Calibration Laboratory Assessment – Dynamic Case Studies – For Betterment

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Abstract-

Measurements play important role & Measurement Correctness or Traceability of measurements is assured by Calibration. The calibration establishes traceability of measurement & Calibration Data without measurement Uncertainty is incomplete. International Standards as IEC25 of the past or ISO/IEC17025 of the present have been the guidance documents all over the world for Test & calibration Laboratories.

Accreditation Bodies Evaluate the Performance of the CAB/Calibration Laboratories and Grants Accreditation by adoption of Methodology specific to its own. This Methodology /Approach /Guidance likely to differ due to reasons not under control and may be risky in some circumstances.

Perhaps, The Methodology /Approach have both Positive & Negative Impacts. Needless to address the Positive impact, as the Objective is to promote International Acceptability of the Product & Services. However, the Negative Impact that has Very Adverse effects for measurement Traceability & Measurement Uncertainty needs Immediate Attention as to improve the Quality of Services.

This paper is compilation of Two Case studies of C-0022 & C-0085 in to single entity addressing realistic issues from open source data for betterment

Index Terms-

Laboratory Assessment, CMC, Measurement Traceability & Uncertainty Propagation, Conformity Assessment Body- CAB.

Introduction-

Measurement is Comparison between known (Standard) & unknown (Device under Calibration) and "CMC "is the Best Measurement Capability in Calibration Terminology. Measurement is a must establishing the relation between two variables (alone Source or alone Measure is not all helpful.)

Splitting of the CMC in to source and measure has serious issues and the same is addressed as case studies in the following.

In case, Accreditation Body encourages two different CMCs, One for Sourcing & Another for Measurement then, there is Very High Risk, as laboratories or CABs seeking Accreditation get in to equipment specifications and the same gets transferred to CMC s – making the objectives of Assessment null & Void. This compiled Case study is the Dynamic Status of the Existing System based on the open source /published data from the websites.

Objectives & Methodology:

1. To review the existing scenario of laboratory assessment methods implemented in India by NABL
2. To identify the root causes of poor Assessment.
3. To provide a solution for qualitative Assessment for laboratory performance.

Scenario of Laboratory assessment in India

The calibration laboratory assessment in India is characterized by,

1. Inadequate or poor assessment capabilities of NABL -Assessors
2. Extremely Poor or Non responsive nature of the Assessment Body - This case study itself is a realistic example where in there has not been any response from NABL in spite of availability of Case Study data over than 30days (from july 3rd) that too keeping ILAC, APLAC & IAF in mail communication loop .
3. Poor coordination or isolation among the team members of NABL
4. Excessive bias for Government third party calibration laboratories even though they totally depend upon the private infrastructure (test & measuring equipment used for calibration activity are not being manufactured by Government)
5. totally confused methodology of assessment

6. Lack of professional approach or dynamism & Non - use of modern IT infrastructure, is it mails, or web updates.
7. Data that of "Getting Accreditation is a time consuming & Intricate procedure –K.Srimoolanathan – Calibration manager, Accurate Co .Pvt Ltd "If we had more governing bodies apart from NABL for Facilitating the Accreditation Process, It might have been faster and smoother –

Source: my.labgo.in/k-srimoolanathan-calibration-manager-accurate-co-pvt-ltd-bangalore/

Above is the status in India with regard to accreditation.

Risk Assessment & Analysis:

As The Accreditation Body Encourages two different CMCs, One for Sourcing & Another for Measurement then, laboratories seeking Accreditation adopts the following.

Laboratories or CABs Copies Sourcing Equipment Specification under Source Category & Measuring Equipment Specification under Measure Category & Project the same as CMC as per NABL 121 clause 3.0 (Source & Measure Concept).

Technical Auditor Checks only "Correctness of Reproduction of Data with reference to applied scope and Specifications." If correct then, CMC (Equipment Specification in this specific context) is recommended. NABL grants/Publishes Recommended CMC while CMC equals Manufacturers specification limit of equipment & Not at all the Calibration Measurement Capability.

Due to this approach, the Technical Evaluation /Assessment levels has been at zero level (Realistic Evidences are these case studies itself.) Too much documents are generated without interrelations leading to unorganized & useless data.

Data Collection:

The open source data from www.nabl-india.org has been collected for analysis and compilation of these case studies. Copy of the Case studies has also been shared over mail to NABL , APLAC & ILAC for Improvements during the 1st and 3rd weeks of July 2017.

1. http://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=1114
2. http://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=1573

1. Report C-0022 for Electronics Test & Development Centre, Bangalore, India - under direct control of Government of India –
Contains 13 pages covering DC V & I, AC V&I, Ω, C, L, Power, Frequency, RF Attenuation, VSWR/Reflection coefficient etc. – As Evidenced, the laboratory copied Measuring Equipment Specification from page 1 to 6 & Sourcing Equipment Specifications from page 6 to 13 - Projected the same as CMC,(Appendix-i)

2. Report C-0085 for Institute for Design of Electrical Measuring Instruments, Mumbai, India - under direct control of Government of India
Contains 19 pages covering DC V & I, AC V&I, Ω, C, L, Power, Frequency, RF Attenuation, VSWR/Reflection coefficient etc. – As Evidenced, the laboratory copied Sourcing Equipment Specification from page 1 to 11 & Measuring Equipment Specifications from page 12 to 19 - Projected the same as CMC

Lack of Standardization has lead to Non uniformity of Data presentation as noticed here- This can be improved by Adoption and Enforcement of Templates- by Accreditation Body.

Data Organization:

The available data has been analyzed for measurement activities of

DC voltage –low and high, DC current Low & high, AC voltage –low and high, AC current Low & High, Resistance, Capacitance, Inductance, Temperature simulation, Oscilloscope, Power DC & AC and Energy

During Assessment, The laboratories are required to demonstrate measurement through established traceability and arriving at measurement uncertainty by carrying out the measurement task and not by copied Equipments Specification.

For clear understanding, the data / activity is organized in tabular format.

Analysis:

SL. NO.	DATA OF C0022	FACTS (Error in Evaluation & Grant of CMC – Due to Unrealistic CMCs & Cases of Output Measurement Uncertainty is lower than Input sourcing uncertainty - That is against the Measurement Science)
1A	Page No.1 declares CMC of 0.46% for 15KV DC voltage measurement by the use of HV Probe Fluke 80F15 (That accepts 10 M Ω input Resistance meter and has got Accuracy of ±2%) along with DMM 34401(Agilent that has got Input Resistance of 10M Ω±1%)	With this combinational set up of probe of 2% , and Meter Input R of 1%, The Uncertainty of Measurement (k=2) for 15 KV DC voltage cannot be better than(that too, considering Type A component =0) Exp Measurement **Uncertainty = 2*√ (2%+1%) = 3.5%** Hence Reported CMC of 0.46% un realistic.
1B	Page No.6 Declares DC sourcing capability of 8.7KV making use of DC Reference STD Fluke 7004, (gives out Low voltages of 1 & 10V), MFC 4808 Datron (gives out 1KV DC), MFC Fluke 5720A (gives out 1KV DC) Null detector AVM2000 (Cannot generate any voltage)& Reference divider 80F15 (Voltage probe referred above and cannot generate any voltage)	8.7KV DC voltage with this Equipment set up cannot be generated - IMPOSSIBLE TASK - so is the measurement uncertainty of 0.46% Even with series connection of sources (No calibration laboratory does this on account of risk) the maximum voltage available would be 1000+1000+10+1=2011volts Hence Reported CMC of 0.46% un realistic.
2	DC Current (Low) Page No.3 Declares CMC of 150 ppm to 50ppm for measurement of DC current of 1nA to 100nA While Page No.7 Declares CMC of 0.2% (2000 ppm) to 53 ppm for Sourcing of DC 1nA to 100nA	Input Sourcing uncertainty is 2000ppm for 1nA while the CMC or measurement uncertainty is 150ppm (Approximately 13.33 times lower than sourcing uncertainty) UNREALISTIC &IMPOSSIBLE
3	DC 1microvolt Page No.1 Declares CMC(k=2) of 1.26% CMC for measurement of 1uV DC with equipments of DC Reference Standard Fluke 7000N, Reference divider Fluke 752, MFC Datron 4808, HV Probe 80F15, DMM 34401A	The noise voltage of the DMM 34401A / itself is 13uV for 10 MΩ input impedance and 40uV for 100GΩ with 1 KHz Bandwidth. The Manufacturer / Designer only guarantee equipment Performance from 10 to 120% of the range. – This "Trend "continues unless the immediate corrective Measures are taken. Unrealistic Measurement Uncertainty of 6.3nV for 1uV DC Measurement
4A	DC Power Page No.3 Declares CMC of 0.005% to 0.012% for measurement of DC Power 100ma to 20A -100mV to 1000V (10mW to 20KW) by showing 8 ½ digit Digital Multi Meter Fluke 8508A	Clear-cut information that No Measurement is done. As Power measurement involves measurement of Voltage & Current simultaneously (8 ½ Digit Digital Multimeter cannot do this specific task) For Demo, the CAB is required to connect the output of Fluke 5520(source) to the input of Fluke 8508 (measuring equipment) to indicate the Measurement capability & Uncertainty. The above specific configuration is impracticable for demonstration – & Hence integrity of the assessment is questionable
4B	Page No.9 Declares CMC of 0.02% to 0.032 % CMC for DC Power 100ma to 20A - 100mV to 1000V (10mW to 20KW) by showing Fluke 5520A	

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Analysis:

SL. NO.	DATA OF C0022	FACTS (Error in Evaluation & Grant of CMC – Due to Unrealistic CMCs & Cases of Output Measurement Uncertainty is lower than Input sourcing uncertainty - That is against the Measurement Science)
5A	DC Current (High) Page No.1 Declares limitations of DC current measurement up to 100Amps only and can no longer measure currents > 100Amps.	CMC shall cover the "Measurement Range "that is demonstrated and not the sourcing capability. Sourcing Uncertainty is basically that of Equipment, in this specific context, applicable to Fluke 5500/5520 with current coil and the manufacture`s limits is 1%
5B	Page No.7 Declares the CMC of 0.35% (3500ppm Sourcing of DC current of 1000A	Even adoption of Sourcing capability, the CMC cannot be better than 1% CMC OF < 0.52% is challenging, and value of 0.35% could not be achieved by Fluke Corporation (A2LA certificate No.2166.01 valid up to April 30, 2018)
6A	DC Resistance Page No.2, Declares CMC of 240 ppm for 1 G Ω & 0.11% CMC for 1 T Ω for DC Resistance Measurement	For 1 GΩ the sourcing /Input uncertainty is 250ppm while overall measurement uncertainty is < 240ppm
6B	Page No.8, Declares CMC of 250 ppm for 1 G Ω & 0.13% CMC for 1 T Ω for Input or Sourcing for the above activity of DC Resistance	For 1 TΩ the sourcing /Input uncertainty is 0.13% While overall measurement uncertainty is < 0.11%. – Output uncertainty is lower than Input uncertainty- Unrealistic
7A	AC Energy Page No.9, Declares CMC of 0.05% to 0.2% at power line frequency of 50Hz for AC Energy, Extract of page 9 is as below (Equipment specifications are 50Hz, 60V to 240V,100ma to 50A (1.2W to 12 KW)	Energy Units are kWh and not kW. Gross error of not understanding the units of Energy by all the parties, CAB being the first, Auditor being the second, NABL being the third .- of technical Assessment / Assessment or Calibration Measurement Capability.
7B	No addressable measurement capability up to page 8 of this Certificate. (Concept of Measure totally vanished here..?)	Calls for serious Review of activities
8A	AC voltage , Page No.1, Declares CMC of 35 ppm For measurement of 100V at 1 KHz AC voltage	The measurement uncertainty has become half (35ppm) of input uncertainty (70ppm)
8B	Page No.6, Declares CMC of 70 ppm for generation of 100V at 1 KHz	Unrealistic measurement
9A	Inductance. Page No.2, declares CMC of 1.2% for 10uH, 0.053% for 100uH, o,o15% for 100mH and 0.032% for 10 H at 1KHz	The contribution of comparison instrumentation is zero
9B	Page No.9, declares CMC of 1.2% for 10uH, 0.053% for 100uH, o,o15% for 100mH and 0.032% for 10 H at 1KHz	- Difficult to Justify
10A	AC Power Page No.3, declares CMC of 120 ppm to 140ppm @50Hz, for voltage Range of 60to 240Volts, current range of 10ma to 50A, & power range of 0.6Watt to 12KWatts Under measure	The measurement uncertainty has become ¼ (120ppm) of input uncertainty (500ppm) at a specific point on the lower side. The measurement uncertainty has become 0.1% or 1/10th (140ppm) of input uncertainty (1800ppm) at a specific point on the lower side
10B	Page No.9, Declares CMC of 0.05% (500ppm) to 0.18% (1800ppm) @50Hz, for voltage Range of 60 to 240Volts, current range of 10ma to 50A, & power range of 0.6Watt to 12KWatts Under Source	Unrealistic measurement

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Analysis:

SL. NO.	DATA OF C0022	FACTS (Error in Evaluation & Grant of CMC – Due to Unrealistic CMCs & Cases of Output Measurement Uncertainty is lower than Input sourcing uncertainty - That is against the Measurement Science)
11A	AC Power factor Page No.3, declares CMC of 135ppm @50Hz, Power Factor of 0.2 to 1 (cos)	This Confirms that Measurement are not done but got CMC? Conflicting & confusing data. The Knowledgeable user fails to arrive at conclusions in making use of Services of the Laboratory (CAB) & Accreditation body As the power factor value is 0 to 1 (phase angle cannot extend beyond +90 to -90 degrees).
11B	Page No.9, declares CMC of 0.025 degrees @50Hz, Power Factor of 0.2 to 1 (cos) ±180 degrees...?	
12A	Capacitance, Page No.3, declares CMC of 16 ppm to 5 ppm for Capacitance measurement of 1pF to 100pF at 1KHz, CMC of 5ppm to 150ppm from 100pF to 1uF CMC of 750ppm (0.075%) for 1Farad at 1KHz	For lower capacitance - The Measurement Uncertainty has become 16 ppm - 1/3rd of input uncertainty /sourcing uncertainty of 50ppm at 1pF. Even 16ppm of 1 PF accounts to 16 atto Farads. (16X10-18 F) The stray capacitance value is much higher as understood by measurement professionals. For Higher capacitance-, the measurement uncertainty has become 0.075% with Input sourcing uncertainty of 0.13% Unrealistic measurement
12B	Page No.8, declares CMC of 50 ppm to 5 ppm for Capacitance Sourcing of 1pF to 100pF at 1KHz, CMC of 5ppm to 60ppm from 100pF to 1nF CMC of 5ppm to 150ppm from 1nF to 1uF CMC of 1300ppm (0.13%) for 1Farad @1KHz	
13A	Inductance , Page No.2,(Measure concept) declares CMC for 10 to 100uH= 1.2 to 0.053% CMC for 100uH to 100mH= 0.053 to 0.015% CMC for 100mH to 10 H= 0.15 to 0.032%	Precise copy of each other, input uncertainty as source and output uncertainty as measure - Real challenge to the Measurement professionals- Logical approach. 1 uH – with 1.2% uncertainty equals to 12nH(k=2) While the actual uncertainty of measurement would be 6nH – IMPRACTICAL SITUATION
13B	Page No.9, (Source concept) declares CMC for 10 to 100uH= 1.2 to 0.053% CMC for 100uH to 100mH= 0.053 to 0.015% CMC for 100mH to 10 H= 0.15 to 0.032%	
14A	Temperature simulation ,Page No.10, declares CMC of 0.03 °C to 0.56 °C For Temperature measurement (confusing statement of source capability in this page even though this indicate measure capability) For K,J,E,T,N,R,S,B,C,L & U THERMOCOUPLES with DATRON 4808 calibrator	No measurement is done as there is no Measuring equipment Thermocouples have got sensitivity of approximately 40uV/°C, (best sensitivity being base metal thermocouples of k type) In case of use of DMM of 1281 as indicated under page 13 for RTD, the noise voltage is around 13 uV and this corresponds to 0.3 °C, Since the noble metal thermocouples sensitivity is low, the Measurement uncertainty cannot remain the same UNCERTAINTY OF 0.03 °C IS UNREALISTIC
14B	Page No.13, declares CMC of 0.03 °C to 0.56 °C for Temperature Source. (confusing - source /Measure -? capability in this page even though this indicate measure capability) For K,J,E,T,N,R,S,B,C,L & U THERMOCOUPLES with DATRON 4808 calibrator	
15A	OSCILLOSCOPE (source category)- Page No.10, The CAB has been given - CMC of 0.1% to 0.0353% (353ppm) for Vertical deflection CMC of 0.4% (353ppm) for Horizontal deflection of 450ps to55 sec - Using Wavetek 9500.	No measurement was done with oscilloscope ,Instead – Oscilloscope calibrator specifications are copied at Both the locations. No one, be it the Auditor, or be it the Auditee, have analyzed this (as None of them are knowledgeable on this) Together, collectively pushed the Oscilloscope Calibration Equipment Specifications to Accreditation body. The Accreditation body did grant CMC as per the page No.1 data (without evaluating correctness /capabilities of auditee/auditor)
15B	OSCILLOSCOPE (source category)- Page No.13 The CAB has been given CMC of 0.1% to 0.0353% (353ppm) for Vertical deflection CMC of 0.4% (353ppm) for Horizontal deflection of 450ps to55 sec - Using Wavetek 9500.	
Further analysis of C0022 - has not at all been optimistic from the objectives of Quality system Requirements - Hence stopped at this stage and taken up C0085.		

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Analysis:

SL. NO.	DATA OF C0085	FACTS (Error in Evaluation & Grant of CMC – Due to Unrealistic CMCs & Cases of Output Measurement Uncertainty is lower than Input sourcing uncertainty - That is against the Measurement Science)
A	DC voltage Page No.12 declares CMC of 10ppm for 10mV with same copy paste equipment of page1	As Measurement Uncertainty of 10ppm (k=2) or 50 nV - at 10mV is Unrealistic as 10ppm of 10 mV corresponds to 100 nano Volts (k=2). The Actual measurement Uncertainty becomes 50nano volts. Impractical To have uncertainty of 50nV as the Thermal noise itself is in excess of 12 uV with this setup. (Equipment of Page 1 or Page 12) Unrealistic measurement
B	Page No.12 Declares CMC of 0.7% for 10uVolts Measurement. with same copy paste equipment of page1 More critical element than Sl.No.1 above	As Measurement Uncertainty of 0.7% (k=2) or 35 nV - at 10uV is Unrealistic as 0.7% of 10 uV corresponds to 70 nano Volts (k=2). The Actual measurement Uncertainty becomes 35nano volts. Impractical To have uncertainty of 35nV as the Thermal noise itself is around 12 uV with this setup. (Equipment of Page 1 or Page 12) Unrealistic measurement
C	Page No.12 Declares CMC of 4ppm for 1050Volts Measurement. While, the actual sourcing Uncertainty for the same voltage of 1050 volts is double the value and equals to 8 ppm	Output CMC= 4 ppm, Input CMC= 8ppm –Unrealistic , Clear indicative of Not carrying out Measurement & Poor Understanding of Traceability of measurement. Unrealistic measurement
D	DC High Voltage , Page No.12 Declares CMC(k=2) of 1.4 % for measurement of 100kV While Page No.11 Declares CMC(k=2) of 1.5 % for generation of 100kV	Output CMC= 1.4% ppm, Input CMC= 1.5% – Conflicting statements –Raises " Doubt on measurement process Integrity Unrealistic measurement
E	DC Current , Page No.1 Declares CMC of 500ppm (0.05%) for sourcing current of 1pA , However the Lab cannot measure the same -The Lab can do the same measurement with CMC of 1.5% as indicated in Page 12	As the Accreditation body cannot assure, cannot confirm, and cannot validate the sourcing uncertainty (without measurement the sourcing uncertainty can be confirmed..?) If at all the validation is required , the uncertainty of measurement cannot be better than 1.5% as indicated in measure capability Everything went by specification "Copy & Paste " and not by measurement with traceability This continues to be the degree of damage if left unattended.

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Analysis:

SL. NO.	DATA OF C0085	FACTS (Error in Evaluation & Grant of CMC – Due to Unrealistic CMCs & Cases of Output Measurement Uncertainty is lower than Input sourcing uncertainty - That is against the Measurement Science)
F	DC Current (High) , Page No.1 Declares CMC of 0.2% for 1000Amps CMC of 150ppm (0.015%) for 100Amps Current under source category. Page No.12 Declares CMC of 0.15% for 1500Amps CMC of 20ppm(0.002%) for 100Amps Current under Measure category.	Error in Evaluation & Grant of CMC, As The output measurement Uncertainty is lower than Input sourcing uncertainty - which is against the Measurement Science. Non Demonstration of 1500 amps measurement capability as the source itself is not there. - First truth. The available High current source itself is 1000Amps that too with uncertainty of 0.2% and obtained CMC of 0.15% (The output measurement Uncertainty is lower than Traceable Input Uncertainty – against the measurement Science) More shocking is that the laboratory has got 100Amps source capability with Uncertainty of 150ppm, if asked to measure the same the Lab has achieved 20ppm CMC - IMPROVEMENTS BY 7 FOLDS -Unrealistic measurement
G1	DC Resistance, Page No.12, Declares CMC of 0.1% for 1 T Ω & 1.5% for 100 T Ω for DC Resistance Measurement	For 1 T Ω the sourcing /Input uncertainty is 2.37% while overall measurement uncertainty is 0.1%..? For 100 TΩ the sourcing /Input uncertainty is 3% While overall measurement uncertainty is 1.5 %. Clarity does not exist in respect of..! What stops the laboratory not to make use of best infrastructure if available for lower CMC or – What drives the laboratory to opt for wider CMC in spite of availability of infrastructure other than lack of knowledge?
G2	Page No2 , Declares CMC of 2.37% for 1 T Ω & 3 % CMC for 100 T Ω for Input or Sourcing for the above activity of DC Resistance	
H	Input (Source) uncertainty is 3% for 100 Tera ohms as per page No. 2 - The traceable CMC for the same measurement Function is 1.5%as per page No.12	As The output measurement Uncertainty is lower than Input sourcing uncertainty - Which is against the Measurement Science- Unrealistic measurement
I	Measurement capability for 10 Peta ohms as per page No. 12 is not validated as there is no way of verification - evidenced by page No.2 Limited to 100 Tera ohms	The output measurement Uncertainty is lower than Input sourcing uncertainty - which is against the Measurement Science. Unrealistic measurement

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Analysis:

SL. NO.	DATA OF C0085	FACTS (Error in Evaluation & Grant of CMC – Due to Unrealistic CMCs & Cases of Output Measurement Uncertainty is lower than Input sourcing uncertainty - That is against the Measurement Science)
J1	AC voltage , Clarity is missing in the Report itself 800 ppm at 1KHz of 2mV or 1MHz 2mV or 10 ppm at 1MHz 20Volts ? in page No.12	The output measurement Uncertainty is lower than Input sourcing uncertainty - which is against the Measurement Science. The measurement uncertainty has become 0.08% (800ppm) while input uncertainty0.62% (6200ppm). Unrealistic measurement - Poor understanding of law of propagation of Measurement Uncertainty Unrealistic measurement
J2	The Lab got of CMC of 800(0.08% to 10 pmm for measurement of this above vide page no. 12 whose traceable uncertainties are 6200ppm (0.62%) to 20 ppm. Needs immediate Attention	
K	Capacitance, Uncertainty of measurement are same as that of Range as in page no.5 & 6	Questionable Evaluation & Grant of CMC, As measurement Uncertainty is same as the Range. Poor Processing
L1	OSCILLOSCOPE (source category) Page No.7, Unrealistic CMC of 3 ppm at 1 ns This is equivalent to measurement of 1 nano second with 3 fempto seconds expanded measurement uncertainty Totally unrealistic..?	Error in Evaluation & Grant of CMC No measurement was done with oscilloscope ,Instead – Oscilloscope calibrator specifications are copied Partially in this specific case where as in C-0022 is perfect Copy & Paste (ctrl C & ctrl V) No one, be it the Auditor, or be it the Audited, have analyzed this (as - None of them are knowledgeable on this)
L2	OSCILLOSCOPE (no measure category with reference to that of c-0022) The Logical / illogical thinking of Source & measure has vanished in c-0085 as compared to c-0022	Together, collectively pushed the Oscilloscope Calibration Equipment Specifications to Accreditation body. The Accreditation body did grant CMC as per the page No.1 data (without evaluating correctness /capabilities of Auditee/auditor) Poor Processing
Further analysis has not at all been optimistic from the objectives of Quality system Requirements - Hence stopped at this stage.		

Improvements:

Methodology – Addressed further …

Way forward in improvement of services and methodologies (For implementation)

To do	Not to do	Remarks / Benefits
Have measurement points for CMCs in the order of either 1-2-5 sequence or in decade sequence, for example DC Voltages ,adopt 1,10,100microvolts or 1,10,100 milli volts or 1,10.100 Kilo volts as the case may be DC Currents , adopt 1,10,100 pA or 1,10,100nA / or 1,10,100uA or 1,10,100mA /or 1,10,100A or 1,10,100KA as the case may be Resistances, adopt Adopt 1,10,100uΩ or 1,10.100mΩ /or 1,10,100Ω or 1,10,100KΩ / or1,10,100MΩ or 1,10,100GΩ /or 1,10,100TΩ as the case may be Capacitance, adopt Specify test frequency as 100Hz,1KHz, 10KHz,100KHz or 1MHz and capacitance values can range from 1 pF to 1 F as the case maybe Same logic/methodology holds good for AC voltages & currents - wherein one can standardize voltage /current and test frequencies	Shall not grant CMC for Sourcing as it is only endorses the copied specifications that too without any verification/ validation For reasons explained. Shall not grant CMC for Measure as it is only endorses the copied specifications that too without any verification/ validation For reasons explained.	In general , The sourcing/Input uncertainty of any lab is basically- The measurement capability of some other lab that calibrates the sources of the lab under assessment. Assigning the CMC of some other lab to the lab under assessment is illogical Adoption of specific measurement points brings standardization both in terms of Measurement Traceability & Uncertainty of Measurement This practice, if enforced will automatically makes the laboratories to focus on measurement capabilities and not dependent on equipment specifications The Measurement points are grouped in to critical(needs expertise) and non-critical (generic) categories and it becomes easier for evaluation

Sample Evaluation sheet/Template is as below

Template for Simplification & Ease of Evaluation of Calibration Lab CMC's- Voltage-Current & Resistance											
CMC to be filled in , the units -same as multiplier & The Measurementparameter											
Multiplier	R in Ω	DC Parameters		AC Voltage in Volts @				AC Current in A @			
		Current	Voltage	100Hz	1kHz	100kHz	1MHz	100Hz	1kHz	100kHz	1MHz
1atto	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
10a	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
100a	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
1femto	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
10f	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
100f	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
1pico	Limit	Check?	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
10p	Limit	Check?	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
100p	Limit	Check?	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
1nano	Limit	Check?	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
10n	Limit	Check?	Check?	Limit	Check?	Check?	Check?	Check?	Check?	Check?	Limit
100n	Check?	Check?	Check?	Check?	Check?	Check?	Check?	Check?	Check?	Check?	Check?
1 µ				Check?		Check?	Check?	Check?	Check?	Check?	
10 µ				Check?							
100 µ				Check?							
1milli											
10m											
100m											
1											
10											Check?
100											Check?
1kilo					Check?	Check?	Limit	Check?	Check?	Check?	Limit
10k		Check?			Limit	Check?	Limit	Check?	Check?	Check?	Limit
100k		Check?	Check?	Check?	Limit	Check?	Limit	Check?	Check?	Check?	Limit
1Mega		Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
10M		Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
100M		Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
1Giga		Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
10G		Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
100G		Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
1Tera		Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
10T	Check?	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
100T	Check?	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
1 Peta	Check?	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
10P	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
100P	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
1Exa	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit

10E	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
100E	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit
1Zeta	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit

Template for Simplification & Ease of Evaluation of Calibration Lab CMC's Inductance & Capacitance											
CMC to be filled in , the units -same as multiplier & The Measurementparameter											
Multiplier	Inductance in H @ test frequencies of					Capacitance in F @ test frequencies of					Remarks
	100Hz	1kHz	100kHz	1MHz	10MHz	100Hz	1kHz	100kHz	1MHz	10MHz	
1pico	Limit	Limit	Limit	Check?	Limit	Limit	Limit	Check?	Check?	Check?	
10p	Limit	Limit	Limit	Check?	Limit	Limit	Limit				
100p	Limit	Limit	Limit	Check?	Limit	Check?	Check?				
1nano	Limit	Limit	Check?	Check?	Limit	Check?					
10n	Limit	Check?	Check?	Check?	Check?						
100n	Check?										
1 µ											
10 µ											
100 µ											
1milli											
10m										Check?	
100m						Check?	Check?		Check?	Limit	
1				Check?	Check?	Limit	Limit	Check?	Limit	Limit	
10		Check?	Check?	Limit	Limit	Limit	Limit	Limit	Limit	Limit	
100	Check?	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	
1kilo	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	
10k	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	
100k	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	
1Mega	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	Limit	

Color Notation:

Limit indicates Theoretical Limits, CAB to specify CMC in the green band (units same as that of parameter & Multiplier)

Not practically realizable	To be checked / verified	Practicable , CMC s can be arrived at

Note/Remarks

This becomes Professional way of reporting CMC s & reflects the true measurement capability of the laboratory.

CAB /Laboratory is required to report the CMC in the matrix considering the parameter and nearest value –

Other cells are of X or? ;

This sample template, can also be adopted for vide spectrum of measurement parameters as, Power (DC, AC, RF), Pressure, Temperature, Dimensional, Mass and much more.

Add any other information as applicable / relevant.

APPENDIX

APPENDIX-I: C-0022 HTTP://WWW.NABL-INDIA.ORG/NABL/INDEX.PHP?C=SEARCH&M=SEARCHLABCERTIFICATE&CNO=1114

APPENDIX-II: C-0085 http://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=1573

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www.ilac.org;
www.nabl-india.org ;
www.euramet.org ;
www.keysight.com;
http://www.fluke.com/
www.tek.com/sites/tek.com/files/media/document/resources /LowLevelHandbook_7Ed.pdf ;

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[5] Calibration philosophy in Practice M/s Fluke

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