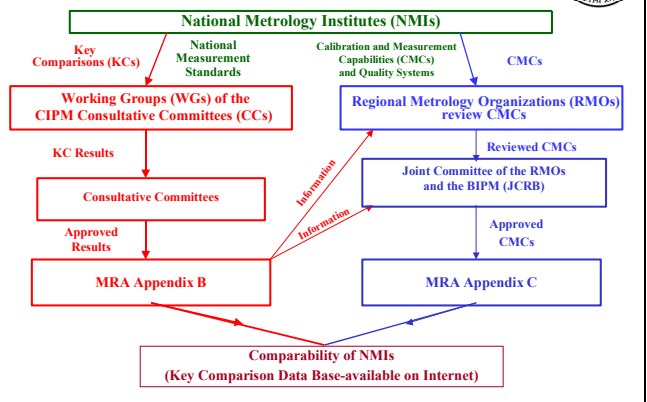
**Establishing the International Acceptability
of
Fluid Quantity and Flow Rate Measurements**

Outline:

1. Background
2. The CIPM-“MRA”-the Mutual Recognition Arrangement
3. The CIPM Working Group for Fluid Flow (WGFF)
4. WGFF Plans
5. WGFF Progress
6. Conclusions

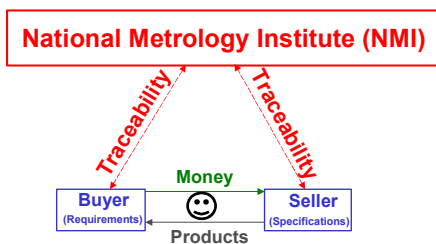


The MRA (Mutual Recognition Arrangement):



Background:

1. Buyers & sellers need “acceptable” measurements,
2. Locally and nationally:



MRA Signatories (50):

- | | |
|-----------------------|------------------------|
| <i>Argentina</i> | <i>Korea</i> |
| <i>Australia</i> | <i>Latvia</i> |
| <i>Austria</i> | <i>Lithuania</i> |
| <i>Belgium</i> | <i>Malaysia</i> |
| <i>Brazil</i> | <i>Malta</i> |
| <i>Bulgaria</i> | <i>Mexico</i> |
| <i>Canada</i> | <i>Netherlands</i> |
| <i>Chile</i> | <i>New Zealand</i> |
| <i>China</i> | <i>Norway</i> |
| <i>Cuba</i> | <i>Poland</i> |
| <i>Czech Republic</i> | <i>Portugal</i> |
| <i>Denmark</i> | <i>Romania</i> |
| <i>Ecuador</i> | <i>Russia</i> |
| <i>Egypt</i> | <i>Singapore</i> |
| <i>Finland</i> | <i>Slovak Republic</i> |
| <i>France</i> | <i>South Africa</i> |
| <i>Germany</i> | <i>Spain</i> |
| <i>Greece</i> | <i>Sweden</i> |
| <i>Hungary</i> | <i>Switzerland</i> |
| <i>Hong Kong</i> | <i>Thailand</i> |
| <i>India</i> | <i>Turkey</i> |
| <i>Ireland</i> | <i>UK</i> |
| <i>Italy</i> | <i>Uruguay</i> |
| <i>Japan</i> | <i>US</i> |

29 Countries in Boldface Type are involved in the WGFF

Int'l Orgs:
Int'l Atomic Energy Agency (IAEA)
Inst. for Refr. Mats and Msmts (IRMM)



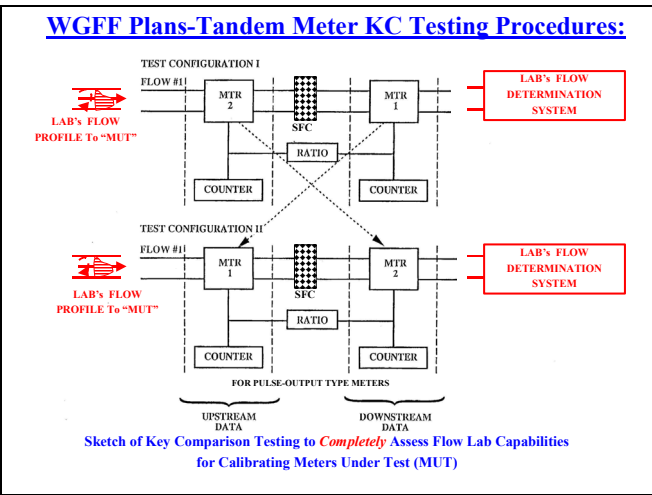
Regional Metrology Organizations (RMOs):

SIM	Interamerican Metrology System
EUROMET	European Union Metrology Cooperation
MENAMET	Middle East & North Africa Metrology
SADOMET	South African Development Cooperation in Metrology
COOMET	Bosnia, Ukraine, Belarus, Kazakhstan, Uzbekistan, Turkmenistan, et al.
APMP	Asian Pacific Metrology Program

WGFF Responsibilities

Measurand	Initiating Country	Assisting Country	Assisting Country
Water Flow	Korea	UK	Mexico
Hydrocarbon Liquid Flow	UK	Japan	US
Air Speed	Japan	Brazil	Netherlands
Volume	Mexico	Australia	Sweden
Gas Flow (High P)	Germany and The Netherlands	US	Korea
Gas Flow (Low P)	US	UK	Korea

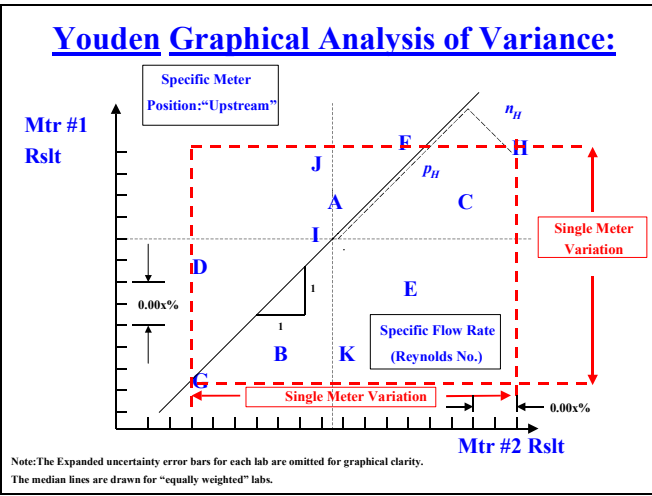
- ### CIPM Consultative Committees (CCs):
1. CCAUV-Acoustics, Ultrasound, and Vibration
 2. CCEM-Electricity and Magnetism
 3. CCL-Length
 4. CCM-Mass and Related Quantities
 5. CCPR-Photometry and Radiation
 6. CCQM-Amount of Substance
 7. CCRI-Ionizing Radiation
 8. CCT-Thermometry
 9. CCTF-Time and Frequency
 10. CCU-Units
- Working Groups:**
1. Density
 2. Mass
 3. Force (WGFF)
 4. Pressure
 5. Avogadro's Const.
 6. Hardness
 7. Fluid Flow (WGFF)
 - a. Water Flow
 - b. Hydrocarb. Liq. Flow
 - c. Air Speed
 - d. Liquid Volume
 - e. Hi-Press Gas Flow
 - f. Lo-Press Gas Flow



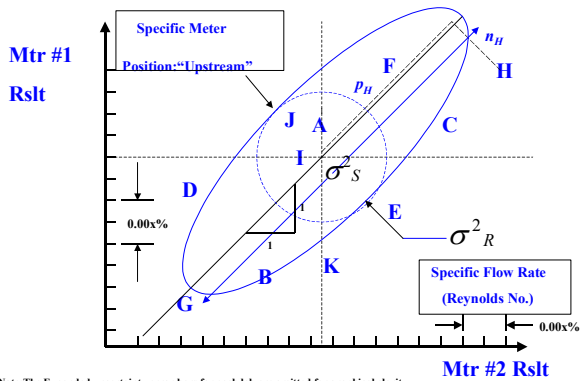
NMIs Participating

Measurand	APMP	EUROMET*	SIM
Water Flow	4	16	5
Hydr. Carb. Liq.	4	15	4
Air Speed	4	8	2
Volume	4	12	6
Gas Flow (Hi P)	4	14	2
Gas Flow (Lo P)	5	14	4

* EUROMET and COOMET



WGFF Plans-Youden Graphical Analysis of Variance:



Note: The Expanded uncertainty error bars for each lab are omitted for graphical clarity. The median lines are drawn for "equally weighted" labs.

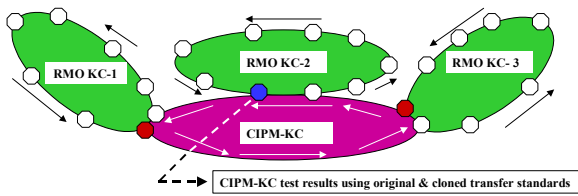
Current WGFF-KC Test Status

Measurand	Initiating Countries	Test Pipe Dia or Scale Size (mm)	Fluid & Flow Rate	Transfer Standard & Status
Water Flow	Korea	100	Water < 300 m ³ /hr	Testing Turbine and Coriolis Meters
Hydrocarbon Liquid Flow	UK	150	Kerosine 45-120 m ³ /hr	Testing of Turbine and Spindle Type PD Meters Planned
Air Speed	Japan	Wind Tunnels > 175x175 mm ²	Air 2-20 m/s	Testing Ultrasonic, Propeller, and Thermal Anemometers (2)
Volume	Mexico	50 & 100 ml & 20 L Measures	Water	Multi-Lab Reproducibility Done for 20l
Gas Flow (High P > 4bar)	Germany and The Netherlands	150	Gas < 1000 m ³ /hr	Testing of Turbine Meters Planned
Gas Flow (Low P < 4bar)	US	25	Gas 7-50 m ³ /hr	Testing of Tandem Critical Nozzles Planned

Proposed CIPM-Key Comparison Testing

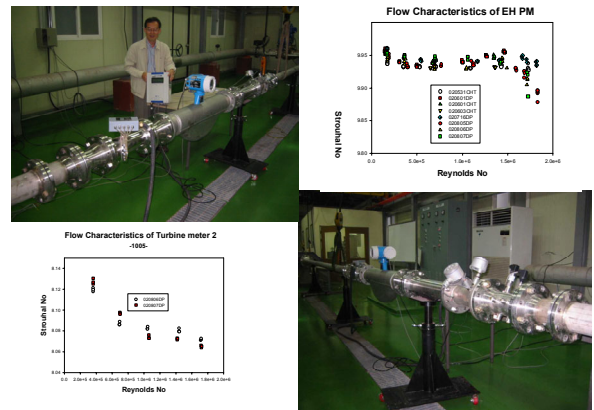
Initial Phase: Initiating Lab produces, tests, and, with WGFF approvals, clones the original transfer standard. Clones tested. KC proposed to CCM.

CIPM-KC Test Phase: Pilot [●], Pivots [●], and 3 NMIs [○] conduct CIPM-KC tests using original and cloned transfer standards; Pilot analyses data and reports results

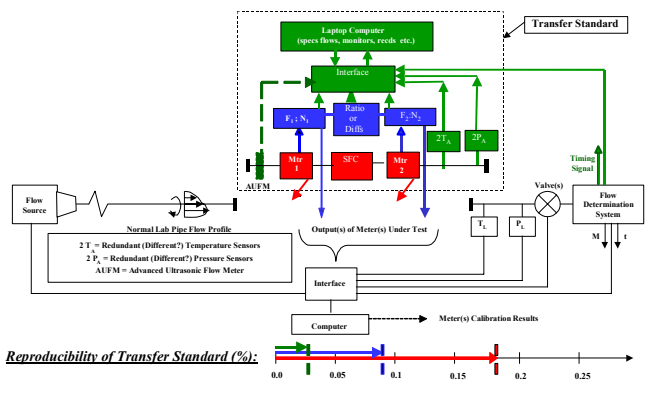


RMO-KC Phase: Pilot and Pivot Labs (3 Pilots) conduct RMO Comparisons in parallel; data analysed and reported to optimize the Comparability of all participating NMIs.

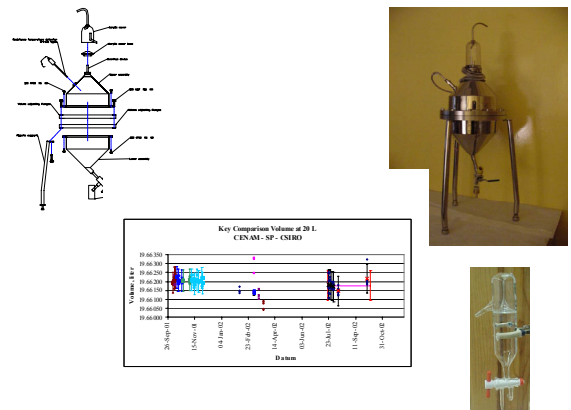
KRISS Progress on Water Flow KC



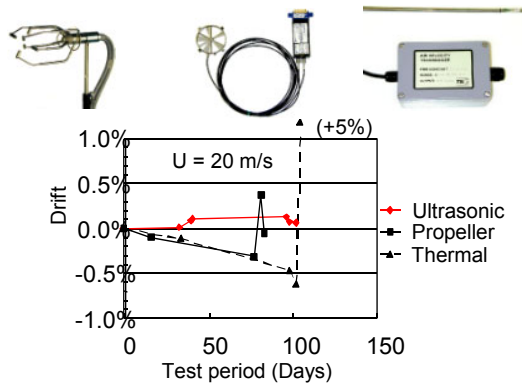
WGFF Plans to Minimize KC Transfer Standards Reproducibility:



CENAM Progress on Volume KC



NMIJ Progress on Air Speed KC



Conclusions:



1. **Goals of MRA and WGFF are realistic,**
2. **WGFF organization and plans can achieve metrological requirements for KCs,**
3. **WGFF strategies should achieve objectives within temporal guidelines,**
4. **KC Database should eliminate “measurement-based barriers” to international trade, and**
5. **Subsequent tests can expand conditions and database, as needed.**