INSTRUMENTATION AND AUTOMATION TESTING ORGANIZATIONS: HOW THEY WORK AND WHY THEY ARE IMPORTANT TO THE INDUSTRY

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INTRODUCTION

Similar to consumer reporting agencies, instrumentation and automation testing organizations conduct evaluations of measurement and control equipment used in the chemical, industrial, water, and wastewater industries. As new instrumentation and automation technologies, hardware, software, and electronics are introduced, it becomes important to be able to:

1. Understand the technologies;
2. Understand the benefits and limitations of the instruments and/or equipment;
3. Verify if equipment meets its manufacturer's stated specifications;
4. Know if the available instruments can meet the requirements of local regulatory, standards, or governing organizations, and most importantly;
5. To be able to make a knowledgeable decision for selecting the right measurement and/or control equipment technology for a specific application.

Instrumentation and automation testing organizations were developed to provide performance evaluation information designed to address these issues.

TESTING ORGANIZATIONS

There are a number of testing organizations worldwide. Each is charged with a similar mission of providing performance evaluation information to the users of instrumentation and automation technologies through various methods (*i.e.*, sharing information from independent in-house testing, conducting industry-wide surveys, and through laboratory and field testing). Some organizations operate on a profit, some are not-for-profit, some are operated through regulatory consortiums or multinational organizations, and some are trade associations. No matter the structure, all of these organizations were developed to achieve the same goals: to provide evaluations or certification of instrumentation and/or automation systems.

EUROPEAN TESTING AND ASSESSMENT OF COMPARABILITY OF ONLINE SENSORS/ANALYSERS (ETACS)

The United Kingdom-based European Testing and Assessment of Comparability of online Sensors/Analysers or ETACS was a European project partly funded by the European Commission under the Standards, Measurement and Testing Programme. The project had eight partners, including the coordination partner which was the private Danish research organization: VKI - Institute for the Water Environment. VKI is the Danish abbreviation for Water Quality Institute, managed by Anders Lynggaard-Jensen Department for Monitoring and Information Technology (MIT) DHI - Water & Environment (a merger between Danish Hydraulic Institute and VKI - Institute for the Water Environment).

During the project, a test protocol for online sensors/analysers for water was developed and tested. All results were handed over to an ISO work group, which was established in 1998 to turn the pre-normative work done in ETACS into a standard. The name of the work group is "ISO/TC 147/WG2:On-line Sensors/Analysing Equipment for Water - Specifications and Performance Tests."

The ETACS project has been completed. Its key objectives were to:

1. Develop a test protocol for validation and comparison of the performance of online sensors/analysers. The test protocol was to be independent of specific sensors/analysers and specific determinands;
2. Practical testing of the test protocol to assess its applicability in order to produce a final test protocol, revised in accordance with the experience obtained;
3. Widespread acceptance of the test protocol by producers/suppliers, users, and relevant authorities to assist its early adoption as an agreed European standard[1].

These objectives were developed to ensure that online water quality measurements would be of sufficiently known and documented quality to be of use for real time process control, regulatory monitoring, and harmonized environmental databases[2].

The objective of ETACS testing protocols was to provide manufacturers with clear performance standards required for achieving certification, reduce the inspection work legislators would have to perform on monitoring systems, and enable users to purchase certified equipment[3].

INTERNATIONAL INSTRUMENTATION EVALUATION AGREEMENT GROUP (IIEAG) OF THE EUROPEAN ORGANISATION FOR CONFORMITY ASSESSMENT (EOTC)

The European Organisation for Conformity Assessment or EOTC located in Brussels, Belgium is an independent, non-profit European body that was established by the European Commission, the European Free Trade Association (EFTA), and the European Standards Bodies. EOTC is run by a general assembly with a Board of Administrators as elected by the general assembly.

EOTC acts as a focal point for conformity assessment in Europe, but does not itself test or certify products and services. EOTC members are national and represent those with a stake in conformity assessment with a customer base of professional operators, manufacturers or suppliers, regulators, and the consumer and worker.

EOTC's vision includes contributions toward the achievement of the Single Market within the European Union and in line with the World Trade Organisation principles and the elimination of technical barriers to world-wide trade.

EOTC's mission includes "…facilitating the development of the mutual recognition of the evidence of conformity that products and services meet their specifications, and to facilitate the market acceptance of this mutual recognition, thereby to contribute to economic adaptation and efficiency by reducing costs…and to serve in the interests of the consumer and the user"[4].

As part of EOTC's vision and mission, the International Instrumentation Evaluation Agreement Group (IIEAG) was developed. This agreement encompasses the "mutual recognition of test and evaluation reports concerning the performance of instrumentation for measurement of physical and chemical properties and for control of processes"[5].

INSTRUMENTATION TESTING ASSOCIATION (ITA)

The Instrumentation Testing Association (ITA) is a non-profit technical and educational organization based in Henderson, Nevada in the United States. ITA's members include the end-users of instrumentation and control systems (*i.e.*, public and private water, wastewater, and industrial treatment facilities), regulatory agencies, consultants, and manufacturers and their representatives.

ITA was formed in 1984 by treatment facilities throughout the U.S. and Canada to cooperatively conduct objective testing of environmental instrumentation and automation technologies to promote the reliability and performance of instrumentation and automation systems. ITA's mission includes advancing the theory and practice of instrumentation and automation through the understanding, selection, improvement, and cost-effective use of instrumentation and automation applications for monitoring and controlling water, wastewater, and industrial systems.

In order to keep the organization as objective as possible, the ITA is governed by its Board of Directors who are limited to personnel from water, wastewater, or industrial organizations as elected by its membership. Each member of ITA has direct input into the planning and development of future projects, as approved by ITA's Board.

ITA has conducted a number of instrument bench and field tests as documented in performance evaluation reports. In addition to testing, ITA conducts studies that are published as instrumentation maintenance benchmarking studies and designer checklists. ITA's publications, educational workshops, and membership are open to any interested party.

SIREP–WIB–EXERA (SWE)

All sister organizations — Evaluation International (formerly known as SIREP) in the United Kingdom, EXERA in France, and WIB the International Instrument Users' Association in the Netherlands — are non-profit organizations comprised of members from companies who use process equipment from the oil and gas, chemical, petrochemical, energy, steel, food, and water industries worldwide. Quoting Tom Kuperij, WIB's Managing Director, "WIB's prime objectives will continue to be to provide reliable, relevant, and timely instrumentation and systems' performance information, to enable and assist members in their optimization of instrument and system selection"[6].

The joint mission statement of SWE is:

> "To undertake appropriate activities (including independent evaluations) in order to provide relevant information and tools which:
>
> - allow members optimally to specify, select, operate, and maintain quality industrial measurement, control and automation instruments and systems which are safe, reliable, effective, economical and environmentally friendly; and
> - stimulates manufacturers to develop and make available automation and process control technology and products which are fit-for-purpose"[7].

SWE members are any organization involved directly or indirectly as users of industrial automation, measurement, and control equipment and systems. However, any company involved with the manufacturing, marketing, or sales of this type of equipment or systems for commercial purposes are excluded from membership.

TESTING APPROACHES

Each testing organization is influenced by different factors and has a different approach to testing. The main approach of each organization is outlined in Table I.

TESTING BENEFITS

Most treatment facilities can experience power outages, dramatic changes in treatment process characteristics, changes in operations and maintenance personnel, and climatic changes. These variables can all have an effect on the performance of instrumentation and automation equipment. That is why field testing of instrumentation and automation equipment over a sufficient time frame is a benefit and can provide real-time data representative of what can be experienced at any treatment facility.

The main benefits of instrumentation and automation testing come from the need to be able to select an instrument or automation system that has a known performance and reliability history, without making the large investment of procuring numerous products to perform independent in-house testing.

Some of the main benefits of testing instrumentation and automation equipment include:

1. Acquired performance and reliability information;
2. Acquired installation, calibration, operation, and maintenance information;
3. Acquired design and application information; and
4. Acquired product information regarding technology, materials of construction, and product assets and limitations.

Table I Testing Approach by Organization

Organization	Testing Approach
ETACS	Temporary organization formed to develop generic test protocol for testing of all instrumentation sensors/analyzers. Any instrument tested using ETACS test protocol are considered certified by the United Kingdom's Environment Agency's Monitoring Certification Scheme (MCERTS).
IIEAG of EOTC	Agreement under the EOTC and the European Free Trade Association (EFTA) for the mutual recognition of test and evaluation reports concerning the performance of instrumentation for measurement of physical and chemical properties and for control of processes.
ITA	Nonprofit organization that conducts cooperative testing of environmental instrumentation for water, wastewater, and industrial treatment facilities. Testing consists of development of testing protocol and procedures by ITA committee and conducting of *in situ* or field testing and laboratory bench testing, documented in a performance evaluation report.
SIREP-WIB-EXERA (SWE)	Non-profit sister organizations that conduct independent evaluations of instrumentation for the processing industries worldwide. Testing programs and protocols are developed in conjunction with the SWE member companies. Programs are carried out by reputable, impartial test laboratories.

CASE STUDIES

The knowledge provided by instrumentation and automation testing can be useful to both end users and manufacturers. End users can use testing information to select a product that is the best for their respective applications, have verification for their ability to meet local regulatory requirements, and know what is required for installation, calibration, operation, and maintenance. Manufacturers can use testing information to fortify a product's design by learning what its limitations might be (*i.e.*, sampling systems, materials of construction, design issues, etc.) and to market their product based on strengths.

The following case studies exemplify how end users, manufacturers, consultants, and regulatory agencies can benefit from instrumentation and automation testing.

Meeting Regulatory Requirements

A wastewater treatment plant in Northern California had a new regulatory requirement imposed in the early 1990s by the state's Regional Water Quality Control Board. The new regulatory requirement included a decrease in the total chlorine residual concentration to a limit of 0.1 mg/liter for the effluent a wastewater treatment plant discharged into a local river. In addition, the new regulatory requirement included continuous monitoring of chlorine residual concentration and a verification or justification of how the limit was being met.

At that time, the treatment facility obtained a performance evaluation report of total chlorine residual analyzers and used this test report to select an online instrument that would best fulfill their needs for their specific application. The plant needed a total chlorine residual analyzer that could continuously monitor the plant's effluent chlorine residual concentration and could also accurately measure to a concentration of 0.1 mg/liter. After thorough examination of the performance evaluation report, a total chlorine residual analyzer was selected. The analyzer was installed and the analyzer performed as expected by the results of the test report.

In addition, the results of the instrumentation and automation testing organization's performance evaluation test report were submitted to the state's Water Quality Control Board to further justify meeting the new total chlorine residual limitations. Because the performance evaluation report was developed by a third-party organization, the Water Quality Control Board accepted the plant's instrument selection and justification of selection to meet the stringent regulatory water quality requirement.

Plant Process Application

A wastewater treatment facility investigated the control of sludge density withdrawal from its primary clarifiers to minimize water intake to the plant's digesters. The treatment plant was undergoing an expansion and wanted to minimize the number of digesters that needed to be built by reducing the amount of water in the sludge.

The wastewater treatment plant personnel presumed that if they could measure the solids concentration of their primary clarifiers with online suspended solids analyzers, they could control sludge density to decrease the amount of water being fed to the plant's digesters, thereby reducing the number of required digesters.

Treatment plant personnel obtained a copy of a testing organization's high range suspended solids analyzers performance evaluation report. After examining the report, it was found that none of the analyzers could perform reliably in a primary sludge application.

Because of the test results published in the testing organization's performance evaluation report, the wastewater treatment plant personnel decided not to pursue the installation of the high-density suspended solids analyzers in their primary clarifiers. Instead, they decided to install a different type of dewatering system prior to the digesters to meet the high sludge concentration requirements and were successful in reducing the number of digesters that needed to be constructed.

The testing organization's evaluation report saved the treatment plant personnel time and money. Plant personnel did not incur the cost of purchasing an analyzer that would not perform in their application and also saved the staff the time that would have been spent troubleshooting the analyzer's performance had they purchased the instrument.

Energy Cost Savings

A wastewater treatment plant had a pure oxygen secondary treatment system. In order save the energy costs of producing pure oxygen for this process, treatment plant personnel wanted to purchase dissolved oxygen analyzers that would work accurately and reliably. With effective and efficient dissolved oxygen analyzers monitoring the pure oxygen system, the plant could save money in the production of pure oxygen and at the same time optimize the secondary treatment process.

Performance evaluation reports of online dissolved oxygen analyzers were obtained and reviewed by a testing organization. Because of the pure oxygen process application, a dissolved oxygen sensor using galvanic technology was selected and installed in 16 different locations in the secondary treatment process. The materials of construction of the dissolved oxygen analyzer selected were able to withstand the high-oxygen concentration of the pure oxygen secondary treatment process.

The performance evaluation report saved the treatment plant personnel time and money. The plant personnel were able to select an analyzer that would withstand the test of time for their application due to the analyzer's materials of construction. In addition, because the analyzers performed accurately and reliably, the wastewater treatment plant was able to optimize the use of the pure oxygen and save considerable energy costs in the production of the pure oxygen.

Instrument Design Addition

An instrument and automation testing organization was testing online turbidity/suspended solids analyzers for water and wastewater treatment effluent. During the testing process, it was noted that one particular analyzer would report higher readings than the conformance test on or about the same time each day. After thorough examination of the installation and ruling out problems with the sensor (*i.e.*, the sensor worked fine in the lab and during the rest of the day), the analyzer installation location, and sampling system, the treatment plant staff could not locate the problem. It was also observed that on some days the analyzer performed fine, all day long.

It was finally observed that the time the analyzer would read higher levels than the conformance test data was when it was fully exposed to the sun. It was also noted that on those days when the analyzer performed fine all day, there was no direct sun exposure or a low cloud cover. It was determined that the exposing the analyzer to full sun interfered with its readings.

The manufacturer of the analyzer made a simple modification to the analyzer's design by installing a sun shield around the sensor. After that design modification was implemented, no further "sun induced" high readings were incurred for the duration of the test.

Instrument Design Modification

While performing a flowmeter performance evaluation test in wastewater collection systems, an instrumentation and automation organization noted that during high periods of rain (or high flows), an area-velocity flowmeter would have low flow readings as compared to conformance testing.

After eliminating any problems with the flowmeter installation, velocity sensor, and electronics, the testing organization discovered that excess moisture was accumulating in the pressure-level sensor atmospheric reference tube. It was further discovered that the accumulated moisture caused a blockage of the reference tube, thereby preventing the reference pressure to be read by the pressure-level sensor.

To resolve this problem, the flowmeter manufacturer modified the pressure-level sensor by adding a dehumidifying device to the atmospheric reference tube. This design modification resolved the analyzer's problem of low reading outputs during high flows.

Auxiliary Equipment Change

A recent test for online ammonia analyzers was in the planning stages for an instrumentation and automation testing organization. Manufacturers involved in the preliminary stages of the testing program were preparing for the future test and one of the manufacturers made a change to its sample conditioning system.

The previous sample conditioning system was comprised of a large and expensive filter system, a large sample pump, and large piping and valving. Although the sample conditioning system was large, the online analyzer only required a very small sample (milliliters) for analysis.

Before the online performance evaluation test, the manufacturer changed the auxiliary sample conditioning system to include a new type of *in situ* filter that requires a small air compressor that draws sample through the filter and also purges the filter with air after taking a sample. The cost of the new sample conditioning system is a fraction of the original sample conditioning system. The new sample conditioning system can now be replaced in a few minutes if required, as compared to days of overhaul of the previous sampling system.

SUMMARY

The benefits of testing are abundant and make it possible for all stakeholders to win. Whether it's the end users or consultants saving money and time by making an informed decision about the best equipment for a specific application, regulatory agencies who can use the performance evaluation reports as a reference document to assist with enforcement issues, or the manufacturers who can improve the effectiveness of their product, all can benefit from the valuable tool performance evaluation reports provide for the industry.

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