San Francisco
Public Utilities Commission

AUTOMATED WATER METER PROGRAM
RADIO FREQUENCY ASSESSMENT

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Review of Aclara RF System Proposal

The following information is required to be provided before approval of this project can be made. These information requirements are established in the San Francisco Planning Department Wireless Telecommunications Services Facility Siting Guidelines dated August 1996. In order to facilitate quicker approval of this project, it is recommended that the project sponsor review this document before submitting the proposal to ensure that all requirements are included.

1. The location of all existing antennas and facilities. Existing RF levels. (WTS-FSG, Section 11, 2b)

   Aclara has no existing antennas and facilities.

2. The location of all approved (but not installed) antennas and facilities. Expected RF levels from the approved antennas. (WTS-FSG Section 11, 2b)

   The Aclara RF System requires an installation of a Meter Telemetry Unit (MTU) at every premise which is to be monitored. Each MTU contains an embedded antenna used to communicate with the Aclara RF STAR® Network. This is approximately 193,000 antenna locations throughout the city (175,000 water and 18,000 electric). In addition, the Aclara RF STAR® Network uses a Data Collection Unit (DCU) to gather the data from the telemetry endpoints and aggregate it. Each DCU has two antennas. The Aclara network will consist of approximately 77 DCU's which are used primarily to receive the MTU transmissions.

   Each of the 175,000 water MTU's will transmit four (4) times per day with a transmit duration of less than 80 milliseconds (0.08 seconds) at under 1.0 Watt of total output power per transmission. The individual MTU safety level is detailed in Appendix A. This device is within the safety limits recommended by the IEEE and the FCC. Also, importantly, safety of these devices is maintained even in the event of a malfunction.

   Each of the 18,000 electric MTU's will transmit twelve (12) times per day with a transmit duration of less than 80 milliseconds (0.08 seconds) at under 1.0 Watt of total output power per transmission. The individual MTU safety level is detailed in Appendix A and is within the safety limits recommended by the IEEE and the FCC. Also, importantly, safety of these devices is maintained even in the event of a malfunction.

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Each of the 77 DCU's will transmit one (1) time per day with a transmit duration of less than 80 milliseconds (0.08 seconds) at 2.0 Watts of total output power per transmission. The individual DCU safety level is detailed in Appendix A and is within the safety limits recommended by the IEEE and the FCC.

Each of the 77 DCU's will also maintain a 1xRTT backhaul connection to the utility head-end computer system. This will be through a Wavecom Q24 cellular modem. Although this is an "always on" configuration, the actual transmit duration for a DCU site is limited by the amount of data being transferred. Each DCU will transmit approximately 3MB (megabytes) of data per day, plus 25% overhead to be conservative, meaning that each cellular modem will be "on the air and transmitting" no more than 45 minutes per day, however the operation is not restricted to 45 minutes nor is it required to be. According to the "Wavecom Q2438F Maximum Permissible Exposure" calculation (Appendix C, authored by Wavecom) indicates that this device is safe for continuous operation at 20cm. separation from the antenna. The DCU antenna is normally located more than 20 feet from ground level. Thus continuous operation of the DCU cellular modem is within the safety limits recommended by the FCC.

3. The number and types of WTS within 100 feet of the proposed site and provide estimates of cumulative EMR emissions at the proposed site. (WTS-FSG, Section 10.5.2)

   Aclara has no other WTS within 100 feet of any of the proposed sides.

4. Location (and number) of the Applicant's antennas and back-up facilities per building and number and location of other telecommunication facilities on the property (WTS-FSG, Section 10.4.1a)

   Aclara MTU's have embedded antennas and will not require the installation of any external antennas at any of the metering locations.

   Aclara DCU's have two external antennas which will need to be sited for each of the DCU installation points within the system.

5. Power rating (maximum and expected operating power) for all existing and proposed backup equipment subject to the application (WTS-FSG, Section 10.4.1c)

   The MTU operating power is 0.25 Watts for standard units and 1.0 Watts for extended range units. We expect most of the MTU's to be "standard units."

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The DCU operating power is 2.0 Watts in UHF and 0.25 Watts on the cellular frequencies.

6. The total number of watts per installation and the total number of watts for all installations on the building (roof or side) (WTS-FSG, Section 10.5.1).

   Each proposed MTU location will have 1.0 Watts of transmit power, and will operate for a maximum of 0.32 seconds per day. The power level of 1.0 Watt will be used in the aggregate power evaluation as a "worst case" calculation.

   Please note that even under the condition of an electronic malfunction, the MTUs are not capable of sustained transmission beyond a few tenths of a second. Their mode of operation is very similar to an electronic flash on a camera: once the transmission occurs, the unit must dwell for a long period of time before another transmission can be made.

   Each proposed DCU location will have 2.0 Watts of transmit power, and will operate for a maximum of 0.08 seconds per transmission.

   Due to the nature of how the Aclara RF system operates, no single UHF transmitter operates for more than 1 second per day (this represents the bulk of the transmitters our system). There are no "UHF hot spots" in the system. Also, the cellular modems operate "as needed" throughout the day, so any given DCU site will typically have less than 45 minutes of transmitter operation in the cellular frequency band (however the operational time is not a requirement per Appendix C).

   Thus the only way to evaluate the total power output of the system is to compute the average system output power for the entire service area. The average system output power for any moment of the day can be computed by taking the total operating time per transmitter, multiplied by the operating power for that transmitter, and then dividing the aggregate sum of all of the transmissions by the total seconds in a day.

   175,000 MTU's operating at 0.32 seconds per day and 1.0 Watts maximum (a conservative number used for calculation purposes: many of the units will be 0.25 Watt units) = worst case 56,000 Watt-seconds per day.

   18,000 MTU's operating at 0.96 seconds per day and 1.0 Watts maximum = 17,280 Watt-seconds per day.

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77 DCU's operating in UHF at 0.08 seconds per day and 2.0 Watts maximum = 12.5 Watt-seconds per day.

77 DCU's cellular modems operating at under 45 minutes per day at 0.25 Watts nominal = 51,975 Watt-seconds per day.

The sum total output of the entire system is less than 125,280 Watt-seconds (34.8 Watt-hours) per day, or equivalently an output power for the entire Aclara RF STAR® Network of less than 1.45 Watts average continuous power, city wide. By comparison, a typical UHF police or fire mobile radio has an output power of 25 Watts, thus a single public safety radio operating for 90 minutes per day will emit more energy into the UHF band than the entire Aclara RF system network. Also note that the total combined output power for all of the devices (MTUs and DCUs in aggregate) in our system is less than the average RF output from a single cell tower.

7. Preferred method of attachment of proposed antenna (roof, wall mounted, monopole) with plot or roof plan. Show directionality of antennas. Indicate height above roof level. Discuss nearby inhabited buildings (particularly in direction of antennas) (WTS-FSG, Section 10.41d)

   No antenna attachment is necessary for the MTU sites.

   The recommended DCU antenna attachment is at pole top for telephone and light poles, or using a roof-mount kit. Antennas are all omni-directional, and are recommended to be mounted at least 8 feet above roof-top. Details and mounting instructions can be found in our previously supplied DCU Installation Guide (see Appendix B).

8. Report estimated ambient radio frequency fields for the proposed site (identify the three-dimensional perimeter where the FCC standards are exceeded.) (WTS-FSG, Section 10.5) State FCC standard utilized and power density exposure level (i.e. 1986 NCRP, 200 $\mu w/cm^2$)

   IEEE Std C95.1.1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz

   FCC's Radio Frequency Exposure Limits, CFR 47 section 1.1310

   The calculated limit for UHF (450-470MHz) is 300 $\mu W/cm^2$. The ambient RF exposure calculations for all installed Aclara RF devices are well under

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0.1 μW/cm^2 at 20 cm. range from the DCU antenna or from the MTU enclosure (Appendix A).

See the "Wavecom Q2438 Maximum Permissible Exposure" document for details on the operation of the cellular modem (Appendix C).

9. Signage at the facility identifying all WTS equipment and safety precautions for people nearing the equipment as may be required by any applicable FCC-adopted standards. (WTS-FSG, Section 10.9.2). Discuss signage for those who speak languages other than English.

   Aclara RF does not propose any specific RF safety signage at any of the installation sites, other than as required by local codes.

10. Statement on who produced this report and qualifications.

    Responses prepared by Dr. Glenn A. Emelko, Ph.D. in Electrical Engineering from Case Western Reserve University in Cleveland, Ohio. Dr. Emelko has been in the wireless telecommunications, computer, and electronics industry for 30 years, and is presently the Executive Director of Technology at Aclara RF Systems Inc. Dr. Emelko may be reached on his direct line at (440) 528-7449 or by fax at (440) 528-7199.

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Appendix A: RF Emissions Safety Limits (based upon Aclara Technical Bulletin TB040049)

STAR® Meter Transmission Unit (MTU) meter modules and Data Transmission Units (DCU) produce an extremely low level pulse of radio frequency (RF) energy when they transmit a meter reading.

There are a number of standards related to the permissible levels of human exposure to radio frequency energy for devices like the STAR® MTU and DCU. The relevant standards are the Institute of Electrical and Electronic Engineers ***IEEE Std C95.1.1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz*** and the **FCC's *Radio Frequency Exposure Limits, CFR 47 section 1.1310***, the RF energy produced by STAR® transmissions at 450 to 470MHz is well within the allowable limits.

Both of these standards establish the maximum power density for operation at 450-470MHz as:

$$S \leq 450/1500 \text{ mW/cm}^2 \approx 0.3 \text{ mW/cm}^2 \text{ maximum } (300 \text{ } \mu\text{W/cm}^2)$$

According to the standard, the effective power density is calculated as an average of exposure for a thirty (30) minute time period for a person which is 20 centimeters (8" or further) from the device. A STAR® MTU or DCU transmission lasts a maximum of 0.28 seconds and may occur as frequently as hourly or as seldom as once every 12 hours. The highest power devices in the STAR® system transmit with two watts of RF energy. The antennas in use are omni-directional; thus at 20.0cm distance the power density is less than 0.000032 mW/cm^2 per watt of transmit power (0.032 μW/cm^2).

For the worst case, a DCU with a maximum output of 2.0W will have a power density of less than 0.000064 mW/cm^2 at 20cm. range. Likewise, an MTU with an output of 0.75W will have a power density of less than 0.000024 mW/cm^2 at 20cm. range. Both of these devices are far below the safety limits set forth in the IEEE and FCC Standards.

For the home user, it may also be important to note that even if the MTU could sustain 1.0W of output power and somehow maintain continuous operation, is it still within the safety limits. Although by design the MTU cannot do this, the power density calculation for these conditions is just under 200 mW/cm^2 which is still within the IEEE and FCC accepted limits for safe operation at 20cm. (8").

Under a malfunctioning condition, the DCU exposure limit will reach approximately 400 mW/cm^2, slightly above the maximum permissible exposure limit if someone is within 20.0cm for 30 minutes. In this failure mode, either a distance of 23.5cm (9.25 inches) from the antenna must be maintained, or an exposure time of no more than 22.5 minutes per 30 minute time period must be observed.

Conclusion:

In summary, the STAR® MTU and DCU RF energy emissions are at extremely low levels; a small fraction of the limit set by national standards. Based on the limits set by these standards, there are no radio-frequency safety issues relating to the use of these products.

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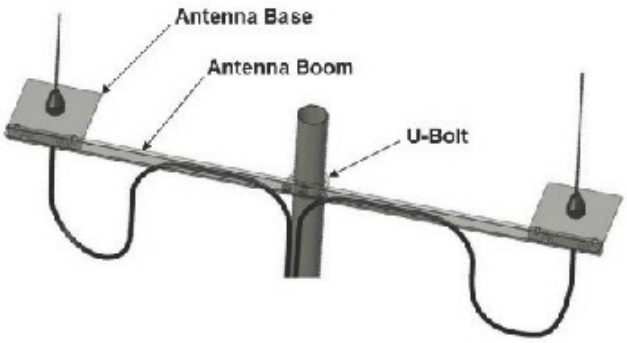
Appendix B: Antenna Installation (from the Aclara DCU Installation Guide)

Mounting RF Antenna

1. Attach RF antenna bases to antenna boom using bolts, washers, lock washers, and nuts. Connect cable to antenna N connector and wrap with 3M self-fusing tape.
2. Attach antenna boom to top of mast pole using one large u-bolt, two locking nuts, and a wrench and/or socket.



3. Secure cables to top section of mast with tie wraps as shown.

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Mounting RF Antenna

1. Attach RF antenna base to antenna boom using bolts with washers, lock washers, and nuts. Connect cable to antenna N connector and wrap with 3M self-fusing tape.
2. Mount a band strap and mounting bracket as high on the pole as possible using the band strap tool. Refer to instructions in *Using the Band Strap Tool and Mounting Brackets* on page 43.

NOTE Position band strap carefully so no wires or foreign objects are trapped behind strap.

3. Attach antenna boom to mounting bracket using two bolts with lock washers and nuts.
4. Align antenna boom so it is parallel to ground, and then tighten hardware with a wrench and/or socket.

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Appendix C: Wavecom Q2438 Maximum Permissible Exposure (provided by Wavecom, exhibit recorded under FCC ID O9EQ2438F)

PCTEST

RF Exposure Evaluation - Maximum Permissible Exposure (MPE)

1. Introduction

This document attempts to prove the safety of radiation generated by RF devices to the human body. The limit for Maximum Permissible Exposure (MPE), specified in FCC 1.1210, is listed below. The power generated by this product is measured by a power meter. Through use of the Friis transmission formula and the maximum gain of the antenna, the distance from the product at which compliance with the MPE limit is achieved may be calculated. Alternatively, near field measurements may be performed to demonstrate compliance at a specific measurement distance.

Near field probe: Wandel & Goltermann EMR-20.

2. RF Exposure Limit

According to FCC 1.1310: the criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (Minutes)
(A) Limits For Occupational / Control Exposures				
30-300	61.4	.163	1.0	6
300-1500	…	…	F/300	6
1500-100,000	…	…	5	6
(B) Limits For General Population / Uncontrolled Exposure				
30-300	27.5	.073	.2	30
300-1500	…	…	F/1500	30
1500-100,000	…	…	1.0	30

F = Frequency in MHz

3. Friis Formula

Friis transmission formula: $Pd = (P_{out} * G) / (4pr^2)$

Where:

Pd = power density in mW/cm^2 (MPE limit)
P_{out} = output power to antenna in mW
G = gain of antenna in linear scale
p = 3.1416
r = distance between observation point and center of the radiator in cm

Ref.: David K. Cheng, Field and Wave Electromagnetics, Second Edition, Page 640, Eq. (11.133)

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4. EUT Operating Condition

Software provided by the client enabled the EUT to transmit and receive data at lowest, middle, and highest channels individually.

5. Climate Condition

The temperature and relative humidity: 22°C and 78% RH

6. Measurement Results

6.1 Output Power into Antenna & RF Exposure Distance:

Channel	Channel Frequency (MHz)	Output Power to Antenna (mW)	Power Density (mW/cm^2)
600	1880	224	0.044
363	835.89	224	0.044
383	836.49	600	0.120

7. Conclusion

The device meets the mobile 20cm. separation distance as specified in Section 2.1091 of the FCC Rules and an appropriate RF exposure compliance statement will be placed in the users manual.

PCTEST MPE REPORT	PCTEST	FCC MEASUREMENT REPORT wavecom		REVIEWED BY: Quality Manager
TEST REPORT S/N: 22/24 2240428269O SE	TEST DATES: April 28-29, 2004	EUT TYPE: Tri-Mode Dual-Band Wireless Evaluation Kit	FCC ID: O9EQ 2438F	Page 2 of 2

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City and County of San Francisco
DEPARTMENT OF PUBLIC HEALTH
ENVIRONMENTAL HEALTH SECTION

Gavin Newsom, Mayor
Mitchell H. Katz, MD, Director of Health
Rajiv Bhatia, MD, MPH, Director of EH

April 23, 2010

TO: Heather Pohl, Project Manager, Public Utilities Commission

FROM: Patrick Fosdahl, Dept. Of Public Health, Environmental Health Services

RE: Review of the ACLARA RF Star System

As requested, I have reviewed the documentation that you and Aclara have provided to me regarding the proposed installation of Aclara RF Star utilities monitoring system to be located throughout the City and County of San Francisco.

I have also reviewed the Aclara radiofrequency report prepared by Dr. Glenn Emelko, Ph.D. regarding radio frequency radiation exposure and compliance with the Federal Communications Commission (FCC) permissible exposure limits for the general public and workers. The report states that approximately 193,000 Meter Telemetry Units (MTU) with embedded antennas will be mounted throughout the city at water and electrical utilities in order to monitor their usage (175,000 water and 18,000 electrical). In addition, the network would use approximately 77 Data Collection Units (DCU). The DCU's would gather the data from the MTU's. The DCU's will be mounted approximately 20 feet above the ground on utility poles. Due to the mounting locations, the DCU antennas would not be accessible to the general public. It is assumed that the poles, in public right-of ways, are spaced at least ten (10) feet from nearby inhabited buildings.

The report states that each MTU's for water will transmit four times per day and the MTU's monitoring electrical usage will transmit twelve times a day. Both sets of MTU's will have a transmit duration of less than 80 milliseconds (0.32 – 0.96 seconds per day) at under 1.0 Watt of total output power per transmission. The embedded antenna in the MTU is estimated to produce a maximum of 0.000024 mW/cm^2 at 20 centimeters. This is approximately .008% of the public limit (0.3 mW/cm^2) which is calculated as an average exposure for thirty minutes. The antennas associated with the DCU will transmit one times per day with a transmit duration of less than 80 milliseconds (0.16 seconds per day) at 2 Watts of total output power. The DCU's are estimated to produce about 0.000064 mW/cm^2 at 20 centimeters from the antenna. This is approximately 0.021% of the public limit (0.3 mW/cm^2). The DCU will also transmit via cellular modem to the PUC head-end computer system. This transmission will be for no more then a total of 45 minutes per day. The calculated power density at 20 cm. for 1880 MHz and 835.89 MHz transmission is 0.044 mW/cm^2. The calculated power density for an 836.49 MHz is 0.120 mW/cm^2. All of these levels are below the FCC public exposure limit.

Based on the information provided in the Aclara report, I would confirm that the MTU and DCU antennas would be in compliance with the FCC standards and would not produce radiofrequency exposures exceeding the FCC public exposure limits.

Recommendations:

- Once the antennas are installed, Aclara should take several RF power density measurements with the antennas operating at full power to verify the level reported in the Aclara report and to ensure that the FCC public exposure level is not exceeded in any publicly accessible area.

- Aclara should be aware that the general public may have concerns about the antennas and potential RF source near their dwellings. Aclara should have in place a mechanism for taking RF power density levels in nearby dwellings when requested by the members of the general public.

- Aclara must comply with all requirements described in the California Public Utilities Commission General Order 95. Specifically, ensure compliance of requirements for warning signs for workers who may work on the utility poles. Install signs containing appropriate contact information and indicating the stay back distance as given in the report. Signage should also include the antenna operator and FCC Category (controlled or uncontrolled). Signs should be mounted between 3 and 9 feet above ground.

- DPW should be provided annually with the list, location and current operating power of all pole mounted operating and non-operating antennas.

Please note that this approval and recommendations apply only to the equipment and conditions as described. If any changes in the equipment or any increase in the effective radiated power described above are made, a new review by the Department of Public Health must be conducted.

Rev. 9/13/10 pf

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September 23, 2010

Ms. Heather Pohl
Project Manager
Advance Meter Infrastructure Program
San Francisco Public Utilities Commission
1145 Market Street, Fourth Floor
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Dear Ms. Pohl:

This letter reports on radio frequency (RF) exposure measurements made on the Aclara meter transmission units (MTU) and data collection units (DCU) now being deployed in San Francisco, to remotely measure water consumption using wireless communications. The measurements were taken in San Francisco on July 22, 2010, by Robert P. Smith of Hammett & Edison, under my immediate supervision. The following persons were present during all or portions of the measurements:

Mr. Curtis Hartdegen, Field Engineer, Automated Water Meter Program
San Francisco Public Utilities Commission

Ms. Heather Pohl, Project Manager, Advanced Meter Inrastructure Program
San Francisco Public Utilities Commission

Mr. Brian Barry, Junior Engineer, Automated Water Meter Program
San Francisco Public Utilities Commission

Mr. Patrick Fosdahl, Senior Inspector, Air Quality Research and Planning, San Francisco Department of Public Health

Mr. Nate Loe, Project Manager, VSI Meter Services

Mr. Thomas Bohrer, Project Manager, Aclara Technologies

As you know, the system is being deployed in San Francisco uses MTUs operating on 467 MHz. The MTUs we observed and measured were operating inside sidewalk water meter vaults, although no shielding effect for the water meter value concrete cap was taken because the measurements were intentionally made with the vault cover temporarily removed. The MTUs transmit a data signal to a DCU on a nearby pole. The DCU in turn relays accumulated data from reporting MTUs back to a central location using an 838 MHz cellular transmitter. Signals are also transmitted at 462 MHz from the DCU back to MTUs, for time

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synchronization. All transmissions are intermittent, to conserve battery power. The MTUs are physically sealed devices that have an internal battery expected to last for 10 to 20 years before needing replacement. The pole-mounted DCUs use a small ("motorcycle size") lead-acid sealed battery, charged by a single photo-voltaic panel, as their power source.

MTU

According the FCC equipment authorization for the MTU, having FCC Identifier LLB09010B, the authorized frequency range is 450-470 MHz, the transmitter power output (TPO) 645 mW, and the emission designator is 12K5F1D. The 12K5 means that the occupied bandwidth for the transmitted signal of 12.5 kHz, and the F1D signifies frequency modulation (the "F" in the emission designator) of a digital signal (the "1" in the emission designator) containing data or telemetry (the "D" in the emission designator). Again according to the manufacturer's FCC equipment certification filing, a typical data transmission lasts 77 mSec, and the maximum duration transmission the MTU is capable of sending is 100 mSec. Under normal operation the maximum number of data transmissions per hour is four, although for the purposes of these measurements that limit was manually overridden so as to allow a series of measurements at various heights and angles relative to the MTU. As shown by the attached Figures 2 and 3, specialized control hardware is needed to perform this override; indeed, the MTU devices employed in San Francisco are normally expected to transmit only four times per *day*, not four times per hour.

The MTU is reported to use an omnidirectional, unity gain transmitting antenna, although the typical mounting of the MTU, below the sidewalk level in a water meter vault, means that the only significant radiation is upwards. The unity gain transmitting antenna means that the maximum effective radiated power (ERP) is also 645 mW. To make it waterproof, the MTU is hermetically sealed, meaning that the case would have to be forced open to replace the battery. Because of this limitation on battery power, the MTU transmission duration and number of transmissions per hour is intentionally restricted. This low duty cycle significantly reduces the RF exposure level that this already low-power device is capable of generating.

DCU (838 MHz Cellular)

The pole-mounted DCU employs two transmitters: An 838 MHz cellular transmitter, for forwarding accumulated data from MTUs back to a central receiving location, where the water meter data can be processed, and a 462 MHz transmitter for sending time synchronization signals back to individual MTUs. The FCC equipment authorization number for the 838 MHz cellular transmitter is reported as O9EQ2438F-M. The equipment authorization is for two bands, 824–849 MHz (the "cellular" band), and 1.85-1.90 GHz (the Personal Communications Services, or PCS, band). Alcara reports that only the 838 MHz cellular band is used, and our measurements found only a signal in the cellular band, and no evidence of any signal in the PCS band. The equipment certification filing shows the maximum cellular TPO as 419 mW, and the maximum cellular ERP as 151 mW. For the cellular band three emissions are authorized: 1M25F9W, 40K0F8W, and 40K0F1D. The first emission is wide-band (1.25 MHz) voice FM, the second emission is narrow-band (40 kHz) voice modulation, and the third emission is

narrow-band FM data; the pertinent emission for the DCU operation is therefore the 40K0F1D emission designator.

DCU (462 MHz)

The 462 MHz DCU transmitter, for sending time synchronization signals back to MTUs, was found to have FCC equipment certification number LLB9975J. This is a higher-power version of the water meter MTUs, with a TPO of 1.78 watts but a narrower emission designator of 7K20F1D; that is, a 7.2 kHz wide FM data signal. Because the pole-mounted 462 MHz talk back transmitter gets its power from a separate lead-acid battery charged by a solar-voltaic panel, a higher transmitter power is possible. There were two separate 460 MHz band cards in each of the two DCUs we observed, each having its own coaxial cable connected to a vertical whip antenna; the two whip antennas are mounted on a T-bar bracket, with a horizontal separation of about three feet. One card is a 467 MHz receiver, the other is a 462 MHz transmitter. Having separate antennas with separate coaxial cable transmission lines for transmitting and receiving avoids the need for a diplexer, and thus simplifies the system design.

Measuring Equipment

A Narda Safety Test Solutions Model SRM 3001, serial number 3001/01 meter, with the Narda Model F-0031 E-field probe, serial number F-0042, were used to measure the power density from the MTU and DCU transmitters. With this probe the frequency range is from 75 MHz to 3 GHz, so both the MTU and DCU signals were well within the probe's operational range. The SRM meter and probe were last calibrated by the manufacturer on April 22, 2008.

The Narda SRM 3001 has both frequency domain and time domain measurement capabilities, meaning that when the frequency under test is known, the instrument can be operated in its frequency-specific time domain mode in order to capture a transient, or pulsed, signal, which is the case for both the MTU and DCU signals. The E-field probe is isotropic, meaning that it is designed to receive signals from all directions and with all polarizations, which is important for RF exposure measurements.

Measurement Results: MTU

The maximum power density at any location 8 inches (20 cm) from the MTU was 0.00182 mW/cm^2, or 0.585% of the 0.311 mW/cm^2 FCC public limit applying at this frequency. However, FCC guidelines specify averaging over a 30-minute period for public (uncontrolled) exposures. Since during normal operation an MTU will be only be allowed to transmit four times per day, there would be a maximum of just one transmission in any thirty-minute period. Even assuming that the maximum transmit interval is 100 mSec, the measured instantaneous peak power density must be adjusted by (1 transmission)(0.1 seconds/ transmission)/ (30 minutes) (60 seconds/minute) = 0.0000556. Thus, the observed maximum instantaneous maximum power density of 0.585% of the public limit is equal to a time-averaged-over-thirty-minutes power density of 0.000000101 mW/cm^2, or 0.0000325% of the public limit; that is, more than six orders of magnitude below the FCC guideline for unlimited time exposure of the

general public. Thus, I conclude that the Alcara MTU meets FCC guidelines for human exposure to RF energy.

It should be noted that this conclusion holds even when a system with tens or even hundreds of thousands of MTUs is installed. This is because for the power density of multiple MTUs to be additive, those units must be within a few feet of each other. While in some cases there may exist a series of water meter vaults in close proximity, the number of such adjacent water meter vaults would be in the single-digit range. Thus, it would be physically impossible to aggregate the exposures caused by hundreds of MTU transmitters, to say nothing of the more than one million MTUs that would have to be aggregated in order to reach the public exposure limit.

Measurement Results: DCU

The maximum power density at any location 8 inches (20 cm) from the DCU unit's cellular antenna, mounted on the front, left-hand top corner of the DCU cabinet, was 0.000025 mW/cm^2, or 0.0044% of the 0.559 mW/cm^2 FCC public limit applying at this frequency. Since no information on the duty cycle for DCU-to-central receive transmissions was available, no time averaging-over-thirty minutes is being applied. However, even if the DCU were to transmit continuously (which is not the case), the power density would still be more than two orders of magnitude below the public limit. Given that the DCU cellular transmitter is mounted on a pole, where immediate public exposure is not possible, I conclude that the cellular portion of the Alcara DCU also meets FCC guidelines for human exposure to RF energy. This would be the case even for nearby multi-story structures, which would be separated by far more than just 8 inches.

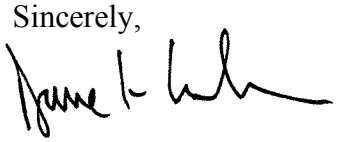
The maximum power density at any location 8 inches (20 cm) from the 462 MHz DCU antenna was 0.00000360 mW/cm^2, or 0.00117% of the 0.308 mW/cm^2 FCC public limit applying at this frequency. While the DCU-mounted 462 MHz transmitter has a higher power capability than the MTU transmitter (1.78 watts TPO versus 0.645 watts TPO for the MTU) because it has access to a larger battery that is additionally recharged by a solar-voltaic panel, this is still a less than 2 watt transmitter operating into a vertical whip transmitting antenna that would typically have a gain of between 3 and 5 dBd, meaning that the ERP is less than 6 watts, even when the transmission line loss is ignored. Plus, the return-path 462 MHz antenna is again mounted at height on a pole, rather than immediately below ground level. Thus, the 462 MHz portion of the DCU is also compliant with FCC guidelines for human exposure to RF energy. Because the pole-mounted DCU cellular antennas and the 462/467 MHz whip antennas were found be to separated vertically by about 12 feet from the DCU cellular antenna, the DCU cellular antenna and DCU 462 MHz antenna RF power densities can be treated as separate. At the Bernal Heights radio site DCU location, a smaller vertical separation of about 6 feet between the DCU cellular antenna and the DCU 462 MHz antenna was observed. However, even if the two power densities were added, they would still be far below the public exposure limit. Further, because the 838 MHz DCU cellular transmissions and 462 MHz DCU transmissions are each intermittent and not synchronized, time-averaging over the FCC-specified 30-minute interval would further reduce the actual combined exposure level.

Conclusion

Due to their low power, short transmission time, and limited number of transmissions per hour, the Alcara MTUs are inherently compliant with FCC guidelines for human exposure to RF energy. The 462 MHz and 838 MHz transmitters in the Alcara DCUs are also compliant with FCC guidelines; although they are not quite as low power as the MTU transmitters, and their larger solar-voltaic panel recharged battery allows more frequent transmissions than for the MTU transmitters, they are also compliant with FCC exposure guidelines because they are still low-power devices, and their transmitting antennas are generally pole-mounted, well above ground level.

Several photographs of the MTU and DCU devices, and measurements process, are attached. All photographs were taken by me on July 22, 2010.

Sincerely,



Dane E. Ericksen

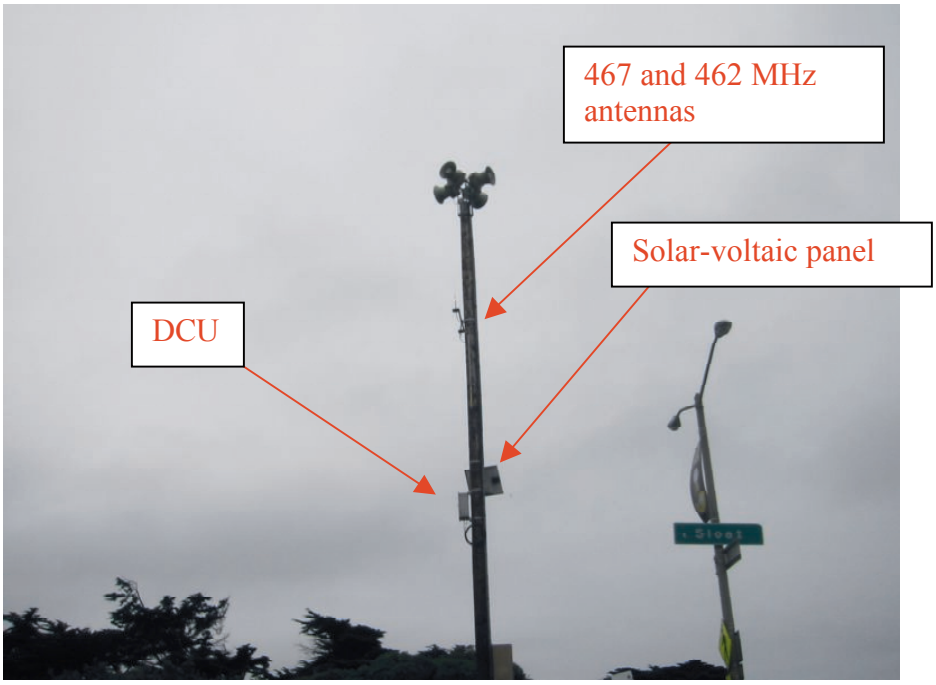
tm

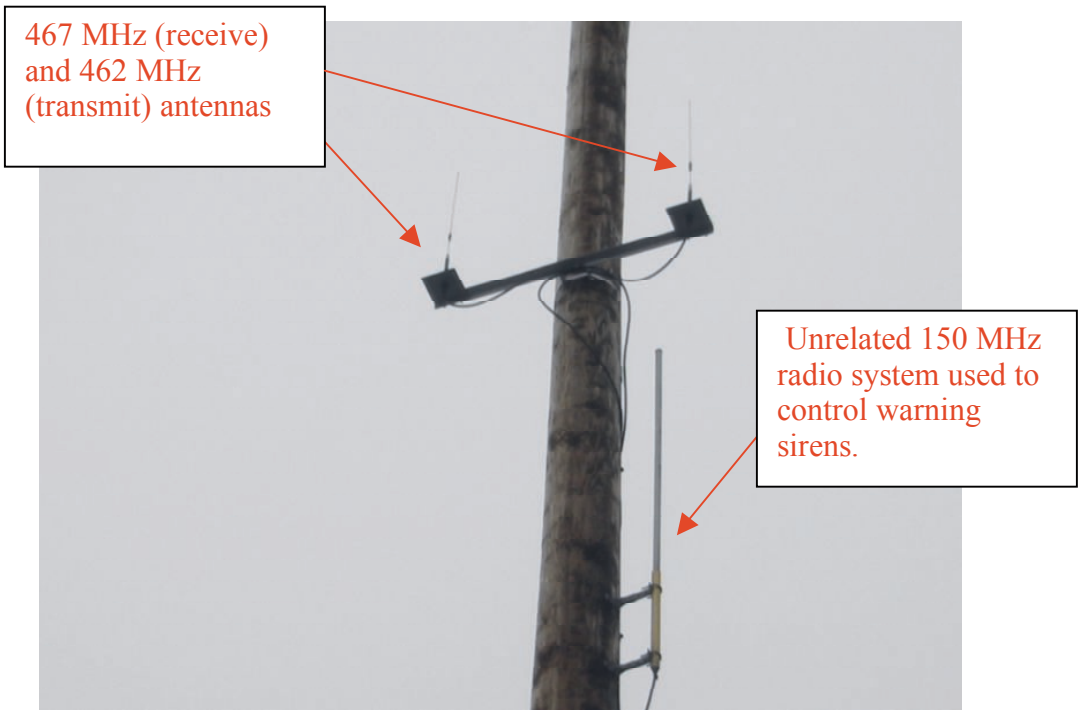
Enclosure

Top: Water meter with transducer.
Bottom: Aclara MTU.

Top and bottom: Manual control override unit used to force more than one transmission every 15 minutes from MTU, to allow RF exposure measurements. Because the MTU is hermetically sealed, a magnetically-coupled control module is used to interface the MTU electronics.

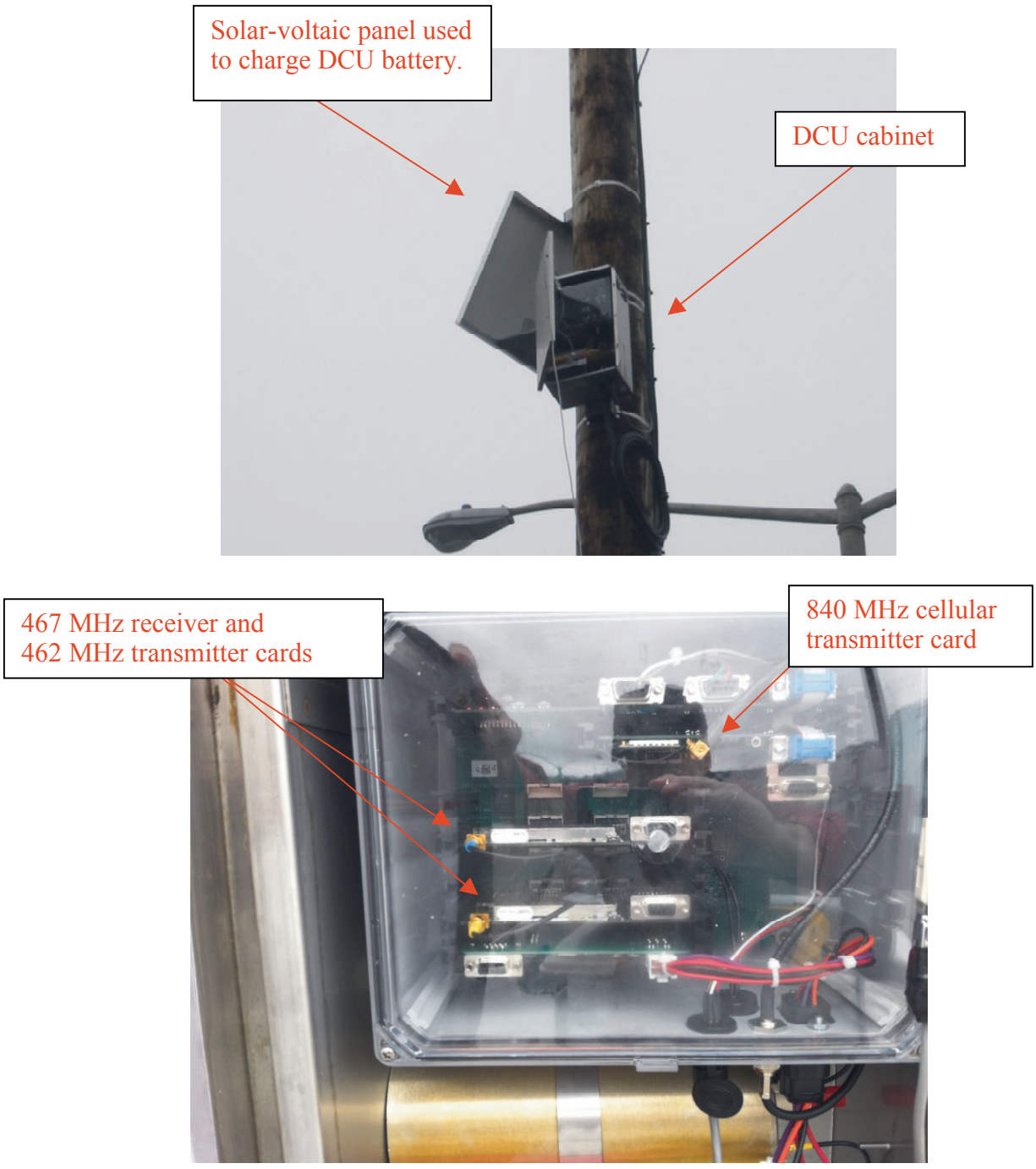
Top and bottom: Measurements at 8 inches (20 cm). The MTU has had the mounting brackets normally holding it to the bottom of the water vault concrete cover temporarily removed.



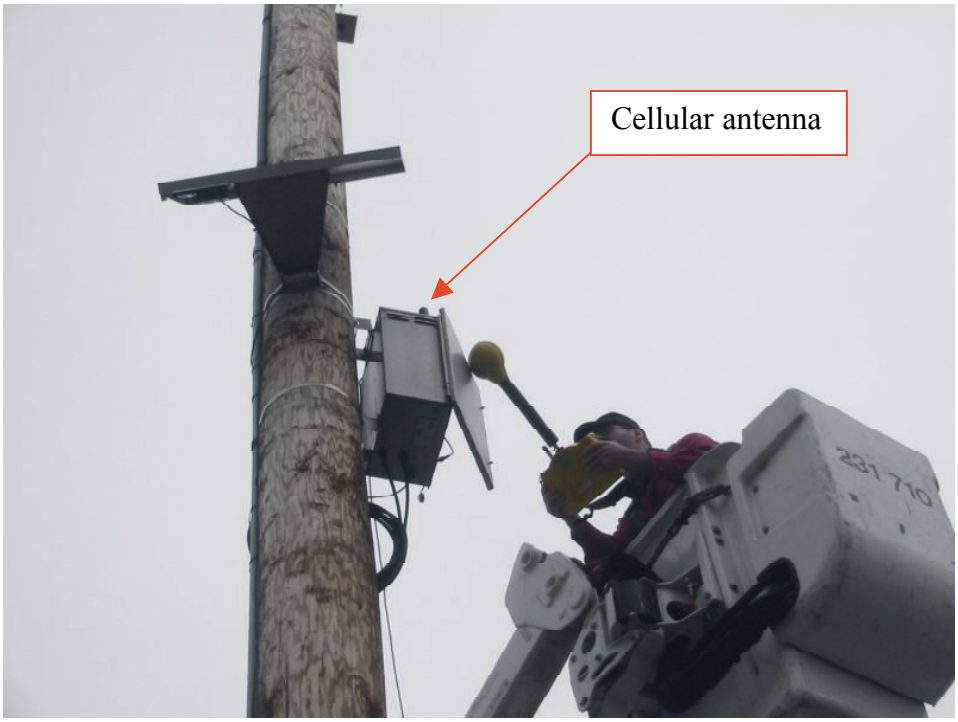


Top: DCU at Sloat Boulevard and 47th Avenue.

Bottom: Close up of the 462 and 467 MHz vertically polarized whip antennas used to receive MTU signals, and to send time synchronization signals back to the MTUs.



Top: Pole-mounted DCU and solar-voltaic panel.
Bottom: DCU modules.



Top: Preparing to measure the 462 MHz DCU power density.
Bottom: Preparing to measure the 838 MHz DCU power density.

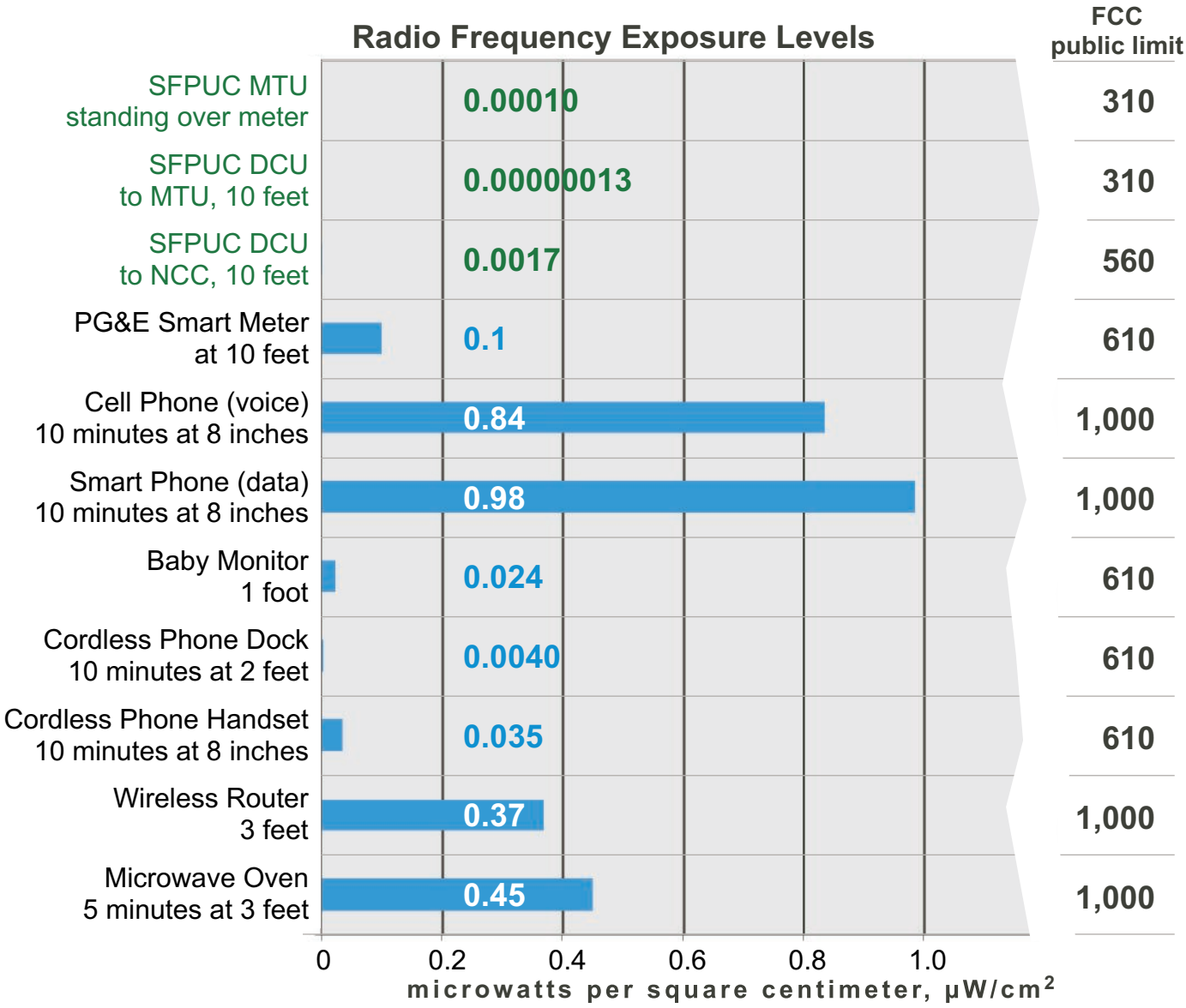
Top: DCU on roof of the Bernal Heights radio site building at 99 Moultrie Street.
Bottom: DCU cabinet, with 838 MHz cellular and 462 MHz transmitters.

San Francisco Public Utilities Commission

Radio Emissions from Remote Water Metering Equipment and Comparison against Common Radio Sources

Data Collection Units (DCUs) are installed on poles at least 20 feet above ground and 10 feet from any public building to collect data from automated water meters and send to SFPUC's network control computer (NCC). DCUs transmit a synchronizing pulse (0.1 second) one time per day to water meters.

Meter Transmission Units (MTUs) are attached to water meters, typically located in sidewalk vaults, taking hourly meter readings and sending that data in short (0.1 second) transmissions four times a day to DCUs. MTUs only collect meter readings and are not capable of remote water shutoff.



Measurements at Aclara DCU and MTU installations were taken by H&E on July 22, 2010. Typical consumer equipment was measured by H&E at other times. PG&E measurement is from the utility's website. FCC public limits are from CFR Title 47 §1.1310. Averaging period for public exposure is 30 minutes, applied to data for MTU, DCU-to-MTU, cell phones, cordless phone, and microwave oven. Minimum distance for power density measurements is 8 inches; closer approaches require measurement of specific absorption rate (SAR).

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