CCM/13-02B (Update 1)

Appendix 4 (CCM Strategy)
KEY COMPARISON TABLES

Metrology Area CCM

Date updated 1 March 2013

Colour codes:	KC Completed	KC In Progress	KC Planned

Table 1
Completed Comparisons and comparions under way

Sub Area	Reference No.	Description	Pilot (Coordinating) Laboratory / Number of praticipants	Start date	Status	Comments	Horizon for repeating (or not) with timeline	How far does the light shine?	Estimate of resouces in person months (PM) for piloting and particpating (per particpant) if known
Density	CCM.D-K1	Density measurements of a silicon sphere	NMIJ / 8	2001	Approved for equivalence, Results available				
Fluid Flow	CCM.FF-K1	Water flow	KRISS / 6	2003	Approved for equivalence, Results available				
Fluid Flow	CCM.FF-K2	Liquid hydrocarbon flow Flow: 5 L/s to 30 L/s	TUVNEL / 6	2005	Approved for equivalence, Results available				
Fluid Flow	CCM.FF-K3	Air speed	NMIJ / 4	2005	Approved for equivalence, Results available				
Fluid Flow	CCM.FF-K4	Liquid volume Water volume: 100 mL, and 20 L	CENAM / 8	2003	Approved for equivalence, Results available				
Fluid Flow	CCM.FF-K5.a	Natural gas at high pressure Flow rates: from 65 m^3/h up to 1000 m^3/h Pressure: 10 bars, 20 bars, and 47 bars	VSL/PTB / 3	2004	Approved for equivalence, Results available				
Fluid Flow	CCM.FF-K5.a.1	Natural gas at high pressure Flow rates: from 65 m^3/h up to 1000 m^3/h Pressure: 63 bars	PTB / 2	2006	Approved for equivalence, Results available				
Fluid Flow	CCM.FF-K5.b	Compressed air and nitrogen Flow rates: from 65 m^3/h up to 1000 m^3/h Pressure: 5 bars, 10 bars, 20 bars, and 40 bars	LNE-LADG/PTB / 5	2004	Approved for equivalence, Results available				
Fluid Flow	CCM.FF-K6	Low pressure gas flow Pressure < 4 10^5 Pa	NIST / 7	2005	Approved for equivalence, Results available				
Fluid Flow	CCM.FF-K4.2.2011	Liquid volume Liquid volume: 100 µL	IPQ / 8	2011	Approved for equivalence, Results available				
Fluid Flow	CCM.FF-K5..a.2	Natural gas at high pressure Flow rates: from 900 m^3/h up to 6500 m^3/h Pressure: 5.0 MPa to 7.0 MPa	PTB / 2	2009	Approved for equivalence, Results available				
Force	CCM.F-K1.a	Low force measurements Force: 0 kN, 5 kN and 10 kN	MIKES / 16	2000	Approved for equivalence, Results available				
Force	CCM.F-K1.b	Low force measurements Force: 0 kN and 5 kN	MIKES / 16	2000	Approved for equivalence, Results available				
Force	CCM.F-K2.a	Medium force measurements Force: 0 kN, 50 kN and 100 kN	NPL / 11	2004	Approved for equivalence, Results available				
Force	CCM.F-K2.b	Medium force measurements Force: 0 kN and 50 kN	NPL / 5	2004	Approved for equivalence, Results available				
Force	CCM.F-K4.a	Very high force measurements Force: 0 MN, 2 MN and 4 MN	NIST / 7	2002	Approved for equivalence, Results available				
Force	CCM.F-K4.b	Very high force measurements Force: 0 MN and 2 MN	NIST / 3	2002	Approved for equivalence, Results available				

Gravimetry	CCM.G-K1	Free-fall acceleration	BIPM / 11	2009	Approved for equivalence, Results available				
Hardness	CCM.H-K1.a	Hardness (Vickers 0.2) Hardness: 240 HV, 540 HV and 840 HV	PTB / 10	2001	Approved for equivalence, Results available				
Hardness	CCM.H-K1.b	Hardness (Vickers 1) Hardness: 240 HV, 540 HV and 840 HV	PTB / 10	2001	Approved for equivalence, Results available				
Hardness	CCM.H-K1.c	Hardness (Vickers 30) Hardness: 240 HV, 540 HV and 840 HV	PTB / 10	2001	Approved for equivalence, Results available				
Mass Standards	CCM.M-K1	Comparison of mass standards Mass: 1 kg	BIPM / 15	1995	Approved for equivalence, Results available				
Mass Standards	CCM.M-K2	Comparison of mass standards Mass: 100 mg, 2 g, 20 g, 500 g and 10 kg	PTB / 14	1998	Approved for equivalence, Results available				
Mass Standards	CCM.M-K3	Comparison of mass standards Mass: 50 kg	LNE / 14	2001	Approved for equivalence, Results available				
Mass Standards	CCM.M-K3.1	Comparison of mass standards Mass: 50 kg	LNE / 2	2009	Approved for equivalence, Results available				
Mass Standards	CCM.M-K5	Comparison of mass standards Mass: 200 mg, 1 g, 50 g, 200 g and 2 kg	NMIJ / 19	2000	Approved for equivalence, Results available				
Pressure	CCM.P-K1.a	Pressure measurements, Phase A1 (gauge mode) Pressure: 50 kPa to 1 MPa	PTB / 4	1995	Approved for equivalence, Results available				
Pressure	CCM.P-K1.b	Pressure measurements, Phase A2 (gauge mode) Pressure: 50 kPa to 1 MPa	LNE / 4	1995	Approved for equivalence, Results available				
Pressure	CCM.P-K1.c	Pressure measurements, Phase B (gauge mode) Pressure: 80 kPa to 7 MPa	INRIM/NIST / 5	1998	Approved for equivalence, Results available				
Pressure	CCM.P-K2	Pressure measurements (absolute mode) Pressure: 10 kPa to 120 kPa	NPL / 9	1998	Approved for equivalence, Results available				
Pressure	CCM.P-K3	Pressure measurements in gas, ultra-high vacuum (absolute mode) Pressure: 3 µPa to 0.9 mPa	NIST / 5	1998	Approved for equivalence, Results available				
Pressure	CCM.P-K4	Pressure measurements in gas (absolute mode) Pressure: 1 Pa to 1000 Pa	NIST / 7	1998	Approved for equivalence, Results available				
Pressure	CCM.P-K5	Pressure measurements in gas (gauge mode) Pressure: 1 Pa to 1000 Pa	NIST / 4	1998	Approved for equivalence, Results available				
Pressure	CCM.P-K6	Pressure measurements (gauge mode) Pressure: 10 kPa to 120 kPa	NPL / 7	1998	Approved for equivalence, Results available				
Pressure	CCM.P-K7	Pressure measurements in oil (gauge mode) Pressure: 10 MPa to 100 MPa	PTB / 9	2003	Approved for equivalence, Results available				
Pressure	CCM.P-K13	Hydraulic gauge pressure: 50 MPa to 500 MPa	PTB / 7	2008	Approved for equivalence, Results available				
Pressure	CCM.P-K12	Leak rates Flow rate of helium leak artefacts Temperature: 23 °C	PTB / 11	2007	Approved for equivalence, Results available				
Torque	CCM.T-K1	Torque measurements 500 N m, 1000 N m	PTB / 8	2005	Approved for equivalence, Results available				
Torque	CCM.T-K1.1	Torque measurements 500 N m, 1000 N m	PTB / 2	2007	Approved for equivalence, Results available				
Viscosity	CCM.V-K1.A	Viscosity measurements of standard liquids Standard liquid A, kinematic viscosity: 10 mm^2/s Temperature: 20 °C	PTB / 18	2002	Approved for equivalence, Results available				
Viscosity	CCM.V-K1.B1	Viscosity measurements of standard liquids Standard liquid B1, kinematic viscosity: 1300 mm^2/s Temperature: 20 °C	PTB / 17	2002	Approved for equivalence, Results available				
Viscosity	CCM.V-K1.B2	Viscosity measurements of standard liquids Standard liquid B2, kinematic viscosity: 400 mm^2/s Temperature: 40 °C	PTB / 16	2002	Approved for equivalence, Results available				

Viscosity	CCM.V-K1.B3	Viscosity measurements of standard liquids Standard liquid B3, kinematic viscosity: 40 mm^2/s Temperature: 100 °C	PTB / 9	2002	Approved for equivalence, Results available				
Viscosity	CCM.V-K1.C	Viscosity measurements of standard liquids Standard liquid C, kinematic viscosity: 40000 mm^2/s Temperature: 20 °C	PTB / 14	2002	Approved for equivalence, Results available				
Viscosity	CCM.V-K2.A	Viscosity measurements of standard liquids Standard liquid A Temperature: -40 °C, -20 °C, and 20 °C	CANNON / 14	2006	Approved for equivalence, Results available				
Viscosity	CCM.V-K2.B	Viscosity measurements of standard liquids Standard liquid B Temperature: 20 °C, 100 °C, and 150 °C	CANNON / 14	2006	Approved for equivalence, Results available				
Viscosity	CCM.V-K2.1	Viscosity measurements of standard liquids Standard liquid close to standard liquid B used in CCM.V-K2.B Temperature: 20 °C, 60 °C, and 100 °C	VSL / 6	2008	Approved for equivalence, Results available				
Density	CCM.D-K2	Density of liquids Temperature: 5 °C to 60 °C Atmospheric pressure	PTB / 8	2004	Report in progress, Draft B				
Density	CCM.D-K3	Solid density standards	NMIJ / ?	2011	Planned				
Density	CCM.D-K4	Hydrometers	INRIM / 11	2011	Report in progress, Draft A				
Fluid Flow	CCM.FF-K2.1.2011	Hydrocarbon liquid and water flow Flow: 10 kg/min to 60 kg/min	VSL / 8	2011	Protocol complete				
Fluid Flow	CCM.FF-K3.2011	Air speed	LNE-CETIAT/PTB / 5	2012	Planned				
Fluid Flow	CCM.FF-K4.1.2011	Liquid volume Liquid volume: 100 mL, and 20 L	CENAM / 10	2011	In progress				
Fluid Flow	CCM.FF-K5.2011	High-Pressure Gas Flow Air / nitrogen / natural gas Pressure: from 0.1 MPa to 8.8 MPa	PTB / 8	2011	Planned				
Fluid Flow	CCM.FF-K6.2011	Low pressure gas flow	SMU / 13	2011	Report in progress, Draft A				
Force	CCM.F-K2.a.1	Medium force measurements Force: 50 kN and 100 kN	NPL / 3	2010	In progress				
Force	CCM.F-K3.b	High force measurements Force: 0 MN and 0.5 MN	PTB / 9	2005	Report in progress, Draft A				
Force	CCM.F-K3.a	High force measurements Force: 0 MN, 0.5 MN and 1 MN	PTB / 6	2005	Report in progress, Draft A				
Hardness	CCM.H-K2	Brinell Hardness	KRISS/NMIJ / 7	2003	Report in progress, Draft A				
Hardness	CCM.H-K3	Hardness Rockwell C (HRC) scale	INRIM / 4	2011	Planned				
Mass Standards	CCM.M-K4	Comparison of mass standards Mass: 1 kg	BIPM / 17	2011	In progress				
Mass Standards	CCM.M-K6	Comparison of mass standards Mass: 50 kg	CENAM / 10	2011	Protocol complete				
Mass Standards	CCM.M-K7	Comparison of mass standards Mass: 500 mg, 5 g, 10 g, 100 g and 5 kg	KRISS / ?		Planned				
Pressure	CCM.P-K3.1	Pressure measurements in gas, ultra-high vacuum (absolute mode) Pressure: 3 µPa to 9 mPa	NIST / 2	2009	Measurement complete				
Pressure	CCM.P-K4.2012	Pressure measurements in gas (absolute mode) Pressure: 1 Pa to 10 kPa	NIST / 7	2012	Protocol complete				
Pressure	CCM.P-K12.1	Leak rates Flow rate of helium leak artefacts Temperature: 23 °C	MIRS/IMT/LMT / 2	2012	Planned				
Pressure	CCM.P-K14	Comparison of absolute pressure in the range 0.1 mPa to 1 Pa Pressure: 0.1 mPa to 1 Pa	METAS / 7	2010	Report in progress, Draft A				
Pressure	CCM.P-K14.1	Comparison of absolute pressure in the range 0.1 mPa to 1 Pa Pressure: 0.1 mPa to 1 Pa	METAS / 2	2011	Protocol complete				
Torque	CCM.T-K1.2	Torque measurements 500 N m, 1000 N m	PTB / 2	2007	Report in progress, Draft A				
Torque	CCM.T-K1.3	Torque measurements 0 N m to 2000 N m	KRISS / 2	2010	In progress				
Torque	CCM.T-K2	Torque measurements 20 kN m	PTB / 6	2005	Report in progress, Draft B				
Gravimetry	CCM.G-K2	Free-fall acceleration	METAS / 12	2010	In progress				

Notes: the pre-MRA "Approved for provisional equivalence" KCs are not reported

Table 2 Planned comparions including on going BIPM comparions

Sub Area	Reference No.	Description	Pilot (Coordinating) Laboratory	Expected Start date	Estimate of resouces in person months (PM) for piloting and particpating (per particpant)	Rational for Key Comparison	Interested /agreed/expressed by:	How far does the light shine?	Special aspects related to logistics
Hardness	CCM.H-KXX	Shore	*VNIIFTRI*	2013	6/pilot (1/participants)	improve traceability and equivalency among NMIs and verification of the new primary definitions	VNIIFTRI, NIM		
Hardness	CCM.H-KXX	Leeb	*PTB*	2013	6/pilot (1/participants)	improve traceability and equivalency among NMIs and verification of the new primary definitions	PTB, NIM		
Hardness	CCM.H-KXX	Brinell Hardness	*NMIJ, KRISS*	2014	6/pilot (1/participants)	improve traceability and equivalency among NMIs and verification of the new primary definitions	NMIJ, KRISS, INRIM, NIST, INMETRO, PTB, NIM, NIMT, VNIIFTRI		
Hardness	CCM.H-KXX	Vickers Hardness	*PTB, INRIM*	2015	6/pilot (1/participants)	improve traceability and equivalency among NMIs and verification of the new primary definitions	NMIJ, KRISS, INRIM, NIST, INMETRO, PTB, UME, NIM, NIMT, VNIIFTRI		
Hardness	CCM.H-KXX	Rockwell B and N scales	*NIST, PTB, INRIM*	2015	6/pilot (1/participants)	improve traceability and equivalency among NMIs and verification of the new primary definitions	NMIJ, KRISS, INRIM, NIST, INMETRO, PTB, UME, NIM, NMIT, VNIIFTRI		
Viscosity	CCM.V-K3.A	Viscosity	NMIJ	2012	6/pilot, 1/participant	improve traceability and equivalency among NMIs	CENAM, GUM, IPQ, LNE, NIM, NIS, NMIJ, PTB, SMU, UME, VSL, NMISA, SIRIM, KEBS		
Viscosity	CCM.V-K3.B	Viscosity	NMIJ	2012	6/pilot, 1/participant	improve traceability and equivalency among NMIs	CENAM, GUM, IPQ, LNE, NIM, NIS, NMIJ, PTB, SMU, UME, VSL, NMISA, SIRIM, KEBS		
Viscosity	CCM.V-K3.C	Viscosity	NMIJ	2012	6/pilot, 1/participant	improve traceability and equivalency among NMIs	CENAM, GUM, IPQ, LNE, NIM, NIS, NMIJ, PTB, SMU, UME, VSL, NMISA, SIRIM, KEBS		
Viscosity	CCM.V-KXX	Viscosity	?	2018	6/pilot, 1/participant	improve traceability and equivalency among NMIs	same as above plus additional participants		
Fluid Flow	CCM.FF-KXXX	Hydrocarbon liquid and water flow	unknown	2019	6/pilot (1/participants)	Demonstrate equivalence to support CMCs, improve flow standards	unknown		
Fluid Flow	CCM.FF-KXXX	Air speed	unknown	2019	6/pilot (1/participants)	Demonstrate equivalence to support CMCs, improve flow standards	unknown		
Fluid Flow	CCM.FF-KXXX	Liquid volume Liquid volume: 100 µL, 100 mL, and 20 L	unknown	2019	6/pilot (1/participants)	Demonstrate equivalence to support CMCs, improve flow standards	unknown		
Fluid Flow	CCM.FF-KXXX	Liquid volume Liquid volume: 100 µL	unknown	2019	6/pilot (1/participants)	Demonstrate equivalence to support CMCs, improve flow standards	unknown		
Fluid Flow	CCM.FF-KXXX	High-Pressure Gas Flow Air / nitrogen / natural gas	unknown	2019	6/pilot (1/participants)	Demonstrate equivalence to support CMCs, improve flow standards	unknown		
Fluid Flow	CCM.FF-KXXX	Low pressure gas flow	unknown	2019	6/pilot (1/participants)	Demonstrate equivalence to support CMCs, improve flow standards	unknown		
Pressure	CCM.P-K3.XXXX	Pressure measurements in gas (absolute mode) Pressure: 1E-9 Pa to 1E-4 Pa	*NMIJ*	2014	8/pilot (2/participants)	test equivalence among NMIs	CMI, NIST, NMIJ, PTB, ...		
Pressure	CCM.P-KXX	Differential pressure 0 to 500 kPa; line pressure 7 MPa to 20 MPa	KRISS and PTB	2014	2/pilot, 1/participant	Improve traceability and equivalency among NMIs	KRISS, PTB, NMIJ, NIST, LNE, INRIM, CENAM,		
Pressure	CCM.P-KXX	Negative gauge – gas, 0 kPa to -95 kPa	To be defined	2016	2/pilot, 1/participant	Improve traceability and equivalency among NMIs	KRISS, PTB, NMIJ, NIST, LNE, INRIM, CENAM, CEM		
Pressure	CCM.P-KXX	Relative pressure, 4 MPa to 20 MPa	To be defined	2018	2/pilot, 1/participant	Improve traceability and equivalency among NMIs	KRISS, PTB, NMIJ, NIST, LNE, INRIM, CENAM, CEM, INMETRO, NIM		
Pressure	CCM.P-KXX	absolute and gauge pressure, 100 kPa to 7 MPa	To be defined	2020	4/pilot, 2/participant	Improve traceability and equivalency among NMIs	KRISS, PTB, NMIJ, NIST, LNE, INRIM, CENAM, CEM, INMETRO, NIM		
Density	CCM.D-KXX(5?)	Absolute volume measurements by optical interferometry	NMIJ	2014	6/pilot, 2/participants	clarifying the correctness of absolute density scales at NMIs	discussed in WGD meeting, not yet agreed		
Density	CCM.D-KXX(6?)	Vibrating-tube densimeter	?	2015	6/pilot, 1/participants	improve reliability and equivalency among NMIs	discussed in WGD meeting, not yet agreed		
Density	ppT properties	Density measurement under high pressure	?	2017	6/pilot, 1/participants	efficiency improvement of heat pump systems, energy industries	discussed in WGD meeting, not yet agreed		
Density	Refractive index of liquids	Measurement of refractive index of liquids	?	2018	6/pilot, 1/participants	sugar industry, food industry and agriculture	discussed in WGD meeting, not yet agreed		