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Calibration - An Awareness Required

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Calibration is a subject that is extremely essential in the field of construction, especially in India, where people possess knowledge but do not fully utilize it, and others lack the necessary knowledge.. This is a preliminary activity that we will have to carry out at the beginning of each project. And unfortunately, in India, specially, it is being observed that this is being ignored. Various concession being asked for not to fulfill the requirement of calibration as per national or international standard. Mostly it is observed that people are habitual in saying that it is calibrated by factory. I am sorry to say that in spite of knowing the requirements, people are trying to convenience the wrong practice. This inspired me rather urge me to choose this subject firstly for my writing.

Yes, the subject calibrations is taken so lightly even by renowned construction company in India and their qualified engineers. Surprisingly the same company and their engineers work outside India and act completely different. The calibrations is a subject every project, start with the first activity. Whether you start a civil job, a mechanical job, whether you are doing some instrumentation job, the calibration is an essential, rather, inherent process. There is also people who do not know what is calibration. I have encountered during my 37 years of working in QA/QC with various national / international company. .the thing that most hurts me that, in spite of knowing the requirement of calibration, people were asking concession. Calibration is a process which required a reference as per ISOI/EC17025. We require to have all the measuring instrument to be calibrated. Problem about the calibration is people does not know why it is required. What is calibrations and how to issue a calibration certificate? So let me start to explain briefly.

Why we require calibration. Let me explain with an example. Imagine you are flying abroad carrying just allowed luggage. But at Airport check in counter they declare it is excess by 5 Kg and it is $100 per Kg. Is it not a joke to you? Is it not a pain to you to spend $500. Upon investigation, it is found that calibration due date is over of weighing machine two years back.The only thing that you know with certainty is that Airlines have essentially cheated the customer unknowingly. Calibrating tools and equipment should give us the confidence that devices are measuring correctly, in this case weighing, the way they are supposed to .

Another example – We almost everybody buy dress materials from various shop. Suppose the measuring scale or tape having error of 1 cm in a meter scale or tape. Can you judge by your naked eye? Whereas the shop owner is making profit knowingly or unknowingly. Suppose he sell 1000 meter of cloth , what is his extra profit . It is 10meter and if per meter cost is INR600 then profit (extra) is INR6000.

Hence Calibration , Why we require calibration.

- **A)** Right and proper calibration reduces the cost of manufacturing error i.e reduce cost of non-quality.
- **B)** Calibration Keeps Processes Safe. When measuring any parameter, such as force or electric current, it is important that the quantities being measured are accurate to maintain product safety.
- **C)** Every measuring instruments shall perform within the limit of accuracy. Continues to deliver the required accuracy. Where adjustment is possible, a device measuring outside of expected limits should be brought back to an acceptable performance level, which is directly related to CALIBRATION .But in the case of non-adjustable equipment the deviation or measurement performance should be recorded and sent for re-calibration.
- **D)** Calibration is important because it helps ensure accurate measurements, and accurate measurements are foundational to the quality, safety and innovation of most products and services we use and rely on every day. Few people realize the critical role and importance of calibration in their daily lives. But calibration improves assurance of precise measurements.
- **E)** Suppose you clamp meter having some error while measuring current. It will be detrimental during welding.

Now, there is a big question , whether we shall recognise factory calibration or not. For that we need to know what factory calibration is.

Factory calibration is certification of equipment performance as per factory specification. As long as factory calibration is not supported by a traceable master calibrator, there is no evidence of sanctity of calibration. Hence if factory calibration certificate does not show any traceability, we shall not consider factory calibration certificate.

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There are few manufacturer who provides a calibration certificate traceable to a master calibrator or there calibration laboratory is accredited by some national or international agency, example NABL in India.

Now what is accredited agency or laboratory? It is a formal approval or recognition, considering the agency has the capabilities, necessary resources and technical competence to perform said activities.

In India there is National Accreditation Board for Testing and Laboratories .i.e.-NABL.

In international level we have “ILAC”; “UKAS” etc.

Next step is to identify a right calibration certificates. We have to review the calibration certificate as mentioned in ISO/IEC 17025:17(E). The following clause shall be checked as completeness of any certificate.

1) 7.8 – Reporting of result
2) 7.8.1 - General
3) 7.8.2 Common requirements for reports(test, calibration or sampling)
4) 7.8.4- Specific requirements for calibration certificates.
5) 7.8.6 – Reporting statement of conformity.

What are the major factor for calibration?

There are three major factor in calibration.

1) Traceability
2) Uncertainty
3) Tolerance

Traceability refers to the value of a standard. where it can be related to stated references (national or international standards) through an unbroken chain of comparisons, all having stated uncertainties (ISO)”.

As per clause no 6.5.1 The laboratory shall establish and maintain metrological traceability of its measurement results by means of a documented unbroken chain of calibrations, each contributing to the measurement uncertainty, linking them to an appropriate reference. In ISO/IEC Guide 99, metrological traceability is defined as the “property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty”.	QUOTE

Uncertainty- *Uncertainty of measurement* is the doubt that exists about the result of any measurement.

For the statement “expressed at 95% confidence level using certain coverage factor this is how it reports its uncertainty. The statement of uncertainty is reported with a coverage factor, which indicates approximatly 95% confidence. This means that if you were to make 100 measurements, you could be confident that (at least) 95 of them would be accurate within the stated uncertainty. We might say that the length of a certain stick measures 20 centimeters plus or minus 1 centimeter, at the 95 percent confidence level. This result could be written:
20 cm ±1 cm, at a level of confidence of 95%.

Let’s Check How to calculate uncertainty

Formul to find outUncertainty (u)

$= \sqrt{[\sum (xi - \mu)2 / (n * (n - 1))]}$

$x_i = i^{th}$ reading in the data set

μ = Mean of the data set

n = Number of readings in the data set

Suppose there is steel plate whose reading were taken by 5 different persons and readings are as 15.33 m, 15.21 m, 15.31 m, 15.25 m and 15.35 m.

Mean = Sum OF all 5 readings / 5 = 15.29

Xi -μ=0.04;-0.08; 0.02; -0.04 ; 0.06

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(xi – μ)2= 0.0016;0.0064; 0.0004; 0.0016; 0.0036 = 0.0136

U = SQRT (0.0136/ 5X4)= 0.026 =0.03

Uncertainty = 0.03 m.

In most of the calibration report we find “Coverage factor of ---k=2

"k" means, both practically and statistically: *The value of the coverage factor, k, is chosen based on the desired level of confidence to be associated with the interval defined by the expanded uncertainty.*

Tolerance & Accuracy -- When we measure certain parameter, there is every possibility to have some error between the measured value and the true value. What is important is to specify the allowable range of errors. In terms of measurement, the difference between the maximum and minimum dimensions of permissible errors is called the "tolerance."

Accuracy – It is degree of correctness. Less the tolerance value more the accuracy.

Example- You need 2” dia Sch 60 thk CS pipe of 6 meter length 20numbers. You have two suppliers namely X & Y and both has to supply 10 nos each.. Acceptable tolerance is 5.0mm. After inspection at both the place the inspector reported as follows.

Pipe supplied by X – All the ten pipes are measured between 5998 to 6002mm.

Pipe supplied by Y = All ten pipes are different dimension varying from 5995 to 6005mm

Now question is who is good supplier having better accuracy. Yes it is X.

Hope it is cleared what is accuracy. & Tolerance.

Now another important term is Standard Deviations.

It is rarely convenient to calculate standard deviations by hand, with pen and

paper alone. But it can be done as follows:

Suppose you have a set of n readings (let’s use the same set of 10 as above).

Start by finding the average:

For the set of readings we used before, 16, 19, 18, 16, 17, 19, 20, 15, 17 and 13, the average is 17.

Next, find the difference between each reading and the average,

i.e. -1 +2 +1 -1 0 +2 +3 -2 0 -4,

and square each of these, i.e. 1 4 1 1 0 4 9 4 0 16.

Next, find the total and divide by n-1 (in this case n is 10, so n-1 is 9),

i.e.

1 +4+ 1+ 1+ 0+4 +9 +4 +0 +16 = 40

40/9=4 44

The estimated standard deviation, s, is found by taking the square root of the total

i.e.=s = 4.44 = 2.1

Question- How many readings do you need take to find an estimated standard deviation?

The more readings you use, the better the estimate will be. In this case it is the estimate of

Uncertainty that improves with the number of readings (not the estimate of the mean or ‘end result’). In ordinary situations 10 readings is enough.

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Conclusion: Though article is chosen on Indian context, but it has a great implication all over the world. Wherever we go from a shopping mall to a multi-speciality hospital, somehow we come across measuring instrument. If we are unware of this importance of calibration, we might face any detrimental issue. A little variation in any test result regarding somebody critical health issue lead to a fatal incident.

Writer is having 37 years of experience in QA/QC working in India & abroad. Retired as Dy. Chief Manager from Technip Energies India Limited .

Reference – ISO/IEC-17025-17(E)