Oscilloscope Calibration & Laboratory Accreditation –Assignment of Unrealistic CMCs & CAPA

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Abstract-

*Measurements are Essential & Measurement Correctness or Traceability of measurements is assured by Calibration. There are millions of Calibration laboratories that claim & perform calibration of oscilloscopes and claim superiority over others by virtue of Accreditation. This Paper gives insight in to the Quality of Assessment of Labs by the Accreditation body through analysis of **"Open Source Data"** available in **"Public Domain"** – objective being "Enlightenment" to Customers, Suppliers & Stake holders (MRAs - Mutual Recognition Agreement) with the objective of **"Do Better"** rather than **"Doing Better"***

*Accreditation Bodies are required to "**Evaluate**" the **"Performance of Calibration Laboratory"** and grant **"Accreditation"** by adoption of **"Correct Methodology"**. This Methodology differs due to **Poor Transparency** and is **Risky** in most of the circumstances as **Evidenced in these Case Studies.***

The methodology that has Negative Impact on measurement Traceability & Measurement Uncertainty needs Immediate Attention to improve the Quality of Services, International Acceptability of the Product & Services and reputation of Assessment Body.

*This paper is compilation of **"10+1" Realistic Case Studies** on "Assignment of Unrealistic CMCs for oscilloscope calibrations " of CC- **2031**, **CC- 2137**, **CC- 2491**, **CC- 2728**, **CC- 2800**, **CC- 2811 CC-2074** ,**CC -2130** ,**CC-2287** & **CC- 2855 + CC- 2049** in to single entity addressing realistic issues in **Do or Die Situation** as **to be Alive**.*

Index Terms-

*Laboratory Assessment, CMC- Calibration measurement Uncertainty (lowest measurement uncertainty during calibration), Measurement Traceability & Uncertainty Propagation, **CAB**- **C**onformity **A**ssessment **B**ody, **CAPA** - **C**orrective **A**nd **P**reventive **A**ctions, **NABL**- **N**ational **A**ccreditation **B**oard for testing and Calibration **L**aboratories – India.*

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 (**Lonely Source** or **Lonely Measure** **is neither meaningful nor helpful**.)*

*Splitting of the CMC in to source and measure has **Serious Issues** and the same is addressed as Case*

Studies (Eye Opener) in the following.

As the Accreditation Body encourages two different CMCs, One for Sourcing & Another for Measurement , The laboratories seeking Accreditation Copies Equipment specifications & the same was Copied as CMC s – making the objectives of Assessment null & Void. This compiled Case study is the Dynamic Status of the Existing System with High Risk factors -

Data Source:

Open Source /Published Data from the Accreditation Body website. https://nabl-india.org/

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. *Giving insight in to the operations of Assessment/Evaluation*
4. *Solution for qualitative Assessment for laboratory performance if corrections are welcome & also ,*
5. *making users to understand what they are getting for the service they are paying …*

Scenario of Laboratory Assessment in India (over more than 20 years)

The Calibration Laboratory Assessment in India is characterized by:

1. *Inadequate or poor assessment capabilities of NABL –Assessors*
2. *Totally confused methodology of assessment*
3. *Lack of professional approach or dynamism & Non - use of modern IT infrastructure, is it mails, or web updates.*
4. *Poor coordination or isolation among the team members of NABL*
5. *Not being responsive – but being reactive...that too after prolonged delays…in other words extremely Poor or Non responsive nature of the Assessment Body –*
6. *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)*
7. *Easy go , don't care attitude and adopting delaying tactics …*

Risk Assessment & Analysis:

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

Laboratories Copies Sourcing Equipment Specification under Source Copies Measuring Equipment Specification under Measure Category - Project the same as CMC as per NABL Unique Practice

(Earlier document number NABL-121 clause 3.0 Source & Measure Concept- Habits die hard).

Non knowledgeable 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 PRACTICE, 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 Accreditation Certificates from Open Source data from https://nabl-india.org/ is analyzed and compiled to arrive at factual data (10+n) Realistic certificates issued vide certificate numbers & Web links).

Certificate Number.	*URL address*	*Data Reference*
CC- 2031	https://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=2160	*Sl No.19 of Page 6*
CC- 2137	https://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=1835	*Sl No.6 of Page 2*
CC- 2491	https://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=2022	*Sl No.11 of Page 6*
CC- 2728	https://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=1838	*Sl No.17 of Page 7*
CC- 2800	https://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=453	*Sl No.12 of Page 5*
CC- 2811	https://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=1114	*Sl No.15 of Page 13*
CC-2074	https://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=3179	*Sl No.6 of Page 2*
CC -2130	https://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=1834	*Sl No.11 of Page 5*
CC-2287	https://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=1573	*Sl No.17 of Page 12,*
CC- 2855	https://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=97	*Sl No.11 of Page 7*
CC- 2049	https://www.nabl-india.org/nabl/index.php?c=search&m=searchlabcertificate&cno=1918	*Sl No.9 of Page 2*

Note: Public domain Open source data (non- confidential) Analysis for Improvements

Data Organization:

Required data for Analysis is extracted from the above certificates without any distortion and organized in tabular format to have clear insight in to the activity –

Certificate	CC- 2031	CC- 2137	CC- 2491	CC- 2728	CC- 2811
Valid till	01.01.2021	10.02.2021	05.12.2019	21.06.2020	01.09.2020
Sl.No Ref.	19 of Page 6	6 of Page 2	11 of Page 6	17 of Page 7	15 of Page 13
Parameter					
Vertical deflection	1mV to 130V (1MΩ)	5mV to 210V (1MΩ)	2mV to 100Vp (1MΩ)Square wave	5mV to 200V (1MΩ)Square wave	6mV to 210V (1MΩ) Square wave
	1mV to 6.6V (50Ω)	1mV to 5.56V (50Ω)	1mV to 100V (1MΩ)DC	1mV to 200V (1MΩ)DC	3mV to 220V (1MΩ) DC
CMC- NABL	1.04 to 0.1%	0.4 to 0.05%	0.5 to 0.058%	0.6 to 0.15%	0.035 to 0.5%
Time base	2ns to20ms 20ms to 5 s	1ns to 55s	1ns to 5s	1ns to 55s	450ps to 55s
CMC- NABL	0.00025 to 0.0025%	0.1 to 10ppm	50ppm	0.30ppm	0.4ppm(calibrator spec is 10ppm?)
Bandwidth	Up to 3 GHz	Up to 1.1 GHz	Up to 1100MHz	Up to 40GHz	Up to 8GHz
CMC- NABL	2 to 5%	2.5 to 4%	2.9 to 5.5%	3 to 4%	2.5 to 8%

Certificate	CC- 2800	CC-2074	CC -2130	CC-2287	CC- 2855
Valid till	05.08.2020	01.01.2021	21.05.2020	30.08.2020	25.09.2020
Sl.No Ref.	12 of Page 5	6 of Page 2	11 of Page 5	17 of Page 12	11 of Page 7
Parameter					
Vertical deflection	6mV to 60v (1MΩ) Square wave	2mV to 5V	1 to 100mV	1mV to 130V (1MΩ)	1mV to 130V Vpktopk
			0.1 to 190V	1mV to 6.6V(50Ω)	
CMC- NABL	0.31 to .12%	0.0005 to 0.001%	0.21 to 0.03%	5 to 0.15%	0.1 to 0.25%
Time base	10ns to 10 ms	1ns to 5s	1ns to 5s	1ns to 20ms	1ns to 5 s
				50ms to 5s	
CMC- NABL	0.01%	0.0011to 0.005%	0.0001 to 0.00003%	3 ppm to 0.6%	2.5 ppm
Bandwidth	Up to 2 GHz	Up to 25 GHz	Upto 26 GHz	Upto 1.1 GHz	Upto 600 MHz
CMC- NABL	2.3 to 6.7%	0.0047 to 0.056dB	0.22 to 0.45 dB	3 to 5%	1.5 to 5%

Activity:

During Assessment, The laboratories are required to demonstrate measurement through established traceability and arriving at measurement uncertainty by carrying out the measurement task, Specific to oscilloscope calibration or accreditation or assignment of CMC – the following is a must

Right way/ Methodology:

Connect the output of the Scope calibrator to an Oscilloscope, *Perform* ***the measurements with the oscilloscope &Arrive at the measured values & measurement uncertainty considering the Repeatability (Type-A evaluation), Input Uncertainty & Readout resolution (Type -B evaluation)***

Available Facts/Data - (Process mapping)

- *All laboratories have "oscilloscope calibrators "of Fluke make to be used..? for calibration of oscilloscopes by " DIRECT METHOD"*
- *No intermediate equipments are required due to the above fact but with exception for bandwidth > 1100MHz*
- *The Device under calibration must be an" oscilloscope" to be meaningful.*
- *All oscilloscopes have got universal template of 8 vertical divisions & 10 horizontal divisions.*
- *The effective area for calibration in the best case is 7 (5 – most popular)for vertical & 9 (5-most popular) divisions*
- *The readout resolution /least count for Analog Oscilloscopes is 1/5 division (0.2) & cannot exceed 0.02 for digitizing scopes.*

Vertical Deflection - Analysis

1. *Best measurement uncertainty with the above factors for Vertical Deflection is (resolution)/ (full scale)= (0.2/7)*100=2.857% for analog scopes – hence the manufacturer will not claim better than 3%*
2. *Best measurement uncertainty for digitizing scopes is (resolution)/ (full scale)=(0.02/7)*100=0.2857% – hence the manufacturer will not claim better than 0.3%*
3. *CMC value < 0.3% for vertical deflection system is un-realistic*

Horizontal Deflection – Analysis

4. *Best measurement uncertainty with the above factors for Horizontal Deflection is (resolution)/ (full scale)=(0.2/9)*100=2.22% for analog scopes – hence the manufacturer will not claim better than 3%*
5. *Best measurement uncertainty for digitizing scopes is (resolution)/ (full scale) =(0.02/9)*100=0.22% – hence the manufacturer will not claim better than 0.25% .*
6. *CMC value < 0.25% for Horizontal deflection system is un-realistic*

Putting the points 3&6 together

CMC value < 0.3% for vertical deflection system & < 0.25% for Horizontal deflection system are Un-realistic

Checking up the data for Vertical Deflection System:

Certificate	CC- 2031	CC- 2137	CC- 2491	CC- 2728	CC- 2811
Vertical deflection	1mV to 130V(1MΩ)	5mV to 210V(1MΩ)	2mV to 100Vp(1MΩ) Square wave	5mV to 200V(1MΩ) Square wave	6mV to 210V (1MΩ) Square wave
	1mV to 6.6V(50Ω)	1mV to 5.56V(50Ω)	1mV to 100V(1MΩ)DC	1mV to 200V(1MΩ)DC	3mV to 220V (1MΩ) DC
CMC- NABL	**1.04% to 0.1%**	**0.4% to 0.05%**	**0.5 to 0.058%**	**0.6 to 0.15%**	**0.035 to 0.5%**
Theoretical limit ≥0.25% Hence					
Inference	**0.1% is False**	**0.05% is Fake**	**0.05% is False**	**0.15%is Fake**	**0.035% is False**

Certificate	CC- 2800	CC-2074	CC -2130	CC-2287	CC- 2855
Vertical deflection	6mV to 60v(1MΩ) Square wave	2mV to 5V	1 to 100mV	1mV to 130V(1MΩ)	1mV to 130V Vpktopk
			0.1 to 190V	1mV to 6.6V(50Ω)	
CMC- NABL	**0.31 to 0.12%**	**0.0005 to 0.001%**	**0.21 to 0.03%**	**5 to 0.15%**	**0.1 to 0.25%**
Theoretical limit ≥0.25% Hence					
Inference	**0.12% is Fake**	**0.0005% is False**	**0.05% is Fake**	**0.15%is False**	**0.035% is Fake**

Checking up the data for Horizontal Deflection System:

Certificate	CC- 2031	CC- 2137	CC- 2491	CC- 2728	CC- 2811
Time base	2ns to20ms 20ms to 5 s	1ns to 55s	1ns to 5s	1ns to 55s	450ps to 55s
CMC- NABL	**0.00025 to 0.0025%**	**0.1 to 10ppm**	**50ppm**	**0.3 ppm**	**0.4ppm**
Theoretical limit ≥ 0.25% Hence					
Inference	**0.00025% is Fake**	**0.1ppm is False**	**50ppm is Fake**	**0.3ppm is False**	**0.4ppm is Fake**

Certificate	CC- 2800	CC-2074	CC -2130	CC-2287	CC- 2855
Time base	10ns to 10 ms	1ns to 5s	1ns to 5s	1ns to 20ms	1ns to 5 s
				50ms to 5s	
CMC- NABL	**0.01%**	**0.0011to 0.005%**	**0.0001 to 0.00003%**	**3 ppm to 0.6%**	**2.5 ppm**
Theoretical limit ≥ 0.25% Hence					
Inference	**0.01% is False**	**0.0011% is Fake**	**0.00003% is False**	**3ppm is Fake**	**2.5ppm is False**

Bandwidth measurements and associated CMC Analysis:

Certificate	CC- 2031	CC- 2137	CC- 2491	CC- 2728	CC- 2811
Bandwidth	Up to 3 GHz	Up to 1.1 GHz	Up to 1100MHz	Up to 40GHz	Up to 8GHz
CMC- NABL	2 to 5%	2.5 to 4%	2.9 to 5.5%	3 to 4%	2.5 to 8%

Certificate	CC- 2800	CC-2074	CC -2130	CC-2287	CC- 2855
Bandwidth	Up to 2 GHz	Up to 25 GHz	Upto 26 GHz	Upto 1.1 GHz	Upto 600 MHz
CMC- NABL	2.3 to 6.7%	0.0047 to 0.056dB	0.22 to 0.45 dB	3 to 5%	1.5 to 5%

Simple glance on the above data indicates the following

1. *The CMC indicated is for frequency or level?*
2. *There has not been any oscilloscope designed & manufactured with bandwidth exceeding 20GHz- hence the question of measurement, witnessing, auditing is ruled out, so is the data pertaining to CC-2728 of 40GHz, CC-2074 of 25GHz , CC-2130 of 26GHz is unrealistic.*
3. *The lab CC- 2811 is not in possession of 8GHz oscilloscope – hence the question of measurement, witnessing, auditing is ruled out - so is the data.*

Root causes Analysis & CAPA

Root cause	Corrective action	Preventive Action
Nothing was done,	Make the team to correct the defects- Accountability issue	MRA – is the tool to correct the defects
None, the Lab, the Auditor, the Auditee or NABL has got the requisite knowledge.		Training a must / required for all the people involved
The diehard habit of "source & measure"	Wipe off this concept from all documents including the accreditation certificate	Drive shall be from IAF/ILAC/APLAC as the Local body does Nothing
Not taking accountability of actions to repair the damage caused.	Recover back the cost from the auditor – terminate the services	Have a Template as recommended
Nor willing to learn – keeping knowledgeable people out of NABL	Beg – Barrow – or buy concept nothing is free in the world.	**To be driven/ initiated by IAF / ILAC / APLAC to respect MRA**
Somehow, push forward nature of domestic laboratories.	Don't insist for Accreditation unless the Accreditation body is correct	
Not getting exposed to realistic case studies,	This is one such Case study- Can help...more to come	
Excessive delays in responding and extremely long understanding /learning time	Put system in place- Time frame response – a Must	

Impact Analysis:

1. **Poor Assessment quality- leading to poor quality of services from the laboratories and undue & ugly competition to be the top money making laboratory leaving ethics.**
2. **Excessive useless certifications and pages of documentation that never helps the industry – the international published under reference (4) is an eye opener – but has not resulted in adaption of the Good Calibration/measurement practices as recommended there in with the present " existing system"**
3. **Unless the international community (IAF, ILAC, APLAC) drives – "Everything remains where it was" justifying Newton`s First Law of motion.**
4. **Technical evaluation activity becomes purchasing power rather than knowledge power.**

Acknowledgements:

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