ICAST 2000 edited by Wan Ramli Wan Daud et. al

CALIBRATION AND TRACEABILITY: ITS IMPORTANCE IN THE GAS INDUSTRY

Rahmat Mohsin, Zulkifli Abdul Majid, Zulkefli Yaacob and Liaw Kim Kiat
Gas Engineering Department
Faculty of Chemical and Natural Resources Engineering
Universiti Teknologi Malaysia
81310 UTM Skudai, Johor Darul Takzim, Malaysia
Tel. No.: 07-5576160 ext 5289, e-mail:rahmat@fkasli.utm.my

Keywords: Calibration; Traceability, Natural Gas

ABSTRACT

Consistency and performance of gas meter reading is highly subjected to the ability to reproduce accurate measurement within acceptable period of time. It is essential that each gas meter must produce higher accuracy of measurement as any deviation from its true values will directly impose unnecessary costing and reflecting unhealthy charging towards gas usage. In line with this requirement, calibration has to be imposed on any type of gas meter in operation at an interval period deemed reasonable and could satisfy existing standard. In a common practice all over the world the involvement of the third party usually is a pre-requisite to carry out calibration work to gas users. This practice seemed accepted as the involvement of either gas supplier or customer will impose uncertainty and element of bias in the whole calibration process. In relation to the calibration chain, traceability plays an important role to identify the link between the reference standard and organisation carrying out the calibration by recognised channel. In the absence of a proper chain link in the calibration process, it is known that the calibration reached a failure. This paper will highlight relation between traceability and calibration and its importance to the gas industry.

INTRODUCTION

The aspect of calibration is a paramount factor in determining the accuracy of any measuring device. Some fundamental concept of calibration will be discussed in this paper to further enhance necessary understanding of gas metering calibration.

A calibration concept plays an important role in any gas metering facilities due to a high quality measure of accuracy assurance in any flow monitoring devices. In the current gas industry development in Malaysia we have a wider choice of device when specifying a gas meter. Even progress has been tremendously made through the development of more convenient type of gas meters, the absolute accuracy of part in a thousand is still unobtainable.

As the gas industry in Malaysia begins to increase its pace in economical growth so does the need for an improved method of gas measurement. The improved gas measurement must also be substantiated with a calibration methodology that is traceable to a certified primary standard. Certified calibration methodology is important for custody transfer. Both buyers and sellers who are involved in custody transfer demand for more accurate gas transfer measurement. In order to achieve a considerable accurateness in custody transfer of gas, calibration of measuring devices has become an important process. To satisfy the needs of improved gas measurement and its calibration traceability in a wide range of gas types and condition is of a considerable task. Improvement in gas measurement should be interdisciplinary. A good meter design, good calibration methodology substantiated with a good human practice will surely produce a considerable result. The calibration facilities currently in use are described in this paper which emphasizes the use of pressure and temperature calibrators. Basic concept of calibration terms commonly used in calibration industry will be discussed throughout the paper.

CALIBRATION CONCEPT

It is vital that the terminology of the subject is understood. Not only a matter of contradictions in the use of the same words by statisticians and engineers, but statisticians themselves sometimes differ in the words they use to describe the same thing.

Calibration is best described as a process that relates the standards to practical measurement. According to ANSI/ASQC M1-1987 calibration is defined as "*The comparison of an ensemble of unverified uncertainty to a calibration ensemble of quantified uncertainty to detect or correct any deviation from required performance specification*s". MIL-STD-45662A describe calibration as "*The comparison of measurement and test equipment or measurement standard of unknown accuracy to a measurement standard of known accuracy in order to detect, correlate, report or eliminate by adjustment any variation in the accuracy of the instrument being compared*".

Calibration is required in order to maintain and monitor instrument performance to as good as new level (GAN) and the credibility of measurement.

It could also provide a safe operation monitoring and control of related process as well as maintaining quality of product at an anticipated cost.

ERRORS VERSUS UNCERTAINTIES

It is essential to distinguish between the *error* and the *uncertainty* in any result obtained from calibration process which normally be presented in most calibration certificates. Error could be easily defined as the difference between the measured and true values, and is unknown while the uncertainty is half the range within which the true value is expected to lie with a stated probability.[1] The uncertainty must never be quoted separately from the probability or confidence level with which it is associated since the two are interdependent.

Four kinds of error that can be present in any measurement are spurious errors, random errors, constant systematic errors and variable systematic errors. *Spurious errors* are a clear mistake that invalidates a result. *Random errors*, sometimes called precision or experimental errors are those which cause a variation in repeated measurements even when the value of the quantity being measured does not change. *Constant systematic errors*, sometime called bias errors are those which do not vary when measurements are made under the same conditions. They do not vary with time, but can vary with the value of the measurement. *Variable systematic errors* are arise from such things as progressive problem from parts in enclosed system, or due to the influence of environment and other contributing factor that variate with time limitation.

ACCURACY

It is generally accepted that accuracy refers to the truthfulness of the instrument. An instrument of high accuracy more nearly gives a true reading than an instrument of low accuracy which indirectly reflects with a quality of particular instrument. Accuracy could also refer to the ability of an instrument to give a reading close to an absolute value referring to a standard established by world standard organization. The general identification of this link is shown in Figure 1.

REPEATABILITY AND REPRODUCIBILITY

Repeatability is a process that reflects ability of any measuring instrument performing a similar function of measurement at a short elapsed time under a

similar measuring condition, where the probable difference of recorded measurement regarded as minimal. Reproducibility applies a similar concept of repeatability and only differs in an identifiable way such as location and time.

It is a declaration stating to which national (international) standard a certain instrument has been compared. Measurement devices from a kind of hierarchy with international and national standard on the top. There is a network comprising the industrialized part of the world, in which standards are compared to each other in order to make sure that measurement readings mean exactly the same everywhere. Traceability could also be expressed as a chain hanging down from the true value. The links represent International Standard, National Standard, Reference Standard and Working Standard (secondary standard). The true value is thus transferred with a certain accuracy. Refer to Figure 2.

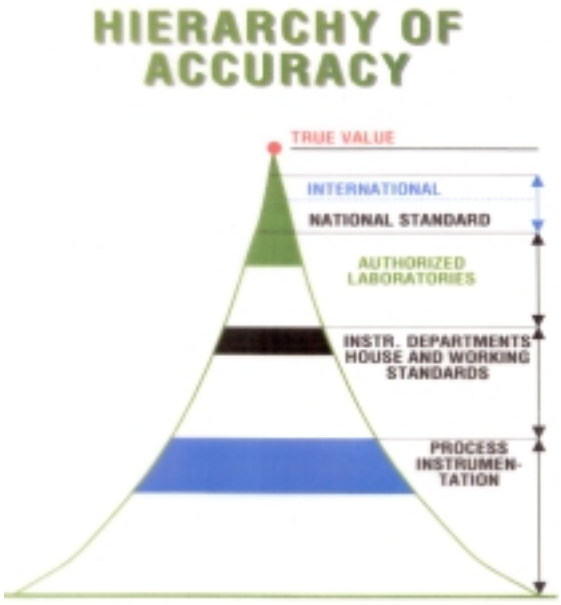

FIGURE 1 Hierarchy of Accuracy

Without the existence of primary standards, measurement equipment would only display changes and repeating the identifiable indications without any trace of its correctness and confidence level. Therefore, it is necessary to understand, identify and implement this concept of traceability to any measuring equipment in ensuring the high degree of accuracy and boosting-up the trust-level between any supplier and customer involving custody transfer process in any relevant field, especially in the gas industry.

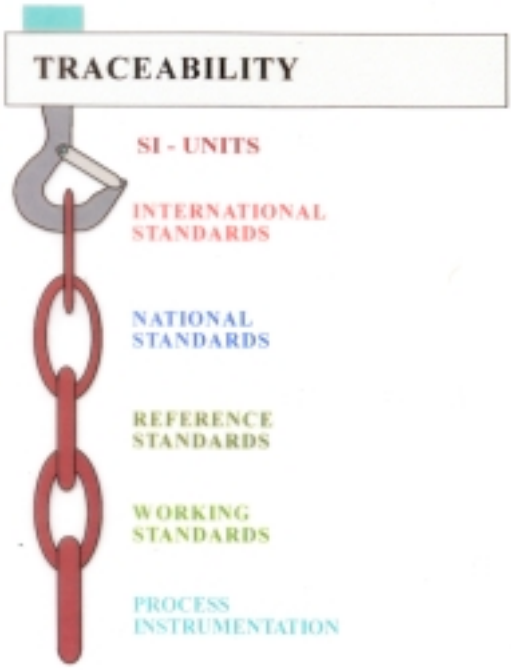

FIGURE 2 Traceability

TRACEABILITY

Without internationally agreed quantities and primary standards, daily technical activity would be impossible. The calibration chain begins with primary standards and ends with the process instruments. In this perspective, investing in the calibration process instruments would require certain documentations regarding the verification and the level of traceability that indicates the reference primary standards used to calibrate and verify the instruments. Thus, this would require significant effort of the supplier to officially provide the instrument customer with the traceable calibration chain certificate of the calibration record carried out with the accredited laboratory.

DRIFTING FACTORS

It is a unique factor which is builds up its own pattern from time to time in any kind of measuring or process instruments due to the variation in signal input,

current or voltage input, resistance input and other kind of system interruption. The drift of the various measuring or process instruments requires periodical calibration. In order to maintain the accuracy of these instruments, they need to be verified against reliable calibration equipment (of higher accuracy classification than the instrument).

Any measuring instrument has attained certain accuracy level and granted with quality guarantee period in which it is prescribed by manufacturer as at time of purchased. The term normally used to refer quality maintenance method of this instrument is called "Good As New" (GAN), reflecting the highest attainable quality at which to be maintained throughout the instrument service life. Drifting factor of any instrument has to be monitored carefully within calibration scheduling period to identify the individual drifting characteristics developed by certain instrument that may vary from one instrument to another. In order to ensure that those instruments are properly maintained at their GAN quality, the drifting factor has to be determined from time to time by their calibration history. It could be developed through a good calibration maintenance schedule which highly depending on the calibration procedures.

QUALITY MAINTENANCE

In carrying out calibration service to a specific instrument certain approved procedure has to be followed. Calibration can be conducted either at field or laboratory bench depending on the availability and importance level of any particular instrument at its operation line. A basic example of this concept could be easily seen and practiced in most of gas metering facilities throughout gas system transmission and distribution. Pressure and temperature are the most common parameters commonly measured in this system by means of transmitter. Sensors used to probe the exact value of these parameters in which data obtained are transferred by means of input signal either in miliamperage (4-20 mA), voltage or resistance (ohm) into a particular transmitter. Pressure or temperature transmitter usually displays values in a digital mode.

Transmitters will progressively drift its value from the original setting and requires calibration to be conducted periodically. It is important to plan a calibration scheduling so as to maintained the purchased quality at GAN level.

CONCLUSION

Accurate measurements are the base factors in determining the efficiency and reliability of any collected reading in comparison with the true value. The

application of calibration in gas industry plays a significant role to ensure the validity of measurement in custody transfer between supplier and customer. A contractual term is commonly employed by this parties as to establish mutual agreement on calibration methodology and scheduling period which purposely has drawn up to maintain as purchased quality.

REFERENCES

Anon., 1988. *Guidelines for Dynamic Liquid Hydrocarbon Measurement*, Kuala Lumpur: Engineering and Procurement Division, PETRONAS.

Anon., 1988. *Guidelines for Gas Measurement*, Kuala Lumpur: Engineering and Procurement Division, PETRONAS.

Baker, R.C., 1989. *Introductory Guide to Flow Measurement*, London : Mechanical Engineering Press.

Denen, D.W.A, 1985. *Shell Flowmeter Engineering Handbook*, 2nd. Edition, London : McGraw Hill.

Harris, M.R., 1992. Measurement Uncertainty in Flowmeter, *Proceeding of A Seminar in Calibration of Flowmeter*, Cranfield Institute of Technology, Cranfield.

Levie, S.A. et al., 1978. *A Study of Interlaboratary Comparisons of Calibrations of 10 orifice plates*, Amsterdam : North Holland Pub. Co.

Sweetland, D. 1992. In-Situ Calibration of Liquid Flowmeters, *Proceeding of A Seminar in Calibration of Flowmeter*, Cranfield Institute of Technology, Cranfield.

1086