MEASURE **TODAY**. ENSURE **TOMORROW.**

Energy Measurement in Makkah- Checking in at Clock Tower

Updating a metering job that we introduced in this space in 2013, we visit Saudi Arabia's largest construction project, incorporating one of the world's tallest structures. The Abraj Al Bait development in Mecca, KSA, with its Makkah Royal Clock Tower visible for 16 miles, hosts as many as 65,000 visitors at any one time.

King Abdul Aziz Endowment Project Makkah SKA- ML

Al Borj Facilities Management provides the complex with all phases of support, either directly or through coordination of a number of specialist vendors, to meet the utility, maintenance, safety and administrative needs of their distinct clients. Delivering the acme of services with consistency requires the efforts of dedicated professional staff and highly reliable tools. Spire Metering Technology is pleased to offer the TP10 ultrasonic energy system to this effort.

Its seven separate hotel and residential towers rising above a diverse commercial space, Abraj Al Bait comprises an area of 1.5 million square meters, in myriad configurations. Two Al Salem Johnson Controls chiller plants meet the complex's cooling requirements, delivering a combined 159,000 tons of cooling capacity. Over 6,000 hotel rooms, 5,000 residences and 1,440 retail shopping and dining establishments require the climate control delivered by these plants. One of Al Borj's tasks is to assess each client for their share of this utility, accurately, reliably, with a minimum of intrusion into the life of the facility. Spire's TP10, with its nonintrusive, easy to install design, is perfectly suited to the task.

Project Chiller Plants- Johnson Controls York- ML

Ultrasonic energy measurement employs two well established sensing technologies, transit time and resistance measurement, to produce the energy value consumed by a system, or by a specific part of that system. Capturing the differentials- of the sound travel in liquid flow, and of temperature between system feed and system return- allows for the straightforward calculation of energy delivered between the inbound and outbound temperature points. In a simple system, involving one heat exchanger, one delivery loop, and one user, the optimal points of measurement are easily identified, and the consumption by the user is easily determined. Much more complex arrangements, such as that found at Abraj Al Bait, can be measured just as easily, if proper care is taken in planning and implementation. Whether addressing a single point of measurement, or 300 points as required in Mecca, the same principles, devices and installation protocols deliver the same reliable energy management solution.

Familiarity with transit time measurement is key to properly selecting and deploying an ultrasonic sensor system. Sound is a mechanical wave, which moves at a certain speed through various media. The sound speed in air, the sound speed in liquids, and sound speed in solids are very different numbers. Yet is each measureable, and documented. Transit time in air provides the basis for ultrasonic level in tanks, basins and channels. Transit time below the water's surface provides a highly reliable measurement of blanket in clarifiers, an important submerged measurement in biosolids management. Applied externally to closed piping systems, transit time ultrasonic energy meters provide accurate measurement employing proven methods.

Using an upstream transducer to generate a sound wave that will travel through a known pipe material, with the flow of a known liquid, and be received by a downstream transducer, we can measure that travel time. We can do the same operation in reverse, generating a sound wave at the downstream transducer, and measure its travel against the flow, receiving it upstream at the end of its route. The difference in time taken for a wave to travel with and against the flow provides us the velocity (**V**) of the energy carrying liquid. Simply adding the cross sectional area (**A**) to this calculation provides us a volume:

$$V \times A = flow$$

Flow rate alone, however, will not tell us how much energy is being delivered to, or consumed by, the user. Again, applying the differential will allow us to make that determination. Placing one surface mounted temperature sensor on the inbound pipe, and one on the corresponding return, will produce two temperatures. The difference between the two values indicates the thermal energy delivered to the space in question.

$$Q = \int_{t^0}^{t^1} qm \times \Delta h \times dt = \int_{t^0}^{t^1} \rho \times qv \times \Delta h \times dt$$

Q = thermal energy, in joules

qm = mass flow, in kilograms/hour

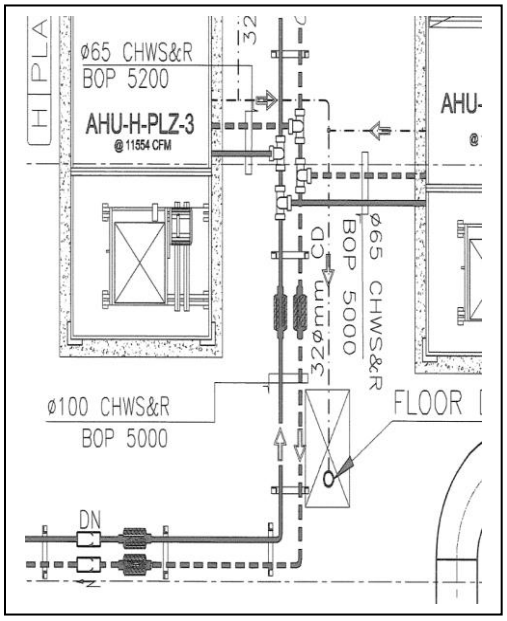
qv = volume flow, in cubic meters/hour

ρ = flow density, in kilograms/cubic meter

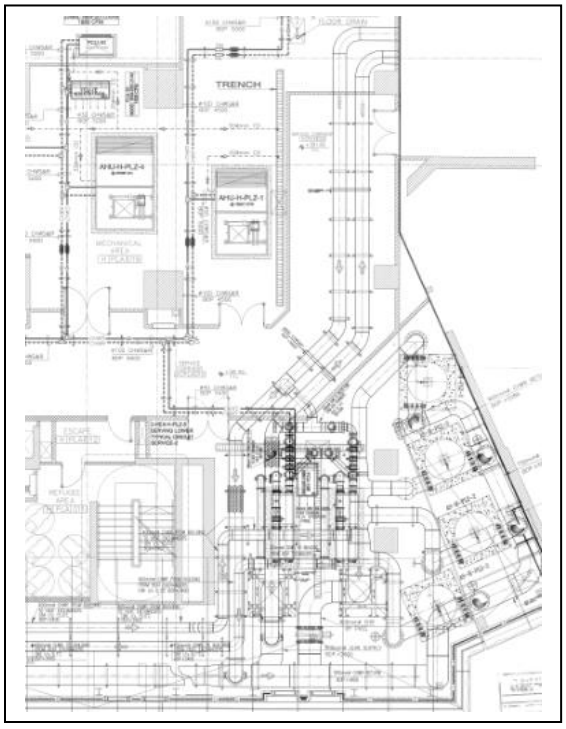
Δh = change in enthalpy, in joules/kilogram

dt = time, in hours

A straightforward method for employing the differentials measured allows for its application in a variety of system piping and thermal carrying materials. This is ideal for a project such as in Mecca, where so many measurements would be required in spaces of widely varying dimension, demand and piping configuration. One instrument, with one installation guide, one programming menu, and one communication protocol simplifies deployment, commissioning, operator training and system optimization, all of which accelerate the return on investment.



Detail of Instrument Location



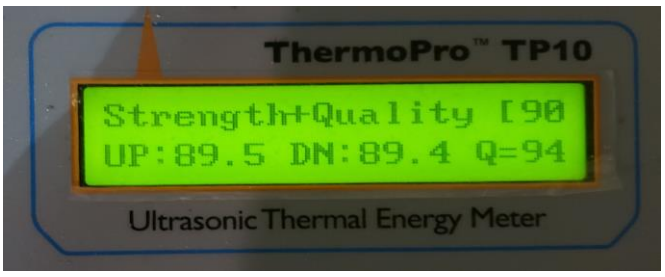
Detail of Floor Plumbing Plan

TP10 Installed ML

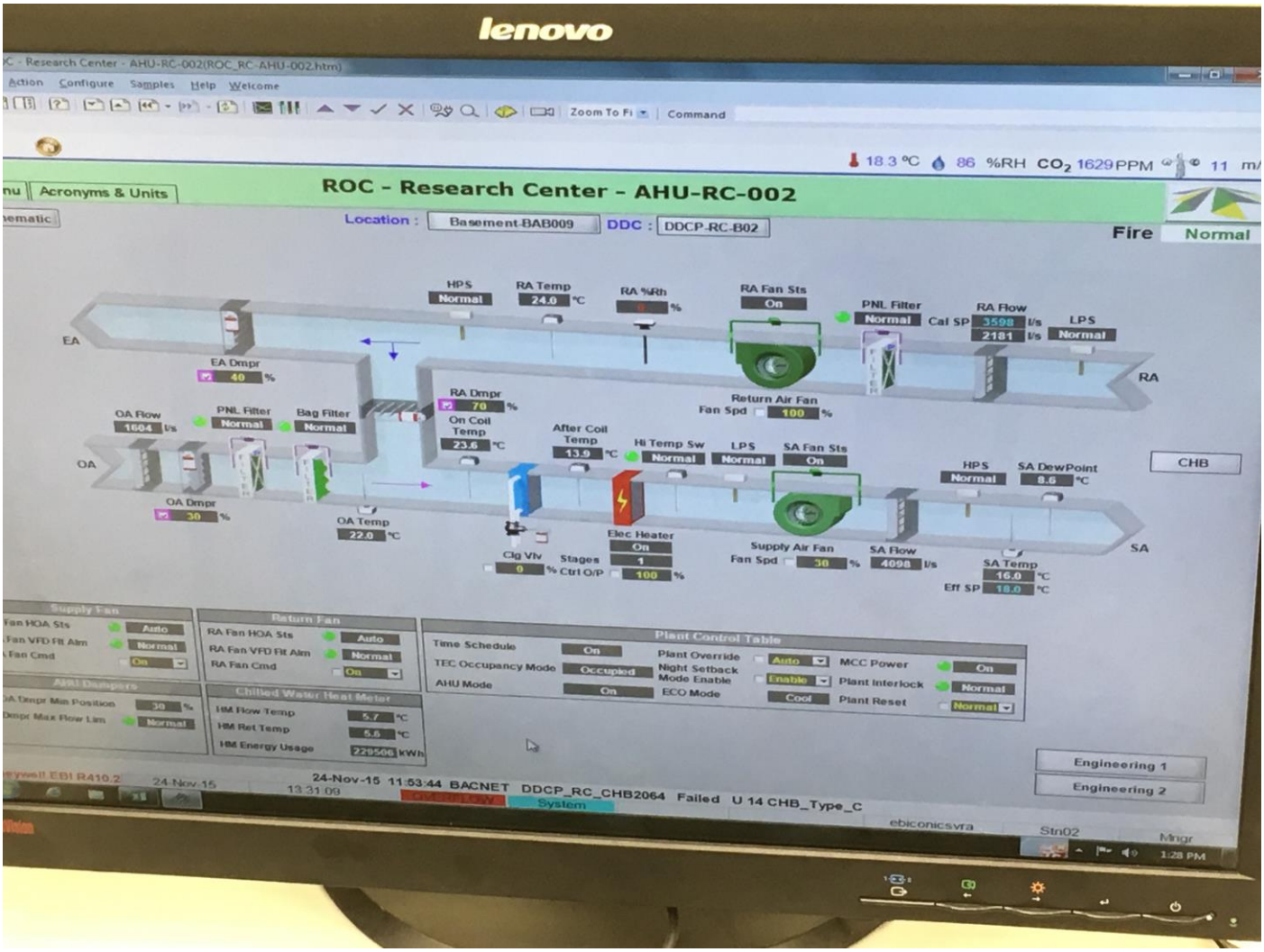
Planning for the deployment of TP10s throughout the complex was supported by Spire MT engineers, who first reviewed the construction drawings, then met with the clients and contractor onsite to discuss objectives and visually inspect proposed installation locations. This is a critical step in the process, as the location of the sensors and accessibility of transmitters is will determine both the accuracy of raw measurements and the ease of operator interface. Key to the success of any project instrumentation is operator accessibility, and while the TP10 requires no routine maintenance to ensure its continuous, reliable measurement, the ability of the operator to inspect installations and view readings will promote effective use and minimize diagnostic tasks. This is especially important for revenue metering, and at any location where no measurements have been made beforehand. It fosters and sustains a level of confidence that system ensure its continuous, reliable measurement, the ability of the operator to inspect installations and view readings will promote effective use and minimize diagnostic tasks. This is especially important for revenue metering, and at any location where no measurements have been made beforehand. It fosters and sustains a level of confidence that system operators and managers can pass along to the clients they serve. Spire supports this by engaging facility managers and installation contractors to ensure clean project execution.

Spire Metering TP10 BTU Meters ML

As the example shows, piping arrangements become quite complex as designers seek to gain efficiencies while improving delivery. It is one matter to reference the intent on a plan and elevation drawing, and at times quite another to recognize this same intent among overlapping piping runs between floors. Repeating the instrument siting exercise over multiple floors, in multiple towers, for myriad space configurations can be especially challenging. Spire was able to review the drawings and discuss the measurement goals, then walk the project with the managers, listening again to their objectives as potential measurement points were inspected. The opportunity to confirm, or as necessary recommend, physical locations for the instrument transmitters and sensors can save the operators plenty of corrective action, and a contractor callback. This is a common sense practice not always followed- instrumentation that is as economical and easily installed as the TP10 often gets overlooked among the larger planning tasks. Yet these features are exactly what make the ultrasonic energy meter a wise choice. A few moments of care before installation greatly increases the long term value of the small investment.



Once properly mounted, the TP10's programming menu guides the installer through the final steps to optimize transducer placements, displaying advanced signal diagnostics that confirm correct sensor orientation. For this reason, ultrasonic transducers are always installed when the pipe is fully charged (flow, however, is not necessary) to provide an accurate acoustic profile. These diagnostic values are then continuously monitored and may be viewed at any time, providing reassurance that the instrument is performing as required. This once installation is complete. TP10 confirms its optimized performance at a glance, eliminating the need for frequent visual sensor inspection and adjustment.



HVAC SCADA SYSTEM - ML

Easy to install on a wide variety of pipe configurations, requiring minimal maintenance, with readily verifiable output- TP10 delivers a simple solution for thermal energy revenue metering. Over 300 successful installations at the Abraj Al Bait project attest to the suitability, robustness and reliability of this solution. Spire Metering Technology is pleased for the opportunity to support the facilities management professionals of Al Borg and their clients in Mecca.

Does your building project require a versatile, simple to deploy instrument model to capture energy delivery and use? Talk with Spire Metering at +1 888 738 0188 or visit https://SpireMT.com.