August 22, 2018

Aclara's response highlighting inaccuracies in "Evaluation of the AclaraI-210+C AMI Meter" by William Bathgate dated May 30th, 2018.

Aclara meters has been at the forefront of Electronic Meter design and manufacturing for over 20 years and has over 100 years of experience in the design and manufacturing of traditional electromechanical meters prior to that. We are in an excellent position to understand the benefits of both technologies, and unquestionably, current electronic meter technology is superior. Smart Meter technology provides accurate and equitable electricity measurements that benefit both the consumer and producer of electric power. The many benefits of smart meters include a safer work environment and reduced carbon emissions due to less vehicle traffic, faster and more accurate response to power outages and system problems, improved efficiency due to better understanding of power use.

Performance standards for electricity meters in the North American market are primarily defined under the umbrella of the American National Standards Institute (ANSI) by a panel of experts representing utilities, manufacturers, regulators, and other interests. Aclara participates actively in this process. Meter standards have rapidly evolved to cover the requirements needed to measure modern devices including today's energy efficient CFL and LED lighting and appliance motors. All manufacturers participating in the market must demonstrate compliance to these metering standards as mandated in most jurisdictions.

Aclara is aware of a series of presentations made by Mr. William Bathgate suggesting that smart meters have a number of problems. The presentations are riddled with numerous erroneous and/or or mis-leading claims about smart-meters that require rebuttal. References to slides in this response are to the specific presentation entitled Evaluation of the Aclara I-210+C AMI Meter dated May 30, 2018 (the "Presentation").

Slides 4, 10, 37:

The assertion that AMI meters have a useful life of 5 to 7 years is factually inaccurate. Modern electronics are highly reliable and are designed and tested to be proven so. Aclara meters are specifically designed for a 15-year life and a specified failure rate of no more than 0.5% for first year of service and 0.3% per year after that, excluding the AMI device. Ninety five percent of meters are expected to be fully functional in service after 15 years. Aclara subjects large populations of product to Accelerated Life Tests (ALT) during development. The devices are run at elevated temperature and humidity for 1000 hours or longer to demonstrate component reliability and calculations are performed in a Weibull reliability model to show that the actual product will meet the stated reliability goals. Many other stress tests are also performed during development, including temperature cycling to extreme temperatures, as well as electrical surge tests designed to simulate worst case field conditions.

Speculation about technical obsolescence is just that. The Aclara I-210+c Meter is highly functional and not only meets the present needs of customers but can also be upgraded as needed if new functionality is required.

Slides 5, 6:

Most electricity meters in North America have a two-wire connection bringing electricity into the home at 240 Volts AC. Electro-mechanical (or analog) meters provided protection against high transient voltages that may be caused by lightning strikes in the vicinity of the meter. Using technology available at the time, the analog meters employed a surge gap with a path to ground that would “Spark over” at a predetermined maximum voltage that the meter could withstand without damage. The surge gap also included a current-limiting resistor that would limit the energy in the surge gap to safe levels. Mr. Bathgate’s assertion that, because modern smart meters do not use this technique, that they must not contain surge suppression and are unsafe. This assertion is also incorrect. The transient voltage stress that modern meters must protect against is differential. That is the voltage is applied between the two wires that connect to the meter itself. The meter is intrinsically safe with respect to the meter box because of the insulating properties of the material it is made from. Solid state protective devices are incorporated into the meter circuitry to reduce the transient voltages that may be present on the power line. These are effectively reduced to the point where semiconductor devices are within their safe operating design limit, and thus undamaged when exposed to line transients. National standards specify that the meters should operate normally when exposed to surge transients of 6 kiloVolts, and all meters are type-tested to meet or exceed these requirements. The claims that the meters will be damaged and become unsafe are false and based on unsound logic.

Slides 7, 11 - 15:

Several mis-leading claims were made regarding the design of the meter Switch Mode Power Supply (SMPS). The Presentation correctly asserts that most homes already contain dozens of devices that incorporate SMPS technology. SMPS is widely used because it is extremely efficient and compact when compared to other power supply design types. All electronic devices marketed in North America that do not intentionally emit RF energy must comply with federal rules (CFR) 47, Part 15, sub-part B. These rules govern what are acceptable limits for RF emissions, and the rules are no different for electricity meters than they are for telephone chargers. The AMI device which does intentionally emit RF energy is subject to a separate set of FCC requirements, to which it is also tested by a certified lab. The Presentation includes a patently absurd assertion that meter designs do not use internal filters, (one of the most basic of all types of electronic circuits) and that Smart meters are not tested to comply with the FCC requirements. Both assertions are false.

Aclara meters are designed using appropriate filter technology to fully comply with all FCC requirements. RF emission measurements must be made in a laboratory setting using a Line Impedance Stabilization Network (LISN). The LISN is necessary to eliminate noise unrelated to the test device. It also provides a standardized impedance and RF measurement port so that results are repeatable between test locations. The tests must be performed in a shielded chamber to eliminate influence from outside RF sources. These tests cannot be performed correctly in a home setting, and although it is unclear what exactly is being measured in the Presentation, the fact that the measurements are being made in-situ, in a residential application, eliminates any credibility to the presented test data. Aclara has extensive test facilities to verify and document compliance. Aclara test result are verified by third-party independent labs including Underwriter Laboratories (UL) using appropriate test methods.

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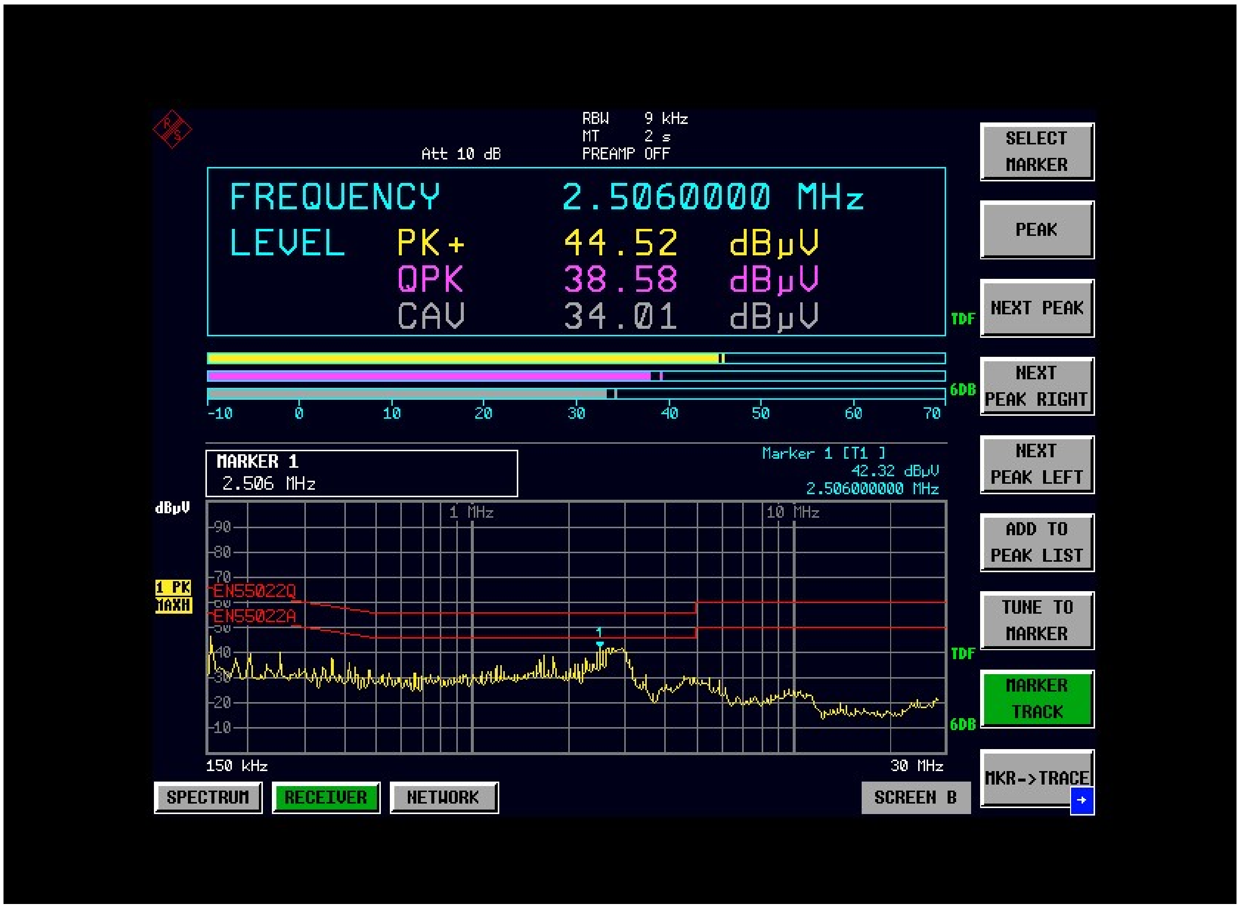
Below is a plot showing RF emissions from an I-210+c meter from 150kHz to 30MHz. Test limits are shown in red and measured emissions are yellow.



Slide 8:

This slide is taken completely out of context from a presentation given by UL Business Development director, Bill Colavecchio. The UL presentation in general was explaining the benefits of UL2735. UL2735 is based in large part, on other time-tested UL standards such as UL746C (which covers requirements for plastic enclosures for electrical devices) and UL840 (which covers safe spacings for electrical insulation). These same UL standards are also referenced in consumer equipment standards. Testing for conformity to UL2735 involves flammability testing, as well as verification of insulation characteristics. Any safety critical areas of design are documented and audited in manufacturing and throughout the supply chain to ensure that no changes or substitutions of material are introduced.

Slide 9:

The Presentation alleges that a lack of surge protection is responsible, with reference to a Youtube video purportedly showing a smart meter fire. The author then cites as the cause of the problem, a varistor in every smart meter (which is actually an electronic component used to provide surge protection). This demonstrates a poor understanding of electronic components and their application. As described earlier, all Aclara Smart Meters produced today are configured with safe, UL approved, surge protection.

Electrical fires can be caused for a variety of reasons. Typically, the insurer will initiate a thorough forensic investigation by trained fire investigators to determine the root cause. That cannot be determined by watching a video on Youtube.

Slides 19-23:

These slides describe in general terms the function of a radio network. Slide 22 – bullet 3 cites a court document, again taken out of context, asserting that the smart meter industry is lying about the characteristics of AMI RF transmission.

The cited document was actually a very thorough reply to an information request made by an Administrative Law Judge (ALJ) who works for the California Public Utilities Commission (CPUC). The judge had simply requested more thorough disclosure of the types and frequency of communications used in the Silver Spring Networks (SSN) mesh network. SSN engineers studied the field performance of several thousand meters and provided the CPUC with a detailed technical analysis, which also demonstrates the inaccuracies in the Presentation.

Again, the finding was a request for information, not a determination of wrongdoing.

Slide 20:

Last Bullet

The back-office application reads the meters a few times per day. The radios will not transmit every 4-5 seconds as stated by Mr. Bathgate. One possibility is that Mr. Bathgate is referring to the frequency in which the meter liquid crystal display (LCD) refreshes and cycles through the different display-quantities the meter is configured to show in the LCD (e.g. Current Tariff, KWh Consumed, etc.). This is not to be confused with the frequency in which the consumption data is transmitted over the wireless network, which the back-office application collects a few times per day.

Also, what Mr. Bathgate is referring to as a 1 to 2-hour data upload time is inaccurate. Mr. Bathgate may be referring to the time it takes the system to read the entire meter population in a given service territory, which might consist of millions of devices. Reading a meter normally involves one or two packets exchanged, which is normally completed in less than a few seconds. In our field analysis we have collected empirical data that supports that, considering all radio operations over a 24-hour period, an individual meter transmits on average for 45 seconds per day.

Slide 22:

Bullet 1

As previously stated, empirical data has been captured and analyzed to demonstrate the total time a meter transmits is on average 45 seconds per day.

Although there are occasional collisions and retransmissions, packet loss due to interference does not cause continuous communication that exceed the maximum duty cycle. The communications network has been designed and optimized to minimize excessive RF transmissions in order to minimize the chance of collisions. Excessive RF collisions would manifest as poor network reliability and increased round-trip latency. Naturally, these are conditions for which the utility monitors.

Note that similar communications protocols and standards are also optimized to minimize interference. For example, technologies such as Wi-Fi, Zigbee and Bluetooth utilize similar spread spectrum techniques to share the frequency band. It would be inconceivable these technologies would have any measure of success if by the same logic they were “busy all day long trying to get it message out”

Bullet 2

The transmit power is within FCC limits for both the 900 MHz mesh radio and the 2.4 GHz Zigbee radios. Zigbee transmission frequency depends on the In-Home Display (IHD) and other Zigbee devices in the home. The Zigbee devices in the home poll the smart meter for rate changes at different frequencies – this is not controlled by the utility or the smart meter. If the utility wants to initiate a rate change to Zigbee devices or initiate a load control event, then the utility will typically do this a maximum of a few times per day.

Additionally, per Itron Networked Solutions (formerly Silver Spring Networks) White Paper on Radio Frequency Emissions, duty cycle, rather than the number of transmissions, is the key factor considered for Maximum Permissible Exposure of RF. Using a realistic high-end duty cycle (4%), the MPE level for a typical Itron Gen5-enabled residential metering device operating in the unlicensed spectrum 902-928 MHz is 0.01 mW/cm2. This is equivalent to 1.6% of the FCC limit; however, actual results may vary depending on the specific meter integration.

Bullet 3:

The court document that Mr. Bathgate refers to is in alignment with previous statements that the expected average transmission times for a meter is 45 seconds in a 24-hour period.

Last paragraph

The Max Tx power is 1W, but with power varying turned on our Tx power can vary anywhere from 10 mW to 1W. In urban areas and neighborhoods, the power will be lower as the signals don't need to travel very far. In rural areas, the power will be on the higher end, as greater distances need to be travelled.

Cellular phones transmit anywhere from 200 mW to 2W. Similarly, to our radio, this transmit power will vary based on the area/distance to a cellular tower.

Slide 24:

First Bullet

Although the HAN Zigbee radio uses AES-128 encryption, the 915MHz radio actually uses a longer encryption key (AES-256) which is more secure.

Second Bullet

The "collector" is a passive gateway/router. Access Point 5 (AP) is the official product name. APs are not capable of sending "false positive" commands nor they can tell meters to shut down in a "tamper" situation. An AP is a layer 3 network infrastructure device and it acts as a router/gateway, similar to a Wi-Fi access point. The AP does not interact with other equipment in the manner described by Mr. Bathgate. In the event that an AP is "shutdown" the network will simply attempt to self-heal by attempting to link the orphaned meters with a new AP so that billing data (e.g. KWh) can be collected by the Utility. The electric service is not interrupted in any manner. If this network self-healing process fails the consequence would be simply that the utility will not be able to read meter billing data until the AP is replaced or fixed.

Third Bullet

As previously explained. The device does not collect data. It simply acts as a gateway (similar to a Wi-Fi access point) for the back-office application to collect the billing data. If someone was successful at jamming all signals the network will simply try to self-heal and find another AP to route data to the Utility.

Slide 25: ***First Bullet***

This is incorrect. Meters do not transmit their usage every 15-minutes. It is also contradictory to previous assertions from Mr. Bathgate (see slide 20) that the meters send their data every 4-5 seconds. The system collects meters data a few times a day, as previously stated. Collection intervals are configured by the utility and of a frequency of just a few times per day.

Second and Third Bullets

The Energy Bridge is not an Itron product and what data the device shares with the Utility is communicated via the customer's ISP provider. In this instance Itron cannot comment since this is a third-party device.

Fourth Bullet

Bullet 4 suggests that smart meters jeopardize data privacy by making the rate of electricity usage visible. This has always been the case with electro-mechanical analog meters. The rate of electricity usage corresponds to how fast the meter disk would spin which is readily observable to anyone in proximity to a meter. Smart meters have similar features that allow a consumer to verify the operation of the meter by observing the display. Aclara meters incorporate display segments that emulate the disk on a mechanical meter. They change precisely with the accumulation of energy and can be used to verify the rate of energy usage and direction of energy flow. The meter LED can be used in the field for verification of accuracy of a meter. Commonly available field test equipment owned by most utility meter shops makes this possible.

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Slides 26 – 31:

As has been stated, modern smart meters are extremely accurate over a wide range. Contrary to the assertions in the paper, the methods for calculating electric energy usage are fairly universally agreed upon and readily available. ANSI is developing a report to explicitly clarify the mathematical models, but much other technical literature is available.

Energy is measured in kWh and is referred to in the industry as an integrating quantity. Electric power is measured in Watts or kiloWatts (kW) and is the product of the voltage multiplied by the current at an instant in time. The rate at which power is consumed, which may change over time, is integrated over some period of time (in hours) yielding a kilowatt-hour total for the time period, or billing cycle.

Most electronic meters use a very accurate technique called digital sampling, where the voltage and current are both measured, typically thousands of times per second. Then the samples are multiplied together to get power in kW. The instantaneous power reading (kW) is multiplied by the time between samples (a tiny fraction of an hour), to get energy in kWh, and that energy value is added to an accumulator. In Aclara residential meters the effective Data rate is about 2500 measurements every second, or one measurement about every 400 micro-seconds. Forty-two measurements are taken for each 60Hz line cycle which is 16.6 milliseconds long. As you can infer, the meter can respond very quickly to changes in load. Because the frequency of the samples is very tightly controlled by a crystal clock, each sample period is exactly the same duration in time. The method of summation of digital samples is equivalent to what Mr. Bathgate called "totalization".

Slide 28:

ANSI test plans cover the wide range of electrical conditions representative of various loads, as defined by industry experts in an open and transparent process. Contrary to statements in the paper, the ANSI standards DO include tests of repeatability, allowing a maximum variation of 0.1% between consecutive readings.

ANSI tests also cover measurement of harmonic content and include test waveforms out to the 19^{th} harmonic of the 60Hz fundamental frequency.

Independence of National Standards

Mr. Bathgate has publicly asserted outrage that the American National Standards Institute (ANSI) standards process is funded by manufacturers and is not independent. Metering standards are created by the C12 committee which is recognized by ANSI. The committee under the governing rules must be composed of a balanced set of interests representing manufacturers, electric utilities, and interested third parties, including US and Canadian government regulators and test equipment providers. The chairman of the C12 Main committee for the past several years has in fact, been an employee of the US National Institute of Standards and Technology (NIST). The C12 membership roster and member affiliation is published in the foreword of each published standard. The National Electrical Manufacturers Association (NEMA) funds the secretariat of the committee to organize and maintain records. The Edison Electric Institute (EEI), a utility organization, separately funds the venue used for meetings. The meetings are open to the public and are conducted in a fair, transparent, and democratic manner and represent the best consensus of all interested parties.

Slide 29:

The methods for calculating energy are well known to anyone skilled in the art. The associated industry patents are public and readily accessible to anyone with Google. Patents can be kind of boring to read. The above explanation is fairly complete. A qualified engineer would already know this.

Slide 31:

The gas-pump example given in the Presentation discussing peak averaging is totally irrelevant. It is erroneous math, in that it treats a five-minute sample period the same as a one-minute sample period. It does not properly account for time in the integration of rate and time and therefore creates an obviously incorrect result. The example is the result of misleading guesswork and a poor understanding of basic integration.

Slide 32:

Bullet 1

As stated above the LED Is provided as a calibration test output. Utilities receive an electronic calibration record with every meter shipped and typically have test equipment to verify accuracy.

Bullets 2 and 3

As stated above, Aclara electronic meters are designed to measure harmonics accurately. Section 5.5.6 of ANSI standard C12.20 specifies performance requirements for Harmonics Influence: Effects of non-sinusoidal waveforms.

Slide 33:

As stated earlier, an Aclara I-210+c meter would make approximately 1250 individual measurements of the start-up current in the example. Electricity meters integrate power over time. They do not use peak averaging, which is an invalid method of measurement, existing only in the imagination of the presentation author.

Slides 34 - 36:

Both analog and digital meters require power to operate. Design for efficiency has always been a factor in meter design because a large number of meters are typically present on an electric distribution grid. In both analog and digital electricity meters the energy used to power the meter is taken from the utility side of the load connection. Because the current needed to self-power the meter does not pass through the current sensing element, it is not measured by the meter and contributes nothing to the measured load. In reality, the meters use approximately 1 Watt of power, which amounts to 1 kilowatt-hour about every 42 days. At retail price, the electricity used to power the meter would cost about one dollar per year. Regardless of the amount, this does not contribute to the consumer's billed usage.

The author of the Presentation made assumptions that the load being reported on an Energy Insight App connected wirelessly to the smart meter were the readings of the meter self-usage. Since this is by design, not possible, it strongly suggests that there are other small electrical loads present (totaling approximately 100 Watts) that Mr. Bathgate was unaware of or deliberately ignored when conducting his testing and writing his presentation. These other loads have nothing to do with the meter and may have contributed to the other misleading observations.

Slide 37:

Bullet 1

Meter life expectancy has already been stated as 15 years.

Bullet 2

Not relevant

Bullet 3

Conformal coatings are selectively applied to improve the reliability of trace spacings by reducing the UL Pollution degree.

Bullet 4

The majority of any surge voltage experienced by the I-210+c is dissipated in a robust wire-wound surge resistor and not the varistor itself. They are not expected to degrade significantly over the lifetime of the product.

Bullet 5 Electricity meters are designed and tested for the wide operating temperature range experienced in North America. The meter displays are industrial grade and not permanently affected by low temperature operation.

Slide 38:

Bullet 1

Meter relays are tested to 5000 cycles at full rated load. This is equivalent to cycling once per day for more than 13 years.

Bullet 2

As previously stated meters already use filtering and meet FCC requirements. The allegations are false.

Bullet 3

As previously stated, the meter self-power is not measured or included in the kWh accumulation of the meter. The measured power has nothing to do with the meter and does not represent the cost of running the meter.

Slide 39:

Bullet 1

Utility companies provide safeguards and disclose what information is being used for.

Bullet 2

RF emissions are within all regulated limits.

Bullet 3

The Aclara I-210+c is designed to withstand normally occurring voltage transients. In extreme cases damage may occur but the product is designed to fail in a safe manner.