

# Ultrapure Water IIoT & Remote O&M

Overview

IIoT Powered by IIoW

Suppliers



# Overview



# Ultrapure Water IIoT and Remote O&M Market will exceed \$800 million in 2026

Operators of ultrapure water systems in power plants, pharmaceutical, semiconductor and other industries requiring ultrapure water will invest \$5 billion in hardware, consumables and services this year to provide high purity water for manufacturing processes. This is the forecast in *Ultrapure Water World Markets* published by the Mcilvaine Company this year. Seven percent of the total expenditures (\$350 million) will be spent for IIoT and Remote O&M. The IIoT segment will grow rapidly over the next decade and reach \$875 million by 2026. This will be due to rapid growth in digital process management as outlined in [\*\*N031 Industrial IOT and Remote O&M.\*\*](#)



# 2026 Forecast by Industry Segment - \$million

Industry	UPW Total 2017	UPW IIoT and Remote O&M 2017	UPW IIoT and Remote O&M 2026
Coal-Fired Power	900	63	158
Semiconductor	1500	105	262
Other Electronics	850	59	148
Gas Turbines	400	28	70
Nuclear	200	14	35
Industrial Power	450	32	80
Other Industries	200	14	35
Pharmaceutical	500	35	87
Total	5000	350	875

# Asia will dominate the Market

- Asia will dominate the market due to its continued expansion of coal fired power, electronics manufacturing and its leading role in generic drugs. However, international companies are dominant in IIoT and in domain expertise. So they should be able to garner a high Asian market share.
- The IIoT & Remote O&M applied to the manufacturing processes will be much larger but ultrapure water is essential to producing reliable steam, salable chips and safe drugs. The challenge is to integrate ultrapure water digital process management with that of the facility.
- In the electronics industries, ultrapure water with a very high degree of purity is used to clean silicon wafers and electronic components. Kurita Water Industries combines IIoT and remote monitoring with a range of products such as deionizers, RO (reverse osmosis) membranes, water treatment chemicals, and ion-exchange resins. Kurita also offers a number of wastewater treatment systems and wastewater reclamation systems that provide an optimal means for treating the organic and inorganic wastewater discharged during the various production processes.

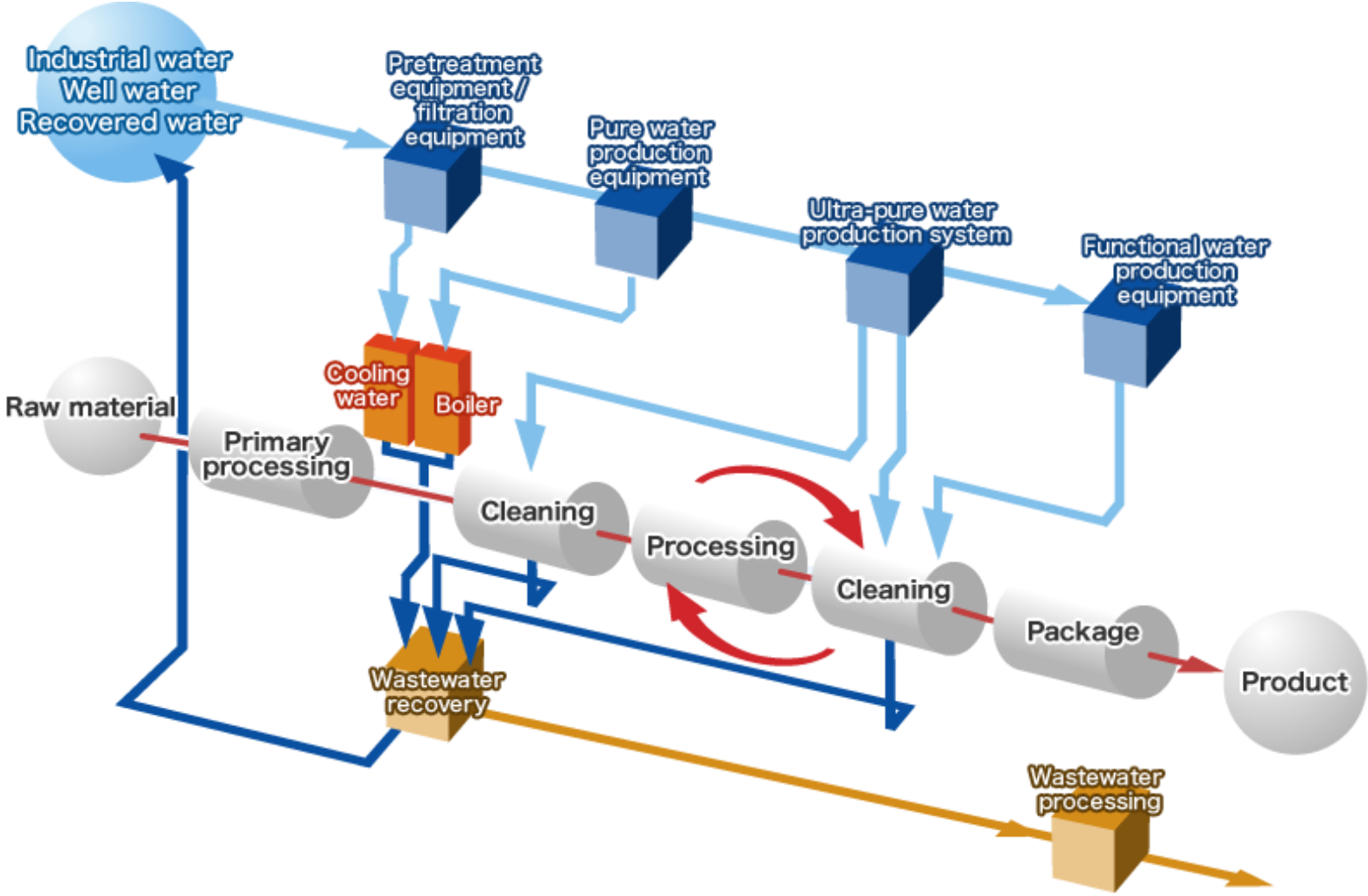
# Kurita Example – Coordinating Automation with Products and Services

- Kurita defines IT sensing technology as the foundation of solutions provided to customers, and visualizes the water treatment status using its original system to provide services for the remote monitoring of customers' water treatment conditions. The purpose of these services is to monitor the water treatment conditions and effects of treatment on a real-time basis with customers at their sites, and to share information about water treatment issues that need to be addressed together so that Kurita can quickly implement more beneficial solutions to all the issues customers face.
- Kurita analyzes the water quality of target facilities on a daily basis and reports the analysis results to customers. It launched a new water treatment management service called "S.sensing," with the aim of building higher value-added systems for customers by visualizing the water treatment effect more directly.
- It will realize optimal water treatment in real time with a system that combines Kurita's original core technologies for measurement, analysis, control, and monitoring by installing the sensing equipment in the plant facilities of customers.

# Kurita Supplies the Chemicals Dictated by IIoT System

- With this system, it controls and optimizes chemicals injected in response to changes in water quality on a real-time basis at the target facilities where water treatment chemicals are used, based on the automatic analysis of the effective density of chemicals and the water treatment effect, along with conventional services to monitor data such as water quality, the amounts of the chemicals injected, and the remaining amounts of chemicals. The items of measured data are instantly transferred to Kurita's server, allowing it to check the water treatment management status as needed from a computer, a smartphone, or a tablet terminal connected to the Internet.
- Kurita will promote higher-quality solutions, such as the ex-ante prediction of problems, the realization of more efficient water treatment specifications, the improvement of productivity, and the reduction of the environmental impact by sharing various kinds of information with customers through the S.sensing services. This information includes items such as the status and effect of water treatment management, the operation data of water treatment facilities, and trends of other temporal changes. The diagram below provides the components in a system providing ultrapure water for liquid crystal display manufacturing.

# Kurita System





# Suez could become the IIoT UPW Leader

- Suez has the opportunity to become the leader in ultrapure water IIoT and Remote O&M. It is acquiring GE Water who has the ultrapure water technology while Suez is remotely monitoring facilities around the world from a center in France. For manufacturers of pharmaceuticals GE Water now offers water treatment, reactor cleaning, USP/UPW production, process fluids treatment and pharmacopoeia monitoring instruments. Its purchase of Sievers many years ago makes it a leading supplier of TOC and other water quality instrumentation.
- The former GE Betz who is a major provider of chemicals for ultrapure water will also now be part of Suez. This group has a large staff of sales engineers who are providing a service as well as sales role. In the future with more IIoT and Remote O&M onsite service will be diminished.

# Veolia adds Mobile Fleets to Dispatch based on Data Analytics

Veolia combines systems and monitoring with mobile fleets with the following features

- Global network at your local service
- Rapid response
- High flow rates capacity solutions
- Zero discharge
- Continuous production
- Preventive service

These capabilities will provide Veolia with the capability in the future to remotely monitor and control ultrapure water at the plant with a combination of permanent and mobile systems.

# Pump, Valve and Chemical Companies will share Cloud System

- Ultrapure water systems require pumps and valves. The suppliers of these pumps and valves are the same companies who supply this flow control equipment to power, semiconductor and pharmaceutical plants. In the future IIoT world the pump and valve suppliers will all have remote control centers and digital process management programs for their products. There will be a remote-control center operating a cloud based open platform system which will integrate and analyze all the pumps and valves as well as all the other components and processes. The end users, main digital process manager and the pump and valve companies will all have real time relevant data.
- The treatment chemicals companies will be monitoring chemical usage and performance. Filter companies will be monitoring filters for ultrapure water, wastewater, lubrication, hydraulic power and dust collection. All the fans and compressors will be similarly monitored and controlled.

IloT empowered by IloW

# IloT empowered by IloW

Successful ultrapure water IloT and Remote O&M will depend on the harnessing of IloW (the Industrial Internet of Wisdom). IloW empowers IloT by

- Interconnecting individuals with IloW resources (CCJ and Ultrapure Water Journal are two examples)
- Interconnecting individuals within a semiconductor, pharmaceutical or power plant complex with many plants. Mcilvaine has constructed a beta site for Berkshire Hathaway Energy. BHE operates more than 100 ultrapure water systems [4S01 Berkshire Hathaway Energy Supplier and Utility Connect](#)
- Interconnecting individuals within disparate divisions (Danaher has both the Hach and Pall divisions which provide monitoring and filtration and could be working with each other).

# Ultrapure Water Journal, CCJ, and McIlvaine as Three IloW Reservoirs

- The next slides show IloW resources relative to power plant ultrapure water and steam monitoring.
- *Combined Cycle Journal* provides original editorial and is a very unique contributor to IloW on gas turbine and combined cycle issues.
- *Ultrapure Water Journal* is now *Ultrapure: Mastering the Industrial Water Cycle*. It has a unique focus on ultrapure water issues.
- The McIlvaine Company has many ultrapure water related publications including
  - [N029 Ultrapure Water: World Market](#)
  - [4S01 Berkshire Hathaway Energy Supplier and Utility Connect](#)
  - [44I Coal Fired Power Plant Decisions](#)
  - [59D Gas Turbine and Reciprocating Engine Decisions](#)



- The successor of *Ultrapure Water Journal*.
- Content is published at [www.ultrapurewater.com](http://www.ultrapurewater.com).
- *GWi | Ultrapure* is now part of the Global Water Intelligence family of water-related publications.

**Areas of coverage:**

- Endusers of high-purity and industrial water. Examples: microelectronics, pharma, power, food/beverage, petrochemical, refineries, general industrial facilities.
- Applications: DI/high-purity water treatment, process waters, boiler water, cooling water treatment, wastewater reclaim/reuse.
- Technologies covered: Instruments/Monitoring, IX, EDI, RO, NF, UF, MF, UV, Chemical Treatment, Materials of Construction, Ozone, others.
- Content: technical articles, patent summaries, news summaries, Water Forum, Discussion Column, Features,



**Examples of Content from our Archive of more than 2,200 Articles published since 1984:**

Article Example	Authors
<a href="#"><u>New Techniques for Real-Time Monitoring of RO Membrane Integrity for Virus Removal</u></a>	Val Frenkel, PhD, Yoram Cohen, PhD, Anditya Rahardianto, PhD, and Sirikarn Surawanvijit, PhD
<a href="#"><u>Can THM Monitoring and Removal Be Improved In High-Purity Water Applications?</u></a>	John DeGenova, PhD, Philippe Rychen, Ignacy Kieler and Malek Salamor
<a href="#"><u>What Lessons Can Be Learned From Steam Generation Chemistry Control And Monitoring Failures?</u></a>	Brad Buecker
<a href="#"><u>What Are Common Cooling System Techniques For Microbiological Control and Monitoring</u></a>	Anthony Selby
<a href="#"><u>Monitoring –How XRF Spectroscopy Can Detect Chlorine Contamination of Anion Resins</u></a>	Greg Bachman, Debbie Schroeder, Dave Moyer and Matt Branham, PhD



# Conferences

## Co-Located Events– May 31-June 1, Portland, OR:

### **UPW MICRO 2017** MICROELECTRONICS INDUSTRY WATER MANAGEMENT

#### UPW Micro Features:

- Pre-Conference Training Workshop, May 30.

#### May 31-June 1: Two Technical Presentation Tracks

- Strand 1: Semiconductor UPW
- Strand 2: Process and Cooling Water, and Wastewater

Roundtable Session Hosted by Semiconductor Water Experts—Networking and Learning Opportunity.

#### Details:

[www.ultrapurewatermicro.com](http://www.ultrapurewatermicro.com)

### **UPW PHARMA 2017** PHARMACEUTICAL WATER CYCLE MANAGEMENT

#### UPW Pharma Features:

##### Day 1:

- Part 1 of Pharmaceutical Water Learning Series
- New Technologies and Case Studies
- Enduser Perspectives

##### Day 2:

- Part 2 of Pharmaceutical Water Learning Series

#### Details:

[www.ultrapurewaterpharma.com](http://www.ultrapurewaterpharma.com)

# Why is Accurate Steam Sampling Critical for Power Plants?

## *UPW Journal*

The failure to accurately sample and analyze saturated, superheated, and reheated steam from boilers or heat recovery steam generators (HRSGs) can lead to significant deposition and corrosion related failures of the steam path in boilers, HRSGs, steam turbines, and any process equipment that comes into contact with the steam. The article discusses the minimum acceptable equipment standards for sampling and on-line analysis of steam from boilers and HRSGs, along with the need for routine carryover testing. Multiple real world case studies of steam sampling, analysis and purity issues are presented with key lessons identified.

It should be appreciated that even the highest purity steam contains sufficient contaminants, ions, and oxides to result in deposition onto steam turbine surfaces in the phase transition zone (PTZ) of the turbine. In the case of elevated impurities in steam produced by a boiler or HRSG, these have the potential to cause additional deposits in the steam turbine as any elevation of the impurity levels will result in increases in concentration in the liquid films and deposits on these surfaces. These deposits increase the risk of corrosion in the steam turbine and also the superheater and reheater sections of the plant where they can form, adversely affecting their performance and reliability. Elevated impurities in steam can be due to steam contaminated because of carryover and/or substandard attemperator spray water. These affects can include the following:

1. Superheaters and reheaters: Deposition during operation of impurities onto internal tube surfaces, which cause a restriction of steam flow. This steam flow reduction from the buildup of a deposit decreases the cooling of the tube and increases the tube metal temperature. This ultimately results in an in-service overheating failure of the tube because of creep.

Deposition during operation of impurities such as sodium sulfate, which become corrosive during repeated shutdown periods with ineffective layup and storage protection when the deposits are exposed to oxygen and moisture. This results in the growth of pits on the tube internal surfaces during shutdown periods and ultimately in an in-service through-the-wall failure.

2. Steam turbines: Deposition during operation of impurities such as silica and copper onto steam turbine surfaces, which disrupt turbine steam flow and decrease turbine efficiency and output (1). Deposition during operation of impurities such as sodium hydroxide and sodium chloride onto steam turbine surfaces during shutdown periods with ineffective layup and storage protection for when they are exposed to oxygen and moisture. This results in pitting in the turbine that then become the initiation locations for in-service cracking to take place, such as stress corrosion cracking and corrosion fatigue, which can then result in in-service failures of the steam turbine.

Article by David Addison and Barry Dooley in *GWI Ultrapure*

<https://www.ultrapurewater.com/category/boiler-feedwater>



# What Lessons can be learned from Steam Generation Chemistry Control and Monitoring Failures?

*UPW Journal*

Combined-cycle power plants dominate new plant construction. Unfortunately, many of the previously learned lessons from coal plants are not carried over to the heat recovery steam generators (HRSG) of combined-cycle units; even though these steam generators operate at high temperatures and pressures. A contributing factor to the lack of knowledge transfer is that combined-cycle units are often minimally staffed, with few or no chemistry-trained personnel.

Research and experience over nearly a century have shown that even trace contamination in high-pressure steam generating systems can cause significant to- severe corrosion, scaling, and fouling. Furthermore, many former solutions to these problems have been demonstrated to be incorrect. Yet, a number of faulty ideas, and/or basic lack of knowledge continue to persist among those who are new to steam generation chemistry or have not had a chance to study modern concepts.

This article by Brad Bueker of Kiewit uses case histories to outline issues that can arise because of improper chemistry control and monitoring, and examines such issues as waterwall tube failures because of corrosion and hydrogen damage, single-phase and two-phase flow-accelerated corrosion (FAC), steam system damage because of transport of impurities from the boiler, and turbine blade fouling and corrosion, also from the transport of impurities.

[https://www.ultrapurewater.com/articles/boiler\\_feedwater/what-lessons-can-be-learned-from-steam-generation-chemistry-control-and-monitoring-failures](https://www.ultrapurewater.com/articles/boiler_feedwater/what-lessons-can-be-learned-from-steam-generation-chemistry-control-and-monitoring-failures)

# New Techniques for Real Time Monitoring of RO Integrity for Virus Removal

*UPW Journal*

- In principle, RO membranes should provide a complete physical barrier to the passage of nanosize pathogens (e.g., enteric viruses). However, in the presence of imperfections and/or membrane damage, membrane breaches as small as 20 to 30 nanometers (nm) can allow enteric viruses to pass through the element and contaminate the product water stream, thereby posing a potential health hazard that is of particular concern for potable water production.
- This project was focused on the development and evaluation of a pulsed-marker membrane integrity monitoring (PM-MIMo) approach for RO processes based on the use of a fluorescent marker. The monitoring approach employs pulsed dosing (via a precision metering pump) of a marker into the RO feed stream coupled with online marker concentration monitoring in the RO permeate by an inline spectrofluorometer. Membrane integrity is then inferred on the basis of real-time analysis of the marker time-concentration profile response in the RO permeate.
- The basic concept of the PM-MIMo approach for detecting membrane breaches was successfully demonstrated, by comparing intact and damaged membranes, in a series of experiments using a diagnostic plate-and-frame RO system and spiral-wound RO pilot system. Results of the developed technique are presented in the project report to allow consideration for adopting this technique by industry for RO/NF online integrity monitoring.
- Val S Frenkel et al <https://www.ultrapurewater.com/articles/wastewater/new-techniques-for-real-time-monitoring-of-ro-membrane-integrity-for-virus-removal>

# Addison tells *CCJ* that you need to Monitor Iron Levels

Thermal Chemistry Ltd's David Addison, a globally recognized water consultant with years of experience in power plant operations, says that accurate measurement of total iron in a combined cycle's steam/water circuit is critical to understanding the degree of effectiveness of the cycle chemistry program formulated to protect against corrosion and deposition.

- He reminds that 99.9% of the materials contacting steam and/or water are ferrous-based—including the carbon steel used in HRSG feedwater, economizer, and evaporator circuits; the P/T11, P/T22, P/T91, and other alloys specified for superheaters, reheaters, and main steam piping; and the stainless steels used in condensers, sample lines, etc. Addison told the *CCJ* editors that one of his goals is to convince those not currently monitoring iron levels to do so and those using the incorrect monitoring techniques to change their approach

# Addison Paper linked from McIlvaine's Global Decisions Orchard to *CCJ*

- [\*\*WATER MANAGEMENT: Ensure a reliable, sufficient supply of quality water to support generation assets, by David Addison and Judy Weir, Thermal Chemistry Ltd.\*\*](#)
- The purpose of any water treatment plant (WTP) for this industry is to produce a reliable and sufficient supply of product at the quality required by the host plant to support generation operations. Organizations such as EPRI and the International Association for the Properties of Water and Steam have long advocated the need to maintain strict quality limits for both makeup and the steam/water cycle to avoid issues such as boiler tube failures and steam-turbine deposition and corrosion. Power generators call their WTPs by different names, some of which refer only to a specific part of the total system—such as deionization or pretreatment. For this presentation, the term WTP refers to all treatment processes used in the production of demineralized makeup from the raw water supplied to the plant. Pretreatment refers to that segment of the WTP producing clarified and/or filtered water for downstream demineralization. It can range from simple chlorination and physical filtration of the water supply to chemical clarification and flocculation followed by sand or multimedia filtration. The demineralization plant refers to the system that removes dissolved ions and produces water of very low conductivity (less than 10 uS/m) and silica (less than 10 ug/L) for boiler makeup, gas-turbine NOx control, etc. The technology may be membrane-based—like reverse osmosis (RO) followed by continuous electrodeionization (CEDI)—or ion exchange, using resin beds. Quality, quantity, and reliability are interlinked, and often the issues impacting one—such as changes in feedwater quality, plant operation, and/or maintenance—affect all. It is difficult to talk about one of these variables without referring to the others...
- This is in the Mcilvaine Global Decisions Orchard but linked from the *Combined Cycle Journal* site

# Suppliers

# ABB's Comprehensive IIoT Solutions

- ABB has comprehensive IIoT solutions for industries utilizing cleanrooms. Its manufacturing execution systems (MES) play an essential role in achieving sustainable competitive advantages in the life science industry today. They enable higher plant efficiency and productivity as well as greater flexibility and agility throughout the production processes.
- ABB collaborates with a leading pharmaceutical MES supplier, Werum IT Solutions GmbH based in Lüneburg, Germany, on control system solutions for life science industries.
- Werum's PAS-X out-of-the-box software product is operating in approximately 800 installations of the world's pharmaceutical and biotech companies. Manufacturing IT products from Werum IT Solutions help pharmaceutical manufacturers increase efficiency, improve productivity, and meet regulatory requirements.



# ABB's Comprehensive IIoT Solutions, cont.

- The collaboration on the joint solution complements ABB's control systems offering with the latest MES technology, which is seen as a key component for efficient production workflows in the life science industry. By bringing together both offerings, ABB and Werum IT Solutions will be able to deliver full scope engineering and validation solutions according to the GAMP5 guideline, and comply with regulations, such as FDA (21 CFR part 11). MES capabilities include:
  - Production order management
  - Quality management
  - Weigh & dispense.
  - Warehouse management:
  - Standard operating procedures (SOPs) – bringing consistency to manual operations by guiding the operator through each step with the required production and safety instructions and checks.
  - Paperless manufacturing – electronic batch record.

# ABB Conductivity Analyzers

- The ABB Type TB82 Series of two-wire conductivity transmitters are available in three base configurations to utilize ABB's two-electrode, four-electrode or toroidal sensors, allowing for installations ranging from ultra-pure water to the most difficult chemical applications
- The ABB Type TB82 Series of two-wire conductivity transmitters are available in three base configurations to utilize ABB's two-electrode, four-electrode or toroidal (electrodeless) sensors, allowing for installations ranging from ultra-pure water to the most difficult chemical applications.
- The TB82 Series is available with traditional programmable outputs or with advanced digital communications utilizing FOUNDATION Fieldbus (FF), PROFIBUS PA (PA) or HART.
- Setup, maintenance and operation in the field is simple. Easy to follow instructions appear above each Smart Key. The user-friendly interface provides for straightforward transmitter configuration and calibration.
- A unique secondary display clearly defines each menu option when programming the transmitters. During normal operation, the secondary display may be configured to show process temperature, current output, concentration type, raw conductivity or software revision depending upon configuration.

# Monitoring Silica - ABB

- Monitoring silica at the outlet of the mixed bed provides a useful check on the state of the anion exchange resin in the bed, as well as checking the quality of the water passing to the boiler as make-up water.
- The final level of silica in the boiler feedwater must be kept as low as possible to reduce the build-up within the boiler drum and the subsequent carryover in the steam. In drum boilers, silica levels are also monitored inside the drum itself.
- Silica is distributed between the water and steam phases inside the drum, with the proportion in the steam rising as the temperature and pressure increase. In high-pressure boilers in particular, silica can be concentrated in the vapor and can be carried over and deposited on downstream equipment such as superheaters and turbine blades.
- The level of silica in the drum is controlled using blowdown, but this wastes expensive treated water and energy each time it occurs. It's therefore important to monitor the build-up of silica to ensure the blowdown cycle is optimized.
- ABB's Navigator 600 Silica analyzer substantially cuts the costs and maintenance associated with silica monitoring in power generation and other large-scale steam and water dependent applications.

# Parameters and Locations for Monitoring Demineralization Plants - Rob Terrell of ABB

## Summary

- Typical parameters and locations for monitoring of demineralisation plants

Sample Location	Parameters
Feed water	Conductivity, TOC, chlorine, temperature
WAC	pH
SAC water	Sodium, conductivity, pH, flow rate, pressure drop, throughput,
Ex Degasser	No analysis normal
SBA water	Silica, conductivity, pH, flow rate, pressure drop, throughput
MB water	Silica, sodium, conductivity, pH, flow rate, pressure drop, throughput
Cation polished water	Sodium

# Controller Parameters – Rob Terrell of ABB

## Controller

- It is important that the controller and the provided software is capable of handling and storing all the data available
  - For a Basic plant, with limited instrumentation, it may be sufficient to use a PLC and simple text screen
  - For Standard and Bespoke plants, a more sophisticated control system may be required, with a DCS or SCADA system, especially if the plant is to be monitored and controlled from a central control room
- More sophisticated plants also benefit from having full mimic screens local to the plant to allow local operation, e.g.
  - step-through regeneration capability,
  - the ability to interrogate the recent operation for fault tracing, etc.
- The ability to modify the control algorithm, e.g. to fine-tune the regeneration sequence is also important for Standard and Bespoke plants
- Data generated should be stored for a period of 12 months or longer to allow periodic assessment of the performance of the plant



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# Key Monitoring Parameters – Rob Terrell of ABB

## Polishing demineralisation plant Key performance/monitoring parameters

- Monitoring of cation polishing is normally limited to:
  - Conductivity
  - Sodium (on-line or off-line)
- Monitoring of MB unit would normally include:
  - Separation of resins during regeneration
  - Silica
  - pH
  - Sodium
  - Conductivity
  - Regenerant strength
  - Flow monitoring
  - Pressure drop



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# Enhanced Demineralisation Needs - Rob Terrell of ABB

## Enhanced demineralisation Summary

Configuration		On-line instrumentation	Off line routines	Regeneration	Physical parameters
Softening	Basic	None	Sample at end of run	Check salt daily Fill salt weekly	Flow measurement on request
	Standard	Hardness monitor	Shift sample	Check salt daily Fill salt saturator	Pressure drop plus flow measurement
	Bespoke			Bulk salt saturator	Pressure drop plus flow measurement
Dealkalisation	Standard	pH monitor	pH check	Acid strength	Pressure drop plus flow measurement
	Bespoke				
Simple Demineralisation	Basic	Conductivity	Silica, sodium	Acid and caustic strength	Pressure drop plus flow measurement
	Standard	Conductivity, Silica		Acid and caustic strength Rinse times	
	Bespoke	Conductivity, silica, sodium, pH		Acid and caustic strength Rinse times Regenerant quality	
Enhanced Demineralisation	Standard	pH monitor	pH check	Acid and caustic strength	Pressure drop
	Bespoke				
Polishing Demineralisation					



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# Danaher Optimistic About IIoT Potential

- Danaher is bullish on IIoT. It sees multiple opportunities in the recurring revenue sector. Examples of recurring revenue include consumables and services in diagnostics and life sciences, and across Pall Corp.'s operations.
- The opportunity facing Danaher comes from embedding more software in its equipment, thereby spurring increased consumables sales and keeping customers engaged with Danaher's services. Moreover, analyzing data from customer usage of equipment can create valuable opportunities for the company to modify its customer offerings.



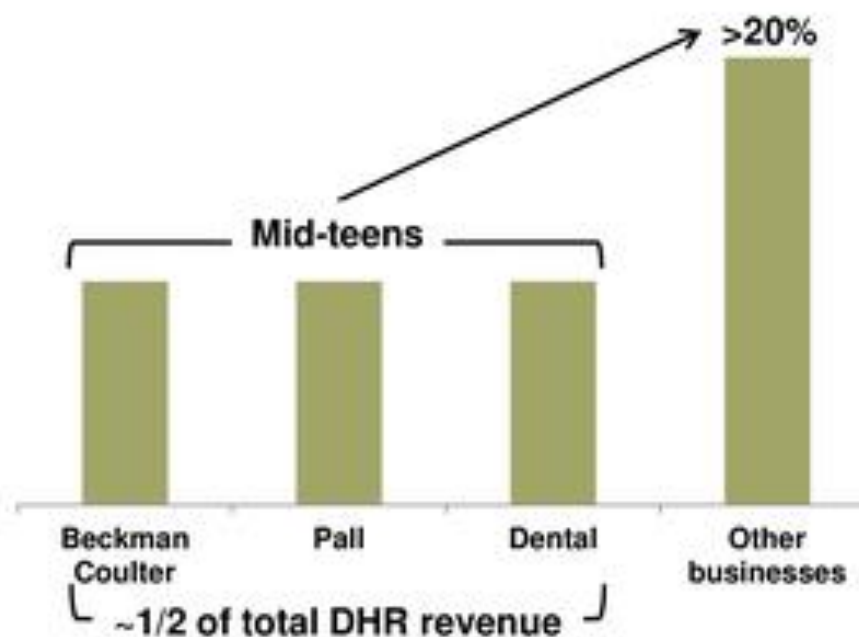


# Danaher's Opportunity

	Revenue	Recurring Revenue*
Water Quality	\$2.0B	55%
Product ID	\$1.6B	40%
Life Sciences	\$2.5B	50%
Diagnostics	\$4.9B	80%
Pall	\$2.8B	75%
Dental	\$2.8B	60%
<b>Danaher</b>	<b>\$16.5B</b>	<b>60%</b>

All revenue figures are aggregate for FY 2015E.  
 \*As a percent of 2015E sales.

## 2015E Business OP Margins



United by resilient business models with significant room to improve through DBS



# Danaher Hach Liquid Particle Counter with Remote Monitoring

Particle monitoring and control of ultrapure water (UPW) are becoming more and more critical to a growing array of manufacturing industries. Advances in precision manufacturing technologies such as flat panel display (FPD) and hard disk drive (HDD) components, require that contaminant particles in process fluids be measured to levels as small as 0.1  $\mu\text{m}$ .

- The Anatel Ultrapure-100 Particle Counter is a compact 2-channel (4-channel optional) liquid particle counter designed for analysis of ultrapure water monitoring applications. It is built around a robust 0.1  $\mu\text{m}$  liquid particle sensor.
- The Ultrapure-100 contains flow control, particle sensing, signal processing and analog output electronics as well as a microprocessor based command/control communications system all in one assembly.
- **Remote control option** The Ultrapure-100 can be controlled remotely from a host computer via an RS-232 serial port (the protocol is factory set). The communications protocol used is either ASCII or SECS-II Standard. The factory default for the Ultrapure-100 is RS-232 communications with ASCII protocol.
- **Hot water monitoring application** For hot DI water monitoring applications, the ANATEL Ultrapure-100 is a proven solution and is rated to 80o C.



# Danaher - Met One Facility Monitoring Systems integrated with Enterprise Information Systems

MET ONE facility monitoring systems are scalable on-line particle monitoring solutions based on open architecture communications that integrate easily with preferred systems. The full suite of remote and portable air particle counters feature full ISO 21501 compliance and 21 CFR Part 11 compliant data management software.

- MET ONE will manage the design and install of your particle counting facility monitoring system  
MET ONE offers project management, system definition and design, software customization, validation, and installation services.
- MET ONE facility monitoring systems will integrate into your existing legacy systems  
Integrate its instruments with an existing Enterprise Information Systems, LIMS, or Building Management System.
- MET ONE gives you on-site service  
Large industry global network of local service offices with fully compliant on-site service for instruments, including full ISO 21501-4 calibrations. The service agreement programs provide proactive pre-scheduled on-site calibration and maintenance services, including discounts for any repairs.
- MET ONE facility monitoring solutions eliminate data silos within multiple systems  
Eliminate validation, maintenance, and upgrades for multiple monitoring systems Eliminate multiple reports by including non-viable particle data with all other production data.
- MET ONE compliance services  
SOP development assistance for manual monitoring Full validation documentation packages for automated systems URS planning  
Validation documentation packages (Installation Qualification/Operation Qualification) Validation testing process and final sign-off assistance.
- MET ONE offers a full suite of environmental sensors and system accessories  
Relative humidity and temperature sensors Air velocity sensors Differential pressure sensors IO modules connect to existing sensors, door switches, tool interrupts, etc. Ethernet switches, touch-screen NEMA computers etc. Distributed vacuum systems Distributed DC power systems Multi-function alarm modules

Met One is part of the Beckman Coulter group which in turn is owned by Danaher. The IIoT commitment of Danaher is reflected in the next two slides.



# Endress + Hauser is focusing on IIoT

- Endress+Hauser is a global supplier of process automation solutions. It develops, manufactures and sells sensors, systems and services for the process industries. Used for both production and inventory control, these products acquire, transmit and evaluate process information. They claim to offer excellent performance at an affordable price, backed up by innovative local and e-service.
- A closely-knit network of production and sales companies, together with local representatives, gives Endress+Hauser a strong global presence.
- A key focus is the Industrial Internet of Things (IIoT). “Innovative products that offer our customers genuine added value represent our best sales argument,” explains Dr Andreas Mayr, Corporate Director Marketing & Technology.
- Endress+Hauser already offers instruments that monitor their own status during the process, while making the sensor and process data available via Internet-based platforms. The seamless integration of instruments into the customer’s automation and IT systems permits on-going optimization of maintenance cycles and process controls, among other things.

# E+H using Digi Wireless Sensors in for Harsh Environments

- Digi International<sup>®</sup>, a leading global provider of machine-to-machine (M2M) and IoT connectivity products and services, announced that its new Connect Sensor cellular gateway has been selected for Endress+Hauser's Inventory Management Solutions. The combination of Digi's Connect Sensor with Endress+Hauser's field instrumentation sensors and the Endress+Hauser SupplyCare cloud platform offers a complete solution for connectivity of industrial sensors in remote locations.
- Digi Connect Sensor is a new battery-powered, enterprise-ready cellular gateway solution for wireless connectivity at locations with either no power or low power that offers the versatility and flexibility to accommodate a variety of sensors. In offering a plug-and-play solution, Connect Sensor allows for remote sensor monitoring to be deployed in environments previously considered too harsh, remote or not economically viable.

# Endress & Hauser Plant Asset Management

Endress+Hauser's offering in Plant Asset Management (PAM) reflects the NAMUR criteria as well as other de-facto standards and best-practice recommendations. E+H supports customers with an asset management solution and services, optimizing the ability to produce, improve quality and reduce operational costs.

All field devices in a production process are assets. Each has to be configured, maintained and depending on Recommendation NE 129 outlines a strategy for managing plant assets that envisages three are industry, calibrated. The associated asset information must be managed and kept up to date throughout the plant life-cycle. NAMUR as of action:

- Continuous evaluation of asset health throughout the life-cycle of the plant
- Provision and archiving of plant information, with seamless transfer of data from the engineering and start-up phase to the operations phase
- Interaction with users, ensuring that operators and maintenance staff are always aware of any actions required to keep the plant running

This three-fold approach provides a solid foundation for continuous improvement of operation and maintenance workflows:

- Monitoring rather than guessing the health of assets leads to more cost effective maintenance strategies
- Having asset information – identity, certificates, configuration history, spare parts, etc. – at the operators finger tips allows him to react quickly to current issues and plan improvements for the future
- Planning, data acquisition and archiving tools allows the maintenance staff to work faster and more efficiently

# E+H and Gerrie Electric extend IIoT in Canada

Endress+Hauser concluded an agreement with Gerrie Electric that makes the independent electrical distributor its latest Authorized Channel Partner. The move, which leverages the strategic relationship between Rockwell Automation and Endress+Hauser Canada Ltd., is a major development in the process automation sector in Canada.

“The evolution to Industrie 4.0 and Industrial Internet of Things offers limitless opportunity for Canadian companies,” said Anthony Varga, CEO and general manager at Endress+Hauser. “Thanks to the strength of our partnership with Rockwell Automation and Gerrie Electric’s expertise, we’ll be able to go to greater lengths to help modernize the Canadian manufacturing sector.”

Gerrie Electric can now provide its process automation customers with new cost saving opportunities through the enhanced integration of Endress+Hauser’s measurement technology with the Rockwell Automation platform. The pre-tested and validated designs between Rockwell Automation and Endress+Hauser offerings help reduce the costs associated with bringing new measuring points or a new production line into the manufacturing facility.

Customers of Gerrie Electric will also have the opportunity to enjoy a single source provider, enabling them to acquire the PlantPax® system, a modern Distributed Control System with best-in-class field instrumentation and measurement solutions that’s trusted globally.

“Enabling big data analysis and the expansion of the connected enterprise is a boon for the Canadian manufacturing sector and is helping our customers compete on a global scale,” said Heather Gerrie, Co-President & CEO at Gerrie Electric. “This partnership strengthens our ability to remain at the forefront in providing the required products, solutions and services on which Canadian manufactures depend.”



# Envirogen Remotely Monitors Ion Exchange System

Envirogen deploys a range of ion exchange system designs to remove a target contaminant or a combination of contaminants. Particular benefits may be found when multiple anionic contaminants are present (i.e., perchlorate, nitrate, uranium), as the treatment problem might be effectively addressed with a single technology.

Sensing, data logging and remote communication capabilities to enable operators to review and attend the unit as needed either from a distance or on site.





# Predictive Diagnostic System from Hach

- PROGNOSYS is a predictive diagnostic system that allows the user (**why not remote O&M monitor**) to be proactive in the UPW maintenance, by alerting **those connected to the cloud system** to upcoming instrument issues. Know with confidence whether changes in measurements are due to changes in the instrument or the water. The PROGNOSYS system runs on the sc1000 platform, displaying two status indicators for every connected PROGNOSYS ready instrument. These indicators give all the information needed to plan preventive maintenance and avoid unexpected emergencies. The measurement indicator monitors the instrument's components and uses that information to alert the user to upcoming instrument needs before measurements become questionable. The service indicator tracks the number of days until the instrument will require maintenance.
- **Comments in red have been added to edited text prepared by Hach**

# Mettler Toledo IIoT

- Mettler Toledo offers various measuring technologies that seamlessly integrate in a smart factory today or provide opportunities for the future.
- Recent developments surrounding Industry 4.0 and the Internet of Things have started to facilitate a major paradigm shift in various manufacturing industries. The traditional production hierarchy with centralized control is shifting increasingly towards decentralized self-organization, in which the resulting product independently communicates with the production devices and actively intervenes in the production process.
- As measuring technologies evolved, digitization has become a core element of innovation. For example, many businesses have made the shift from analog signal transmission to end-to-end digital data transfer. As a result, an intelligent measuring device or sensor provides more than just accurate measuring values. They provide qualified real-time status information about the manufacturing process, including the status of the device or the product.
- The devices also provide information to initiate preventative maintenance actions before problems can occur. This strongly supports operation management in keeping production running, avoiding downtime and planning repair at the right time. Such measuring technology also has the capability to integrate automatically into data networks and control systems, making initial installation and replacement fast and easy.

# Mettler Toledo In Touch Remote Services

Unexpected downtime creates unnecessary challenges in meeting customer's expectations. The ability to be notified of critical equipment issues immediately provides:

- Real-time awareness of equipment health
- Planned service interventions
- Increased productivity

InTouch Remote Support complements Remote Monitoring by alerting the Service Center technicians, so they can investigate when the connected equipment needs further attention.

If necessary, staff at the Mettler Toledo Service Center will access the equipment via a secure connection and take action to resolve problems remotely or dispatch an informed field technician.



# Mettler Toledo has Intelligent Sensor Management for Pharmaceutical Water

TOC and Conductivity measurement systems from Mettler-Toledo Thornton ensure compliance with global Pharmacopeia requirements by providing real-time, continuous and accurate measurement, monitoring and control of purified water systems. pH, dissolved ozone and flow remain important indicators for monitoring water quality, sanitization and control for optimum system performance.

## Conductivity

- UniCond digital ISM sensors with 33% improvement in accuracy
- Pre-calibration and traceable certification for measurement consistency and confidence in regulatory compliance
- Intelligent Sensor Management (ISM) Plug and Measure simplicity and diagnostics capabilities improve performance and support predictive maintenance planning

# Mettler Toledo Data Analytics

- There really is a need to account for the varying ionic load on a DI bed due to both flowrate and composition. This need has been recognized and even implemented using a combination of instruments which seems somewhat cumbersome by today's standards.
- Thornton has been able to provide this capability in a standard compact multiparameter (flow and conductivity as well as other parameters) measuring instrument as its DI-Cap deionization capacity monitoring algorithm.

# Swan Continuous Conductivity Monitoring

- AMI CACE continuously measures conductivity, before and after cation exchange, as well as determining the pH value of the sample and alkalizing reagent concentration.  
The online monitor AMI CACE is a key component of water steam cycle instrumentation as it enables significant cost savings at increased instrument availability.

## **Benefits:**

- No resin changing or resin rinse down time required
- Low maintenance
- Continuous monitoring of sample flow and sample temperature
- Short response time for the detection of anions

# Veolia Remote Monitoring

- The Veolia telemetry system is an efficient real-time 24 hour remote monitoring service that ensures effective operation of equipment, minimizes downtime and reduces operation costs.
- By having remote access, service engineers can observe plant conditions to anticipate plant requirements before arriving to site as well as monitor process parameters to diagnose problems and report on performance. Key characteristics:
  - Plant & equipment can be monitored 24/7
  - One single source for plant and equipment operations and data storage
  - Remote viewing of current plant status
  - Remote monitoring and diagnosis of plant performance and analysis of trends and logs
  - Adaptable to specific project requirements
  - No special software required - the functionality available is via web browser
  - SMS, email or phone alerts to service engineers for rapid response to any faults or problems

# Yokogawa Conductivity Monitoring to detect Ion Exchange Resin Damage in UPW Systems

The measurement of specific conductivity in aqueous solutions is becoming increasingly important for the determination of impurities in water. Yokogawa has designed a full range of precision sensors and instruments to cope with these measurements, even under extreme conditions. Intended for the low conductivity applications found in the semi-conductor, power, water and pharmaceutical industries. These analyzers work with contacting conductivity sensors

