



RADIO FREQUENCY RADIATION (RFR) MEASUREMENT REPORT

SMA Clients: Digicel Jamaica, Cable & Wireless Ja. (t/a bMobile), and Oceanic Digital Jamaica (t/a Miphone)

Location: KMR and St. James

Date(s) Conducted: December 2007 – April 2008

Team:

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BACKGROUND:

Since the phased liberalization of the telecommunications industry in Jamaica, which started in March 2000, that has led to the introduction of competition in the domestic mobile services from new entrants Digicel and MiPhone and the incumbent Cable & Wireless, there has been a proliferation of cellular base stations (hereafter referred to as “cell sites”) in Jamaica.

To provide adequate network coverage and capacity for network traffic, rooftops (Corporate Offices, Business establishments, etc.) are often utilized as cell site locations. In some cases cell sites are located in close proximity to residential areas, schools, hospitals and businesses. These cell sites have attracted the attention and concern of the public, who are worried about possible health hazards posed by the electromagnetic radiation from these sites.

June 9, 2008

Spectrum Management Authority

In response to the public's concern, the National Environment & Planning Agency (NEPA) has approached the Spectrum Management Authority (SMA) to assist in the testing of radiation levels at telecommunication transmission sites.

SMA has arranged a two-phased approach to the execution of the project. In the initial phase, reported on in this document, twenty seven (27) sites were selected in the KMR and St. James regions for testing, nine sites for each cellular provider. The purpose of this project is to determine if the electromagnetic emissions at the sites are within the limits specified by the international standards adopted by the National Environment Planning Agency (NEPA) / Ministry of Health (MOH).

OBJECTIVE

- 1) Perform site surveys, measurements of Radio Frequency Radiation at specific points within the vicinity of the radio base stations where persons are known to perform their normal activities or have easy access to.
- 2) Inspection of sites to determine whether adequate safety precautions (e.g. perimeter fence) are in place, to ensure that there is no unauthorized access to potential hazard zones.

Selection of Sites

The following criteria were used to determine the sites to be included in Phase One of this exercise:

1. Sites which have caused concern among members of the public, as well as sites located in sensitive areas such as near to schools, hospitals, and residential areas.
2. The major towns, primarily the Kingston Metropolitan Area, and Montego Bay, as well as any site outside of these areas that has attracted public scrutiny.

ADOPTED RFR STANDARD IN JAMAICA

There are four established standards utilized for the measurement of RFR. Namely: **Canada Safety Code 6 (99-EHD-237)**; **U.S. FCC MPE limits - 47 CFR § 1.1310**; **ICNIRP Reference Levels 1998 for Time varying Electric and Magnetic fields**; **IEEE C95.1 – 2005 Electric and Magnetic fields**. All standards are established with guidelines for Occupational exposure and General Population exposure. The levels defined for General Population are more restrictive than those for the Occupational exposure; in addition a comparative look at the General Population standards shown in table 1 below shows that for frequencies in the cellular bands (800, 900, 1800, & 1900MHz) the International Council on Non-Ionizing Radiation Protection (ICNIRP) Reference Levels 1998 for Time varying Electric and Magnetic fields was the most restrictive.

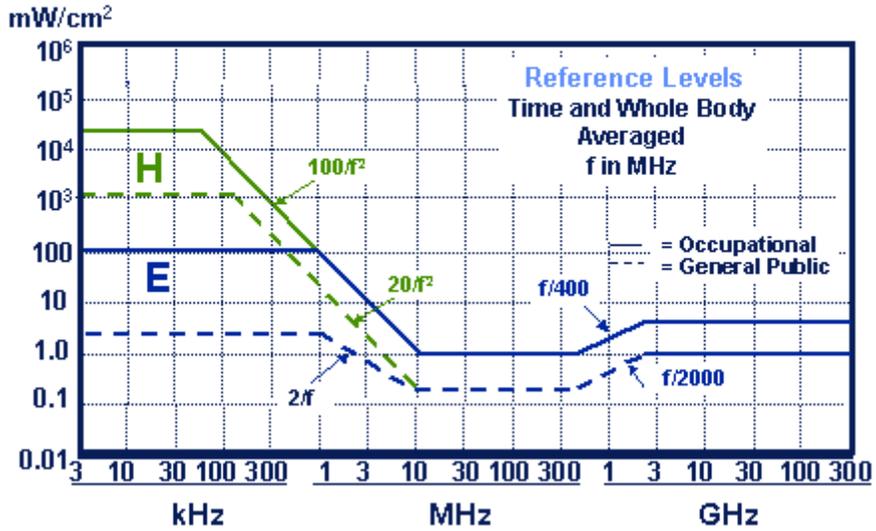
Frequency Range (MHz)	Canada Safety Code 6	FCC MPE limits	ICNIRP (General Population)	IEEE C95.1 – 2005
10 to 300	0.2	0.2		
10 to 400			0.2	0.2
300 to 1500	f/1500 (0.2 to 1 mW/cm ²)	f/1500 (0.2 to 1 mW/cm ²)		
400 to 2000			f/2000 (0.2 to 1 mW/cm ²)	f/2000 (0.2 to 1 mW/cm ²)
2000 to 300000			1	
2000 to 100000				1
1500 to 100000	1	1		

Table 1 Comparison of Maximum Exposure Limits for General Population

The International Council on Non-Ionizing Radiation Protection (ICNIRP) standard is used in most European countries and has been adopted by NEPA for Jamaica. The ICNIRP standard provides a two-tier set of Radio Frequency (RF) Radiation exposure limits. The higher tier is referred to as *Occupational* and states the tolerable limits for persons who work on equipment installed at radio base stations, while the more restrictive tier is referred to as *General Population* and states tolerable limits for members of the public who may be within the vicinity of radio base stations.

The tests were conducted in accordance with the International Council on Non-Ionizing Radiation Protection (ICNIRP) standard for General Public.

International Council on Non-Ionizing
Radiation Protection (ICNIRP)



Source: International Commission on Non-Ionising Radiation Protection (ICNIRP) Secretariat. (1998). *Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (up to 300 GHz)*

OVERVIEW OF ELECTROMAGNETIC RADIATION

a. What is Electromagnetic Radiation?

Electromagnetic radiation can be defined as waves of electric and magnetic energy moving together (i.e., radiating) through space. These waves are generated by the movement of electrical charges. **Electromagnetic field** refers to the electric and magnetic environment existing at some location due to a radiating source such as an antenna. An electromagnetic wave is characterized by its wavelength and frequency. The **wavelength** is the distance covered by one complete wave cycle. The **frequency** is the number of waves passing a point in a second.

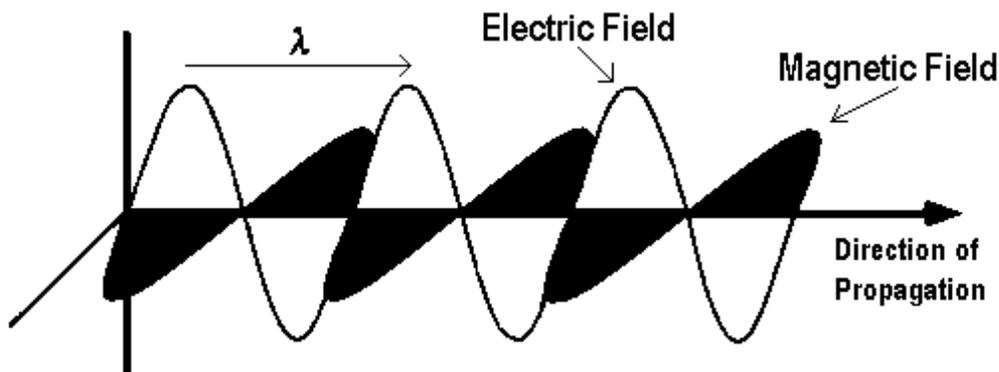


Figure 1 *Electromagnetic Fields*

Source: Federal Communications Commission, Office of Engineering and Technology. (August 1999)..

Electromagnetic waves travel through space at the speed of light. Wavelength and frequency are inversely related by a simple equation: $f \times \lambda = c$, where f is the frequency, λ is the wavelength and c is the speed of light through free space. Since the speed of light is a constant quantity, high frequency electromagnetic waves have short wavelengths and low-frequency waves have long wavelengths. The Electromagnetic Spectrum includes all of the various forms of electromagnetic energy ranging from extremely low frequency (ELF) energy (with very long wavelengths) to all the way up to X-rays and gamma rays which have very high frequencies and correspondingly short wavelengths. In between these extremes lie radio waves, microwaves, infrared radiation, visible light and ultraviolet radiation, respectively. The Radio Frequency (RF) part of the electromagnetic spectrum can generally be defined as that part of the spectrum where electromagnetic waves have frequencies that range from about 3 kHz to 300 GHz (FCC, August 1999)

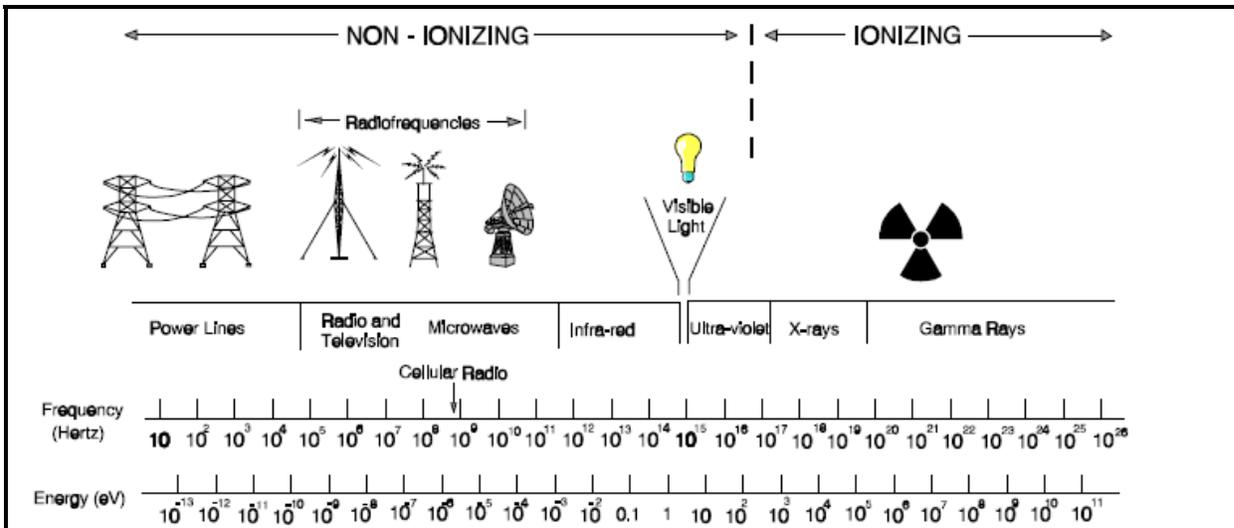


Figure 2 *The Electromagnetic Spectrum*

Source: Federal Communications Commission, Office of Engineering and Technology. (August 1999).

As shown in Figure 2 above, the Electromagnetic Spectrum can be divided into ionizing and non-ionizing regions.

b. Ionizing Radiation

Ionization is the process by which charged particles such as electrons or ions are added or removed from a neutral atom or molecule. At a frequency of approximately 2420 Million MHz, the electromagnetic energy is sufficient to ionize water molecules. Therefore, frequencies at or above this level are classified as ionizing. Ultraviolet radiation from the sun is one of the main sources of Ionizing Radiation. Other sources include: Nuclear materials and X-rays. It is also important to note that the effects from Ionizing Radiation are cumulative.

c. Non-Ionizing Radiation

The photon energies of RF electromagnetic waves are not sufficient to ionize atoms and molecules. RF energy is, therefore, characterized as non-ionizing radiation, along with visible light, infrared radiation and other forms of electromagnetic radiation with relatively low frequencies. Thermal effects, that is heating of the body, is associated with non-ionizing radiation.

d. RFR Measurement

Because an RF electromagnetic field has both an electric and a magnetic component, it is often convenient to express the intensity of the RF field in terms of units specific for each component. The unit volts per meter (V/m) is often used to measure the strength of the electric field, and the unit amperes per meter (A/m) is often used to express the strength of the magnetic field.

Another commonly used unit for characterizing an RF electromagnetic field is power density. Power density is most accurately used when the point of measurement is far enough away from the RF emitter to be located in what is commonly referred to as the "far-field" zone of the radiation source. Typically the far field is located at a distance several wavelengths from the RF source. In the far field, the angle between the electric field vector, $|\mathbf{E}|$ and magnetic field vector, $|\mathbf{H}|$ is 90° and so the power density can be calculated from the vector product $\mathbf{E} \times \mathbf{H} = |\mathbf{E}||\mathbf{H}|$. It is only necessary to measure one of these quantities in order to determine the other quantity or the power density. Power density is defined as power per unit area. Power density can therefore be expressed in terms of watts per meter squared (W/m^2), milliwatts per centimeter squared, (mW/cm^2) or microwatts per centimeter squared, ($\mu\text{W}/\text{cm}^2$).

Closer to the antenna is the near field zone, located at a distance approximately half of a wavelength away from the antenna. In the near-field, the physical relationships between the electric and magnetic components of the field are usually complex. In this case, it is necessary to determine both the electric and magnetic field strengths to fully characterize the RF environment. At frequencies above approximately 300 MHz it is usually sufficient to measure only the electric field to characterize the RF environment, if the measurement is not made too close to the RF emitter.

e. Broadband RF Field Strength Meter and Probes

Broadband RF Field Strength meters typically measure non-ionizing radiation with a high degree of accuracy within the frequency range from 100 kHz to 60 GHz (depending on the probe used). Probes are calibrated separately from the measurement instrument and are classified as either Shaped or Flat. Shaped probes are designed and manufactured so that their sensitivity mirrors a particular standard as closely as possible. So measurement obtained using a shaped probe will be expressed as a "% of a standard". Flat probes on the other hand are designed and manufactured to be equally responsive to every frequency within its rated frequency range. This makes the process to determine compliance at a multi emitter site using a flat probe very difficult, unless each emitter except the one that is being measured is powered off. For flat probes, the RF field strength is expressed as V/m, A/m or W/m^2 .

Results and Observations

<i>No RF power density was measured that equated to or exceeded limits published in the International Council on Non-Ionizing Radiation Protection (ICNIRP) standard.</i>

Survey Equipment and Procedures

Survey Equipment :

- Narda NBM-550 Broadband Field Meter (acquired in July , 2007)
- Narda EF 0391 (NBM) E-Field Probe (100 kHz-3GHz)

L3 Communications, equipment vendor provided training to a team comprising personnel from the SMA, NEPA, MOH, and the service providers (Miphone, Digicel and C&WJ).

Procedure

Prior to the start of the RFR survey, the following technical data pertaining to each site was collected:

- Operating Frequencies
- Maximum Power Output
- Gain of Antenna
- Height of Tower

The collected data was then used to determine the RFR limits and Hazard distance in accordance with the ICNIRP standard before going into the field.

While in the field, the appropriate probe, EF 0391, was connected to the NBM-550 Broadband Field Meter, and the meter was powered on and allowed to initialize before the measurement settings (Display Mode, Measurement Unit, and Frequency) were selected.

The surveyor begins the measurement process by sweeping areas that are accessible by occupational staff, such as inside the equipment room and the termination points for the coaxial cables from the antennas to the equipment. The surveyor will then do a walk test around the general area that is accessible by the general public. During the exercise the probe was directed at the emitting antennas and the location where the maximum power density was observed noted and the level recorded.

The above steps are repeated for the different service providers at the agreed cell sites.

Note: While conducting the survey, it is recommended that there be **NO** RF emitting device present on the person of the surveyor.

**Calculated
Limits**

ICNIRP:

Table 1 Reference Levels for General Public to Time-Varying Electric and Magnetic Fields.

Frequency Range (f)	Electric Field (E)	Magnetic Field (H)	Power Density (S) (E,H Fields)
	(V/m)	(A/m)	(mW/cm ²)
<1 Hz	—	3.2×10^4	—
1 - 8 Hz	10,000	$3.2 \times 10^4/f^2$	—
8 - 25 Hz	10,000	4000/f	—
0.025 - 0.8 kHz	250/f	4/f	—
0.8 - 3 kHz	250/f	5	—
3 -150 kHz	87	5	2.0; 995
0.15 - 1 MHz	87	0.73/f	2.0; 20/f ²
1 - 10	$87/f^{1/2}$	0.73/f	2.0/f; 20/f ²
10 - 400 MHz	28	0.073	0.2
400 - 2,000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	f/2000
2 - 300 GHz	61	0.16	1.0

Theoretical results based on frequency in use by Operator

The following assumptions were made in the calculation below:

- The centre frequency for the downlink band of the cell site was used as the operating frequency(f) (where MEL = f/2000)
- The parameters used in the calculation of the Hazard Distance were selected from the antenna sector with highest values for Gain and Output Power.
- All sector antennas are directional therefore maximum exposure will be highest directly in front of the antenna.

Digicel	C&WJ	Miphone
<p>Operating frequency :</p> <p><u>942MHz</u></p> <p>Maximum allowable level : $f/2000 \text{ mW/cm}^2$ $1 \text{ mW/cm}^2 = 1/1000 \text{ W/cm}^2$ $= (1/1000) * 100 * 100 \text{ W/m}^2$ $1 \text{ mW/cm}^2 = 10 \text{ W/m}^2$ therefore: $f/2000 \text{ mW/cm}^2 = f/200 \text{ W/m}^2$ $= (942/200) = \mathbf{4.71 \text{ W/m}^2}$</p> <p><u>1822MHz</u></p> <p>Maximum allowable level : $f/2000 \text{ mW/cm}^2 = f/200 \text{ W/m}^2$ $= (1822/2000) * 10 = \mathbf{9.11 \text{ W/m}^2}$</p>	<p>Operating frequency :</p> <p><u>835MHz</u></p> <p>Maximum allowable level : $f/2000 \text{ mW/cm}^2$ $1 \text{ mW/cm}^2 = 1/1000 \text{ W/cm}^2$ $= (1/1000) * 100 * 100 \text{ W/m}^2$ $1 \text{ mW/cm}^2 = 10 \text{ W/m}^2$ therefore: $f/2000 \text{ mW/cm}^2 = f/200 \text{ W/m}^2$ $= (835/200) = \mathbf{4.175 \text{ W/m}^2}$</p> <p><u>1969MHz</u></p> <p>Maximum allowable level : $f/2000 \text{ mW/cm}^2 = f/200 \text{ W/m}^2$ $= (1969/2000) * 10 = \mathbf{9.85 \text{ W/m}^2}$</p>	<p>Operating frequency :</p> <p><u>875MHz</u></p> <p>Maximum allowable level : $f/2000 \text{ mW/cm}^2$ $1 \text{ mW/cm}^2 = 1/1000 \text{ W/cm}^2$ $= (1/1000) * 100 * 100 \text{ W/m}^2$ $1 \text{ mW/cm}^2 = 10 \text{ W/m}^2$ therefore: $f/2000 \text{ mW/cm}^2 = f/200 \text{ W/m}^2$ $= (875/200) = \mathbf{4.38 \text{ W/m}^2}$</p> <p><u>1944MHz</u></p> <p>Maximum allowable level : $f/2000 \text{ mW/cm}^2 = f/200 \text{ W/m}^2$ $= (1944/2000) * 10 = \mathbf{9.72 \text{ W/m}^2}$</p>
<p>Predicting Hazard distance from antenna</p> $R_{mel} = \sqrt{\frac{P_{avg} \times G_{abs}}{4\pi MEL}}$ <p>Rmel is Max exposure distance MEL is Max Exposure Limit Pavg is average power Gabs is absolute gain</p> <p>e.g.: at 25 Balmoral Ave</p> <p>MEL = $\mathbf{4.71 \text{ W/m}^2}$ Pavg = 45dBm = 31.62W Gabs = 18dBi = 10exp18dB/10 = 63.1</p> $R_{mel} = \sqrt{\frac{31.62 \times 63.1}{4 \times \pi \times 4.71}}$ <p>Rmel = 5.8m</p> <p>This calculation indicates that the minimum safe distance to avoid RFR exposure would be 5.8m from the antennas.</p>	<p>Predicting Hazard distance from antenna</p> $R_{mel} = \sqrt{\frac{P_{avg} \times G_{abs}}{4\pi MEL}}$ <p>Rmel is Max exposure distance MEL is Max Exposure Limit Pavg is average power Gabs is absolute gain</p> <p>e.g.: at Old Harbour</p> <p>MEL = $\mathbf{4.175 \text{ W/m}^2}$ Pavg = 40dBm = 10Watts Gabs = 10exp 18dB/10 = 63.1</p> $R_{mel} = \sqrt{\frac{10 \times 63.1}{4 \times \pi \times 4.175}}$ <p>Rmel = 3.47m</p> <p>This calculation indicates that the minimum safe distance to avoid RFR exposure would be 3.47m from the antennas.</p>	<p>Predicting Hazard distance from antenna</p> $R_{mel} = \sqrt{\frac{P_{avg} \times G_{abs}}{4\pi MEL}}$ <p>Rmel is Max exposure distance MEL is Max Exposure Limit Pavg is average power Gabs is absolute gain</p> <p>e.g.: at Cross Roads</p> <p>MEL = $\mathbf{4.38 \text{ W/m}^2}$ Pavg = 40dBm = 60Watts Gabs = 10exp 17dB/10 = 50.12</p> $R_{mel} = \sqrt{\frac{60 \times 50.12}{4 \times \pi \times 4.38}}$ <p>Rmel = 7.57m</p> <p>This calculation indicates that the minimum safe distance to avoid RFR exposure would be 7.57m from the antennas.</p>

MEASURED RESULTS

Note:

For each site listed in the table below the readings recorded are stated as a Maximum, Average and a Percentage of the ICNIRP Standard. The surveyor is in motion while the readings are being taken and once the surveyor has started the measurement process the meter keeps a track of the maximum value and the average value recorded for that session. At the end of the survey the maximum value is then used to calculate the value for the percentage of the ICNIRP standard.

TABLE 2 MEASURED RESULTS TAKEN AT DIGICEL CELL SITES

DATE	Site Name (Digicel)	Recorded measurements	Calculated Hazard distance (m)	Operating Frequencies (MHz)	Tower Height (m)	Output Power (dBm)	Antenna Gain (dBi)
Dec. 12, 2007	Nuttall Hospital	Max: 0.001W/m ² 0.0034% of ICNIRP standard	4.11	900 & 1800	30	45- All sectors	15 dBi - All antennae
	Jones Town_NPHL (Blood Bank)	Max: 0.0379W/m ² 0.804% of ICNIRP standard	5.8	900 & 1800	20	45- All sectors	18dBi- 3 *1800 18dBi- 2* 900 15dBi -1 * 900

DATE	Site Name (Digicel)	Recorded measurements	Calculated Hazard distance (m)	Operating Frequencies (MHz)	Tower Height (m)	Output Power (dBm)	Antenna Gain (dBi)
Jan. 22, 2008	25 Balmoral Avenue	Max: 0.0072W/m ² Avg: 0.0035W/m ² 0.153% of ICNIRP standard	5.8	900 & 1800	45 (ant @ 24m)	ABD&E - 45 C- 37 F-39	15dBi- 3 *1800 18dBi- 1* 900 15dBi- 2* 900
	Constant Spring Golf Club	Max: 0.0094W/m ² Avg: 0.0047W/m ² 0.20% of ICNIRP standard	7.31	900 & 1800	30	D,E,F - 45 A,B - 47 C- 45	15dBi- 2*1800 18dBi- 2* 900 15dBi- 1* 900 15 dBi-1* 1800
Feb. 1, 2008	Windward Road	Max: 0.0060W/m ² Avg: 0.0026W/m ² 1.25% of ICNIRP standard	5.8	900 & 1800	30	45- All sectors	15dBi- 3*1800 15dBi- 2* 900 18dBi- 1* 900
	Manley Meadows	Max: 0.0249W/m ² Avg: 0.0125W/m ² 5% of ICNIRP standard	5.8	900 & 1800	24	45- All sectors	18dBi- both frequencies

DATE	Site Name (Digicel)	Recorded measurements	Calculated Hazard distance (m)	Operating Frequencies (MHz)	Tower Height (m)	Output Power (dBm)	Antenna Gain (dBi)
Feb. 1 2008	Portmore Mall	Max: 0.0122W/m ² Avg: 0.0083W/m ² 2.5% of ICNIRP standard	5.8	900 & 1800	24(900) 19-(1800)	F-39 A-D - 45	15dBi- 3*1800 18dBi- 3* 900
April 24, 2008	Cornwall Regional Hospital	Max:0.0033W/m ² Avg: 0.0013W/m ² 0.07% of ICNIRP standard	4.11	900 & 1800	30	A,C,F -45 B,D, E -43	15 dBi - All antennae
	Leaders Avenue (Montego Bay)	Max:0.0399W/m ² Avg: 0.01W/m ² 0.85% of ICNIRP standard	7.31	900 only		15 - 1 sector @ 10	C-47 A,B -45

TABLE 3 MEASURED RESULTS TAKEN AT CABLE AND WIRELESS JA. LTD. CELL SITES

DATE	Site Name (C&WJ)	Recorded measurements	Calculated Hazard distance (m)	Operating Frequencies	Tower Height (m)	Output Power (watts)	Antenna Gain (dB)		
Dec. 11, 2007	Public Health Inspector's Office, Old_HarbourExch	Max: 0.022W/m ² 0.527% of ICNIRP standard		1900 &	26.00	10Watt	18.2	18.2	18.2
			3.47	850	29.0	10Watt	17.3	18.0	18.0
	Ken's Wildflower Lounge, Portmore Bayside	Max: 0.004W/m ² 0.096% of ICNIRP standard	2.45	850	25.0	10Watt	15.0	15.0	15.0
Jan. 23, 2008	Weymouth Drive Washington_Exch	Max: 0.0036W/m ² Avg: 0.0009W/m ² 0.086% of ICNIRP standard		1900 &	25.00	10Watt	18.2	18.2	18.2
			3.2	850	24.0	10Watt	17.3	17.3	17.3

DATE	Site Name (C&WJ)	Recorded measurements	Calculated Hazard distance (m)	Operating Frequencies	Tower Height (m)	Output Power (watts)	Antenna Gain (dB)		
Jan. 23, 2008	Constant Spring Road (Oakland)	Max: 0.0064W/m ² Avg: 0.0013W/m ² 0.153% of ICNIRP standard	3.46	1900 &	35.0	10Watt	18.2	18.0	18.0
				850	35.0	10Watt	18.0	16.5	16.5
Feb. 4, 2008	Harbour View	Max: 0.0034W/m ² Avg: 0.0008W/m ² 0.081% of ICNIRP standard	4.52	1900 &	32.0	10Watt	18.2	21.0	18.2
				850	30.0	10Watt	17.3	20.3	17.3
	Windward Road Primary Norman_Gardens	Max: 0.0059W/m ² Avg: 0.0008W/m ² 0.120% of ICNIRP standard	3.27	1900 &	16.0	10Watt	18.0	18.0	18.0
				850	15.0	10Watt	17.5	17.5	17.5

DATE	Site Name (C&WJ)	Recorded measurements	Calculated Hazard distance (m)	Operating Frequencies	Tower Height (m)	Output Power (watts)	Antenna Gain (dB)		
Feb. 4, 2008	Manley Meadows	Max: 0.005W/m ² Avg: 0.003W/m ² 0.120% of ICNIRP standard	3.27	1900 &	15.0	10Watt	18.0	18.0	18.0
				850	15.0	10Watt	17.5	17.5	17.5
April 25, 2008	Montego Freeport	Max: 0.0131W/m ² Avg: 0.0027W/m ² 0.314% of ICNIRP	3.47	1900 &	35.0	10Watt	18.0	18.2	18.2
				850	35.0	10Watt	14.2	18.0	18.0
	Summit_Police_Station	Max: 0.0021W/m ² Avg: 0.0007W/m ² 0.050% of ICNIRP standard	3.47	1900 &	20.0	10Watt	18.2	18.2	18.2
				850	30.0	10Watt	18.0	18.0	18.0

TABLE 4 MEASURED RESULTS TAKEN AT MIPHONE CELL SITES

DATE	Site Name (Miphone)	Recorded measurements	Calculated Hazard distance (m)	Operating Frequencies	Tower Height (m)	Output Power (W)			Antenna Gain (dB)		
						GSM	CDMA	UMTS	GSM	CDMA	UMTS
Dec. 17, 2007	Cross Roads	Max: 0.0022W/m ² 0.053% of ICNIRP standard	7.57	850CDMA & 850/1900 GSM	30	60	40	40	17	16	16.6
	Half-Way-Tree	Max: 0.0010W/m ² 0.024% of ICNIRP standard	7.57	850CDMA & 850/1900 GSM	30	60	40	40	17	16	16.6
Jan. 18, 2008	New Kgn <i>Measurements taken from the roof of Dyoll Building</i>	Max: 0.064W/m ² Avg: 0.026 W/m ² 1.46% of ICNIRP standard	7.57	850CDMA & 850/1900 GSM	30	60	40	40	17	16	16.6
June 5, 2008	New Kgn 2	Max: 0.0047W/m ² Avg: 0.0011 W/m ² 0.11% of ICNIRP standard	7.57	850CDMA & 850/1900 GSM	30	60	40	40	17	16	16.6

DATE	Site Name (Miphone)	Recorded measurements	Calculated Hazard distance (m)	Operating Frequencies	Tower Height (m)	Output Power (W)			Antenna Gain (dB)		
						GSM	CDMA	UMTS	GSM	CDMA	UMTS
Jan. 18, 2008	Hope Pastures	Max: 0.013 W/m ² Avg: 0.004 W/m ² 0.30% of ICNIRP standard	7.57	850CDMA & 850/1900 GSM	30	60	40	40	17	16	16.6
	Mary Brown Corner	Max: 0.0015W/m ² Avg: 0.0004W/m ² 0.034% of ICNIRP standard	5.51	850CDMA & 850/1900 GSM	12	NONE	40	NONE	NONE	16	NONE
May 6, 2008	Portmore	Max:0.0162W/m ² Avg:0.0083W/m ² 0.37% of ICNIRP standard	7.57	850CDMA & 850/1900 GSM	30	60	40	40	17	16	16.6
	Kingston (Down Town)	Max:0.0148W/m ² Avg:0.0017W/m ² 0.34% of ICNIRP standard	5.51	850CDMA & 850/1900 GSM	38	NONE	40	NONE	NONE	16	NONE

DATE	Site Name (Miphone)	Recorded measurements	Calculated Hazard distance (m)	Operating Frequencies	Tower Height (m)	Output Power (W)			Antenna Gain (dB)		
						GSM	CDMA	UMTS	GSM	CDMA	UMTS
April 25, 2008	Montego Bay 1	Max:0.0122W/m ² Avg: 0.0024W/m ² 0.28% of ICNIRP standard	7.57	850CDMA & 850/1900 GSM	30	60	40	40	17d	16	16.6
	Half Moon	Max:0.0011W/m ² Avg: 0.0004W/m ² 0.025% of ICNIRP standard	7.57	850CDMA & 850/1900 GSM	50	60	40	40	17	16	16.6

RADIATION LEVEL GRAPHS

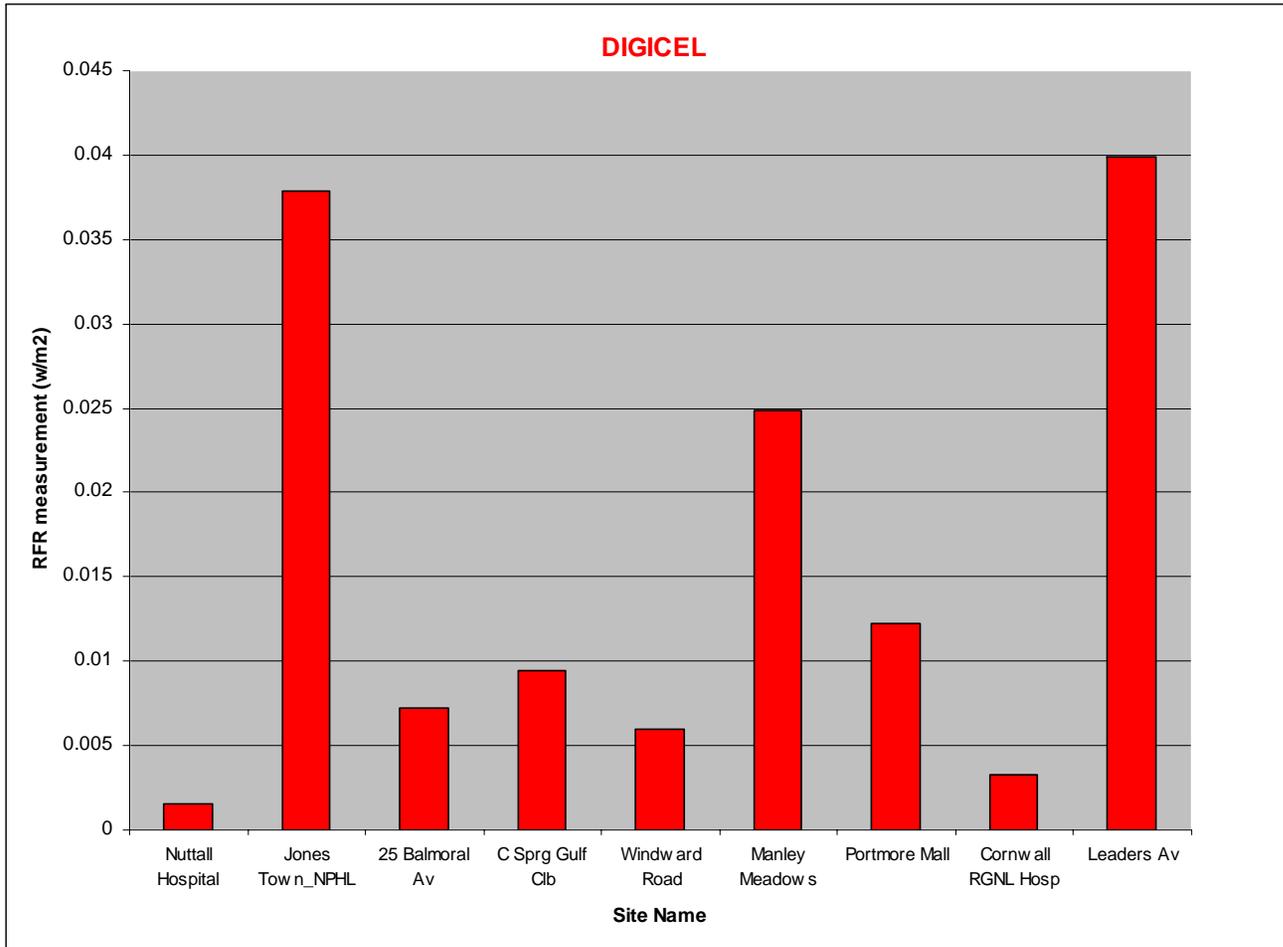


Chart 1 Power Density Distribution for Digicel Cell Sites

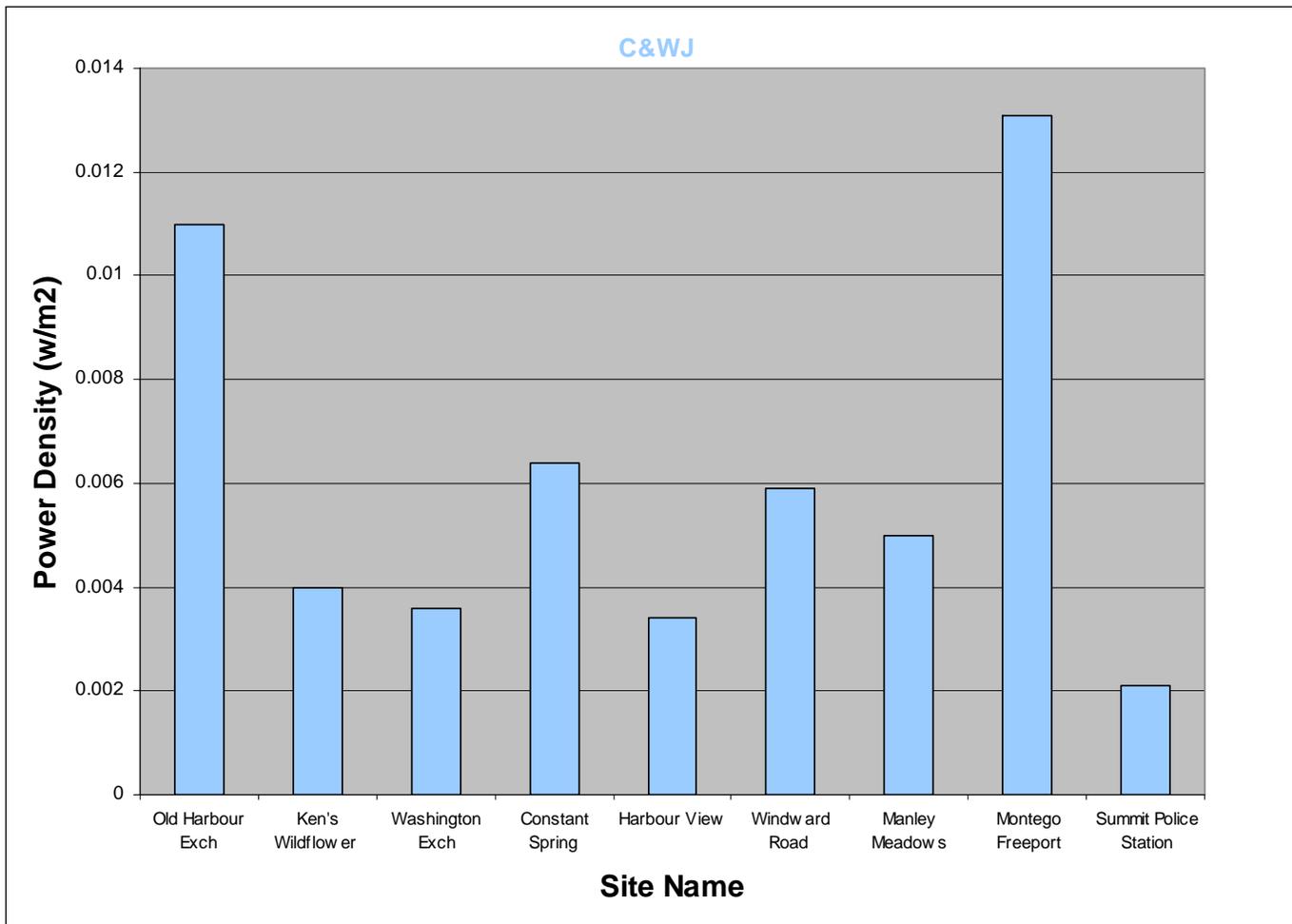


Chart 2 Power Density Distribution for C&WJ Cell Sites

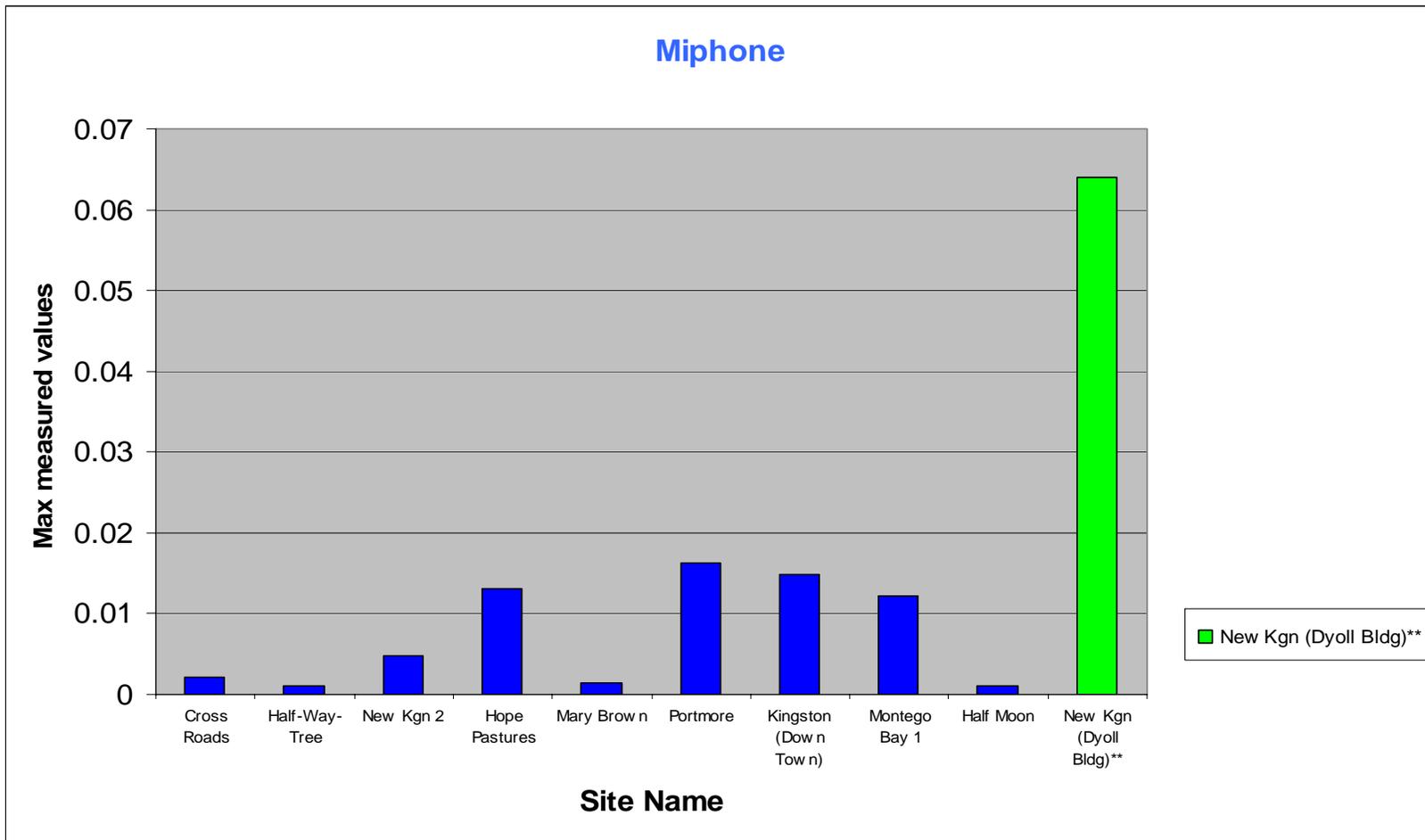


Chart 3 Power Density Distribution for Miphone Cell Sites

***RFR level recorded at this site was non-standard since it was taken at a location where general public would not have had access*

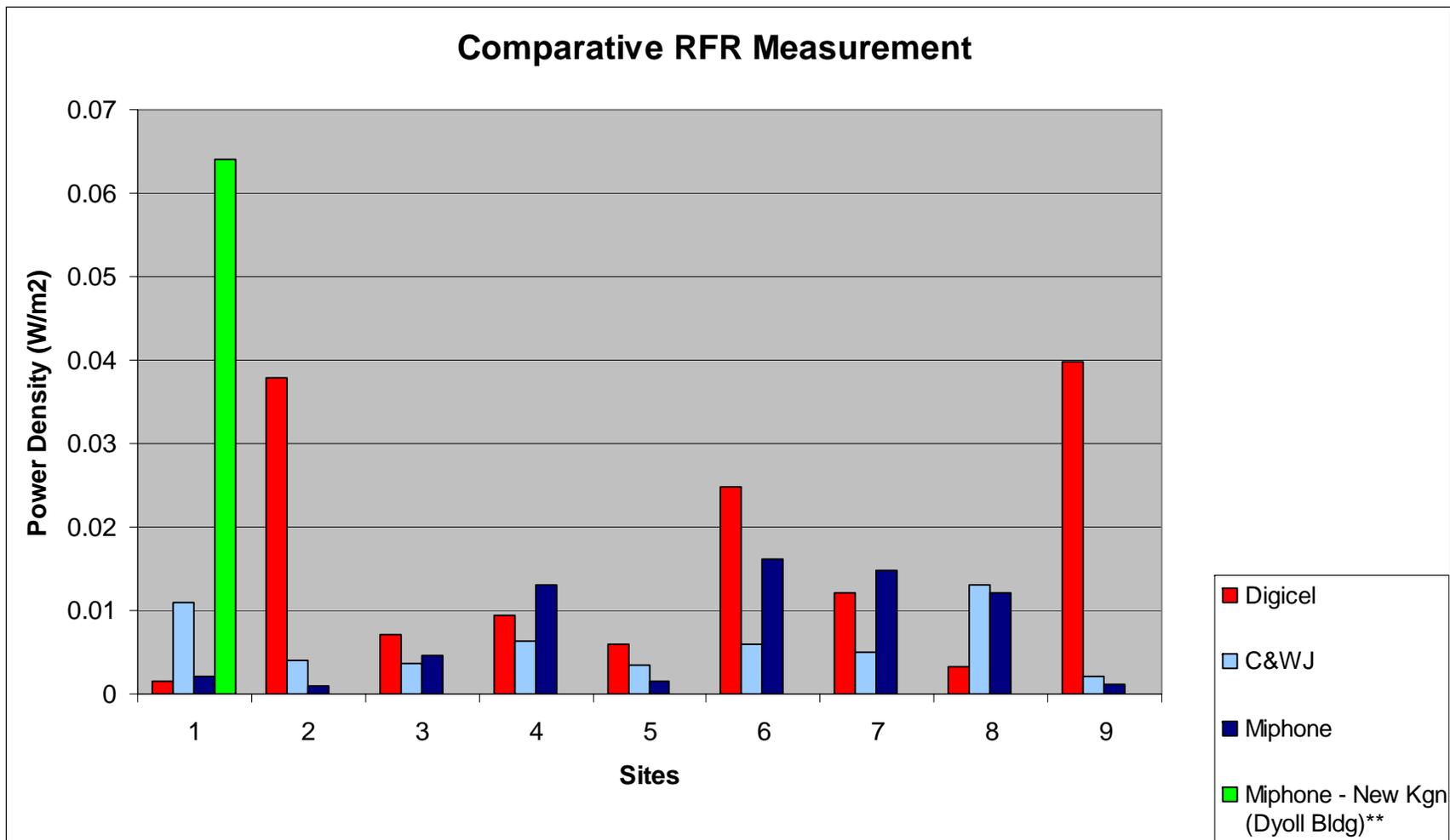


Chart 4 Comparative Distribution of Power Density for the Cell Sites Surveyed

***RFR level recorded at this site was non-standard since it was taken at a location where general public would not have had access.*

ANALYSIS

Factors Influencing Radiation Level

The radiation levels recorded at the sites were influenced by a number of factors. Some of the key factors include:

1. Height of the transmitting antenna above ground level
2. Proximity to other cell sites
3. Output power of the transmitting antennas
4. Orientation of the antennas

The two most prominent factors that affected the measurement of the radiation level in the survey were the height of the transmitting antennas above the ground relative to the height where the surveyor takes the measurement and the proximity of other cell sites to the one of interest. It was observed that the higher the transmitting antennas are above the surveyor, the lower the radiation level. In cases where there exist two cell sites at a location, the contribution of radio frequency fields of the adjacent site will cause the radiation level of the site of interest to be higher.

The radiation level at a cell site is determined by the magnitude of the power density, i.e. the power per unit square, therefore the higher the power that is radiated from the transmitting antennas, the higher the radiation level will be. Therefore from a practical standpoint, the highest possible radiation level will be directly in front of the antennas. Unlike the case for occupational staff, access to these areas by members of the general public is usually restricted.

The antenna orientation (tilt angle) in the vertical plane is one of the factors which is used to define the coverage area of a cell site. The tilt angle is determined by the electrical built in tilt or mechanical adjustment. The antennas are usually within 7° of the vertical axis which means they are never pointing directly to the ground. The extent to which the tilt angle of the antennas will affect the radiation level is dependent on their steepness.

Summary of Measurements

The highest radiation level (0.022 W/m^2 or 0.527% of ICNIRP Standard) for Cable and Wireless was recorded at the Montego Bay Freeport site, while the lowest radiation level (0.0015 W/m^2 or 0.050% of ICNIRP Standard) was measured at the Summit Police Station. The average radiation level for the Cable and Wireless sites was 0.006 W/m^2 , while the variance (average squared deviation of each measurement from the average of the distribution) was 0.00001 W/m^2 . Essentially the variance will give a measure of the variability or spread of the distribution (measurements). For both sites where the highest and lowest radiation levels were recorded, those measurements may be attributed to the orientation of the antennas (tilt angle). The site at the Montego Bay Freeport served users within the vicinity of the Freeport and the Summit Police site served user at the Airport. The circle of coverage for the Freeport site would be less than that of Summit Police Station, which extended its coverage to the Airport. Having a smaller coverage area the Freeport site will therefore give power density reading that are higher than the Summit Police Station site which has a wider coverage area.

For Digicel, the highest radiation level (0.04 W/m^2 or 0.85% of ICNIRP Standard) was recorded at their Leader's Avenue site, while the lowest level, 0.001 W/m^2 or 0.0034% of ICNIRP Standard, was observed at Nuttall Hospital. The average radiation level for the Digicel sites was 0.0158 W/m^2 . The variance was 0.00022 W/m^2 . The relatively high level at Leader's Avenue can be attributed to the height of the antennas which were approximately 10 meters above the ground and the fact that there was a Cable and Wireless tower of equal height within 15 meters of the Digicel tower. Also, the measurement was taken above ground level (on top of the NWC tank). The height of the antennas above ground level at Nutall Hospital was 30 meters and so the low power density recorded at that site could be attributed to this.

The highest radiation level (0.0162 W/m^2 or 0.37% of ICNIRP standard) recorded for MiPhone was at the Portmore site. In contrast, the lowest radiation level (0.0004 W/m^2 or 0.025% of ICNIRP) was observed at Half Moon. The average radiation level for the Miphone sites was 0.014 W/m^2 , while the variance was 0.000037 W/m^2 . The higher power density reading recorded at Portmore can be attributed to the fact that this site is collocated with Digicel. The contribution of radio frequency fields of the Digicel operation will therefore cause the radiation level of the site to be higher. In contrast, the lowest power density (0.0004 W/m^2) was observed at Half Moon, where the tower was approximately 50 meters and it was not collocated with any other operator.

Note:

A power density reading of 0.064 W/m² (or 1.46% of ICNIRP Standard) was recorded on the roof of the Dyoll Building which is adjacent to the MiPhone Building where the antennas were located. The Dyoll building roof level is roughly the same height as the Miphone cellular antennas. This value is non-standard as access to this location is very limited and members of the general public do not have access to this location. RFR levels were again recorded for the site at ground level and the results were 0.0047W/m² or 0.11% of ICNIRP standard

Assertions

For sites operating dual frequency bands, for example 900/1800 MHz (Digicel), 850/1900 MHz (Cable and Wireless) and 850/1900 MHz (Miphone), a Maximum Exposure Limit (MEL) was calculated for each frequency band. In reference to Table 1 above we find that the MEL is proportionate to the operating frequency (MEL = f/200), that is, the higher the frequency, the higher the MEL. Therefore, for sites operating with dual frequency bands compliance is evaluated against the lower MEL, which is calculated from the lower frequency, as this provides the more restrictive threshold in accordance to the ICNIRP Standard.

Challenges

The main challenges encountered while taking measurements were the physical environment at some of these sites, for example, location of some permanent structures (Walls, Building etc.) and the landscaping. These challenges were physical impediments and did not affect the objective of the survey, which was to determine the maximum radiation level that the general public would be subjected to from the sites.

CONCLUSION

The measured results showed that the maximum power density levels recorded were below the ICNIRP exposure limits for General Public. The variation in the power density levels recorded for each site can be attributed to several factors such as: Output power, antenna orientation, antenna gain, tower height, operating frequencies and the RF environment. The higher readings recorded were due mainly to the height of antennas above ground, orientation of antennas and the RF environment. As indicated in the readings no levels were recorded that exceeded the ICNIRP General Public Limits.

Access to sites inspected was controlled by locked perimeter fences for field sites and building access restriction to rooftop sites. The mechanisms in place were adequate to prevent unauthorized access; however there were **NO** RF warning signs to inform persons of the possible exposure to RFR at certain points.

Note: The findings contained in this report are specifically based on the International Council on Non-Ionizing Radiation Protection (ICNIRP) standard for the General Public. However, there are some fundamental measures that mobile companies can initiate to ensure that tower climbers and other personnel who work in close proximity to these antennas are not subjected to RFR exceeding the occupational limit stipulated by ICNIRP. Some of the recommended guidelines include:

1. RF warning signs
2. Barriers or fences restricting access to areas that exceed limit
3. Maps of areas at site where limits are exceeded
4. Education on the hazards of RFR exposure and limits
5. Information on techniques for controlling exposure
6. Contact information for all licensees at the site
7. Access to personal monitor and other RFR alerting devices for persons working in areas that may exceed limit
8. Access to RFR protective clothing
9. Access logs (sign in and sign out)

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