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My Tour of a Commercial Environmental Laboratory

meas·ure /meZHər/

verb

1. ascertain the size, amount, or degree of (something) by using an instrument or device marked in standard units or by comparing it with an object of known size.

from Google's English dictionary as provided by Oxford Languages

So much of what goes on in the environmental affairs arena depends on *measurements*. Environmental policymaking, advocacy, regulatory development, enforcement, and litigation depend on accurate and precise measurements of the types, quantities, and properties of chemical compounds found in a wide variety of environmental media, including soil, groundwater, surface water, stormwater, industrial wastewaters, air emissions from industrial operations, indoor air, and ambient air, just to name a few. Some of these measurements can be made on-site. In many cases though, it is necessary to go off-site to a dedicated laboratory facility so that sophisticated methods, techniques, and instrumentation can be used to detect and measure the quantity and character of chemical compounds and other important parameters in samples that are representative of the sampled media. That's where commercial environmental laboratories come in.

Many of us have some experience in and around laboratory environments, even if it goes back to high school chemistry class. I spent plenty of time in and around laboratories during my undergraduate days as a chemical engineering student, and as a co-op student in the research and development center of a major oil company. In these environments, the importance of utilizing sound technique and giving due care and attention to sensitive analytical instruments to achieve accurate and precise results was always emphasized. It was necessary to plan and record every step of an experiment or test. It was also necessary to understand and calculate error rates, and to determine whether such error rates were within acceptable bounds. It was quite challenging at times, and I must confess that I may have spent an hour or two (or more) catching up on class experiments during "make-up weeks."

Now imagine conducting laboratory operations at scale. Instead of 15 students performing the same experiment in a university laboratory, imagine a facility occupying a footprint the size of a distribution center or a small manufacturing operation and employing as many as 50 or more trained scientists, laboratory technicians, and other staff. Instead of working with a handful of samples to conduct a single test or experiment, imagine taking in hundreds – or even thousands – of samples and performing five times as many tests every week.

I had the opportunity to tour a commercial environmental laboratory for the first time last month. I was bombarded with a lot of information right out of the gate. As a result, I tended to focus on the larger-scale logistics of the operation. With that in mind, this following summary of my impressions during the tour mostly focuses on these larger-scale issues:

Sample Collection. As the saying goes, "garbage in, garbage out." To obtain meaningful analytical results, sample collection must almost always be part of a well-thought-out plan. The sample collection process can be a very tricky affair, particularly if the ultimate goal is to analyze for constituents at extremely low levels. After all, this is the point in the process where cross-contamination and other interferences might be introduced. Commercial environmental laboratories can assist with this effort by, for example, providing proper and uncontaminated sample collection equipment for a particular job. At the end of the day though, if there are quality control problems with the sample collection effort, even the most skilled environmental laboratory won't be able to produce meaningful and defensible analytical results.

Sample In-take. The laboratory that I toured has a dedicated space for its sample in-take process. The laboratory typically receives a single shipment of samples each day from a common carrier. Each shipment consists of dozens of coolers packed with sample containers and ice. Laboratory technicians in the sample in-take area inspect each sample batch, as well as the accompanying paperwork. Additional sample preparation is conducted as necessary prior to ensuring that the samples are delivered to the appropriate individual laboratory for analysis.

Sample Preparation. Many analytical laboratory tests require extensive sample preparation. As an example, a common laboratory method for PFAS analysis involves a complicated series of solvent extraction, addition of internal standards, and solid phase extraction to remove potential interferences and to account for sample losses. Despite this fact – and contrary to my expectation – I saw little, if any, traces of sample preparation activities in the individual analytical laboratories. These steps are now mostly automated, and to some extent, take place within the analytical instrument itself. Not too long ago, many of these steps would have been performed manually.

Sample Storage. Sometimes, a particular batch of samples must be retained for additional tests to be run. This need might arise for a number of reasons. For example, quality control problems may arise with an initial round of tests, thus necessitating the need to run the same tests again. Or, based on an initial round of results, the customer may request that additional tests be run on the same sample batch. The laboratory that I toured maintains sufficient space and resources, as well as a sophisticated system, for ensuring that all samples are properly stored unless and until they are no longer needed. The laboratory also maintains a tracking system and has established internal protocols for determining when such batches of samples are no longer needed and thus must be appropriately discarded.

Managing Laboratory Wastes. Laboratory wastes - including regulated hazardous wastes - are generated as the result of running scores of environmental analytical tests each week. Sophisticated systems are in place for ensuring the proper “satellite accumulation” of hazardous wastes, as well as accumulation and storage prior to shipment to an off-site facility for final treatment and disposal. In addition, close attention is paid to good housekeeping in areas where laboratory wastes are stored. (The same could also be said for the other areas of the facility as well.)

The dictionary definition that I quoted to open this article makes the act of measuring sound so simple. My tour of a commercial environmental laboratory made it abundantly clear that it is not, particularly if the objective is to obtain accurate, precise, and ultimately, defensible results. There is so much that goes into the process of measuring. It is quite an impressive thing to witness first-hand.

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