



Ambient Levels of Radio Frequency Emissions in the Kingdom of Bahrain:

Results of measurements made between
January and March 2009

A Report issued by the
Telecommunications Regulatory Authority

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Purpose:

To present the results of RF field strength measurements taken in Bahrain.

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1 Executive Summary

- 1.1 Use of the radio spectrum is widespread and concerns regarding the effects that radio frequency signals may have on human health are a global phenomenon.
- 1.2 The International Commission for Non Ionizing Radiation Protection (ICNIRP) is an independent scientific organization that works purely on the basis of science and research with no consideration for any economical, commercial, social or political aspects. ICNIRP was established to research and study the effects of non-ionizing radiation (which includes radio frequency signals) on human health.
- 1.3 ICNIRP provides its recommendations, guidelines, and research results to the World Health Organization (WHO), which adopts these recommendations and guidelines as a basis for its health regulations and notices concerning protection from electromagnetic field radiation (EMF, which includes radio frequency signals).
- 1.4 Following extensive research, ICNIRP has produced guidelines setting out levels of non-ionizing radiation at or below which there is no scientific evidence to show any danger to human health. These levels have been accepted and adopted by the WHO.
- 1.5 It is important to note that the ICNIRP levels are based on experimental data to establish a level of exposure at which there is no scientific evidence to show any danger to human health and that this level has then been reduced by a factor of 50 to establish the exposure limit for the general public.
- 1.6 In September 2008 the Public Commission for the Protection of Marine Resources, Environment and Wildlife (the Commission) adopted a draft Ministerial Order to establish limits for RF exposure in Bahrain. The Order adopts the ICNIRP guidelines bringing Bahrain in line with the wider international community.
- 1.7 The Ministerial Order is the result of cooperation between the Commission, the Telecommunications Regulatory Authority (TRA) and other concerned parties in Bahrain, with inputs from recognised international experts in the field. The Commission has advised that the publication of the Ministerial Order in the official Gazette is imminent.
- 1.8 TRA has purchased specialised equipment to enable the level of radio frequency signals in the Kingdom to be measured and compared with the Ministerial Order (i.e. ICNIRP guidelines). TRA intends to cooperate with the Commission to map the levels of radio frequency signals throughout the Kingdom. The results will be published on the TRA web site (and in periodic reports such as this).
- 1.9 During the period January to March 2009 measurements of RF field strengths were made at 11 locations throughout the Kingdom of Bahrain. The results of these measurements are presented in section 4 of this report and show that there are clear variations in the levels of RF field strengths between different locations and also between different frequency bands. The detailed results collected also illustrate that RF field strengths at a particular location vary over time.

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- 1.10 The key findings of the measurements presented in this report are:
- a. The RF field strengths measured in the telecoms bands were all significantly below the ICNIRP guideline.
 - b. The highest RF field strengths measured in the telecoms bands were observed in the GSM1800 down-link frequencies (base station transmissions) at the City Centre Mall. The levels were below 1/40 (40 times lower) or 2.5% of the ICNIRP level. Similar, albeit slightly lower, levels were measured in the GSM900 and Tetra bands at the Mall.
 - c. The highest RF field strengths observed during the period were in the broadcasting bands (measurements taken at the CIO). The levels were approximately 1/20 (20 times lower) or 5% of the ICNIRP level. These measurements were taken inside the building close to a closed window which faced the broadcasting antennas. The glass in the window will have absorbed some of the signal and it is reasonable to assume that the signal levels immediately on the other side of the glass would have been higher.
- 1.11 The following actions will be taken as a result of the above:
- a. Additional open air (i.e. outside) measurements in the broadcasting bands will be taken in the vicinity of the office of the CIO and surrounding area in order to investigate further the RF signal levels resulting from the broadcast antennas.
 - b. Whilst the signal levels measured at the City Centre Mall are significantly below the ICNIRP levels and are not a concern, they are higher than the levels observed in these bands at other locations. These signals are the result of 'in-building' repeaters and therefore additional measurements in the GSM and TETRA bands will be taken at the City Centre Mall in order to obtain a more detailed picture of RF signal levels at the Mall.
- 1.12 TRA will continue with the measurement campaign to compare RF signal levels throughout the Kingdom with the ICNIRP guidelines.

2 Introduction

- 2.1 The last 25 years have seen a rapid increase in usage and development of radio technologies. Such technologies are used extensively by both government and private sectors and as a result more and more antennas have been deployed. Antennas are now a common sight, particularly in urban areas, and this has resulted in concerns regarding radio frequency signals that they emit.
- 2.2 There are numerous sources of such signals and antennas can transmit for a variety of purposes, including: TV and Radio broadcasting, private and government operated radio communications systems, aeronautical and maritime communications or radar applications. In addition to these 'intentional radiators' there are also electronic or electrical systems which radiate electromagnetic fields (EMF) unintentionally, examples include: microwave ovens, computers and TV screens, electricity power lines and associated sub-stations and transformers. And finally, there are naturally occurring sources of electromagnetic fields such as static discharges.
- 2.3 In 1992, the International Commission for Non Ionizing Radiation Protection (ICNIRP) was established to research and study the effects of non-ionizing radiation on human health. ICNIRP is an independent scientific organization that works purely on the basis of science and research with no consideration for any economical, commercial, social or political aspects.
- 2.4 ICNIRP provides its recommendations, guidelines, and research results to the World Health Organization (WHO), which adopts these recommendations and guidelines as a basis for its health regulations and notices concerning protection from EMF radiation.
- 2.5 Following extensive research, ICNIRP has produced guidelines setting out levels of non-ionizing radiation (which includes EMF radiation discussed above), at or below which, there is no scientific evidence to show any danger to human health. These levels have been accepted and adopted by the WHO.
- 2.6 It is important to note that the ICNIRP levels are based on experimental data to establish a level of exposure at which there is no scientific evidence to show any danger to human health and that this level is then reduced by a factor of 50 to establish the exposure limit for the general public.
- 2.7 In September 2008 the Public Commission for the Protection of Marine Resources, Environment and Wildlife (the Commission) adopted a draft Ministerial Order to establish limits for RF exposure in Bahrain. The Order adopts the ICNIRP guidelines bringing Bahrain in line with the wider international community.
- 2.8 The Ministerial Order is the result of cooperation between the Commission, the Telecommunications Regulatory Authority (TRA) and other concerned entities in Bahrain, with inputs from recognised international experts in the field. The Commission has advised that the publication of the Ministerial Order in the official Gazette is imminent.

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- 2.9 In response to the increasing levels of concern regarding radiation from antennas, the TRA has purchased equipment to measure (and compare with INCIRP guidelines) the ambient level of radiation produced by the most prevalent broadcasting and communications technologies and services deployed in Bahrain. TRA, working together with the Commission, will use this equipment to measure the ambient levels of electromagnetic fields produced by broadcasting and communications technologies at different locations to investigate the levels of radiation to which the public is exposed and to compare these with the Ministerial Order.
- 2.10 Over time, TRA and the Commission plan to create a profile of the levels of electromagnetic fields produced by broadcasting and communications technologies throughout the Kingdom of Bahrain. Results will be published on the TRA web site (www.tra.org.bh). This report is part of the process.

2.11 Scope

- 2.12 This report presents the results of measurements made between January and March 2009 at the following locations:

Location	General Area	Specific Location
1	Central Informatics Organisation, Isa Town	Cisco Training room on second floor
2	City Centre Mall	Customer service point on ground floor
3	Crowne Plaza Hotel	Boardroom number 1 at the conference centre
4	French School, Muharraq	Playground
5	International Exhibition Centre	Multiple locations
6	Malkya	Villa 2201, Block 1034
7	Saar	Villa 2782, Block 507, Saraya 1
8	St. Christopher's School, Isa Town	Playground
9	Taib Tower, Manama	TRA office on 7 th floor
10	Tubli	Al Mahmood Villa
11	Seef District	5 th Floor, Rabiya A-4 Building

3 Measurement methods

3.1 Measurement Equipment

- 3.2 The equipment used for the measurements is that procured from Satimo, including the Insite Box, Insite Free and EME Spy measurement systems.
- 3.3 All equipment used is covered by a valid calibration certificate issued by the manufacturer.
- 3.4 The measurement systems use an omni-directional probe to receive RF signals from all directions; these are then summed in order to calculate the total exposure level per frequency band. RF signal levels can be expressed in a number of ways, including as a percentage of the ICNIRP recommendation.
- 3.5 The three different types of measurement equipment used do not present the results in the same format, thus there are some differences between sites in the way that results are presented. Measurements taken with the Insite Box cover a period extending from days to a week or more, whereas results obtained with the Insite Free and EME Spy cover a shorter period of time (minutes to hours).

3.6 Insite Box measurements

- 3.7 For each site, the Insite Box was installed and configured to take measurements in each band every 12 seconds. This generated measurement data for approximately 22 hours each day for the following bands:

- FM Radio 88MHz – 108MHz
- TV (Band 3) 174MHz – 223MHz
- TETRA 380MHz – 400MHz
- TV (Band 4/5) 470MHz – 830MHz
- GSM 900 925MHz – 960MHz
- GSM 1800 1805MHz – 1880MHz
- UMTS 2110MHz – 21170MHz
- WLAN 2400MHz – 2500MHz

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- 3.8 The data was then transmitted to TRA at 3am each day with the new measurement cycle commencing at 5am.
- 3.9 Figure 1 below illustrates a typical installation of the Insite Box.



Figure 1: Installation of Insite Box at Taib Tower.

3.10 Measurements with the Insite Free

- 3.11 The Insite Free system was installed on the 5th floor of the Rabiya A-4 Building. Measurements were taken inside the building and also outside at the same level (see Figures 2 and 3 below) on the north facing side of the building.

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3.12 With the system installed inside and using the lower band probe¹, an initial sweep of all bands between 100KHz and 3GHz was performed in order to identify the bands in which emissions could be detected. The system was then programmed to take detailed measurements of RF field strengths in the bands identified. The bands were:

- TV (Band 2) 47MHz – 68MHz
- FM Radio 88MHz – 108MHz
- GSM 900 925MHz – 960MHz
- GSM 1800 1805MHz – 1880MHz
- UMTS 2110MHz – 21170MHz

3.13 The system was then taken outside the building at the same level and the above measurements were repeated.

3.14 Finally, the low band probe was replaced with the upper band probe² and measurements were made (outside) over the WiMax band.



Figure 2: Installation inside at Rayib Building

¹ The lower band probe covers the frequency range 100KHz to 3GHz.

² The upper band probe has a frequency range of 2GHz to 6GHz

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Figure 3: Installation outside at the Rayib Building showing the upper band probe

3.15 Measurements with the EME Spy

3.16 The EME Spy was configured to take measurements in each band every 10 seconds. The operator spent approximately 1 hour visiting different location at the International Exhibition Centre. The measured bands were:

- FM Radio 88MHz – 108MHz
- TV (Band 3) 174MHz – 223MHz
- TETRA 380MHz – 400MHz
- TV (Band 4/5) 470MHz – 830MHz
- GSM 900 (UL) 880MHz – 915MHz
- GSM 900 (DL) 925MHz – 960MHz
- GSM 1800 (UL) 1710MHz – 1785MHz
- GSM 1800 (DL) 1805MHz – 1880MHz
- UMTS (UL) 1920MHz – 1980MHz
- UMTS (DL) 2110MHz – 21170MHz
- WLAN 2400MHz – 2500MHz

4 Results

4.1 Insite Box

- 4.2 Figure 5 to 12 below present the results of measurements taken at each site showing the minimum, maximum and average field strengths measured, per band, as a fraction of the ICNIRP level.
- 4.3 Note that the vertical scale is logarithmic rather than linear. Logarithmic scales are useful as they make it possible to clearly plot quantities with a very small values and also very large values on the same graph. However, the result is that smaller readings appear to be more significant than they would be had the graph been a linear plot.

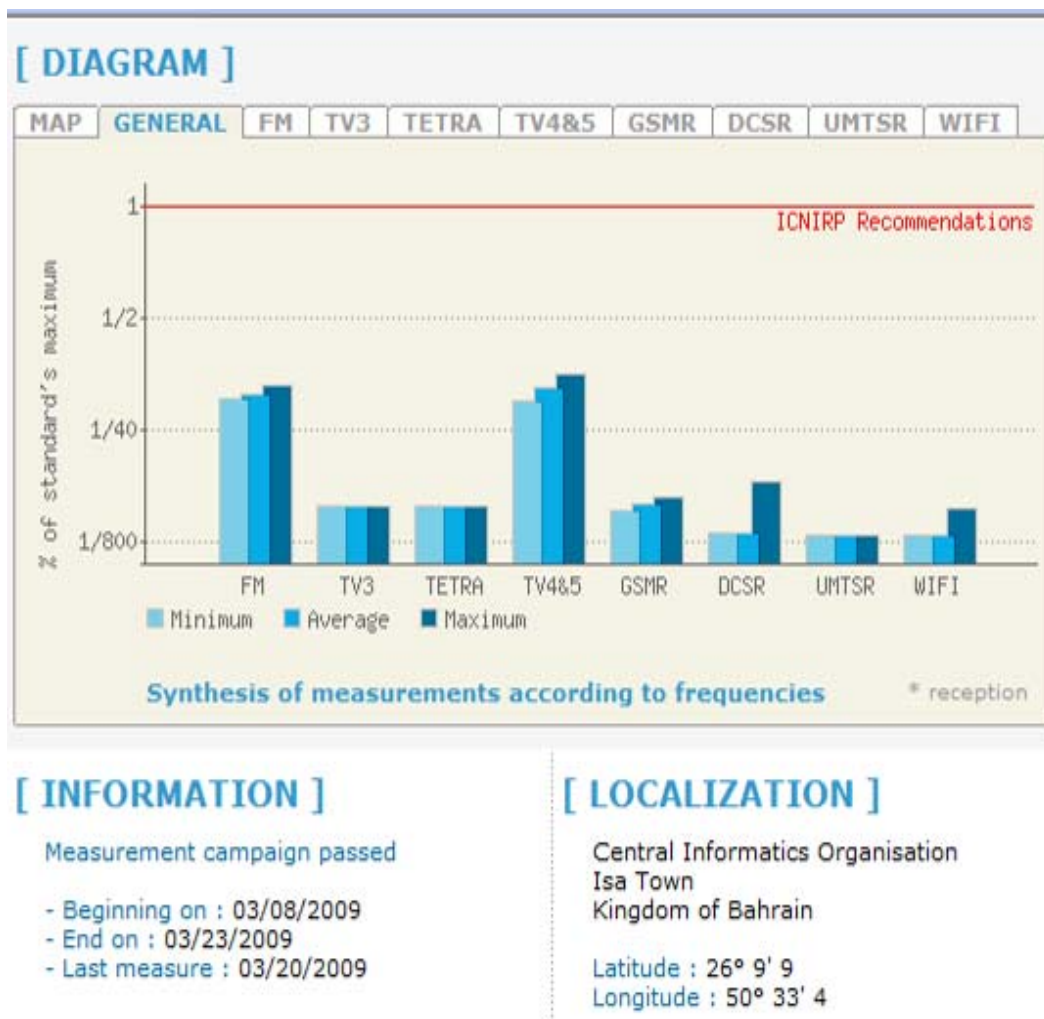


Figure 4: Results for CIO

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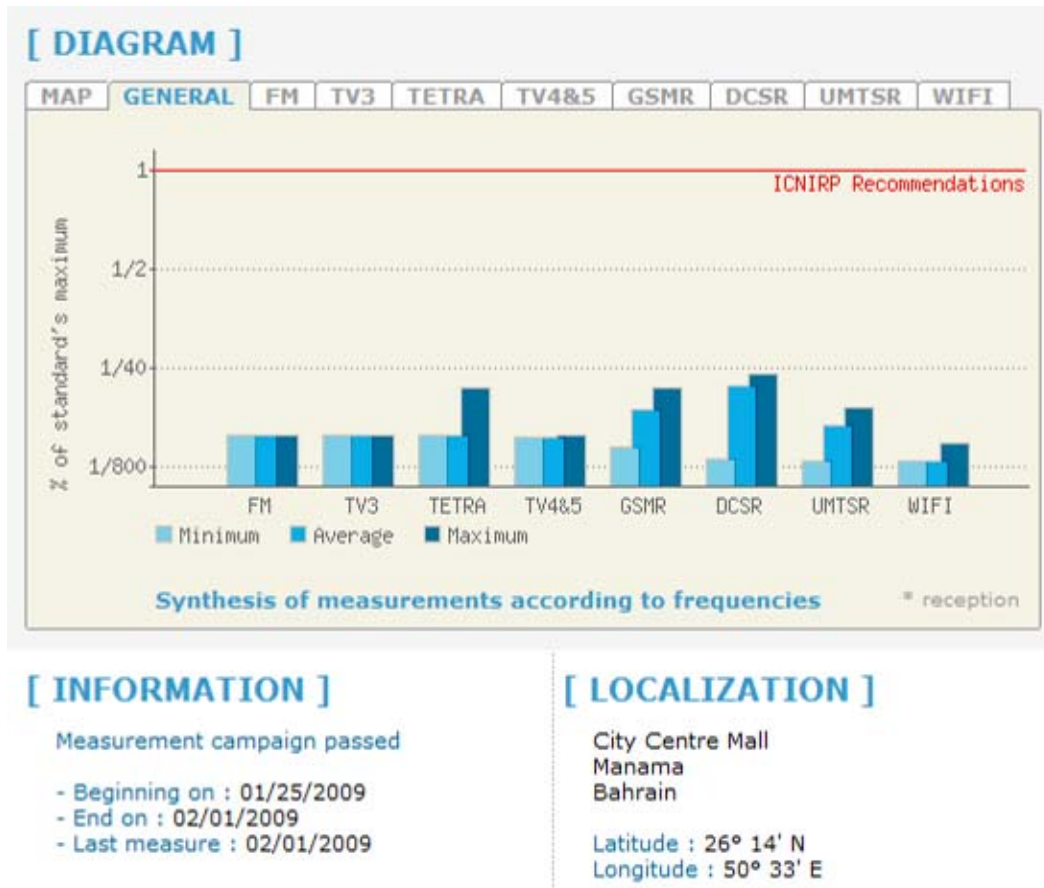


Figure 5: Results for City Centre Mall

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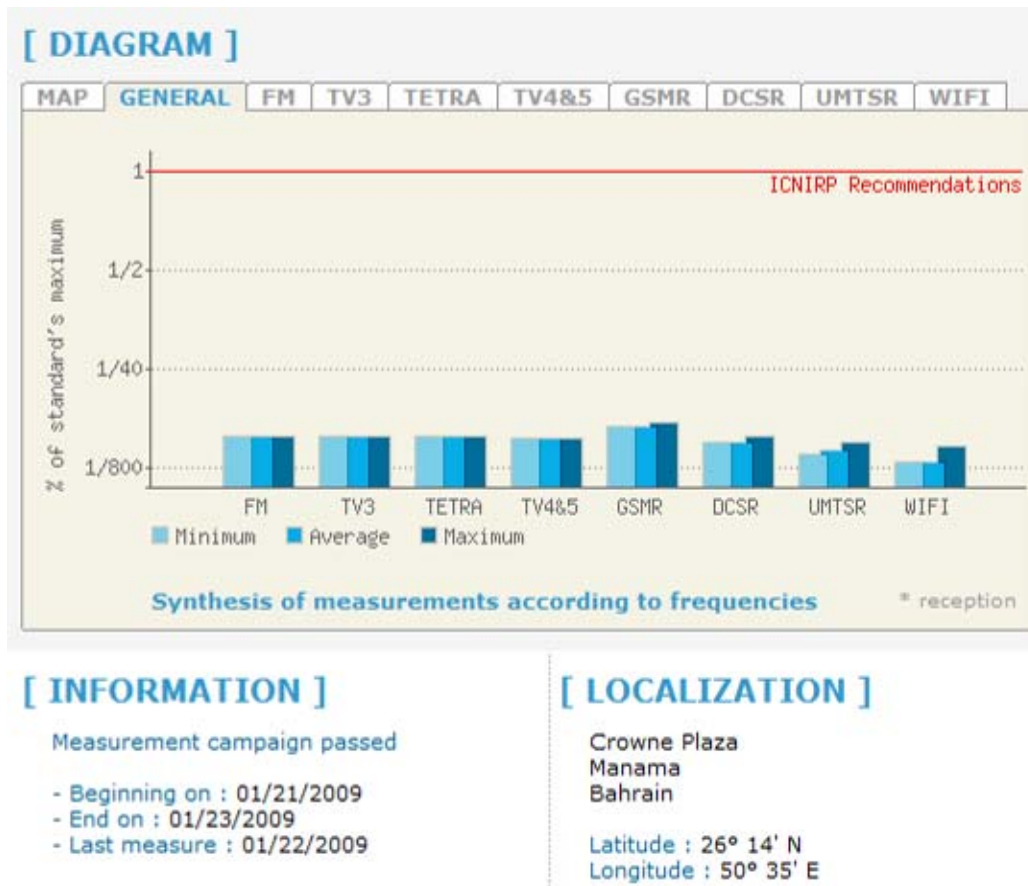


Figure 6: Results for Crowne Plaza

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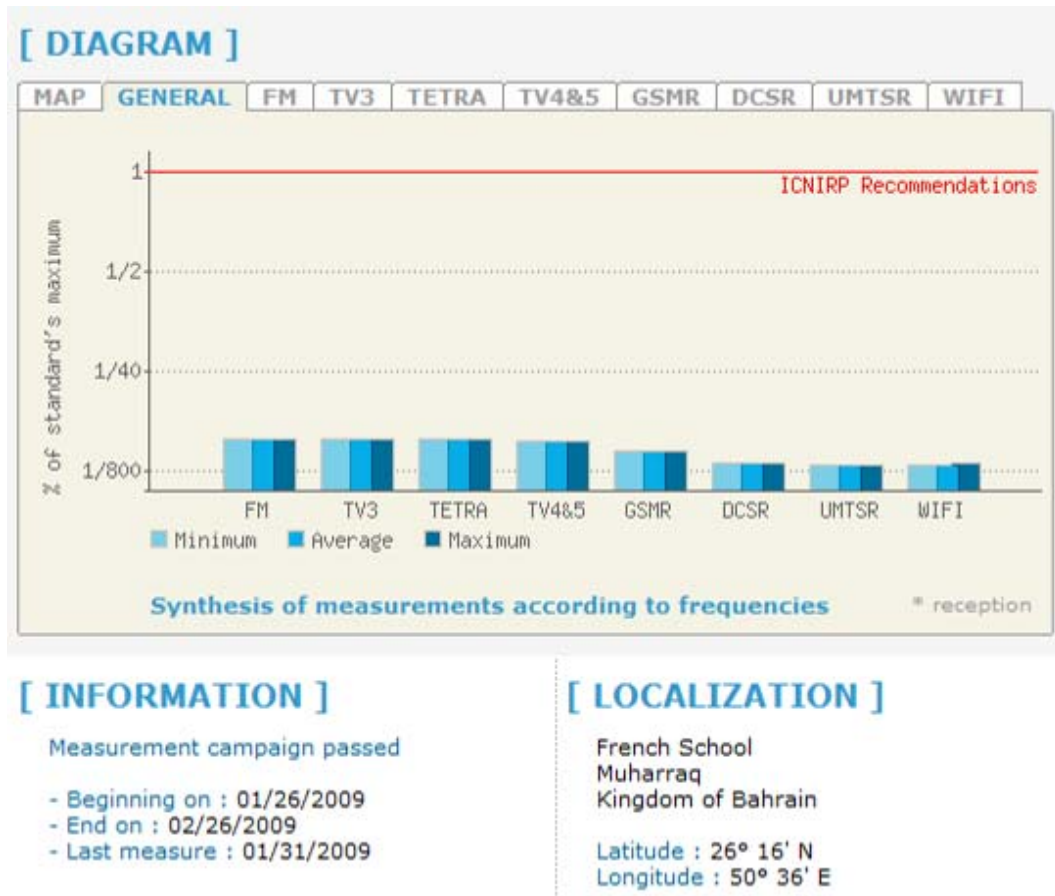


Figure 7: Results for French School

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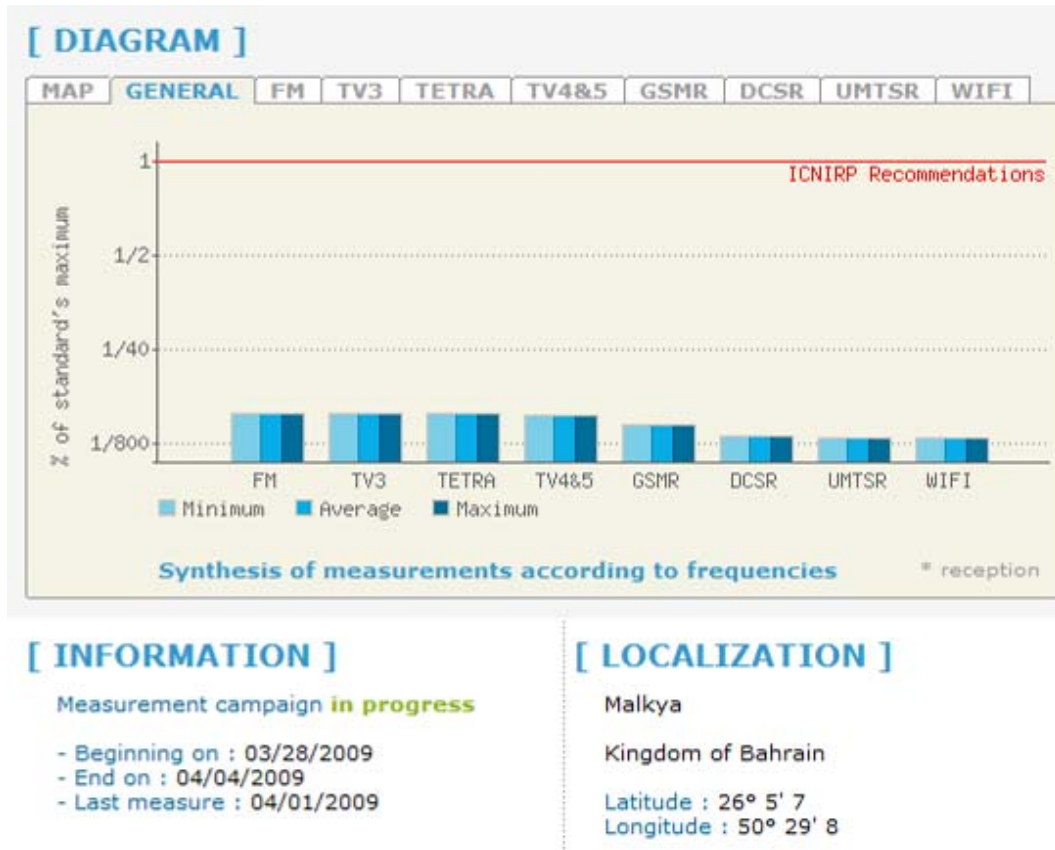


Figure 8: Results for Malkya

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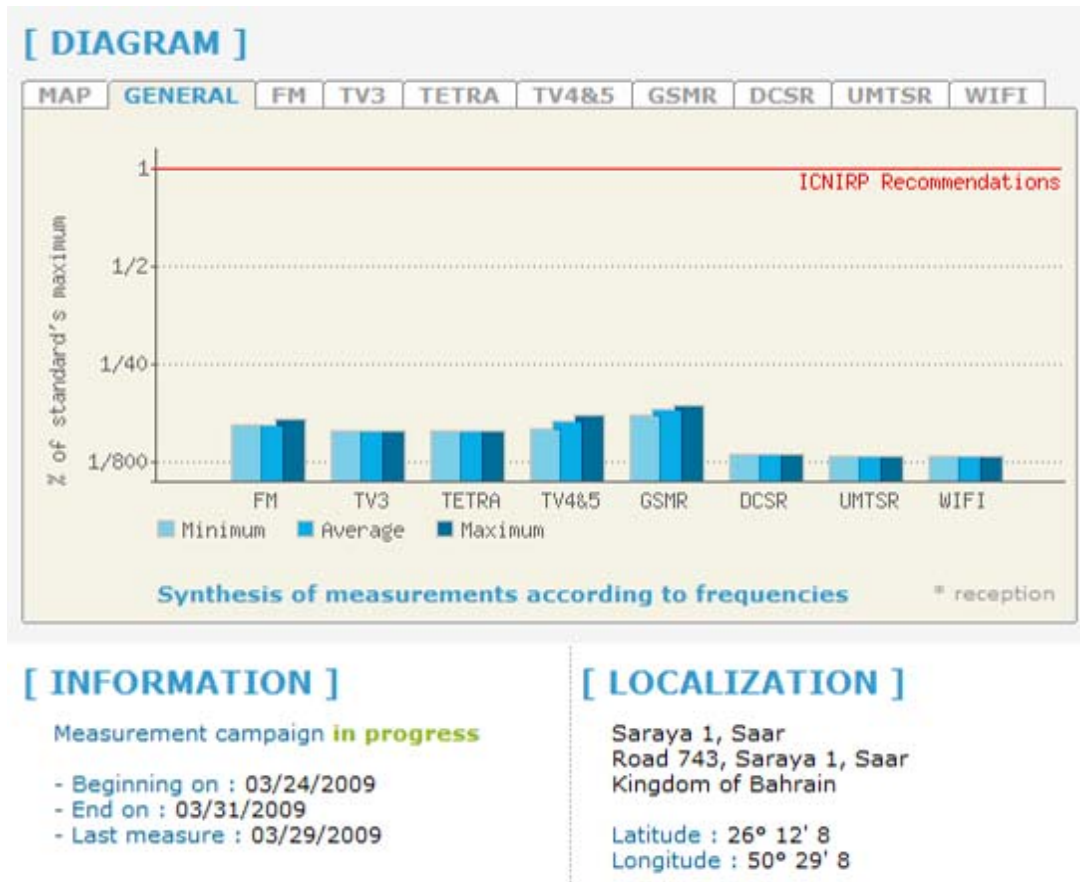


Figure 9: Results for Saar

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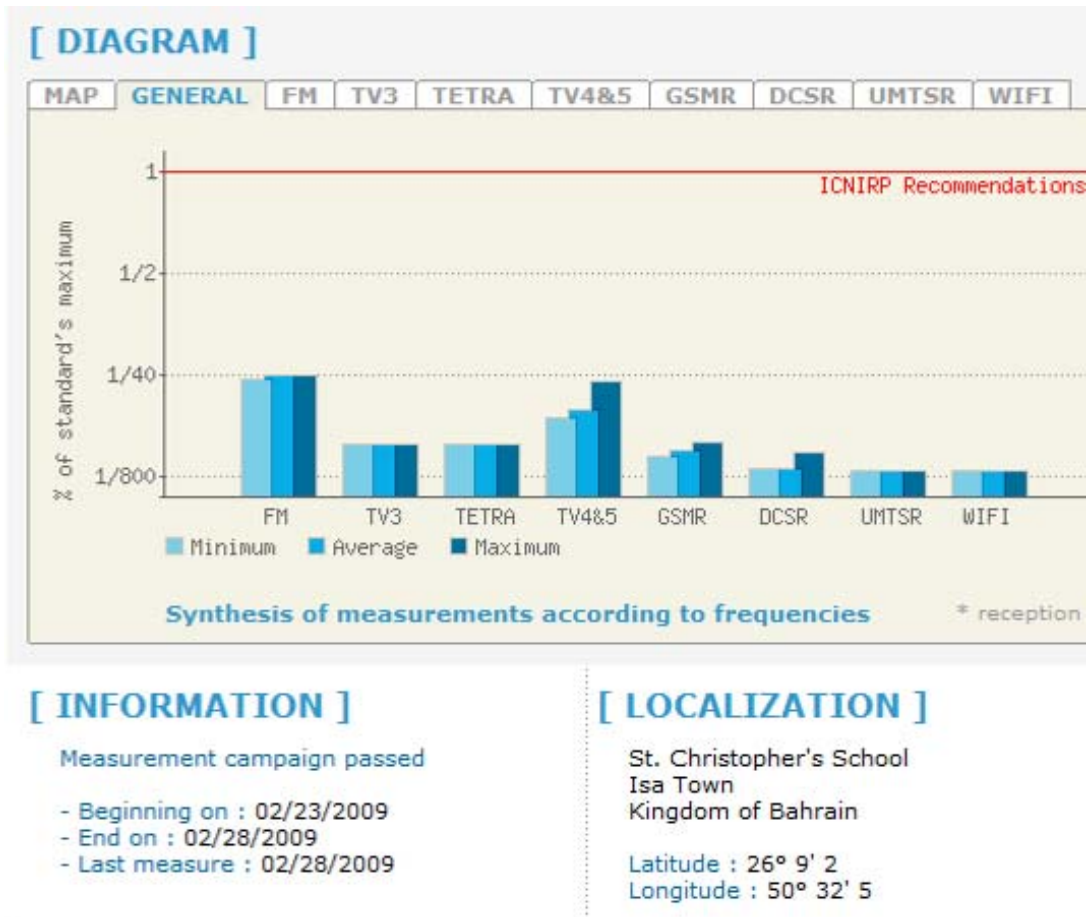


Figure 10: Results for St. Christopher's School

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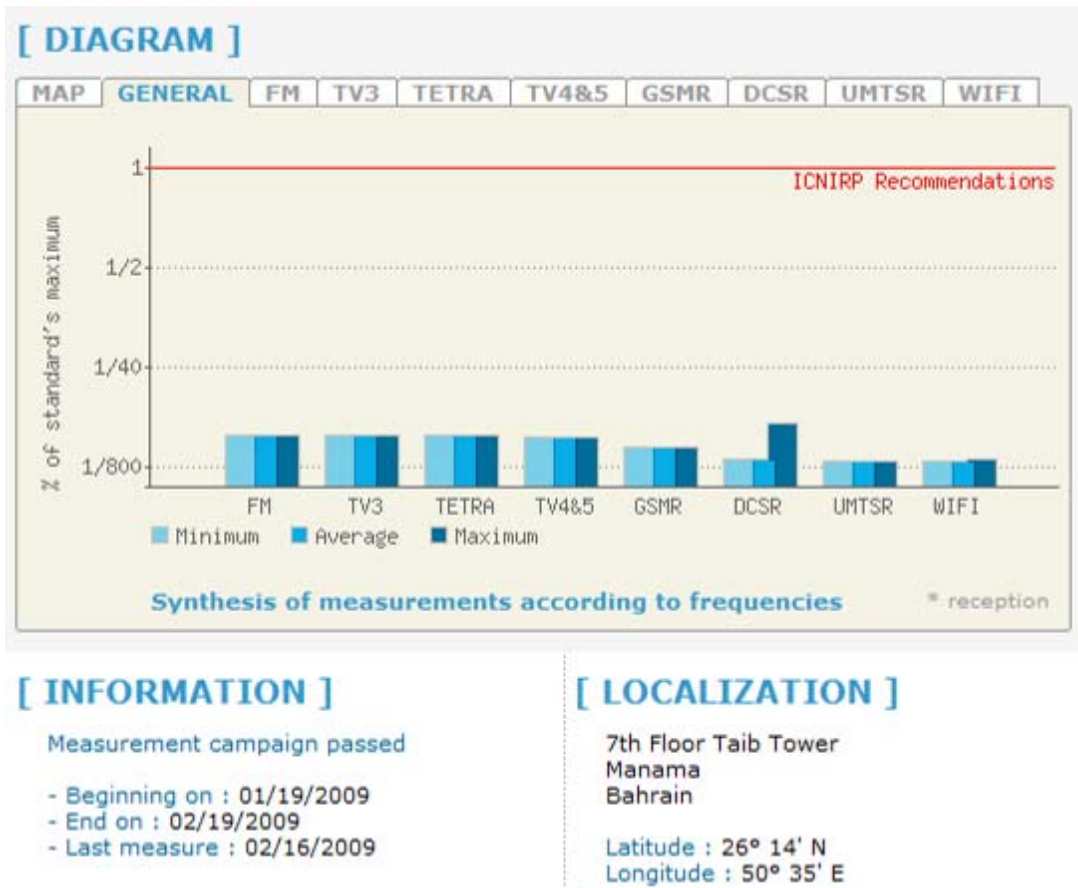


Figure 11: Results for Taib Tower

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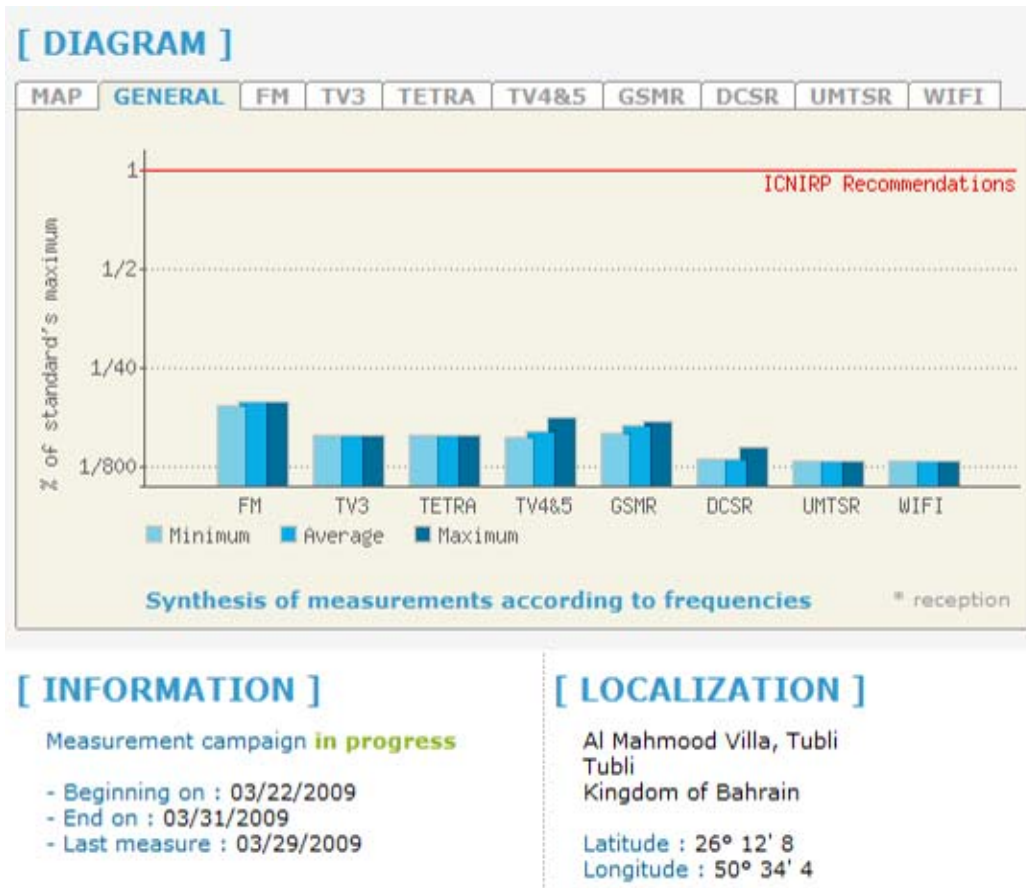


Figure 12: Results for Tubli

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4.4 Insite Free

4.4.1 Inside

- 4.5 The full measurement results are presented at Attachment 1.1.
- 4.6 The total exposure over all bands measured represents 1.23% of the ICNIRP level for the general public.
- 4.7 No field strengths above 0.21V/M were detected on any individual channel³, however, the software predicted that GSM field strengths could rise to approximately 0.4V/m under maximum traffic loading.
- 4.8 The maximum field strength detected on an individual channel represents 0.5% of the ICNIRP level for the general public.

4.8.1 Outside – low band

- 4.9 The full measurement results are presented at Attachment 1.2.
- 4.10 The total exposure over all bands measured represents 6.64% of the ICNIRP level for the general public.
- 4.11 No field strengths above 0.935V/M were detected on any individual channel⁴, however, the software predicted that GSM field strengths could rise to approximately 1.87V/m under maximum traffic loading.
- 4.12 The maximum field strength detected on an individual channel represents 2.2% of the ICNIRP level for the general public.

4.12.1 Outside – Upper band

- 4.13 The full measurement results are presented at Attachment 1.3.
- 4.14 The maximum field strength detected in the WiMax band was 0.0025V/m. At this frequency the ICNIRP level for the general public is 61V/m, thus this level is approaching a thousandth of the ICNIRP level and makes a negligible contribution to the overall exposure level.

³ This maximum was detected at 945.4MHz. At this frequency the ICNIRP level for the general public is 42V/m.

⁴ This maximum was detected at 937.2MHz. At this frequency the ICNIRP level for the general public is 42V/m.

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4.15 EME Spy

4.16 Figure 14 below shows the results of the measurements at the International Exhibition Centre.

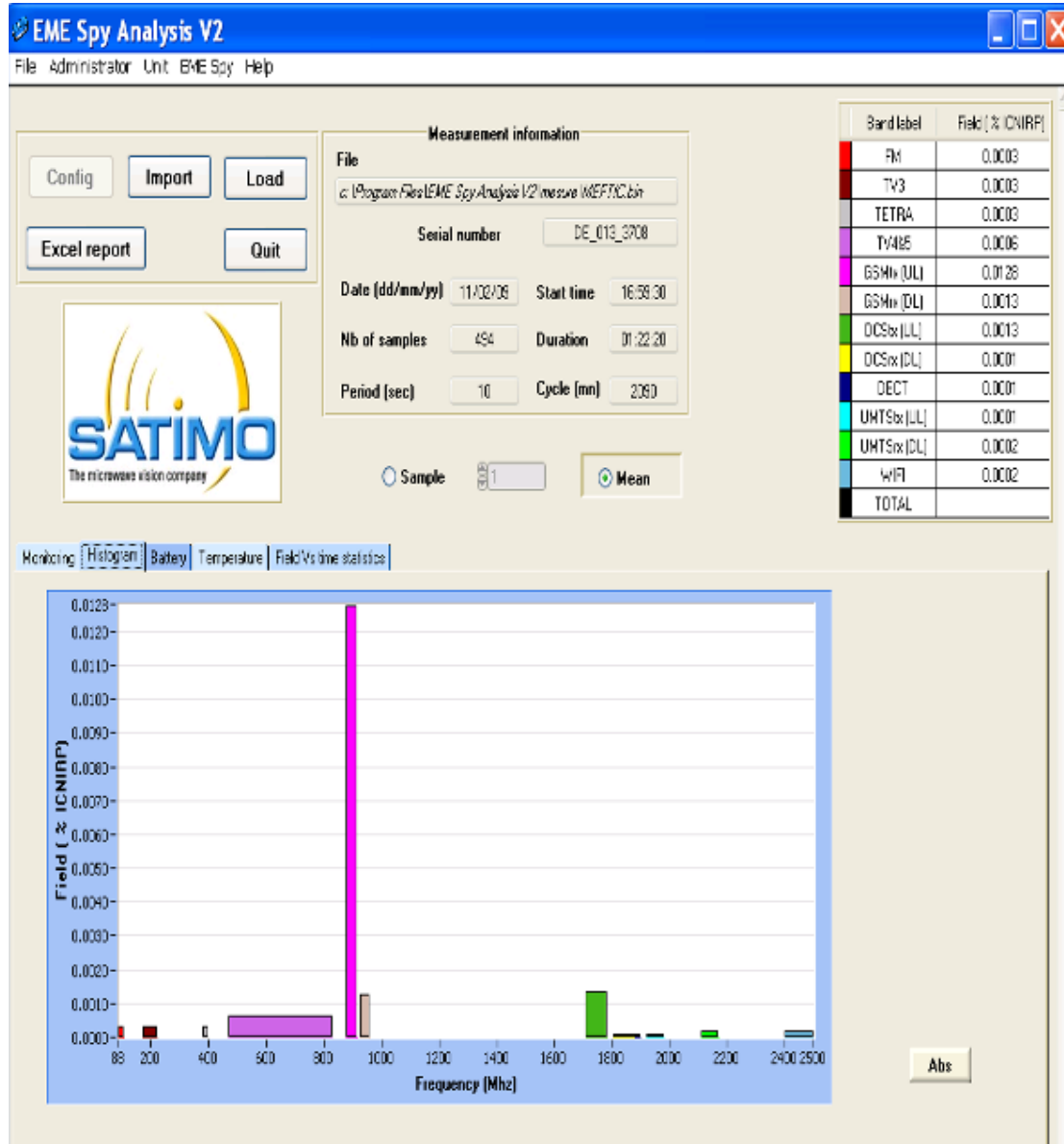


Figure 13: Results for International Exhibition Centre

5 Conclusions

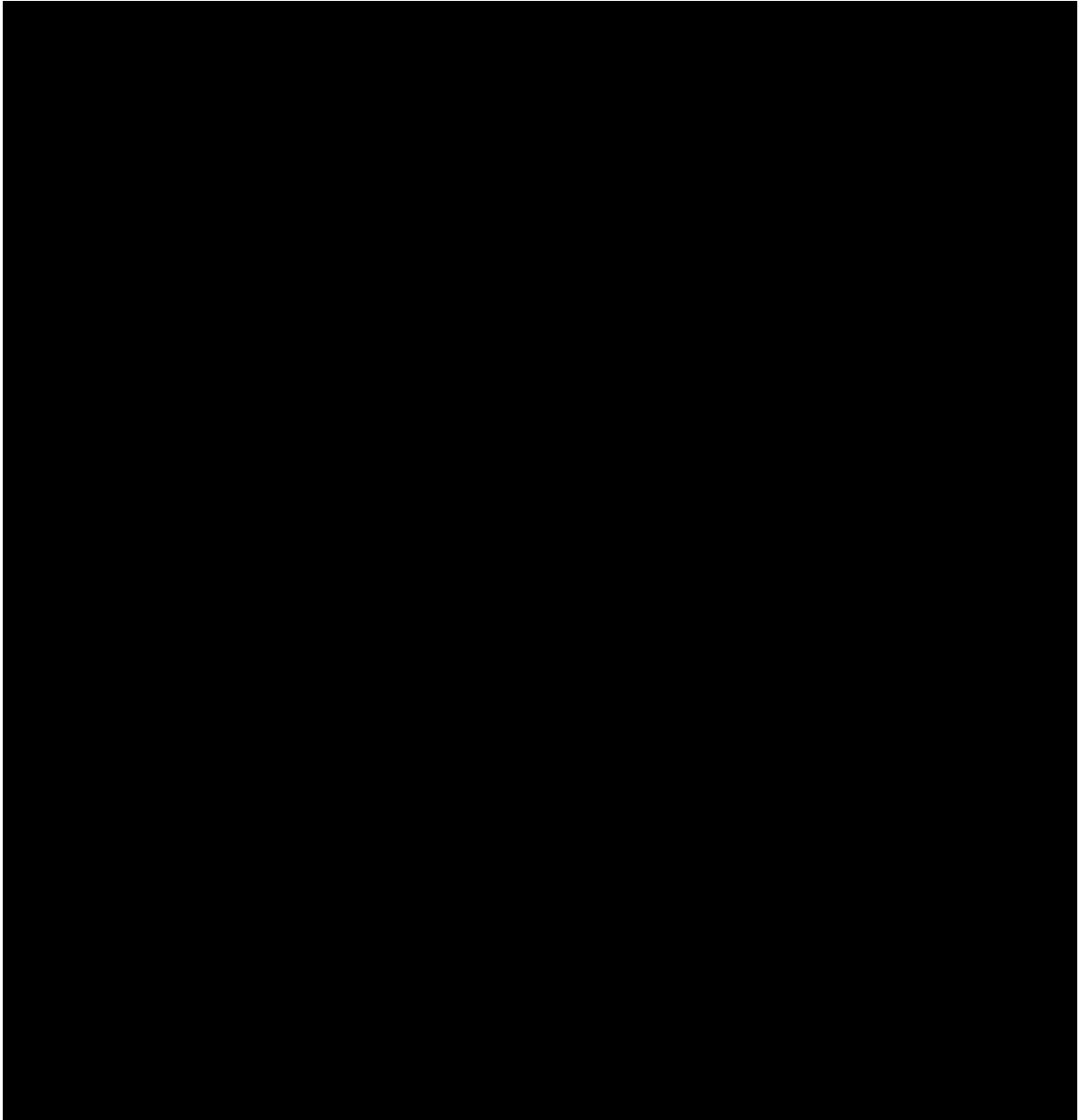
- 5.1 No measurements at any site exceeded the ICNIRP guidelines.
- 5.2 The most significant measurements in telecommunications bands were measured at the City Centre Mall. These were at GSM1800 down-link frequencies (base station transmissions) which were below one fortieth or 2.5% of the ICNIRP level. Similar, albeit slightly lower, levels were measured in the GSM900 and Tetra bands.
- 5.3 The highest signal levels measured were in the broadcast bands and resulted from transmissions originating at the Ministry of Information site in Isa Town. The levels measured inside the CIO offices are approximately one twentieth or 5% of the ICNIRP level. These measurements were taken inside the building close to a closed window which faced the broadcasting antennas. The glass in the window will have absorbed some of the signal and it can be anticipated that the signal strength immediately on the other side of the glass would have been higher.

6 Next Steps

- 6.1 Additional open air (i.e. outside) measurements in the broadcasting bands will be taken in the vicinity of the office of the CIO and surrounding area using the Insite Free system in order to investigate further the RF signal levels resulting from the broadcast antennas.
- 6.2 Whilst the signal levels measured at the City Centre Mall are significantly below the ICNIRP levels and are not a concern, they are higher than the levels observed in these bands at other locations. These signals are the result of in-building repeaters and therefore additional measurements in the GSM and TETRA bands will be taken at the City Centre Mall using the Insite Free system in order to obtain a more detailed understanding of RF signal levels at the Mall.
- 6.3 TRA and the Commission will continue with the measurement campaign to map RF signal levels throughout the Kingdom.

Rayib Building, Seef

A1.1 Inside



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A1.2 Outside – low probe

INSITE Session Report Total percentage of Exposure limit : 6.64%

Band name:	47M-68M	TV II	BAND n*1						
Number of selected peaks:	1								
Total Field:	0.0495 V/m								
Total Field (V/m):	0.0495								
Reference Level (V/m):	28.0000		(ICNIRP Recommendation)						
List of peaks:	1	2	3	4	5	6	7	8	9
Frequency (MHz):	62.778584								
Channel Number:	0								
Number of TRX:	1								
Detected Level :	0.0495 V/m								
Remeasured Level :	-								
Extrapolated Level :									

Band name:	87M5-108M	FM	BAND n*2						
Number of selected peaks:	15								
Total Field:	0.1180 V/m								
Total Field (V/m):	0.1180								
Reference Level (V/m):	28.0000		(ICNIRP Recommendation)						
List of peaks:	1	2	3	4	5	6	7	8	9
Frequency (MHz):	96.875681	93.303993	92.299456	96.466425	94.978221	104.949183	89.76951	102.977314	106.065336
Channel Number:	0	0	0	0	0	0	0	0	0
Number of TRX:	1	1	1	1	1	1	1	1	1
Detected Level :	0.0810 V/m	0.0375 V/m	0.0365 V/m	0.0323 V/m	0.0315 V/m	0.0221 V/m	0.0214 V/m	0.0196 V/m	0.0168 V/m
Remeasured Level :	-	-	-	-	-	-	-	-	-
Extrapolated Level :									

Band name:	925M-935M	E-GSM	BAND n*3						
Number of selected peaks:	14								
Total Field:	0.1272 V/m								
Total Field (V/m):	0.1272								
Reference Level (V/m):	41.8190		(ICNIRP Recommendation)						
List of peaks:	1	2	3	4	5	6	7	8	9
Frequency (MHz):	933.5	929.9	930.1	929.5	933.3	932.9	929.7	928.3	928.5
Channel Number:	0	0	0	0	0	0	0	0	0
Number of TRX:	1	1	1	1	1	1	1	1	1
Detected Level :	0.0610 V/m	0.0588 V/m	0.0588 V/m	0.0386 V/m	0.0356 V/m	0.0224 V/m	0.0210 V/m	0.0205 V/m	0.0197 V/m
Remeasured Level :	-	-	-	-	-	-	-	-	-
Extrapolated Level :									

Band name:	935M-960M	GSM 900 DL	BAND n*4						
Number of selected peaks:	2								
Total Field:	2.6402 V/m								
Total Field (V/m):	2.6402								
Reference Level (V/m):	42.0444		(ICNIRP Recommendation)						
List of peaks:	1	2	3	4	5	6	7	8	9
Frequency (MHz):	937.2	945.4							
Channel Number:	11	52							
Number of TRX:	4	4							
Detected Level :	0.9351 V/m	0.9319 V/m							
Remeasured Level :	-	-							
Extrapolated Level :	1.8701 V/m	1.8637 V/m							

Band name:	1805M-1880M	GSM1800 DL	BAND n*5						
Number of selected peaks:	1								
Total Field:	1.2006 V/m								
Total Field (V/m):	1.2006								
Reference Level (V/m):	58.4173		(ICNIRP Recommendation)						
List of peaks:			1	2	3	4	5	6	
Frequency (MHz):	1866.2								
Channel Number:	817								
Number of TRX:	4								
Detected Level :	0.6003 V/m								
Remeasured Level :	-								
Extrapolated Level :	1.2006 V/m								

Band name:	2110M-2170M	UMTS DL	BAND n*6						
Number of selected peaks:	2								
Total Field:	0.2448 V/m								
Total Field (V/m):	0.2448								
Reference Level (V/m):	61.0000		(ICNIRP Recommendation)						
List of peaks:	1	2	3	4	5	6	7	8	9
Frequency (MHz):	2132.8	2127.800064							
Channel Number:	0	0							
Number of TRX:	1	1							
Detected Level :	0.2137 V/m	0.1194 V/m							
Remeasured Level :	-	-							
Extrapolated Level :									

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A1.3 Outside – high probe

INSITE Session Report

Total percentage of Exposure limit : **0.00%**

Band name:	2110M-2170M UMTS DL		BAND n°1			
Number of selected peaks:			(ICNIRP Recommendation)			
Total Field:						
Total Field (V/m):						
Reference Level (V/m):	61.0000					
List of peaks:	1	2	3	4	5	6
Frequency (MHz):						
Channel Number:						
Number of TRX:						
Detected Level :						
Remeasured Level :						
Extrapolated Level :						

Band name:	WiMax		BAND n°2			
Number of selected peaks:	1		(ICNIRP Recommendation)			
Total Field:	0.0025 V/m					
Total Field (V/m):	0.0025					
Reference Level (V/m):	61.0000					
List of peaks:	1	2	3	4	5	6
Frequency (MHz):	3514.700544					
Channel Number:	0					
Number of TRX:	1					
Detected Level :	0.0025 V/m					
Remeasured Level :	-					
Extrapolated Level :						