



TRADITIONAL PROCESS ANALYSERS – IS IT OUTDATED TECHNOLOGY? A CASE STUDY BY UNITED UTILITIES

OVERVIEW OF PRACTICAL NATURAL GAS SAMPLING

FLOW CHECKS MADE EASY WITH PORTABLE ULTRASONIC FLOW METER RENTAL

PRECISION RADIOTHERAPY TREATMENT USING A CLINICAL MR LINEAR

THE FUTURE OF GLOBAL COMPLIANCE AND INDUSTRIAL INNOVATION



DECEMBER 2024 ISSUE 34

PRECISION



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END OF YEAR REVIEW 2024

2024 has been a productive year for the Institute, and the number of new members who have joined us has grown since last year.

We are starting to see a small shift in the demographics of these new members. The numbers joining aged between 18 and 39 has increased compared to other years, and the variety of professions that work is starting to change as it encompasses new and emerging technologies. This new generation of engineers and technicians are vital to the future, not just of the Institute but of the profession, and the Institute is committed to finding ways to improve and to be as welcoming as possible to the widest pool of people working in the fields of Measurement, Instrumentation and Control. Last year we launched our Women's Network, and in early 2025 we will be launching a similar group for Early Career Engineers. Keep an eye on your emails and newsletters in the new year to find out how you can support or get active with this group.

There are lots of ways that you can get involved directly with the work of the Institute. We have several very active and engaging Special Interest Groups, who focus on a particular subject area or project. These include Standards SIG, Cyber Security SIG, Measurement SIG, Measurement Skills SIG, and more. You can see the full list of SIGs on the InstMC website and their individual pages contain information about their projects, upcoming events and contacts details if you want to find out more. The same is true for our Local Sections. If you are not already a member, check the website to see if there is an active section near you. You can login to the Members Area of the InstMC website and select any number of SIGs and/or Local Sections you would like to join the mailing list for.

If you don't see a SIG or Local Section that is right for you, and you would like to start your own, please get in touch and we would be happy to help you do that.

You will soon receive your annual subscriptions renewal information. At the AGM and EGM in July the membership agreed to a 3.5% increase in fees for 2025. We have tried to keep the fee increase as low as we can, and we are conscious that the cost-of-living crisis will be impacting many of our members. Please remember that we offer the option to pay your subscription by

Direct Debit to spread the cost over 12 or 4 regular payments. You can switch to DD from the Members Area of the website.

I also want to remind you that we have remissions and discount options available for members who find themselves temporarily in a difficult financial situation. I encourage you to contact the membership team if necessary and let us see if we can find a way to support you to retain your membership.

I wish you all a Merry Christmas and a happy and prosperous 2025.



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Ben Thompson, Instrumentation Field Service Engineer, United Utilities, specialising in instrumentation and control, and water quality monitoring.

PRECISION

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OVERVIEW OF PRACTICAL NATURAL GAS SAMPLING



Natural gas is a pivotal player in the global energy landscape, powering industries, heating homes, and supporting electricity generation. As it is transported globally in various forms, maintaining its quality is paramount. This necessitates accurate and representative sampling methods. This article explores key sampling techniques, highlights the challenges in preserving sample integrity, and discusses some of the latest technological advancements in the field.

The Importance of Accurate Sampling

Effective natural gas sampling is essential not only for compliance with safety and quality standards but also for financial accountability. Inaccurate sampling can lead to significant losses and disputes, costing companies thousands of dollars. A well-documented case involved a major pipeline operator that faced severe financial penalties due to discrepancies in gas composition reported at the custody transfer point. Understanding and implementing the best practices in gas sampling is critical, especially as many companies hire less experienced personnel in this area. Sampling errors can result in incorrect billing, disputes over gas quality, and financial penalties imposed by regulatory bodies.

Key Parameters in Natural Gas Sampling

Several factors must be considered during natural gas sampling:

- **Gas Composition:** Determining the composition of natural gas is crucial for assessing its energy content and potential corrosion risks during transportation. Components such as methane, ethane, and hydrogen sulfide must be measured accurately to ensure compliance with contractual obligations and safety standards.

A comprehensive analysis of gas composition also allows operators to identify potential issues that could arise during processing and transportation.

- **Water Content:** Excess moisture can lead to pipeline corrosion and operational issues. For instance, one pipeline experienced significant integrity failures due to unaccounted water content, leading to costly repairs and operational downtime. Moisture not only affects gas quality but can also disrupt downstream processes and affect the accuracy of flow measurement systems. Incorrect sampling can significantly impact financial evaluations and downstream processes, highlighting the need for stringent monitoring of water content.
- **Impurities:** The presence of contaminants can adversely affect gas quality and processing compounds can corrode equipment and compromise the quality of processed gas. Regular monitoring of these impurities is essential to ensure that gas remains within acceptable limits, thereby protecting the infrastructure and maintaining product quality.
- **Hydrocarbon Dew Point:** Understanding the temperature at which heavier hydrocarbons condense is vital for preventing

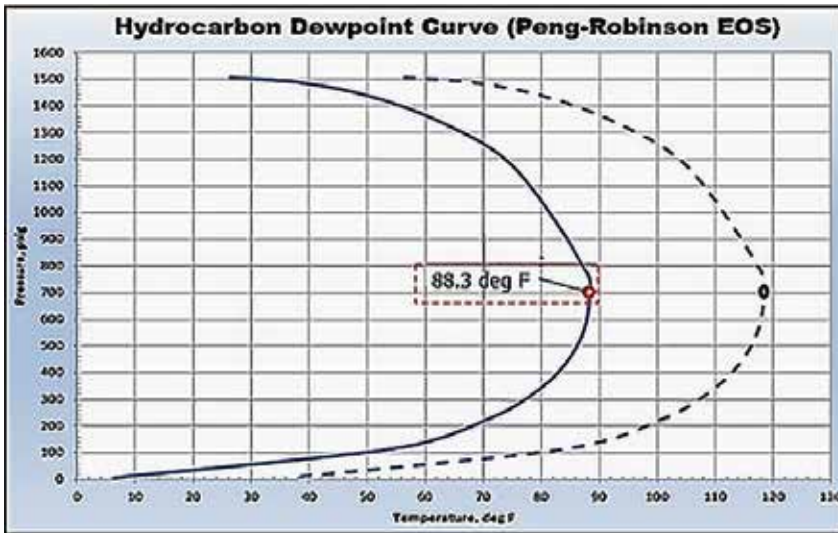


Fig 1. Rich Gas Dew Point – 700 PSIG - 88 Deg F (Compliance with GPA2166 dotted line 30 of F)

Rich gas can change to liquid in the cylinder if the temperature drops. This shows the effect of liquid droplets that fall out in cold cylinders.

		BTU	Density	C5+	GPM
Location 1	Warm Cylinder	1197.14	0.7066	1.022	4.585
	Cold Cylinder	1208.17	0.7128	1.264	4.752
	Diff%	0.92%	0.88%	23.68%	3.64%
Location 2	Warm Cylinder	1249.37	0.738	1.284	5.838
	Cold Cylinder	1251.73	0.7395	1.368	5.855
	Diff%	0.19%	0.20%	6.54%	0.29%
Location 3	Warm Cylinder	1248.12	0.7374	1.134	5.888
	Cold Cylinder	1260.67	0.746	1.518	6.001
	Diff%	1.01%	1.17%	33.86%	1.92%

Fig 2. Local gas company heated sample bottle test results.

measurement errors during sampling. This measurement is critical, especially in colder climates, where temperature fluctuations can lead to condensation in the pipeline. Monitoring the hydrocarbon dew point helps to mitigate risks associated with liquid dropout during transportation, which can lead to inaccurate readings and financial discrepancies.

Sampling Methods: Spot vs. Continuous

Two primary methods dominate natural gas sampling: spot sampling and continuous sampling.

- **Spot Sampling:** This method involves collecting a single sample at a specific time. While it is cost-effective, it may not capture

fluctuations in gas composition. For example, if a spot sample is taken during a period of gas quality variation, the results could misrepresent the overall gas quality, leading to significant financial implications. It is crucial to ensure that spot sampling is representative of the gas being transported, and this is where understanding the thermal dynamics of the gas becomes essential. The use of a specific design of extension tube to move the Joule-Thompson effect away from the sample collection point is important.

Spot samples can be affected by temperature variations and collection methodology, making it critical to consider the thermal

state of the gas when conducting manual sampling. Heating the sampling equipment is vital even when it is assumed that the temperature is above the Hydrocarbon dew point, particularly valid during cold weather, to prevent liquid dropout and ensure that the sample accurately reflects the gas composition. Techniques such as using heated and insulated sample bottles can help maintain the temperature of the gas sample and reduce Joule-Thompson effects, preserving its integrity or representativeness during the collection process.

- **Continuous Sampling:** This method captures gas composition over time, making it more reliable for pipelines with variable gas mixtures. Continuous sampling systems are often used in high-demand settings, where gas composition can change rapidly, ensuring that the data reflects the actual conditions of the gas flow. The use of automated systems can enhance sampling efficiency, reduce human error, and provide real-time data for analysis.
- **Heating of Sampling Collection Equipment:** One of the critical aspects of natural gas sampling is the heating of the sampling equipment to prevent condensation and ensure accurate representation of gas quality. During the sampling process, especially in colder climates, the temperature of the gas can drop, leading to condensation of heavier hydrocarbons. This can result in inaccurate sampling and misrepresentation of the gas composition.
- **Importance of Heating:** Heating sampling equipment, including bottles and tubing, is essential to maintain gas in its gaseous state. The use of heated sample bottles, for example, can prevent liquid dropout and ensure that the sample collected is representative of the gas in the pipeline. Additionally, employing

insulation for tubing and connections helps maintain the temperature of the gas throughout the sampling process.

- **Cold and Hot Tests:** Conducting both hot and cold sample collection tests is vital to understanding the behavior of natural gas under different temperature conditions. Cold tests versus Heated sample bottle testing can help assess how the gas sample energy (BTU) values vary with temperatures, identifying potential financial issues, for instance, collection in a cold state may be causing incorrect analysis at the laboratory since the sample will be heated during laboratory review and thus show over-reading of the energy values.

Figure 1. shows the HDC values for a typical rich gas in Oklahoma state with test results from a local gas company testing shown in Figure 2.

Technological Advancements in Sampling

Recent advancements in technology have significantly improved natural gas sampling accuracy. Inline sampling systems now allow for real-time monitoring of gas composition, while remote sensing technologies enable continuous data collection and analysis. These innovations not only enhance data accuracy but also improve operational efficiency by reducing the need for manual sampling interventions.

New technologies such as IoT integration allow for remote monitoring and data analysis, providing operators with valuable insights into gas quality and composition in real time. This capability is especially beneficial for managing pipelines across vast distances, where on-site personnel may not be readily available.

- **Raman Analysis Laser Techniques:** One promising advancement in gas sampling is the integration of Raman spectroscopy, a non-invasive technique that utilizes laser light to provide detailed information

about gas composition. This method works by analyzing the scattering of light as it interacts with gas molecules, allowing for real-time monitoring of various components without the need for physical sampling. Raman analysis can detect a wide range of gases, making it an invaluable tool for monitoring the composition of natural gas under various conditions.

The Gas Processors Association (GPA) Tulsa Oklahoma has recently reviewed this technology, noting that as advancements continue, the accuracy achievable with Raman techniques may improve to be used in natural gas custody metering. This technology has the potential to enhance accuracy and responsiveness in gas sampling, potentially reducing the frequency of manual sampling interventions.

Challenges in Sampling Integrity

Maintaining the integrity of gas samples during collection, transport, and analysis is crucial. Factors such as contamination, temperature changes, and pressure drops can alter sample composition, leading to inaccurate results. For instance, contamination during sample transfer can lead to erroneous conclusions about gas quality, impacting downstream operations.

Environmental conditions must also be improved to ensure sampling accuracy. For example, fluctuations in ambient temperature can affect sample integrity, leading to condensation or evaporation that skews results. Regulatory compliance is another critical aspect, as different regions have varying standards that must be adhered to. Keeping abreast of these regulations is vital for operational and legal compliance.

Best Practices for Effective Sampling

Developing robust sampling protocols is essential. These should include regular equipment calibration, adherence to specified sampling frequencies, and meticulous data management practices to ensure

accurate results. Training personnel in proper sampling techniques and the importance of equipment maintenance is also critical to prevent costly errors. Regular audits of sampling practices can further enhance the reliability and accuracy of the sampling process.

Future Trends in Natural Gas Sampling

As the industry evolves, the integration of innovative technologies will continue to shape the future of gas sampling. Non-invasive techniques using infrared (IR) lasers and advanced sensors promise to enhance real-time monitoring capabilities, allowing for quicker response times to changing gas compositions. The push towards digital transformation in the oil and gas sector will likely drive further advancements in sampling technology, making operations more efficient and reducing the potential for human error.

Conclusion

Natural gas sampling is integral to ensuring quality, safety, and compliance in pipeline transportation. By focusing on key parameters and embracing advanced methodologies, industry professionals can enhance sampling accuracy, minimize financial disputes, and support the overall integrity of natural gas operations. The future of gas sampling looks promising, with technology set to play a crucial role in addressing the evolving challenges of industry.

References

- ISO 10715:1997 - Natural Gas Sampling guidelines.
- ASTM D1945-03(2015) - Standard Test Method for Analysis of Natural Gas by Gas Chromatography.
- API MPMS Chapter 14.1 - Natural Gas Fluids Measurement.
- GPA 2166-05 - Field Verification of Natural Gas Properties.
- Oklahoma BTU Sample Testing: Dean Graves ISHM Oklahoma.
- Hydrocarbon Dew Point Curve: Philip A Lawrence – Dew Point, Wet Gas and its Effect on Natural Gas Sampling Systems East Area Flow Measurement Workshop Malaysia 2017.

FLOW CHECKS MADE EASY WITH PORTABLE ULTRASONIC FLOW METER RENTAL

In the ever-evolving landscape of industrial operations, the need for accurate, reliable, and cost-effective flow measurement is paramount.

One innovative solution gaining traction is the use of portable clamp-on ultrasonic flow meters, either as rental devices or as part of a comprehensive flow check service provided by skilled engineers.

Advantages of portable clamp-on ultrasonic flow meters



Portable clamp-on ultrasonic flow meters represent a breakthrough in flow measurement technology. Attached to the outside of the pipe, these devices do not require any process interruption, making them ideal for temporary measurements or troubleshooting. By using ultrasonic waves to measure the flow of liquids through pipes, these

meters offer a non-intrusive method that is both precise and versatile.

The rental model – cost-effective and flexible



The rental model for clamp-on ultrasonic flow meters presents a compelling proposition for industries that need periodic flow measurement, but cannot justify the expense of permanent installations. Renting allows companies to access advanced technology without significant financial investment, enabling them to conduct short-term projects or emergency diagnostics with minimal disruption and cost. This flexibility is particularly beneficial for sectors such as chemical processing and HVAC systems, where flow dynamics can vary significantly over time.

Flow check services – expertise on demand

Many service providers now offer a flow check service, where trained engineers bring portable clamp-on ultrasonic flow meters to the site. This service model combines the technological advantages of ultrasonic flow meters with the expertise of seasoned professionals.

Engineers can not only perform accurate flow measurements, but also provide comprehensive analyses and actionable insights based on their findings. This integrated approach ensures that potential issues are identified early, and performance optimisation recommendations are grounded in real-world data.

Emerson manufactures and supplies the world's only ATEX certified portable flow meter for use on sites with hazardous areas and flammable gases, e.g. Oil & gas production sites, refineries, chemical plants, distilleries and wastewater sites with methane in confined spaces.

Future smart flow management

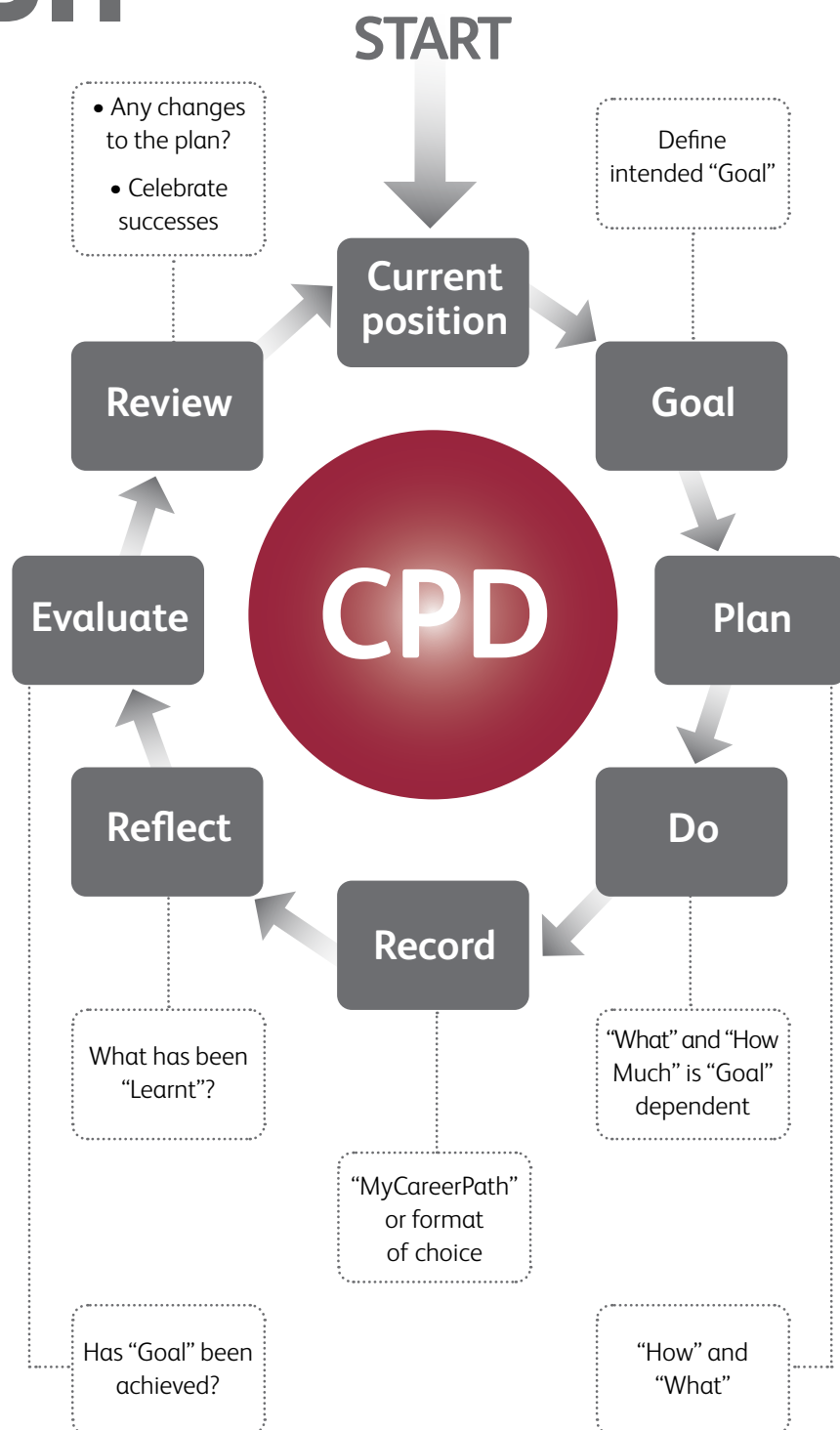
The adoption of portable clamp-on ultrasonic flow meters, either through rental or as part of a professional service, is transforming how industries approach flow measurement. It offers a cost-effective, flexible, and precise solution that aligns with the increasing demand for operational efficiency and reliability. And as technology continues to advance, the role of these innovative devices is set to expand, heralding a new era of smart, data-driven flow management.

Clamp-on ultrasonic flow measurement as a rental or report service, with battery-powered meters are available from 1 week to long-term.

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Simon Millington

ANSWERING YOUR QUESTIONS ON THE CPD AUDIT

Continuing Professional Development (CPD) refers to the process of tracking and documenting the skills, knowledge, and experience that professionals gain both formally and informally throughout their career. It involves maintaining and developing competencies to remain effective in the engineering field.



Why is CPD important?

It is essential for career development, ensuring engineers stay up-to-date with the latest advancements, regulations, and industry standards. CPD demonstrates a commitment to professional growth and enhances career prospects.

How does CPD impact me as an InstMC member?

CPD is a requirement for active InstMC members (excluding students and affiliates) and Engineering Council registrants.

What counts as CPD? CPD activities can be anything that helps you learn and grow professionally. Here are some examples:

- **Formal Learning:** Courses, seminars, and technical meetings where you gain new skills or knowledge.
- **Informal Learning:** On-the-job training, workshops, reading technical books or journals, and other self-directed learning.
- **Peer and Professional Interaction:** Mentoring others, sharing your expertise, or collaborating with colleagues to develop skills.
- **Contributing to the Profession:** Presenting at events, conducting research, or writing articles and papers to share knowledge.
- **Volunteering:** Helping out with activities at professional organisations like InstMC and engaging in projects related to your field.
- **Developing Business Skills:** Learning about planning, financial management, business regulation, and other skills that support your professional growth.

How does the CPD audit work?

The InstMC conducts an annual audit, where a random selection of 5% of current members will be asked to submit their CPD records for review.

Members that submit a satisfactory record are exempt from the CPD audit for the next 3 years.

What should I expect if I'm selected for the CPD audit, and how do I prepare for it?

We encourage all members to keep their CPD records updated throughout the year. Regularly logging your activities and reflecting on how they contribute to your professional growth will simplify the audit process should you be selected.

What happens if I ignore requests to submit my CPD record?

Failure to engage with the CPD audit could lead to the loss of the professional Engineering Council Registration. Non-Engagement could mean that you are no

longer compliant with the Code of Professional Conduct and may ultimately lead to membership being terminated.

InstMC will make every effort to be in contact with those selected for the CPD Audit, and this will include multiple emails, letters, and phone calls. However, we will only use the contact information that you provide, so please check your details are up to date by logging into the Members' Area of the website.

Last year, InstMC introduced a new set of procedures for the CPD Audit, placing greater emphasis on supporting our members while highlighting the importance of active engagement in CPD. We're pleased to report an impressive compliance rate of 98%, marking a significant improvement compared to previous years. Thank you for your commitment to professional development!



To help members prepare a CPD record, we have created templates for them to use to ensure their record meets the InstMC and Engineering Council requirements. We have also created a CPD guide which includes examples from members' CPD record from previous years.

Visit: https://www.instmc.org/_userfiles/pages/files/cpd/pd_63_cpd_guide_with_examples_4.pdf

SENSORS AND THEIR APPLICATIONS CONFERENCE IN LIMERICK

In August the Institute was delighted to hold the incredibly successful Sensors and their Applications Conference, co-located with 5th International Conference of Fibre Optic and

Photonic Sensors for Industrial and Safety Applications at the University of Limerick.

This Conference built on the heritage of the successful series of 'Sensors and their Applications' Conferences, first held in 1983 and reflects the changing landscape since then. It was organised by the Institute of Measurement & Control (InstMC), with the support of the Institute of Physics (IoP), the China Instrument & Control Society (CIS) and the Optical Fibre Sensors Committee (OFSC) of China Optical Engineering Society.

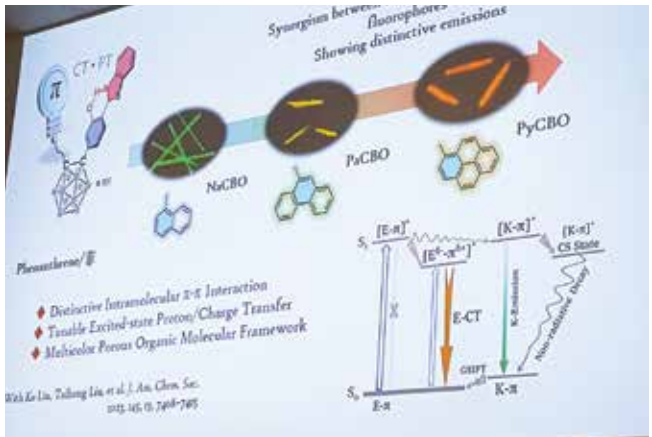
The Conference brought both researchers and instrument developers and users together from across the world to discuss the latest developments in, and directions for, the field.

We had 99 delegates from 8 different countries in attendance.

Our Keynote speakers included, Prof. Dr. Yu Fang, Academician of the Chinese Academy of Sciences, Prof. Zhengying Li, Wang Guofa, Wang Jiachen, Prof. Grattan, Prof. Lewis and Prof. Desheng Jiang.

Conference proceedings are being prepared and will be available from the Institute website, and selected papers will be appearing in a Special Edition of Measurement: Sensors.





ENGINEERING TECHNICIANS

(EngTech) apply proven techniques and procedures to solve practical engineering problems and apply safe systems of work.

What is professional registration?

- **Recognition** through membership of a relevant Professional Engineering Institution (PEI), that an individual's knowledge, understanding and competence have been assessed and confirmed through Professional Review.
- **Verification** that they have attained the standard required for inclusion on the national register in the appropriate category of registration.
- **Commitment** by an individual to maintaining their competence through Continuing Professional Development (CPD), professional behaviour for the benefit of society and their commitment to the engineering profession.

Registration is open to any competent practising engineer or technician, with different levels and pathways to registration available.

Why you should become professionally registered?

For yourself

- Recognition of your competence as an engineer or technician.
- Demonstrable evidence of your commitment to the profession.
- Internationally recognised status.
- Enhanced career prospects.

For your employer

- Increased technical/managerial credibility.
- Competent workforce.
- Competitive advantage.

For society

- Ensures the public is safeguarded through provision of independent and trustworthy advice, products and services and safe and reliable infrastructure.
- Assurance of ethical and sustainable behaviour.

Engineering Technicians shall demonstrate

Contribution to either the design, development, manufacture, commissioning, decommissioning, operation or maintenance of products, equipment, processes or services

Supervisory or technical responsibility

Effective interpersonal skills in communicating technical matters

Commitment to professional engineering values



WWEM — A SWEET SHOP OF INSTRUMENTATION & INSPIRATION

OLIVER GRIEVSON
ASSOCIATE DIRECTOR AND TECHNICAL AUTHORITY
AT ATKINSRÉALIS AND AT
ROYAL ACADEMY OF ENGINEERING

The Water, Wastewater & Environmental Monitoring Conference & Exhibition is where all those who are involved in instrumentation in the water industry gather annually.

It is where announcements are made on the latest industry innovations and regulations. With the way the water industry is being portrayed in the press in recent years and the monitoring challenges that the industry faces in the next ten years, this year's event at the NEC on 9th and 10th October was an occasion not to be missed.

The conference sessions included whole elements on regulatory monitoring where not only the current challenges of delivering were discussed, but also the future challenges of installing 24,000 monitoring stations upstream and downstream of storm overflows, not to mention 6,000 event duration monitors in pumping stations and 1,000 flow meters, which involve installation partly beneath the nation's major thoroughfares.



The Digital Water stage covered everything from BIM and Digital Twins to Cyber-Security with the demonstration stage showing us how projects and programmes have used monitoring and control to help the industry towards its goal of net zero emissions amongst many other things.

The Institute of Measurement & Control (InstMC) featured in a number of different areas. The work of the Cyber Security SIG was highlighted by David Fisher-Holt on the Digital Water Stage on the second day of the conference where the work of the National Metrology Skills Alliance (NMSA) SIG was also of particular interest. On Day 1 the subject of competence was brought up and how to demonstrate it. There is an obvious ask of water industry

experts to help shape a water industry section to help demonstrate metrology compliance in the industry and provide a good level of governance to an industry which is seeing an explosion of monitoring of the wastewater system.

The jewel in the crown of WWEM is the Instrumentation Apprentice Competition organised by Professor Oliver Grievson, a fellow of the Institute and an Associate Director at AtkinsRéalis, and Dr Leo Carswell of the WRC. The competition saw apprentices from Severn Trent Water, South West Water, Thames Water and United Utilities compete in teams of two. The InstMC kindly gift student membership to all of the apprentices that take part in the competition. At the gala dinner, the team of Jamie Benson & Nathaniel

Ward of United Utilities took the trophies. As part of the competition, the sponsoring companies will take the winning team over the next year or two and help train them up to become future technical leaders within the water industry by providing them with additional training and experiences that will stretch their knowledge.

Thanks must go to the sponsoring companies of the Instrumentation Apprentice Competition including ABB, Siemens, Hach, Xylem, In-Situ Process, Badger Meter, Endress+Hauser, Vega Control Systems, RS Hydro, Siris Environmental.

University students and Early Career Researchers are also an integral part of WWEM. Students and researchers from the Universities of Exeter, Sheffield and Cranfield presented their monitor research all the way from paper-based sensors undertaking wastewater-based epidemiology to pipebots which are being designed to work within pipes to detect failures and the eventual desire to undertake live repairs as part of Twenty65 project.

The SWIG Early Career Researcher Poster Competition showcased

some of the most exciting emerging talents in water sensor innovation. Announced back in April, the competition invited Early-Career Researchers to share their pioneering advancements in sensor technology, all aimed at revolutionising the water industry.

A total of 13 entries were submitted, each offering innovative approaches to the development and use of water sensors in various settings. The posters drew considerable attention from industry professionals and sparked lively discussions among attendees throughout the WWEM 2024 exhibition.

After careful deliberation by the SWIG board of directors, three outstanding finalists emerged. Jah Shamas of the University of Sheffield presented Fibre-Optic Sensing for Monitoring Partially-Filled Pipe Flows. He was followed by Michaela Hogan of Aquamonitrix with Development of Total Inorganic Nitrogen Analyser: Facilitating New Process Control Opportunities for N2O Mitigation and Energy Saving in Wastewater Treatment; and finally Yicheng Yu from the University of Sheffield took us into robotics with Acoustic Sensing for Pipe Inspection Robots. All three finalists delivered engaging

presentations during the event, impressing both the audience and the panel of SWIG judges. Their enthusiasm and expertise created a real buzz in the room as they confidently fielded questions and showcased their research.

The competition wrapped up at the gala dinner, where the winners were announced. Michaela Hogan took home the top prize of £1,200 for her innovative work, while Jah Shamas secured £500 for second place, and Yicheng Yu earned £200 for third. Michaela's victory was a fitting reward for her impressive research, though all three finalists received high praise for their contributions.

The SWIG Early Career Researcher Poster Competition provided a fantastic platform for groundbreaking research and allowed early-career innovators to connect with industry leaders. All 13 entries underscored the critical role of sensor technology in addressing future challenges in the water sector. The competition celebrated the next generation of water sensor innovators, showcasing the incredible opportunities awaiting future participants.





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TRADITIONAL PROCESS ANALYSERS – IS IT OUTDATED TECHNOLOGY? A CASE STUDY BY UNITED UTILITIES

Protecting our environment

In recent decades, new legislation coupled with an advancement in technology, has transformed the way that industry approaches environmental challenges. The water industry is no exception. Regulated by the Environment Agency (EA), all operators discharging effluent into a watercourse are bound by their permits requirements. One of the hottest topics in the water industry in recent years has been the tightening of both phosphate and iron levels by the regulator and, in turn, meeting those requirements in an effective and responsible manner, which also gives the best value for customers.

Generally accepted as best practice in the industry, and operating throughout many regions in the UK, dosing of a chemical to act as a coagulant during the treatment process has proven effective thus far in meeting permit commitments. Although there are others, iron-based compounds appear to have become recognised as a standard for best performance. You may have already spotted a downfall of this process: removing phosphate with iron seems counterintuitive, as an effluent must also not be rich in iron! This is why it is absolutely imperative that the dose is correct.

Let's go back a step to how this removal concept works. In the water industry there are two generalised types of phosphate which are talked about. Orthophosphate, which is soluble, so is dissolved in the water and can't be seen, and total phosphate which is orthophosphate combined with any other phosphate contained in solids bouncing about in the influent. A coagulant is dosed, this sticks to all the phosphate molecules, both ortho and total, makes them heavy enough to drop out within the existing treatment process and voila! – phosphate free effluent. Simple right? Unfortunately for those with unpredictable phosphate loading however, it isn't quite that simple!

So, what can go wrong? Excessively high levels of both phosphate and iron can be detrimental to the watercourse. Phosphate can encourage new ecosystems to grow which are harmful to the existing ecology, for example algal blooms and depletion of oxygen. Whilst high levels of iron can be toxic to the very ecology it is trying to protect. Should a coagulant be dosed ineffectively there can be a couple of common outcomes:

1. Underdosing of coagulant may result in complete or partial

failure of settlement in the following processes. A complete failure of settlement may cause effluent to be rich in both phosphate and a newly introduced iron, risking breach of permit on both iron and phosphate. A partial failure of settlement may cause effluent to only be rich in phosphate.

2. Overdosing of coagulant may result in complete depletion of removable phosphate resulting in iron being discharged into the water course as soluble iron, risking breach of permit due to iron levels.

Where it becomes difficult – Process analysers

In any process industry where treatment parameters are not consistent, it becomes crucial to begin measuring those very parameters so that effective processes may be put in place. The water industry is not an exception to that and in order to combat the nature of unpredictable phosphate loading, phosphate analysers are installed throughout UK wastewater sites.

Typically, these devices utilise a reagent-based chemistry in the form of colorimetry – how intense a colour change in a sample there is following a reagent being added, correlates

to how much phosphate is in the sample. A method which when it's done right, is highly accurate and produces some excellent data for monitoring or control purposes. Unfortunately, when a highly accurate method collides with a highly aggressive and inhospitable process environment, such as the inlet of wastewater site, issues can begin to develop.

Imagine a cuvette of 10ml, now imagine trying to put 10ml of a liquid into that cuvette, which is composed of human waste, industrial waste, sanitary products, grit, road run off and anything else

you can think of! It is an almighty challenge. Now imagine a device doing that on its own and being able to successfully measure a critical parameter for your control system. Many manufacturers out there offer incredible product ranges, some have even adapted their products to better suit this inhospitable wasteland of measurement, unfortunately though they all suffer from similar pitfalls.

Process colorimeters evolved from lab instruments, becoming ruggedised and automated for process use. As such, some inherent difficulties of the measuring principle

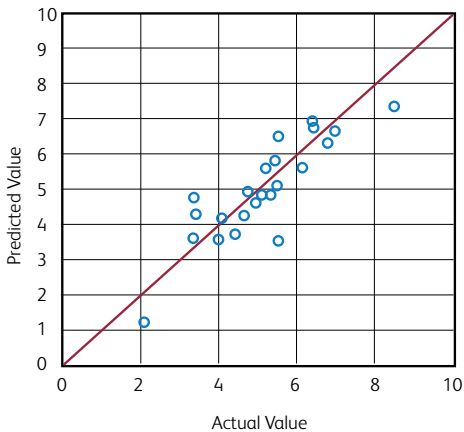
still apply. For example, the analyser does not submerge in the process, it therefore must obtain a sample through a pump, pumps require pipework and as the sample is so small, the pipework is small, small pipework on highly turbid, fouling applications creates blockages and therefore an analyser with no sample. A good counter to a poor sample, is to improve sample quality, in this case perhaps via a filtration system. By filtering a sample however, the ability to measure total phosphate is removed creating an element of estimation which undermines the concept of measurement to begin with.

POTENTIAL MAINTENANCE ISSUES & REQUIREMENTS

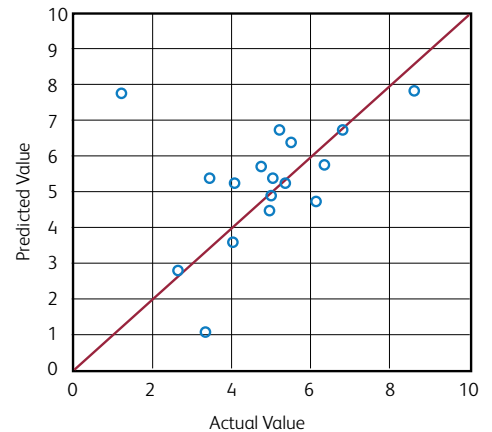
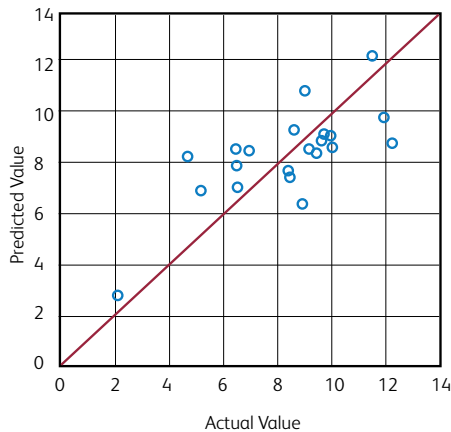
Sample Filtration & Acquisition	Traditional Colorimeter
Weekly filter changes required	Reagent and cleaning solution require changing regularly
Filters require manual cleaning utilising hazardous chemicals and a several step process to be done by an operator	Sample must be free from solids/ slime or risk system failure
Filter probe holder often may become damaged or no longer submerged due to fast flow, turbulent process	Cleaning solution isn't sufficient to keep photometer free of fouling, requires instrument technician to clean regularly
Chemical clean solution with unit requires making manually through the dilution of chemicals	Reagent crystallises if not kept flowing (analyser downtime)
Chemical clean solution known to corrode and damage internal components of the system	
System required to be internally air tight to remain vacuum for suction of sample	
Little/no diagnostics to detect fault or sample failure	



Ortho Phosphorous



Total Phosphorous



The new alternative – Measuring phosphate by not measuring phosphate

Colorimeters, and wider analysers are excellent pieces of kit in the right environments: highly accurate creating a wealth of data to digest. However, in more aggressive applications they can be unreliable and prone to failure. In this context, a failed or inaccurate analyser can result in a higher process risk than without one at all.

Is there a proven industry accepted alternative method out there? No. Is it possible to measure phosphate in such an aggressive environment with existing technology? Well, that is up for debate. A proof-of-concept trial, run by United Utilities in conjunction with Process Measurement and Analysis Ltd and New Zealand based Lutra, has been successful in achieving exactly that. A traditional probe type measuring device inserted directly into the process, reagent free, filtration free and highly accurate.

Data was collated from: existing online instrumentation, manual samples verified by a UKAS accredited laboratory, and from a scan electrolyser configured for TSS and UV254.

Conceptually the premise is simple, instead of measuring phosphate, measure something else (or several things) that can then be correlated to a phosphate measurement. In the world of instrumentation, that isn't an uncommon practice, for example:

how many flow meters measure flow? Typically, they actually measure velocity which then correlates to flow. Exactly the same concept. In this case, perhaps an increase in organics signals an increase in phosphate or vice versa? Dubbed a 'surrogate' phosphate measurement, the spectrometer was the foundation of the trial although in total the following data was compiled for assessment by Lutra:

Existing Plant Instrumentation:

- Influent Flow (ML/d)
- Influent Ortho Phosphorous (mg/L)
- Ferric Flow (L/h)
- Effluent Turbidity (NTU)
- Effluent Iron (mg/L)
- Effluent Ammonia (mg/L)

Trial Equipment:

- UV254 (Abs/m)
- TSSeq (mg/L)

UKAS Lab:

- Total Phosphorous
- Ortho Phosphorous

Although limited to one location, results were extremely promising, with an additional bonus over conventional colorimeters in the form of both a total and orthophosphate result surrogate being established. Coefficients of determination (R²) for both surrogate parameters and for the existing process analyser compared with lab samples proved particularly interesting. The orthophosphate surrogate parameter

presented as significantly more accurate with an R² value of 0.8 in comparison to 0.58 of the process analyser.

Furthermore, the total phosphate R² value, to which there is no comparison, presented at 0.55 – measuring comparatively just as accurately as an online analyser measuring orthophosphate.

A superior methodology is difficult to materialise into a marketable product if the cost excessively outweighs the benefit. A dive in the financials shows that this is not the case for this proof of concept. Costs of maintenance and operation for a traditional analyser often amount to several thousand pounds per annum, the trial system presented a more than modest cost saving of 55.13% per annum. Extrapolated over a large organisational asset base, the trial presents a potential cost saving of millions over the lifespans of their assets. In reality this saving is expected to be much higher due to plant efficiencies and downtime not included in those figures.

Should you wish to hear more about the topic, including a breakdown of the financials, a presentation, entitled 'Optical Measurement of Phosphate in Wastewater' is available on the InstMC YouTube channel.

Ben Thompson

Instrumentation Field Service Engineer
United Utilities

InstMC CNW Early Career
Engineer of the Year 2024

FOCUS ON A SIG MEASUREMENT

When I searched for “measurement” on the BBC website, the first results were a teaching tool for primary and secondary schools, and very little else – and it got me pondering how our perception of words change with accumulated knowledge.

I’m fortunate to be watching, first hand, a new young observer of the world learning about measurement, and often find us using single pieces of fusilli pasta as a unit of weight (surprisingly close to 1g) or describing how long a dinosaur is in the “average child” which is taken, helpfully, to be 1m tall at the moment. I wonder when you first felt that you understood what measurement is?

Measurements are so prevalent now within all businesses, that people who understand the details, produce reliable results and are able to improve measurement processes, are critical to sound business development. When the Measurement SIG (M-SIG) met in September, this was at the

core of our discussions - what role should the InstMC have today in supporting early career individuals to recognise the importance of accurate measurement? What training opportunities are there open to them, and how can they have confidence in the value of that training? Where can metrologists seek advice when aspiring to achieve certification or accreditation against International Standards within their businesses? And how are upcoming changes to International Standards going to affect businesses?



Measurements are so prevalent now within all businesses, that people who understand the details, produce reliable results and are able to improve measurement processes, are critical to sound business development.



We realised that we don’t have all the answers, but as a committed team, we are excited about making a difference. It has been a long time since we have met in person, so we decided to meet to celebrate where we are now, what we have achieved since the M-SIG was first formed in 2017 and look to the future. The discussions will all be carried forward into the new year, in work streams that focus on topics such as (1) the proposed update to ISO 10012 – an International Standard which provides a framework for confidence in the validity and reliability of measurement results, applicable to any organisation, of any size, in any field (2) how the InstMC should help promote Measurement as a Career and (3) national recognition of skills and techniques.

If you would like to stay up to date; please select “measurement” as an interest in your “Manage My Profile” page on the InstMC website. We will be sending out an update on how the meeting went, and invitations to future topical events, shortly. You would be welcome to come along. Please contact measurement.sig@members-instmc.org for further information.

Claire Elliott
Deputy Chair, Measurement SIG

Q&A

Ben Thompson

Ben Thompson,
Instrumentation
Field Service
Engineer at United
Utilities and winner
of the Central
Northwest Early
Career Engineer
Award 2024.

What was the root of your interest in Engineering?

I grew up with the armed forces, more specifically the Army's Royal Engineers. Surrounded by people with a very clear engineering mindset burnt the following into my brain: 'here is a problem, now how do we overcome it?' I still have the memories of my dad mumbling 'improvise, adapt, overcome' as he tried to fix even the trivialist of issues, like putting a new handle on the kitchen cupboards. Living in Germany at the time of my teens, I was very lucky to have done my school work experience working on vehicles such as the Panther Command Vehicle with the REME. When the time came, I knew an apprenticeship was for me and applied for quite a few. At first I wanted to explore civil engineering, but I'm lucky to have dodged that bullet and joined the instrumentation & control trade instead. To be honest, I didn't know what the job exactly meant when I took it, but what teenager does know what C&I is?! It was the best thing I ever did though and have never looked back.

What is your vision of Engineering in Britain for the next ten years?

I still hear about the glory days of UK manufacturing from some of my older colleagues, where as a nation, we were largely self-sufficient in so many areas of industry. My view is that we are slowly starting to realise that having those manufacturing capabilities is a benefit to Britain, rather than a liability. I hope that as a country, we encourage homegrown investment into a refreshment of our national infrastructure and manufacturing industries which

would inherently need a growing number of highly skilled engineers and technicians of all disciplines. I still often see old equipment, like legacy power supplies, with the British flag on, yet the new ones I purchase now mostly come from Europe or Asia. I'm not sure how long it will take, but the vision I choose to believe is that one day, most engineers will be working in facilities which are designed and manufactured by British engineers, supplying goods or services for the people of Britain and owned and operated in the interest of British investors.

What should the UK government do to address the shortage of UK engineers?

I think more needs to be done to encourage the growth of junior level professionals, such as technicians, to help them progress to engineers. In order to make this happen, I think there are two main barriers.

Firstly, industry often runs at a minimum amount of manpower and when the work is piling up, it often means things like professional development fall by the wayside – why would an organisation allow an already in-demand technician to take time off, or use organisational resources, to pursue goals with the aim of moving on? Secondly, I think the government and Engineering Council together need to revitalise and encourage the EngTech accreditation – generally technicians perform hands on work and an organisation has a legal duty to make sure that person is competent for various legal reasons, why would an individual or organisation then ask for EngTech when they have already assessed that competency?

If a technician then doesn't join a PEI, they may have no knowledge of progression through UK-SPEC competencies and personal assessment. I would suspect there are many technicians out there who would love the progression but just don't know how to. Should EngTech be appealing, and they gain that recognition, they would learn about PEI's and the support they offer to progress.

I'm not trying to devalue graduate engineers in any way here, they are of course vitally important, however should there be a good blend of graduate and technician engineers then the benefits would be incredible. It is useless designing the best piece of equipment in the world if it is impractical for users, or impossible to maintain. That blend would give us the happy medium we sometimes need in engineering. Engineers like to engineer, but sometimes they need someone who has been there and done that to

engineer a bit of worldly experience into the project.

What do you do in your free time to relax?

My wife calls me a 'secret nerd', personally I don't think it's so secret though. I recently enrolled on an evening course, funded by the Liverpool City Region ahead of the expected skills shortage for the upcoming HyNet series of projects. It's about hydrogen machine maintenance, that's my idea of fun. Outside of that I also enjoy a little bit of history and after watching a programme featuring a certain 'Uhtred of Bebbanburg', I have become slightly obsessed with the Vikings! I do also of course, enjoy a beer or two.

Given one wish what would that be?

If I had one wish, it would be for everybody to have equal access to all opportunities, whether that be for education, employment, growth or any of the other factors so important in a modern society. That way, everybody has the opportunity to thrive, regardless of their background or circumstances. This is one of the reasons I decided to join the Institute; our values align and together we have a bigger voice on influencing not only our professional standards, goals and discipline but also those of the wider society. So big kudos to all of the local sections out there who are hard at work, with an outstretched hand to our communities making that happen!



At first I wanted to explore civil engineering, but I'm lucky to have dodged that bullet and joined the instrumentation & control trade instead.



THE OT CYBER EVOLUTION AND IMPROVEMENT STORY!

A long, long time ago, before the invention of operational technology (OT) cyber security, when the world was young, engineers grew amazing designs in their heads, scratched them out on paper, and built incredible engines. Huge machines were controlled like big toys, vast physics were brought under their thumbs, and systems made to do great and profitable actions.

Engineers built networks of things, connectivity was everything, SCADA was born out of automation dreams. IT and engineers become enemies. Engineers wanted more connections as IT desperately plugged system gaps. Management demanded more and more information, so the engineers provided “Glass Factories” with industrial information streams creating vast process information lakes and beautiful business information portals. Manufacturing execution systems were spawned from MRP, and Manufacturing grew up to become 2.0 and beyond....

All the while, the engineers delighted in making machines do things, and managers loved the control of their numbers. The IT people were more and more appalled with the connectivity of the strange unknown incomprehensible OT World and their beloved clean IT World.

The engineers revelled in their machinery world and thought that no outsider would understand their languages or their special machines. The IT people tried more and more to wrap up the strange OT world. OT information and control became more valuable but still felt safe in its strange engineering world.

The bad guys who loved taking other people’s money, or information, or vandalising stuff for their own good reasons, became more and more interested in this engineer’s magic world. They had been assaulting the IT World for decades and this new target seemed more exciting and challenging. The bad guys eventually

learned how to talk the engineers’ languages, they built new OT hacking tools and learned a new technique of scavenging OT relevant data – OT open-source intelligence (OT OSIN).

The engineers’ world was now under attack. Some dastardly groups and nations took pot-shots at each other, some with blunt instruments and some with fiendishly clever programming.

This was still a long, long time ago.

The world of engineers and process people and IT people was implored to get together and fight a combined fight. The Senior Boards were begged to talk their language. Business speak and engineers speak was documented and studied for some guidance on how to improve them and bring about wise words that could be understood by each group. For many organisations this new communication and the much-needed security and resilience of their organisations was sadly always someone else’s problem.

This was still a long, long time ago.

Out of these struggles was born a new role. A mix of engineer, process understanding, and IT security - The OT Expert. These SMEs were often generalists, sometimes having great skills in some areas and much knowledge of many other areas. These OT security unicorns knew that significant investments in resources, standards, frameworks, tools, software, gadgets, money, and time were required. The industry needed many more suitably qualified and experienced persons. They knew that many gadgets and software were not yet invented, so they spoke up and pleaded for improvements.

Industry forums, groups, associations, institutes, and conferences abounded with speaking unicorns. The herds gathered in a shy but quietly determined way although also knowing their attention spans were short. They had at least three day-jobs each.

This was still a long, long time ago.

Many conference speakers knew that the few instances of cyber-attacks on OT System were often too few, “not in my back yard”, not in my industry, not in my country, and would of course always happen to other people. They offhandedly saw that news items were increasing, attacks were increasing, industry news articles were improving but still any proactive changes in their own programmes for improving security and resilience were either non-existent or way too slow to be effective.

The conference speakers sadly realised that either the public news of deaths due to OT cyber-attacks or new national regulation was needed to instigate the necessary improvements to even have some hope of detecting and resisting the bad guys. They knew they could never win the wars, but with the right resources they could fight harder and defend well.

So, regulation was born across EU through the good works of the European Union Agency for Network and Information Security (NIS) and all their collaborators. The NIS regulations followed the GDPR and similar regulations in its international spread. The UK had recently ‘brexited’ so took their own variation of the EU NIS regulation on board.

This was still a long time ago.

The NIS Security Regulation was ratified across EU, and few took notice.

The UK published the UK NIS, and a few took notice.

The UK Regulator Competent Authorities (CAs) took notice and setup small but quickly growing herds of ‘unicorns’. These herds/teams consulted with their Operators of Essential Services (OES) to launch guidance, frameworks, advisory and standards services. Some OES took note of their guidance. Many OES started their improvements, some ignored the calls, some didn’t have the suitably qualified and

experienced designers to carry out the improvements. The engineers usually had three other day jobs!

This was some time ago.

Some CAs started some NIS Inspection services to assure and verify, through sampling, the veracity of OES's reports of their NIS compliance. The CAs and OES were using the UK National Cyber Security Centre's Cyber Assessment Framework (CAF) as a yard-stick guide for NIS compliance. This NIS Inspection Service, together with guidance and engagements, and closer engagements between CAs and OES brought about some rapid improvements in the OES's aims for NIS appropriate and proportionate security and resilience. There are many more points in the NIS UK regulations, such as reporting incidents etc. but the oft repeated phrase is "10.1 and 10.2 Appropriate and Proportionate."

The improvements in the UK security and resilience were now at last underway.

Across the EU the changes from NIS EU to NIS2 EU were seen and now ratified in law.

The next chapter in the UK is The Cyber Security and Resilience Bill which may be looked at as NIS UK 1.1 ?!

The different groups of people involved in NIS across EU, and NIS in UK, realised that some elements of NIS needed improvements and enhancements.

Some changes were made to improve the detailed processes of NIS, and some changes to take the NIS success story regulation out to more operators across our civilisation.

Following extensive consultation NIS UK changes have been laid in front of UK parliament.

NIS2 EU has completed consultations and is due for legal enforcement from the fourth quarter of 2024.

Both changes are seen as having extensive, or potential for extensive, pressure for critical and important entities to pull their socks up and effectively enact industry standards methods for security and resilience.

Some of the key changes for each regulation, from NIS to NIS2 and now the CSR (Cyber Security and Resilience) Act:

- Enhanced OT Security Measures
- Increased Accountability
- Broader Scope
- Collaboration and Information Sharing
- Penalty Enhancements

The future of the NIS Regulations is evolving. The outcomes of the regulations are expected to bring about further and faster paces of improvements in time. The UK Cyber Security and Resilience Bill in 2024 is welcomed as a further aid to improve the safety and security of the UK.

Many sectors have a very long journey of improvements ahead of them. There is a drought of experienced people to help each sector's journey. NIS and NIS 2 have made significant improvements in many sectors already and changes such as the Corporate Social Responsibility Bill will expand these improvements.

Many organisations find these improvements onerous until made business-as-usual. The advice is to take simple programme steps, one step at a time, which will then help achieve improvements, which can in turn become business-as-usual.

Boards need to be able to realise, understand and act upon appropriate and proportionate security and resilience. Engineering teams need appropriate and proportionate resources and smart risk appetites from the Board. Management teams need to be able to speak Board language and engineering language.

Collaboration and information sharing both inside and outside organisations, and at a national level are essential. In society's eyes we are all one team. The battle is on against both the bad guys and the 'accidental' guys. The battle has been waging for decades. We must plan. We must prepare. We must fight. We must not fail.

C'mon!

I have always advocated a measured and celebrated 'stairway' of continual improvements, a firm knowledge of the 'jigsaw' of assets, systems, people and processes, together with an 'A-Team' of respected improvement change instigators. The benefits to those who innovate using such techniques are clear.

This has been the story of the UK Cyber Security and Resilience regulation in its youth and its effect on UK security and resilience over recent years.

The UK has a positive story, in which I am personally proud to have been quite a big cog. There is still a long way to go.

Cevn Vibert CEng CITP FInstMC
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PRECISION RADIOTHERAPY TREATMENT USING A CLINICAL MR LINEAR ACCELERATOR

PETER NORMAN, MINSTMC, MIET

This article's aim is to describe the advances of Clinical Linear Accelerators with focus on the advantages of the Magnetic Resonance Linear Accelerator (MR Linac).

This combines the highly precise soft tissue contrast of a 1.5 Tesla MRI scanner with a 7MV flattening and filter-free, linear accelerator to deliver precision radiotherapy. The two combined technologies precisely locate tumours, tailor the shape of X-ray beams in real time and accurately deliver doses of radiation

to moving tumours which may also be very small.

Leading UK research work has been carried out by the Royal Marsden, London since 2018, together with their academic partner The Institute of Cancer Research (ICR), London. Funding came as a grant from the Medical Research Council to the ICR and was supported by the Royal Marsden Cancer Charity. Their research and key role in the research consortium of seven internationally renowned cancer centres (established 2012) by a Swedish MR Linac manufacturer helped shape and enable this technology for roll-out to cancer centres worldwide.

The design and development of the technology has been driven from a modern, medical engineering business hub in Crawley, West Sussex.

Electron Gun: An electron gun produces the electrons which then enter the accelerating waveguide.

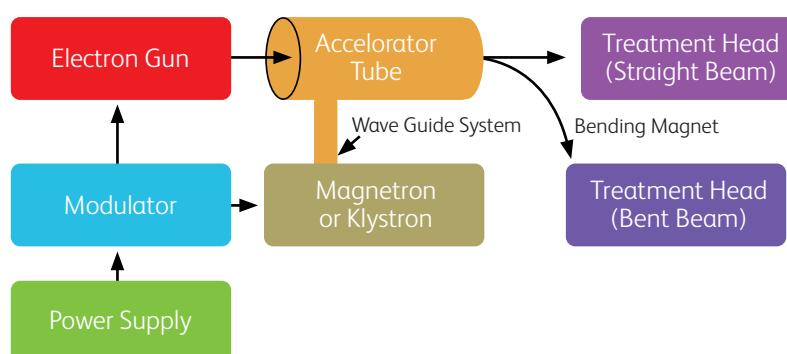
Thinking back to thermionic valves and cathode ray tubes, electron guns consist of a heated filament (~800°C – 1100°C) to release a cloud of free electrons. These electrons are immediately accelerated by a low E-field. Electron guns can either be of the diode or triode type. A Diode consists simply of the heated cathode and an anode to set the accelerating voltage. A Triode has a control grid between the cathode and anode which serves to recollect a portion of the liberated electrons. Thus, the triode design allows for a variable beam current by preventing a variable fraction of electrons from reaching the accelerator.

Magnetron: Magnetrons produce the microwave power for the accelerating waveguide.

Klystrons: Amplify the microwaves.

Accelerating Waveguide: A series of microwave resonance cavities used to accelerate the electron beam to higher levels of energy.

The key internal components of a typical Clinical Linear Accelerator:



The waveguide is a hollow metallic channel directing the microwave power from the Magnetron/Klystron to the Accelerating Waveguide. The waveguide is filled with an insulating gas to prevent electrical arcing. Microwave transparent ceramic barriers prevent the gas from leaking into the vacuum spaces filling the Magnetron/Klystron and the Accelerating Waveguide.

Circulator: A device in the waveguide used to prevent microwave energy from reflecting towards the Magnetron/Klystron.

Bending Magnet: The bending magnet is a magnetic lens used to focus and position the electron beam to intercept the target (for photon treatments) or, scattering foil (for electron treatments). The angle of bending varies according to manufacturer but may be 90°, 112.5°, or 270°. Magnetic focus attempts to be achromatic (does not separate by energy at point of focus).

Treatment Head: The treatment head contains beam production and shaping components including a multi-leaf collimator (MLC) and an optical distance indicator.

Cooling System: Typically, by water for stability of operation and energy efficiency.

Internal Components

The key internal components of a typical MRI scanner are:

A superconducting magnet, a cryogenic cooling system, a gradient coil to enable special encoding, a RF Coil, anatomically tailored MRI Coils, a power distribution unit, gradient amplifiers, a RF amplifier, and, a RF receiver assembly. Communication is via an, image reconstruction computer with peripheral devices and the assembly incorporates MRI safety systems and RF shielding. The gradient coil and MRI coils are for careful control of magnetic fields around certain parts of the human body for achieving best imaging quality.

Incompatible Technologies

(MR + RT): Two main engineering challenges arise from the effect of the magnetic field on radiation beam generation and the mutual effect of strong radiofrequency (RF) fields produced by both the linear accelerator and the MR scanner. These can impair both treatment delivery and image quality.

The engineering solution to mitigate the influence of the high magnetic field on the linear accelerator was to modify the active shielding of the MR magnet to create a concentric, low-field central area which accommodates the Linac beam and other susceptible components. Also, the RF cage that shields the environment from the MR RF signals was made an integral part of the MR scanner. Similarly, the linear accelerator is shielded from the MRI's transmitted RF. The product was named 'Unity' as a result.

The working anatomy of the MR Linac – Unity model:

Inside the outer housing surrounding the patient treatment 'tunnel', the linear accelerator is mounted on an intrinsically stable slip-ring gantry mechanism to allow the Linac to smoothly rotate through 360° around a cylindrical cryostat containing the 1.5 T superconducting magnet of the MR imaging system, at a maximum speed of 6 rpm. This enables high precision RT treatment delivery to the patient. Simultaneously, high quality MR images are rapidly acquired at five frames per second in the sagittal, coronal and axial anatomical planes, in any combination and at any time before, during, and after treatment delivery. This facilitates adaptive radiation therapy to be delivered.

The cryostat is a thermally insulated enclosure storing liquid helium for cooling the superconducting magnet.

Unity has a 160-leaf multi-leaf collimator (MLC) moving in the longitudinal direction. The MLC

shapes radiation fields on the isocentre plane. In addition, Unity has an MV imager (MVI) with an imaging dimension of 22 × 9.5 cm², which is used for the MLC leaf calibration and ionization chamber alignment.

The term "isocentre" - in Magnetic Resonance Imaging (MRI) - refers to the precise centre point within the magnetic field of the MRI scanner. This point is particularly important because it represents the area where the magnetic field is most uniform and where the gradients are most linear.'

The patient couch moves only in the longitudinal direction resulting in treatment fields being defined away from the isocentre according to the target position in the patient body



Credit: The Royal Marsden Cancer Charity

References sources:

Public on-line material from The Royal Marsden / NHS Foundation Trust (13/ Oct/2023)

Introduction to Clinical Linear Accelerators – Oncology Medical Physics (.com)

Magnetic Resonance Imaging (MRI) – Medical Imaging Source (.com)

Elekta Unity for Magnetic Resonance Radio Therapy (MR/RT) – White Paper (2022)

Elekta Unity MR-Linac commissioning: mechanical and dosimetry tests – Oxford Academic: Journal of Radiation Research (14/ Nov/2022)



Scan QR Code to find out more about The Royal Marsden cancer research treatment

THE FUTURE OF GLOBAL COMPLIANCE AND INDUSTRIAL INNOVATION

In a world where industries are increasingly subject to evolving regulations and safety standards, adapting to these changes is crucial for maintaining operational safety and efficiency.

One of the most important developments in recent years is the shift in how industries approach compliance and inspections, particularly in hazardous environments like explosive

atmospheres. For companies operating globally, this challenge has only intensified with the onset of new regional regulations and post-Brexit shifts, such as the shift from European ATEX to the UK's UKEX standards.

The Challenge of Evolving Regulatory Landscapes

Historically, industries had to adhere to the ATEX Directive that governs equipment used in explosive environments. However, once the UK departed from the EU, new challenges arose with UK based companies now needing to navigate both ATEX and UKEX (the UK's domestic equivalent) standards.

Around the world, industries face an increasingly fragmented regulatory landscape. From BS EN60079-17 and ATEX standards in Europe to PUWER (Provision and Use of Work Equipment Regulations 1998) and UKEX in the UK, and regional

equivalents in Asia and the Americas, the need for a flexible, multi-regional approach to safety and compliance has become clear.

What is the response to these challenges?



Industrial sectors are increasingly turning toward cloud-based inspection platforms to meet global compliance needs. These platforms allow companies to manage everything from routine

safety checks to complex compliance requirements in real-time, providing unparalleled flexibility and efficiency. By embracing digital transformation, industries are able to streamline the management of safety-critical assets across borders, regions, and regulatory frameworks.


Modern inspection tools have moved well beyond manual processes. Whereas previously, technicians relied on numerous paper forms or lengthy manual data entry to document their work in the field, they are now able to use mobile devices to upload inspection data instantly. This allows real-time tracking of asset health, fault management, and compliance status, giving the end user visibility and control over their processes. Time is saved, accuracy is enhanced and the risk of human error is reduced.

Innovation in Inspection and Asset Management


Compliance is no longer a process that can be managed within the confines of a single set of standards. Industrial companies are now required to comply with a multitude of regulations, often operating in regions that have their own sets of standards for safety and asset management.

UKEX is one example of how regulatory environments can shift quickly, requiring companies to pivot and adapt. Likewise, as companies look to expand their operations into new regions, meeting regional standards becomes critical. This demand has spurred innovation in compliance management, particularly through cloud-based tools that are designed to be flexible with the ability to scale in line with the business.

One of the key advantages of modern inspection platforms is their customisation and flexibility. Industrial environments demand highly specific solutions tailored to unique operational needs. The flexibility of digital platforms allows for personalised workflows, enabling industries to configure inspections,



Modern inspection tools have moved well beyond manual processes. Whereas previously, technicians relied on numerous paper forms or lengthy manual data entry to document their work in the field, they are now able to use mobile devices to upload inspection data instantly.



fault management processes, and documentation requirements to meet their precise needs.

For instance, companies can now create custom fault codes and track faults in real-time, ensuring that any issues are addressed quickly and efficiently. Additionally, the digital nature of these platforms enables live updates from the field, ensuring that engineers, technicians, and management have immediate access to the latest information on asset/tag health. This type of innovation marks a significant step forward in real-time asset management, increasing overall operational efficiency.

With all documentation stored digitally, the audit process becomes much easier to manage. Companies

can access necessary data at the click of a button, helping them stay on top of compliance requirements and minimise any risks.

The Future of Compliance and Digital Collaboration

The software and platforms are increasingly designed with collaboration in mind, allowing companies to work closely with software developers to create bespoke solutions. This approach ensures that platforms evolve to meet the changing needs of modern industries, providing ongoing support and development to keep in line with regulatory changes and operational demands.

The focus in industry is shifting from reactive safety measures to proactive management, using real-time data to predict and prevent issues before they escalate. This shift not only helps industries stay compliant with regulations but also enhances overall safety and operational efficiency.

As industries around the world continue to navigate a complex web of regulations and standards, the need for flexible, digital solutions will only grow. These platforms are set to become indispensable tools for industries looking to remain compliant in an ever-changing landscape.

Dr Martin Hold, Engineering & Compliance Leader, HTS Engineering Driving Technological Innovation in Safety Solutions

LOCAL SECTION NEWS

CENTRAL NORTH-WEST

In my last update we were reviewing the submissions for our new Award 'Early Career Engineer 2024'. I'm delighted to say that we had some extremely good submissions, and the winner was presented with his award at our Annual Awards Night in October. Ben Thompson of United Utilities submitted a project on 'Optical Measurement of Phosphate in Wastewater'. Ben presented his project as a technical talk and the recording is on the InstMC YouTube channel.



In October we continued our tradition of holding our Annual Awards evening. In central Manchester we held the event with 150 people and presented Student Awards to University of Manchester, Best Embedded Systems Project, sponsored by Sella Controls, and Liverpool John Moores University Best Performance in control modules, sponsored by ITI Group. It was great to see so many there after a dip in 2023 including Megan Hine (North of Scotland section) and Brian Jones (South-East section). This year we switched to a musical act in place of a comedian and this was received very well.



Our Technical Talks have continued at lunchtime online. We place the videos of the sessions on the InstMC YouTube channel. In the period we have had Bens' presentation in October, EI 15 update by Steve Sherwen of RPS and Comprehensive File, Data And Removable Media Protection For Real-time OT Networks by Simon Giddings of OPSWAT in November. We take a break in December and the first session in 2025 will take place on 15th January 'As Simple as PID - A New Approach to Closed Loop Real-time Optimisation' by Dr Paul Oram, of Ortomation Ltd. Do send your ideas for future sessions. In 2025 we will have a hybrid program with some face-to-face sessions and others remaining exclusively online. Chris O'Hara would love to hear your suggestions (please email the chair for details to be passed on cnw_chair@members-instmc.org).



In October we released our very first podcast. 'Episode 1 – Welcome to InstMC Central North West Section' which allowed Darren Glover, Chris O'Hara and myself to discuss who we are, what we do and

how people can get more active in the Institute. Episodes 2 and 3 are currently in production, where we are starting to explore more technical conversations. Find the channel on YouTube (@cnw_podcasts) and Spotify (instmc_cnw).

Looking to 2025, we will host the following awards:

- Early Career Engineer 2025
- Apprentice of the Year 2025



Details of both are on our 'Students and Awards' page on the Local section webpage.

I look forward to having just as much to report in the next edition. If you want to keep up to date on a more frequent basis then please follow our LinkedIn page <https://www.linkedin.com/company/instmc-central-northwest/posts/>

Dave Green,
Local Section Chair,
Central North-West

A FIRST FOR THE SOUTH-EAST SECTION

On Wednesday 18th October the South-East section held their first in-person Technical Lecture since the pandemic. The lecture was held at City, University of London, with over 100 registered to attend, with the majority being students at the university.

The subject for the event was “Advanced Ground Robot Supervision Systems”, presented by Matt Graves, Digital Principal from Rockwell Automation.

Matt took us through the current stage of development of remote autonomous robots, in particular for the offshore oil & gas industries, but with many other potential applications in hazardous locations and environments.

A video of stair climbing robots, carrying cameras, sensors and tools, with autonomous navigation from a remote location was extremely impressive.

The City, University of London Robotic Society and the rest of the audience plied Matt with many questions

after the presentation, which continued until moving on to refreshments provided by Measurement and Control Engineers London.

The slides associated with the presentation are available on the InstMC website, South-East Section page.



CALLING VOLUNTEERS FOR LOCAL SECTIONS!

With new boundary changes in place at the start of 2024, several local committees are looking for volunteers to help keep our community activities thriving. We're especially looking for support in the Southwest Section (Southwest England/South Wales), so if you're in this area, your help could make a huge difference.

Volunteering is a fantastic way to make an impact, meet others in your area, and support the ongoing work in your local section. Our Committee Chairs would be happy to chat about what's involved and how you can contribute.

Please contact member.communication@instmc.org to express your interest.

Need more information about your local section? Here's a quick guide:

- Unsure of your Local Section? – Simply log into the Members Portal on the InstMC website to check your member profile for details.
- Haven't heard from your Local Section recently? – Reach out to your local Chair for the latest information (contact details are available on the InstMC website or reach out to the InstMC staff for assistance).

Your support is also needed in Anglia, Central England, and North Central Sections—and together, we can bring new energy to our local activities.

We look forward to seeing some new faces step forward and get involved.



ADVERTISING RATES

2025

Discounts can be given if 3 or more adverts are taken. POA.

Full Page	£1,420
Half Page	£860
IFC	£2,290
IBC	£2,290
OBC	£2,290

INSERTS

A4 & A5 Inserts £860

Inserts are accepted into Precision magazine and must go to the entire UK circulation.

CIRCULATION BREAKDOWN:

1796 UK Engineers / 556 Overseas Engineers
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The Institute of Measurement and Control is committed to promoting the professional excellence and standing of engineers and technologists at all levels in the automation, instrumentation, control and related industries.

Precision is a coffee-table style quarterly magazine exploring the world of engineering, with a focus on measurement, control and automation.

Precision offers reviews and opinions from experts in the field and presents technical and feature articles in an easy-to-comprehend style. The magazine is circulated to our +2000 members and shines a spotlight on current topics, developing technology and member-related news.

A digital edition is also available on our website for anyone interested in the various uses of measurement and control. Control

We are always on the lookout for fresh exciting content, so if you would like to contribute an article, please email us with your ideas or finished article of approximately 1000 words.

For all advertising and content enquiries, please email jane.seery@instmc.org.



PRECISION MAGAZINE

SPOTLIGHT ON STAFF:

Q&A with InstMC
Staff Member
Hazel Panganiban,
Membership
Administrator.

How long have you been with InstMC?

I've been with the Institute for a little over three months now. The team has made me feel very welcomed and I'm learning a lot from all of them. I'm excited to see where this journey will take me.

What is your background?

I studied Tourism in the Philippines for two years, and then I decided to move to the UK. My first job was as a hotel receptionist where I later became a supervisor. Working in hotels doesn't always go well with childcare because of the rotating shift pattern so I decided to move to the corporate industry where I worked as a receptionist for a global infrastructure consulting firm, all my hard work paid off when a member of staff saw my potential and hired me to be the PA for their team. Everything I have learnt throughout my career is useful for my current role at the Institute.

What is your role at InstMC?

I am the Membership Administrator. It is a new role, so we are all exploring which tasks I could take on from the team. For now, I deal with membership queries and process new membership applications. I have also started taking on some professional registration tasks to help balance our team's workload.

Can you describe a typical day in the office?

It's hard to think of a typical day really, as each day could be very different which makes this role so exciting! I get to speak with professionals, each with their varied queries. My day kicks off by checking if there are any voicemails waiting for me. Then, I dive into my inbox, checking through my flagged emails and any pending queries that have popped up after I logged out the day – just making sure that everything is handled and dealt with on time. Once I've tackled that, it's time to sort through new applications and check things off on my to-do list. Each task brings something different, and I am excited to learn lots more.

What do you bring to the team?

I am very well-organised, and this skill is very useful when doing admin tasks for the team. I am also a cheerful person, and I believe I add a little banter to our lovely team!

What do you like best about working for the InstMC?

I am really enjoying my time at the InstMC. This is a new experience for me, and I am loving every minute of it! The best part is that we have such a small team which makes it so much easier to get along with everyone. They are always happy to help me as I familiarise myself with this new role.



What do you do to unwind, once your working day is over?

This is a tricky one because once my working shift is over, my parenting shift starts! I usually have a couple of hours after work before I have to pick up my toddler from nursery and I use that time to do errands and make our dinner but once they are in bed, that's when I can truly 'unwind'. I tend to relax with a glass of wine while watching my favourite TV series and sometimes, I go to Zumba/Salsa classes which I enjoy a lot.

Can you tell us a fun fact about yourself?

I can speak 3 languages fluently - my native language which is Tagalog (Philippines), English (of course), and Portuguese (Brazil). I love learning different languages and I can also say 'how are you?' and 'thank you' in about 15 languages!

ARE YOU MISSING OUT ON TAX RELIEF?

InstMC Annual Subscription Fees Tax Relief

If you are a taxpayer in the UK, have paid your own InstMC annual subscription fees (i.e. it has not been paid for by your employer) then it is possible that you can claim tax relief on your InstMC annual subscriptions (and Engineering Council annual subscription if applicable) at your personal tax rate (20%/40%/45% as individually applicable). **You can also retrospectively claim for up to four previous years if you have not claimed before.** To be admissible the subscription must be relevant to your employment or self-employment.

There are two ways of doing this...

- For those who currently submit an annual tax return, you can include your InstMC subscription fees in the Employment Expenses section of the tax return.
- For those who do not currently submit an annual tax return, you can follow the following link to HMRC (visit: <https://www.gov.uk/tax-relief-for-employees/professional-fees-and-subscriptions>) which will guide you through the process to claim for Professional Fees & Subscriptions using a P87 form.

Please note that there is an HMRC "List of approved professional organisations and learned societies" at this web address: <https://www.gov.uk/government/publications/professional-bodies-approved-for-tax-relief-list-3> which the HMRC uses to determine if the subscription is eligible for tax relief – for some unknown reason InstMC is listed under "M" as "Measurement and Control Institute of".

If you are in any doubt, please seek independent tax advice and if you are an overseas/non UK tax paying member, please make contact with your own local tax authorities to see what, if anything may be possible.

OUR CORE TEAM

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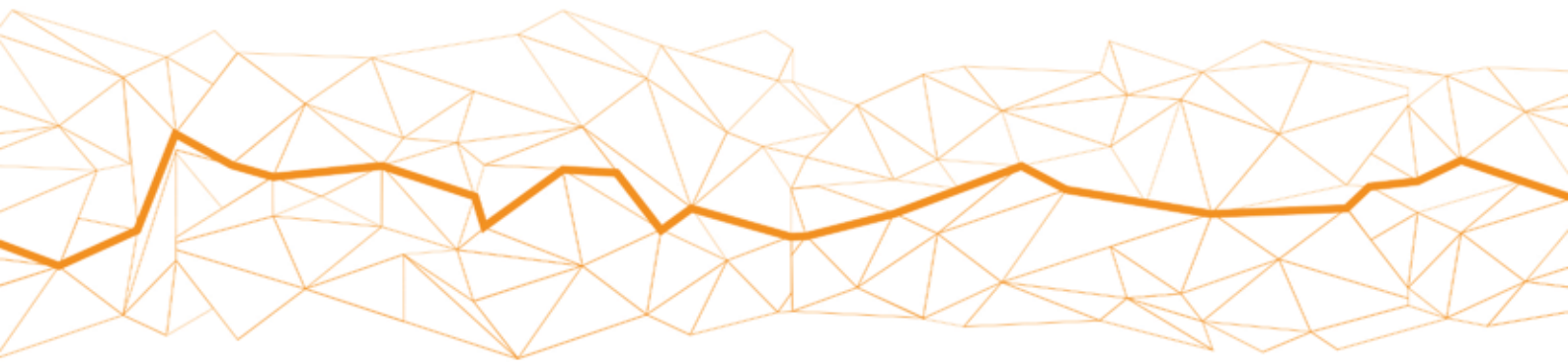
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