# Assuring the quality of field and laboratory measurements in the context of the risk-based approach of ISO17025:2017

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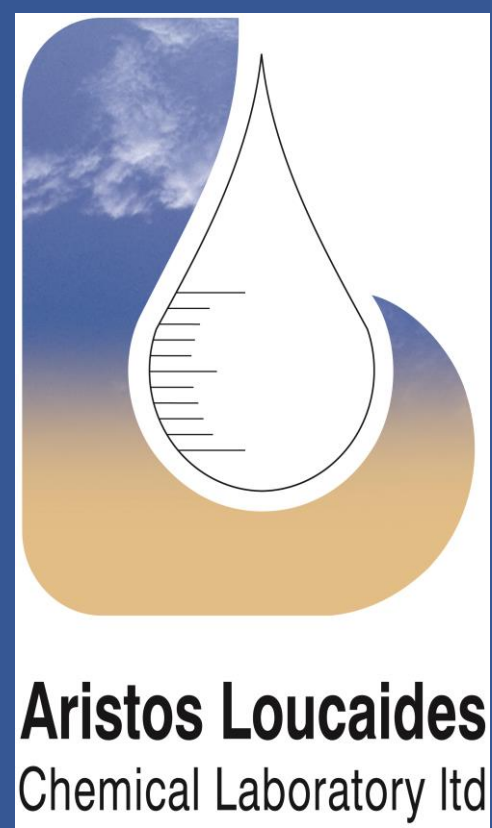
INTRODUCTION

The advent of the latest edition of the accreditation standard has been pushing labs towards more realistic approaches in relation to risk appraisal and risk management. Field sampling as well as in-situ measurements, in particular, require good perception of risk, in the overall context of assuring the quality of sampling protocols, sample integrity, transportation conditions, analytical results and most importantly safeguarding the laboratory's liability.

METHODOLOGY

While, under normal circumstances, most site measurements can be repeated and verified in the laboratory, it is seldom the case that, specific measurements that need to be carried out on-site, cannot be replicated or verified in the lab, and they form at the same time an integral part of the interpretation of the in-lab acquired results.

We will be examining specific in-situ and laboratory testing scenario, with examples drawn out of our daily activities during the past three decades.

The following scenaria will be addressed in detail, highlighting the risk-based implications in the context ISO 17025:2017:

- In-situ biocide measurements (free residual & combined)
- In-situ temperature measurements
- Halogenated aliphatic hydrocarbons sampling and testing in relation to drinking water installations
- The role of in-situ observations in parameter assignment

It is highlighted that risk, in the context of above scenaria, will be examined from different perspectives. These will include sample integrity, consistency and trueness of testing results, decision making rules, regulatory compliance and laboratory accountability especially in relation to the expression of opinions & interpretations.

RESULTS AND DISCUSSION

Scenario #1 – In-situ biocide measurements (free residual & combined)

Biocide measurements often form an integral part of sampling, especially in drinking water applications. It is always advisable to also carry out these measurements in-situ, for a number of reasons. Primarily, in-situ measurements provide the most reliable result and also the fastest way to evaluate the significance of the results. For example, remote residential areas, with underused outlets and long supply pipelines, usually suffer from inadequate biocide concentrations. This results in detrimental effects on the distribution network and increased risk in relation to the microbiological quality of the water. Under these circumstances, it is imperative that both free residual and total biocide concentration measurements are carried out, especially when there is a suspicion of biofouling in the distribution network.

A typical example of in-situ biocide measurements, following resident complaints for bad odour in their drinking water supply, revealed the following results:

Determinant	Unit	Water sample from mains
In-situ measurements		
Chlorine, free residual	mg/L	0,02
Chlorine, total	mg/L	0,3
In-lab measurement		
Total Organic Carbon, TOC	mg/L	2,287

The near-zero free residual chlorine concentration urged for an additional measurement of total or combined chlorine. This clearly demonstrated the extent of biofouling in the system which was also exemplified by the subsequent laboratory measurement of TOC.
In this case, based on the in-situ measurements, the customer was notified immediately that they would have to pursue this further with the local water supply authority.
This is a typical example of mitigating the customer's risk, while at the same time strengthening the laboratory's position and assuring compliance with the ISO17025:2017 risk appraisal requirements.

Scenario #2 – In-situ temperature measurements

Temperature measurements fall within a category of in-situ measurements that are virtually unique and cannot be reproduced realistically in the lab.

One application that makes use of in-situ temperature measurements, as part of the sampling protocol, is the sampling for Legionella bacteria. Legionellae are the bacteria responsible for legionnaires' disease, an atypical form of pneumonia that is potentially lethal. Sampling for these bacteria from healthcare premises requires strict adherence to taking and recording biocide and also temperature measurements. The latter form an integral part of the Test Certificates submitted to customers and also, and most importantly, an indispensable tool used in risk assessments. It is therefore of critical importance to know the exact pre & post flush temperatures of both hot and cold water outlets.
From another perspective, these in-situ temperature measurements provide a useful means of locating high risk outlets that require immediate attention. It is highlighted that the effect of excessively high cold water temperatures and likewise low hot water temperatures is also reflected in the laboratory findings as shown below:

Sampling period	Sampling point description	Legionella	Legionella ID**	T_{cold}, ºC	T_{hot}, ºC	$T_{50/50}$, ºC
March 2019	Mens'shower 50/50 (pre-flush)	<10	-	-	-	-
	Mens'shower 50/50 (post-flush)	<10	-	21,9	53,2	37,3
July 2019	Mens'shower 50/50 (pre-flush)	<10	-	-	-	-
	Mens'shower 50/50 (post-flush)	<10	-	26,8	29,1	27,9
September 2019	Mens'shower 50/50 (pre-flush)	>1x10³	Legionella pneumophila sgp 1	-	-	-
	Mens'shower 50/50 (post-flush)	>1x10³	Legionella pneumophila sgp 1	28,2	29,6	28,7
Units		cfu/litre	-	-	-	-

Above results show three consecutive samplings from the same point. The effect of the transition to higher cold water temperatures and lower hot water temperatures is clearly reflected in the September results, where the system is already fully colonized with Legionella bacteria.

Scenario #3 – Halogenated aliphatic hydrocarbons - Sampling and testing in relation to drinking water installations

One of the main risks associated with drinking water supplies, originating from surface waters, is the potential for the formation of chlorination by-products. This takes place when surface waters rich in dissolved organic material (e.g. from dams, lakes etc.) are superchlorinated. During the chlorination process, chlorine combines with dissolved organics to form the halogenated aliphatic hydrocarbons, also known as trihalomethanes (THM's). These substances are proven carcinogens and their concentration in drinking water is strictly regulated.
Our lab is engaged in THM's sampling and analysis in the context of contractual agreements with water authorities and governmental bodies. As part of the risk assessment carried out for accredited testing methods, the sources of uncertainty, relating to sampling and sample storage & trsnportation, are dealt with in detail. In this context, specific risks associated with the transportation and sample preservation for THM's analysis have been studied.
Repeated testing was carried out on preserved and unpreserved portions of different drinking water samples, all originating from water reservoirs. The objective of this study was to ascertain the significance of the time lapsing between sampling and analysis, while at the same time highlighting the critical role of sample preservation.
Two typical cases are discussed in the context of this poster.

Case 1

Halogenated Aliphatic Hydrocarbons (THM's)						
Determinant	Sample A					
	Preserved			Unpreserved		
	Day 1	Day 4	Day 7	Day 1	Day 4	Day 7
Bromodichloromethane	7,10	7,43	6,42	8,33	9,32	9,44
Bromoform	2,06	2,1	1,93	2,12	2,27	2,27
Chlorodibromomethane	8,69	8,78	7,81	9,51	10,05	9,96
Chloroform	3,78	4,51	3,94	4,63	5,90	6,36
Total THM's	21,6	22,8	20,1	24,6	27,5	28,0
Unit	μg/L					
Limits (according to drinking water directive)	100 (total)					

Preserved sample shows stable and consistent results over the duration of the experiment. On the other hand, the unpreserved portion clearly demonstrates the increasing THM's formation potential. This provides evidence that an unpreserved sample can show an increase of up to 40% in total THM's, after 7 days from sampling. As a conclusion, running delayed THM's testing on unpreserved drinking water samples increases the risk of vastly overestimating THM's concentration with a subsequent impact on the laboratory's liability. This may result in the customer being falsely alerted and engaging in unnecessary actions, including costly cleaning and flushing works and switching to alternative water supplies.

Case 2

Halogenated Aliphatic Hydrocarbons (THM's)		
Determinant	Sample B	
	Preserved	Unpreserved
	Day 1	Day 1
Bromodichloromethane	4,93	6,51
Bromoform	2,25	2,48
Chlorodibromomethane	7,49	8,90
Chloroform	2,10	2,89
Total THM's	16,8	20,8
Unit	μg/L	
Limits (according to drinking water directive)	100 (total)	

The importance of sample preservation is also shown in case 2 above, where a 24% increase in total THM's takes place just within one day from sampling in the unpreserved sample.

CONCLUSION

In view of the above, it becomes evident that testing laboratories involved in sampling must have an excellent understanding of the customer processes and full awareness of legal implications. This is critical in obtaining the right sample, from the right point, at the right time, especially in the context of failure investigations and crisis management in general.
Moreover, the choice of *fit-for-purpose* instrumentation for field measurements is another aspect that needs careful consideration in the risk appraisal and management context of ISO17025:2017. Whilst laboratory confirmation/verification of field measurements is always advisable, this should not underestimate the need to also safeguard the validity of field measurements to the best attainable level. This is especially true in the demanding contemporary testing services sector, where, the need for fast and justified decisions in the field becomes more and more imperative, especially when this dictates further actions and/or additional testing in the lab.

ACKNOWLEDGMENTS

REFERENCES

1. Laboratory analytical records