RADIOFREQUENCY RADIATION MEASUREMENT SURVEY

HONOLULU, HAWAII

MAY 14-25, 1984

Nonionizing Radiation Branch
Office of Radiation Programs
U.S. Environmental Protection Agency
P.O. Box 18416
Las Vegas, Nevada 89114

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RADIOFREQUENCY RADIATION SURVEY - HONOLULU, HAWAII

NONIONIZING RADIATION BRANCH
OFFICE OF RADIATION PROGRAMS
U.S. ENVIRONMENTAL PROTECTION AGENCY

Background

During the period May 14-25, 1984, members of the Nonionizing Radiation Branch, Office of Radiation Programs, U.S. Environmental Protection Agency, with cooperation from the Federal Communications Commission (FCC) and the Hawaii State Department of Health, conducted a survey of radiofrequency (RF) radiation exposure levels throughout the Honolulu, Hawaii metropolitan area. The purpose of this study was to measure and document the RF exposure levels caused by broadcast stations in Honolulu. The stations included AM radio, FM radio, and television (TV) stations having frequencies within the range of 550 kHz to 512 MHz.

Measurements of RF radiation exposures were performed at 21 different locations in and near Honolulu. The data are given under "Survey Results" and in Appendix 1. Measurement sites were selected on the basis of transmitting antenna locations and proximate areas which were judged, prior to the study, to present the possibility of public exposure to relatively intense RF fields. The measurement locations selected by no means represent an exhaustive collection of all possible high intensity areas but, in our judgment, are representative of areas where public exposure levels of RF fields in Honolulu may be highest.

Instrumentation and Measurement

Measurements of RF field intensities were performed using a variety of instruments including both broadband isotropic field survey meters and narrowband tuneable field strength meters in conjunction with calibrated antennas. A list of equipment used during the study is given in Appendix 2, and some of the units and terms used in this report are listed in Appendix 3.

The equipment used in these measurements has been calibrated by the Nonionizing Radiation Branch by referencing to fundamental power standards of the National Bureau of Standards. The measurements reported here are believed to be accurate within an absolute tolerance of about ± 2 decibel. This corresponds to a possible uncertainty of +58% and -37% in the stated power densities and a possible uncertainty of +26% and -21% in the stated electric or magnetic field strengths. For example, a stated power density of 500 $\mu W/cm^2$ could in reality be as low as 315 $\mu W/cm^2$ or as high as 790 $\mu W/cm^2$.

In general, care was given to measurements of the resultant field vectors through the use of isotropic probes or mutually orthogonal measurement of all field components. In certain instances, a combination of equipment was used to best define the exposure fields, i.e., a single instrument was insufficient to fully characterize the exposure fields in some cases.

In some instances, exposures are expressed in terms of broadband RF intensity values; in others, a distinction is made between medium-wave fields (those due to AM radio stations) and very-high-frequency (VHF) fields (those due to FM radio and TV stations). In general, when broadband fields were observed to be less than an equivalent plane-wave power density of approximately 100 microwatts per square centimeter ($\mu W/cm^2$), efforts were not made to determine the contributions made by individual stations or bands of frequencies.

Survey Results

The Honolulu measurement data follow. An asterisk (*) means that the indicated location is normally only accessible by maintenance personnel. All other locations are accessible to the general public, e.g., residents, office workers, tourists, and transient passers-by.

1. Ala Moana Americana Hotel
   410 Atkinson Drive
   Site of KITV (TV, Ch.4) and KPOI-FM.

   Observation deck (outside): 311 $\mu W/cm^2$ (254 $\mu W/cm^2$ from KITV (TV, Ch.4) and 57 $\mu W/cm^2$ from KPOI-FM).

   Restaurant (inside): 40 $\mu W/cm^2$ maximum; less than 2.6 $\mu W/cm^2$ typically.

   *Rooftop near KPOI-FM antenna mast: 20,000 $\mu W/cm^2$ maximum; greater than 1,000 $\mu W/cm^2$ within 6 meters of antenna mast.

2. Pan Am Building
   1600 Kapiolani Boulevard

   Inside 14th floor suite facing KGMB tower and Ala Moana Hotel: range of 1.5-50 $\mu W/cm^2$ with highest values near corners of windows.

   *Rooftop (outside): 60 $\mu W/cm^2$ maximum near corner of roof.

3. Iliki Hotel
   1777 Ala Moana Boulevard

   Inside restaurant (Top of the I): typically 1 $\mu W/cm^2$.

   *Rooftop (outside): 7-26 $\mu W/cm^2$.

4. Coty Tower
Across from the KGMB tower that supports KGMB (TV, Ch.9), KHET (TV, Ch.11), and KQMQ-FM.

Ground level: typically 265-530 $\mu W/cm^2$ from VHF band; maximum of 663 $\mu W/cm^2$ (VHF) in parking lot. Typically 133-186 $\mu W/cm^2$ (VHF) on sidewalk; maximum of 318 $\mu W/cm^2$ (VHF).

Rooftop (outside): 375 $\mu W/cm^2$ (VHF); root-sum-squared (RSS) AM electric fields of 8.3 $\mu W/cm^2$ at central roof location; RSS AM value of 383 $\mu W/cm^2$ at corner of roof showing an electric field enhancement factor of 6.8 or a power density enhancement of 46.

Apartment 1003 (10th floor): 27-60 $\mu W/cm^2$ on balcony.

5. Hilton Hawaiian Village Hotel
2005 Kalia Road
Site of KUMU-FM and KHNL (TV, Ch.13), formerly, KIKU-TV.

*Roof of Tappa Tower: maximum of 1,300 $\mu W/cm^2$ (VHF); maximum of 2,650 $\mu W/cm^2$ (VHF) on top of elevator shaft near antenna mast.

Oceanside Tower (12th floor balcony): 2.7 $\mu W/cm^2$.

Rainbow Tower (29th floor balcony): typically 3.2 $\mu W/cm^2$, maximum 13 $\mu W/cm^2$.

Diamond Head Tower (balcony): 2.4 $\mu W/cm^2$.

6. KGU and KKUA: AM Tower
Ahui Street

Near fence at base of tower: maximum of 608 mA/m magnetic field strength (plane-wave equivalent power density of 14,000 $\mu W/cm^2$); up to 300 V/m electric field at fence (plane-wave equivalent power density of 24,000 $\mu W/cm^2$) with a value of 100 V/m (plane-wave equivalent power density of 2,650 $\mu W/cm^2$) at 10 meters from the fence.

7. KWAI (formerly KZHI), KNDI, KCCN, KISA: AM Tower
Nimitz Highway

Near fence at base of tower: maximum of 741 mA/m magnetic field strength (plane-wave equivalent power density of 20,700 $\mu W/cm^2$); up to 300 V/m electric field at fence (plane-wave equivalent power density of 24,000 $\mu W/cm^2$) with a value of 100 V/m (plane-wave equivalent power density of 2,650 $\mu W/cm^2$) at distance of 6-10 meters from the fence.

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*Normally only accessible by maintenance personnel.

8. The Villa on Eaton Square
400 Hobron Lane

Rooftop (outside): typically 100-200 V/m (AM) (plane-wave equivalent power density range of 2,650 to 10,600 $\mu W/cm^2$) in open areas; greater than 300 V/m (plane-wave equivalent power density of 24,000 $\mu W/cm^2$) over walls at edge of roof and/or near metal objects. RSS AM magnetic field of 123 mA/m (plane-wave equivalent power density of 570 $\mu W/cm^2$). Maximum VHF field of 2.5 V/m (plane-wave equivalent power density of 1.7 $\mu W/cm^2$).

Ground level cable experiment: Maximum induced RSS RF current in cable dropped from top of building of 0.51 amps. Ground level field strength of 1-2 V/m. Open-circuit voltage unknown and could not be measured without arcing occurring.

9. Kaimuki; KAIM-FM, KAIM (AM, auxiliary transmitter), KOHO (AM), KUMU (AM)
3555 Harding Avenue

Vicinity of tower in parking lot: FM maximum 830 $\mu W/cm^2$ with associated AM field at same location of 44.9 V/m (plane-wave equivalent power density of 535 $\mu W/cm^2$). Maximum AM electric fields of 102 V/m (plane-wave equivalent power density of 2,760 $\mu W/cm^2$) over car roof and 60-70 V/m (plane-wave equivalent power density of 955 to 1,300 $\mu W/cm^2$) near fence. Maximum AM magnetic fields of 9.0 A/m (plane-wave equivalent power density of 3,054,000 $\mu W/cm^2$) at fence.

10. Kapiolani Manor
1655 Makaloa

Rooftop (outside): typically 60 $\mu W/cm^2$.

Roof pool area: 20-30 $\mu W/cm^2$.

11. Ala Moana Pacific Center
1585 Kapiolani Boulevard

18th floor interior corner office area facing the KGMB tower and Ala Moana Hotel: 4 $\mu W/cm^2$ maximum.

12. KGMB Tower Area
1534 Kapiolani Boulevard
Site of KGMB (TV, Ch.9), KHET (TV, Ch.11), and KQMQ-FM.

Parking lot: 27-40 $\mu W/cm^2$ VHF.

Sidewalk adjacent to tower: typically up to 100 $\mu W/cm^2$ VHF.

13. Ala Moana Shopping Center
1450 Ala Moana Boulevard

Parking lot adjacent to Ala Moana Hotel: typically 50-60 $\mu W/cm^2$ VHF, maximum 110 $\mu W/cm^2$ VHF.

14. 1350 Ala Moana

*Rooftop: 25-60 $\mu W/cm^2$.

15. Discovery Bay
1889 Ala Moana Boulevard

Resolution Tower apartment 4113 (41st floor) facing Hilton Hawaiian Village Hotel complex: typical interior value of 1.7 $\mu W/cm^2$, maximum of 26 $\mu W/cm^2$ on balcony.

*Rooftop: 25-166 $\mu W/cm^2$ (largely AM).

16. La Ronde Restaurant
1441 Kapiolani Boulevard, 23rd Floor

Inside: typically 9-13 $\mu W/cm^2$, minimum 1.1 $\mu W/cm^2$, maximum 26 $\mu W/cm^2$ without KHAI-TV (Ch.20) on the air. Located nearby, Channel 20 field approximately 8 $\mu W/cm^2$.

17. KMAI (FM), KIKI (AM), KHVH (AM), KZOO (AM)
331 Kamani

Parking lot: up to 212 $\mu W/cm^2$ due to FM, 27 $\mu W/cm^2$ due to AM at resultant maximum field location.

Inside, Graphic Pictures: typically 4-10 V/m, 48 V/m at top of stairs, 200 V/m at surface of wall (all values probably largely due to AM fields).

Inside, Bartley's Town and Country Shop: typically 2-5 V/m, 25-30 V/m near shelves, up to 300 V/m near floor fan and label machine. RF burns caused by label machine.

Inside, Superior Travel: typically 5-8 V/m.

*At tower base: 9.3 A/m magnetic field (plane-wave equivalent power density of 3,261,000 $\mu W/cm^2$); 100 V/m electric field (plane-wave equivalent power density of 2,650 $\mu W/cm^2$).

*Upstairs in transmitter room: 100 V/m electric field (plane-wave equivalent power density of 2,650 $\mu W/cm^2$).

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*Normally only accessible by maintenance personnel.

18. 1717 Ala Wai

Inside 30th floor, corner apartment closest to AM radio tower: typically 2-3 V/m (plane-wave equivalent power density of 1-2 $\mu W/cm^2$); RSS magnetic field strength of 240 mA/m (plane-wave equivalent power density of 2,170 $\mu W/cm^2$). All fields due to AM stations.

*Rooftop: magnetic fields in range of 130-171 mA/m^2 (plane-wave equivalent power density of 637 to 1,100 $\mu W/cm^2$).

19. Ala Wai Tower; KSSK (AM), KORL (AM), KIFH (AM)

Outside fence at base of tower: 30-100 V/m electric field in parking lot toward Villa at Eaton Square (plane-wave equivalent power density of 239 to 2,650 $\mu W/cm^2$); 150-250 V/m (plane-wave equivalent power density of 5,970 to 16,600 $\mu W/cm^2$) at waist height at 3 feet from fence; 15 V/m (plane-wave equivalent power density of 59.7 $\mu W/cm^2$) outside Health Club; 10 V/m (plane-wave equivalent power density of 26.5 $\mu W/cm^2$) inside Health Club. Up to 2.85 A/m magnetic field strength at fence (plane-wave equivalent power density of 306,000 $\mu W/cm^2$).

20. KULA-FM (Not in Honolulu proper)

Outside fence surrounding tower: 100-212 $\mu W/cm^2$ (VHF) at field maxima.

21. Century Center Building
Site of KHON-TV (Ch.2)

*Rooftop: maximum of 240 $\mu W/cm^2$ near central area. Also, strong AM at edge of roof.

The above data are also tabulated in Appendix 1. To aid readers, this table also provides estimated specific absorption rates (SARs) since most standards are now based on the concept that whole-body average SARs depend on frequency.[1] The SAR can be determined theoretically or experimentally, and is proportional to the intensity of the incident field which can be measured, as was done in this survey. The whole-body average SAR for man or laboratory animals depends primarily upon the frequency of the applied RF field and the size, shape, and orientation of the absorbing

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*Normally only accessible by maintenance personnel.

[1] The approach taken here has been to assume whole-body exposures, but some high level magnetic fields are very localized and so values for these may not represent whole-body averages.

body. These three factors determine the frequency at which the whole-body average SAR of an absorbing object reaches its maximum value. This phenomenon is called resonance and the frequency for the maximum whole-body average SAR value is called the resonant frequency. The resonance frequency range associated with human absorption is approximately 30 to 300 MHz (includes the VHF band), and, as an example, the whole-body average SARs may be as large as approximately 0.4 W/kg for an incident power density of 1 mW/cm^2 (1000 $\mu W/cm^2$) for these frequencies. The dependence of the SAR on frequency is illustrated by the fact that the whole-body SAR in the AM band is about 10,000 times less than the SAR in the FM band at equivalent field intensities. In Appendix 1, we have assumed resonance, therefore, the SAR estimates for the VHF band are the limiting maximum case, i.e., the actual SARs should be at the calculated values or less. A similar approach was used to estimate SARs for AM frequencies; SARs were calculated for the high end of the AM band.

The Environmental Protection Agency (EPA) has not yet proposed Federal Guidance for radiofrequency radiation exposure levels. However, to help place these measured exposures in perspective, it should be noted that, in some instances, the public exposure levels are above values that have either been recommended or adopted by various organizations and/or regulatory bodies, i.e., the values recommended for continuous exposure of the general public by the International Radiation Protection Association (IRPA), the State of Massachusetts, Multnomah County, Oregon, and the City of Portland, Oregon, as well as the draft proposed recommendations of the National Council on Radiation Protection and Measurements (NCRP).[2] For example, exposures measured at nine locations exceed the proposed NCRP recommendations and these plus one additional location also exceed the IRPA guidelines.[3] In addition, public exposures at two locations exceed the current American National Standards Institute (ANSI) C95.1-1982 radiation protection guide. These two locations are:

(1) the tower in Kaimuki, location 9
(2) the Ala Wai tower, location 19

The potential for occupational exposures in excess of the ANSI C95.1-1982 and the American Conference of Governmental Industrial Hygienists (ACGIH) recommended continuous exposure limits was identified at five of the study locations, including the two mentioned above. These five locations are:

(1) rooftop of the Ala Moana Hotel, location 1
(2) rooftop of Tappa Tower, Hilton Hawaiian Village Hotel, location 5
(3) the tower in Kaimuki, location 9
(4) tower at 331 Kamani, location 17
(5) the Ala Wai tower, location 19

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2 Given in Appendix 4
3 The proposed NCRP and IRPA guidelines are different in the AM frequency band

The survey locations where measurements were found to exceed selected standards are listed in Appendix 5.

The FCC requested EPA assistance in investigating accounts of window washers at high-rise buildings receiving RF burns from the long metal cables used to support window washing platforms. Radiofrequency currents can be induced in long metal conductors that are in radiofrequency electromagnetic fields. It is just this phenomenon that makes an antenna work. An experiment was arranged in which a cable was extended from the roof of the Villa at Eaton Square to ground-level to attempt to measure the currents induced in the cable. We were able to measure almost one-half ampere of current in the cable even though the ground-level electric field strengths were only 1-2 V/m. It was not possible to measure the open-circuit voltage on the cable, but the voltage was sufficient in strength to produce electrical arcs from the cable to grounded objects. Under these particular conditions (the presence of conductors such as metal cables in low frequency fields), the RF burn phenomena is difficult to control even with different grounding methods, and shocks and burns present a real hazard for window washers using metal cables. Depending on whether metal cables are hung in close proximity to flammable materials (cloth awnings, grass, brush) or close to street level, fire hazards and/or shocks or burns to passersby inadvertently touching cables might be possible. But, since this is primarily an occupational problem related to work practices, it was brought to the attention of the Occupational Safety and Health Administration (OSHA) which is working to address this matter. Resolution of work practice problems should obviate any potential hazard.

APPENDIX 1

RF RADIATION EXPOSURE MEASUREMENTS IN HONOLULU, HAWAII

May 14 - May 25, 1984

	LOCATION	SITE	FREQ. BAND	TOTAL POWER DENSITY* $\mu W/cm^2$	SAR* W/kg	Comments
1.	Ala Moana Hotel	Observation Deck	VHF	311	0.124	Outside
		Restaurant	VHF	40 max. <2.6 typ.	0.016 0.001	Inside
		Rooftop**	VHF	20,000 max. >1,000	8.00 0.4	Near mast Within 6m of mast
2.	Pan Am Bldg.	14th Floor Suite	VHF	1.5-50	0.0006-0.020	Inside-facing KGMB & Ala Moana
		Rooftop**	AM,VHF	60	0.024	Outside near corner of roof
3.	Iliki Hotel	Restaurant	VHF	1	0.0004	Inside Top of the I
		Rooftop**	VHF	7-26	0.0028-0.010	Outside
4.	Coty Tower	Ground Level	VHF	265-530 typ.	0.106-0.212	Parking lot
			VHF	663 max.	0.265	Parking lot
			VHF	133-186 typ.	0.053-0.074	Sidewalk
			VHF	318 max.	0.127	Sidewalk
		Rooftop	VHF	375	0.150	Outside
			AM	8.3	3.32×10^{-7}	Center
			AM	383	1.53×10^{-5}	Corner
		Apartment 1003	VHF	27-60	0.011-0.024	10th floor

*Power Density for AM frequencies is the plane wave equivalent power density derived from measurements of either electric or magnetic field intensity. Resonance is assumed, therefore, SAR estimates for the VHF band are the limiting maximum case. Using a similar approach for AM frequencies, SARs were calculated for the high end of the AM band. Also, typ. = typically and max. = maximum.

**Normally accessible only by maintenance personnel.

	LOCATION	SITE	FREQ. BAND	TOTAL POWER DENSITY $\mu W/cm^2$	SAR W/kg	Comments
5.	Hilton Hawaiian Village Hotel	Tappa Tower**	VHF	1,300 max. 2,650 max.	0.520 1.060	Roof Top of elevator shaft near antenna mast
		Oceanside Tower	VHF	2.7	0.0011	12th Flr. balcony
		Rainbow Tower	VHF	3.2 typ. 13 max.	0.0013 0.0052	29th Flr. balcony 29th Flr. balcony
		Diamond Head Tower	VHF	2.4	0.001	Balcony
6.	KGU and KKUA AM Tower Ahui Street	Near Fence-Tower Base	AM	14,000 max.	0.00056	Magnetic field
		At Fence	AM	24,000 max.	0.00096	Electric field
		10 Meters from Fence	AM	2,650	0.000106	Electric field
7.	KWAI (formerly KZHI), KNDI, KCCN, KISA AM Tower - Nimitz Hwy.	Near Fence-Tower Base	AM	20,700 max.	0.000828	Magnetic field
		At Fence	AM	24,000 max.	0.000960	Electric field
		6-10 Meters from Fence	AM	2,650	0.000106	Electric field
8.	Villa on Eaton Square	Rooftop	AM	2,650-10,600	0.000106-0.000424	Outside, open areas, electric field
			AM	>24,000	0.00096	Edge of roof near metal object, electric fields
			AM	570	2.28×10^{-5}	Magnetic fields
			VHF	1.7 max.	0.00068	-----
		Ground Level	AM	0.265-1.06	1.06×10^{-8} - 4×10^{-8}	-----

	LOCATION	SITE	FREQ. BAND	TOTAL POWER DENSITY $\mu W/cm^2$	SAR W/kg	Comments
9.	Kaimuki;KAIM-FM,KAIM(AM), KOHO(AM), KUMU(AM) (Near Tower-Ground Level)	Parking Lot	VHF	830	0.332	Electric fields
		Parking Lot	AM	535	2.14×10^{-5}	Electric fields
		Over Car Roof	AM	2,760	0.00011	Electric fields
		Near Fence	AM	1,300 max.	5.2×10^{-5}	Electric fields
		At Fence	AM	3,054,000 max.	0.122	Magnetic fields, localized to tower tuning circuits
10.	Kapiolani Manor	Rooftop	AM,VHF	60	0.024	Outside
		Roof Pool Area	AM,VHF	20-30	0.008-0.012	-----
11.	Ala Moana Pacific Center	18th Floor Office	AM,VHF	4 max.	0.0016	Interior corner facing KGMB tower
12.	KGMB Tower Area 1534 Kapiolani Blvd. Site of KGMB (TV), KHET (TV), and KQMQ-FM	Parking Lot	VHF	27-40	0.0108-0.016	-----
		Sidewalk	VHF	100 typ.	0.0400	Adjacent to tower
13.	Ala Moana Shopping Center	Parking lot	VHF	50-60 typ.	0.020-0.024	Adjacent to Ala Moana Hotel
			VHF	110 max.	0.044	
14.	1350 Ala Moana	Rooftop**	VHF	25-60	0.010-0.024	-----
15.	Discovery Bay	Resolution Tower on 41st Floor Facing Hilton Village Hotel	AM,VHF	1.7 typ. 26 max.	0.00068 0.0104	Apt. 4113 interior Apt. 4113 balcony
		Resolution Tower**	AM,VHF	25-166	0.010-0.0664	Rooftop

LOCATION	SITE	FREQ. BAND	TOTAL POWER DENSITY $\mu W/cm^2$	SAR W/kg	Comments
16. La Ronde Restaurant	23rd Flr. (Inside)	VHF	9-13 typ.	0.0036-0.0052	-----
			1.1 min.	0.00044	-----
			26 max.	0.010	Without Ch.20
			8	0.0032	Ch.20 field
17. KMAI(FM),KIKI(AM), KHVH(AM),KZOO(AM) 331 Kamani	Parking lot	VHF	212 max	0.0848	-----
		AM	27 max	1.08×10^{-6}	-----
	Graphic Pictures-Inside	AM	4.24-26.5 typ.	$1.7 \times 10^{-7} - 1.06 \times 10^{-6}$	-----
		AM	611	1.24×10^{-5}	Top of stairs
		AM	10,610	0.000424	Surface of wall
	Bartley's Town & Country Shop-Inside	AM	1.06-6.63 typ.	$4.2 \times 10^{-8} - 2.65 \times 10^{-7}$	-----
		AM	166-239	$6.64 \times 10^{-6} - 9.56 \times 10^{-6}$	Near shelves
		AM	23,873	0.000955	Near floor fan and and label machine
	Superior Travel-Inside	AM	6.63-17.0	$2.65 \times 10^{-7} - 6.8 \times 10^{-7}$	-----
	Tower Base**	AM	2,650	0.000106	Electric field
			3,261,000	0.013	Magnetic field, localized to tower tuning circuits
	Transmitter Room-Upstairs**	AM	2,650	0.000106	Electric field
18. 1717 Ala Wai	Inside Corner Apt. 30th Floor	AM	1-2 typ.	$4 \times 10^{-8} - 8 \times 10^{-8}$	Closest to AM
		AM	2,170	8.68×10^{-5}	Tower,magnetic field
	Rooftop**	AM	637-1,100	$2.55 \times 10^{-5} - 4.40 \times 10^{-5}$	Magnetic field

LOCATION	SITE	FREQ. BAND	TOTAL POWER DENSITY $\mu W/cm^2$	SAR W/kg	Comments
19. Ala Wai Tower; KSSK(AM) KORL(AM), KIFH(AM)	Outside Fence at Base of Tower	AM	239-2,650	9.56×10^{-6} - 0.000106	Parking lot at Eaton Square
	3 Ft. from Fence	AM	5,970-16,600	0.000239-0.000664	Measured at waist height
	Outside Health Club	AM	59.7	2.39×10^{-6}	-----
	Inside Health Club	AM	26.5	1.06×10^{-6}	-----
	At Fence	AM	306,000	0.0122	Magnetic field, localized to tower tuning circuits
20. KULA-FM	Outside Fence Surrounding Tower	VHF	100-212 max.	0.040-0.0848	-----
21. Century Center Bldg.	Rooftop**	VHF	240 max.	0.0960	Central area. Strong AM also at edge of roof

APPENDIX 2

LIST OF EQUIPMENT USED IN HONOLULU FIELD STUDY

Instruments for Industry Model EFS-1 broadband electric field strength meter.

Instruments for Industry Model RHM-2 isotropic, broadband electric field strength meter.

Holaday Industries Model 3001 isotropic, broadband electric field strength meter.

Narda Microwave Model 8616 isotropic, broadband radiation monitor with model 8631 magnetic field probe.

Nanofast Model EFS-500 fiber optic electric field sensor with model EFR-500 E-field sensor receiver.

Singer Model DM-105A dipole antenna kit.

Singer Model 92200-3 loop antenna.

Singer Model 91550-1 RF current probe.

Potomac Model FIM-21 AM Band field strength meter with 50 ohm feed through.

Potomac Model FIM-71 VHF field strength meter.

Potomac Model FIM-72 UHF field strength meter.

Hewlett-Packard Model 141T spectrum analyzer mainframe with model 8554L RF plug-in and model 8552B IF plug-in.

APPENDIX 3

UNITS/TERMS

Hertz (Hz):	A unit for expressing frequency equivalent to cycles per second, ie., one Hertz is defined as one cycle per second
kHz:	Kilohertz; 1 kHz equals 1000 Hz
MHz:	Megahertz; 1 MHz equals 1000 kHz
mA/m:	milliampere per meter; an expression for the strength of a magnetic field
mW/cm^2:	Milliwatts per square centimeter; an expression for the power density of an electromagnetic field, 1 mW/cm^2 = 1000 $\mu W/cm^2$
$\mu W/cm^2$:	Microwatt per square centimeter; an expression for the power density of an electromagnetic field, 1000 $\mu W/cm^2$ = 1 mW/cm^2
VHF	Very-high-frequency; that part of the electromagnetic radiation spectrum between 30 and 300 MHz, i.e., includes the frequencies for FM radio and television broadcast transmission (channels 2-13)
V/m:	Volts per meter; an expression for the strength of an electric field
Power density:	A term to describe the intensity of incident electromagnetic radiation fields

APPENDIX 4

SUMMARY OF VARIOUS RADIOFREQUENCY RADIATION EXPOSURE STANDARDS

	VHF		AM	
Standard	SAR(W/kg)	S($\mu W/cm^2$)*	SAR(W/kg)	S($\mu W/cm^2$)*
ANSI, ACGIH	0.4	1,000	**	100,000
Massachusetts, Multnomah County, NCRP (in draft)***	0.08	200	**	20,000
IRPA	0.08	200	**	2,000
Portland	0.04	100	**	500

* S is the plane-wave equivalent power density expressed in units of microwatts per square centimeter.

** These standards are not based on limiting the whole-body SAR to specific values in the AM band frequency range but rather simply specify maximum permissible power densities.

*** Reported at the 1984 Annual Meeting of the National Council on Radiation Protection and Measurements, Washington, D.C., April 5, 1984.

APPENDIX 5

LOCATIONS WHERE RF RADIATION MEASUREMENTS EXCEED SELECTED GENERAL POPULATION EXPOSURE GUIDELINES[1]

SURVEY LOCATION	IRPA			Draft NCRP, Massachusetts			ANSI		
	AM		VHF	AM		VHF	AM		VHF
	E*	H*	S*	E*	H*	S*	E*	H*	S*
	68.8-87	.18-.23	200	275	0.73	200	614	1.63	1000
#1 - Ala Moana Hotel									
• Observation Deck			X			X			
• Rooftop**			X			X			X
#4 - Coty Tower									
• Ground Level			X			X			
• Rooftop			X			X			
#5 - Hilton Hawaiian Village Hotel									
• Tappa Tower Rooftop**			X			X			X
#6 - KGU and KKUA AM Tower - Ahui St.	X	X		X					
#7 - KWAI (formerly KZHI), KNDI, KCCN, KISA AM Tower - Nimitz Hwy.	X	X		X	X				
#8 - Villa on Eaton Square (Rooftop)	X			X					
#9 - Kaimuki: KAIM-FM, KAIM(AM), KOHO(AM), KUMU(AM)	X	X	X		X	X		X	
#17 - KMAI(FM), KIKI(AM), KHVH(AM), KZOO(AM) - 331 Kamani									
• Parking lot			X			X			
• Graphic Pictures - Inside	X								
• Bartley's Shop - Inside	X			X					
• Tower Base**	X	X			X			X	
#18 - 1717 Ala Wai (Inside)		X							
#19 - Ala Wai Tower: KSSK(AM) KORL(AM), KIFH(AM)	X	X			X			X	
#20 - KULA-FM			X			X			
#21 - Century Center Bldg.									
• Rooftop**			X			X			

[1]For comparison, note that 12 locations exceed the IRPA interim guidelines, 11 locations exceed the NCRP draft proposed guideline, and 5 locations exceed the ANSI standard.

*E = Electric field strength, Volts/meter; H = magnetic field strength, Amperes/meter; S = the plane-wave equivalent power density expressed in units of microwatts per square centimeter. For the IRPA guideline, actual limits for electric and magnetic field strength depend on frequency.

**Normally accessible only by maintenance personnel.