

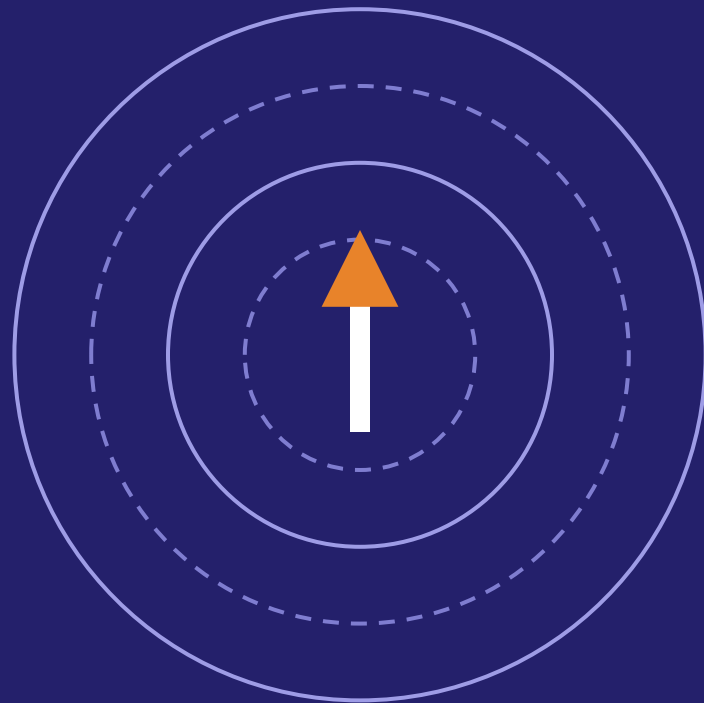


Seminar: Radiation effects of telecommunication systems and their risks to citizens' health

Regulatory framework, international standards and the role of the TRA

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Lebanon

Panel discussion | Friday 9 October 2026 | Beirut Arab University – Tripoli



Presentation Overview

1 EMF basics

What radiation is, what exposure means, and what limits protect

2 Standards and limits

Who sets them: basic restrictions, reference levels, ICNIRP 2020

3 5G & New technologies assessment & Lessons from abroad

Active antennas and how a base station is assessed today

4

Lebanon: Telecom law, TRA role, workers, EMF modernization program

Law 431/2002, the 2010 regulation, compliance, duties, worker safety

Five ideas to understand before the details

1

EMF

Energy around transmitting antennas travels as electric and magnetic fields.

2

Exposure is not power

A transmitter's rated power is not the same as the exposure a person receives.

3

Basic restrictions

Limits inside the body (SAR, absorbed power density): the real health protection.

4

Reference levels

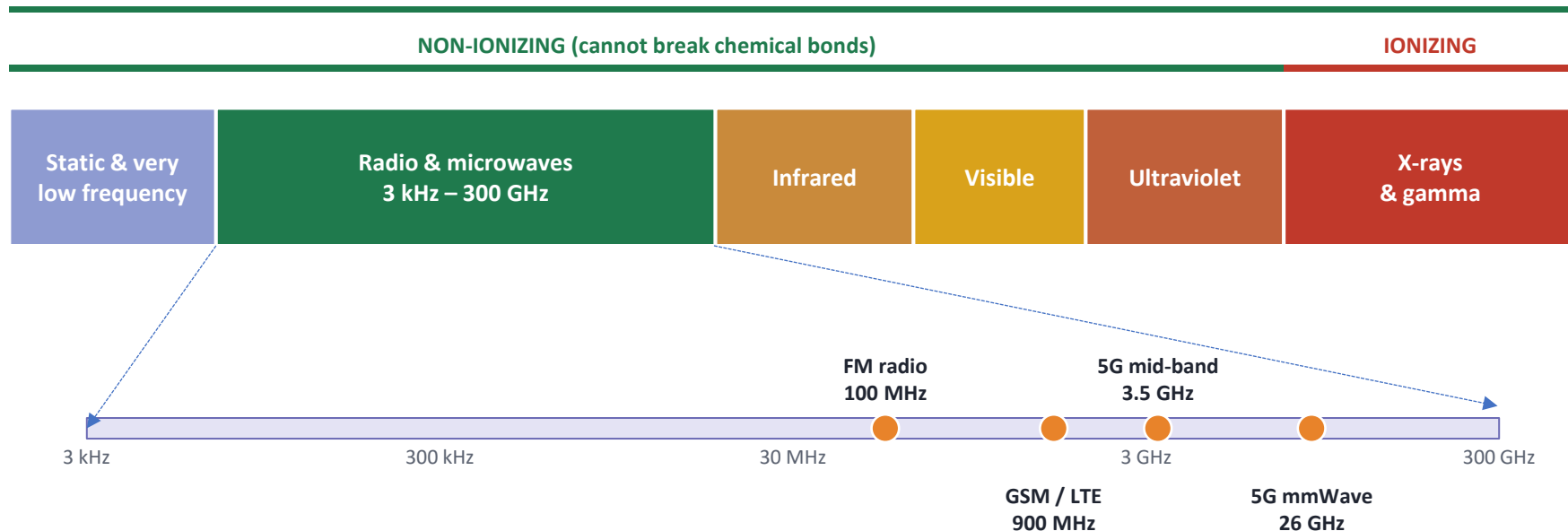
Limits on measurable external quantities (E, H, power density): practical screening levels.

5

Compliance

Within the reference levels: compliant. Above them: assess the basic restrictions in more detail.

Where do telecom emissions sit?



Non-ionizing

Photon energy is too low to break chemical bonds or ionize atoms.

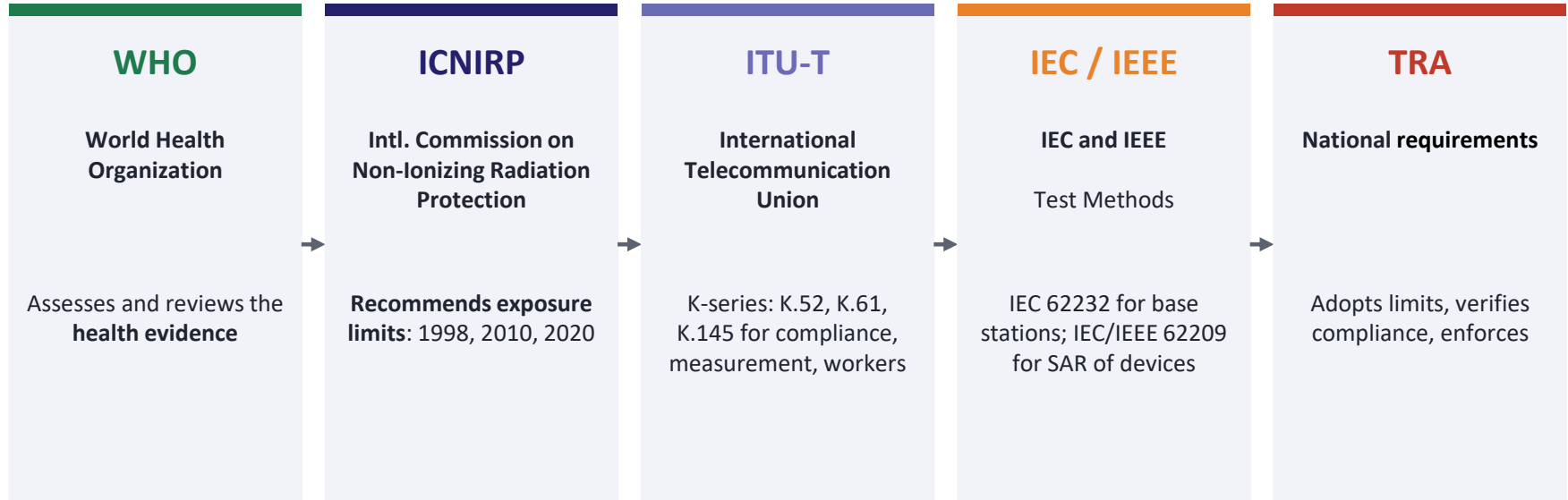
Established effects

RF: tissue heating, measured as SAR (W/kg).
Low frequencies: nerve stimulation.

Safety margins

ICNIRP effect threshold 4 W/kg whole body; limits are 10x lower for workers and 50x for the public.

Who sets the international standards?



Most countries, including the EU, follow ICNIRP recommendations.

Some set stricter national limits for precaution (e.g. Switzerland, Brussels).

ITU-T K-series: what each recommendation does

Recommendation	Purpose (summary)
K.52	Guidance on complying with exposure limits for installations (2024)
K.61	Guidance on measurement and numerical prediction of exposure near telecom installations (2025)
K.70	Mitigation techniques for exposure near multi-source sites (cumulative)
K.145	Assessment and management of exposure of workers at radiocommunication sites (2020)
K.153 / K.156	Supporting assessment practice for newer systems (2023, 2024)
K.160	Close-to-body devices, IoT and mmWave exposure assessment (12/2025)

Two Levels of Protection: Basic Restrictions & Reference Levels

The central technical distinction in any EMF compliance assessment

BASIC RESTRICTIONS

Inside-body exposure metrics

- Whole-body SAR (W/kg)
- Local SAR (W/kg)
- Absorbed power density (W/m^2)

REFERENCE LEVELS

External screening quantities

- Electric field E (V/m)
- Magnetic field H (A/m)
- Incident power density (W/m^2)

Below the Reference Level → screening passes | Above → detailed assessment, not automatic harm

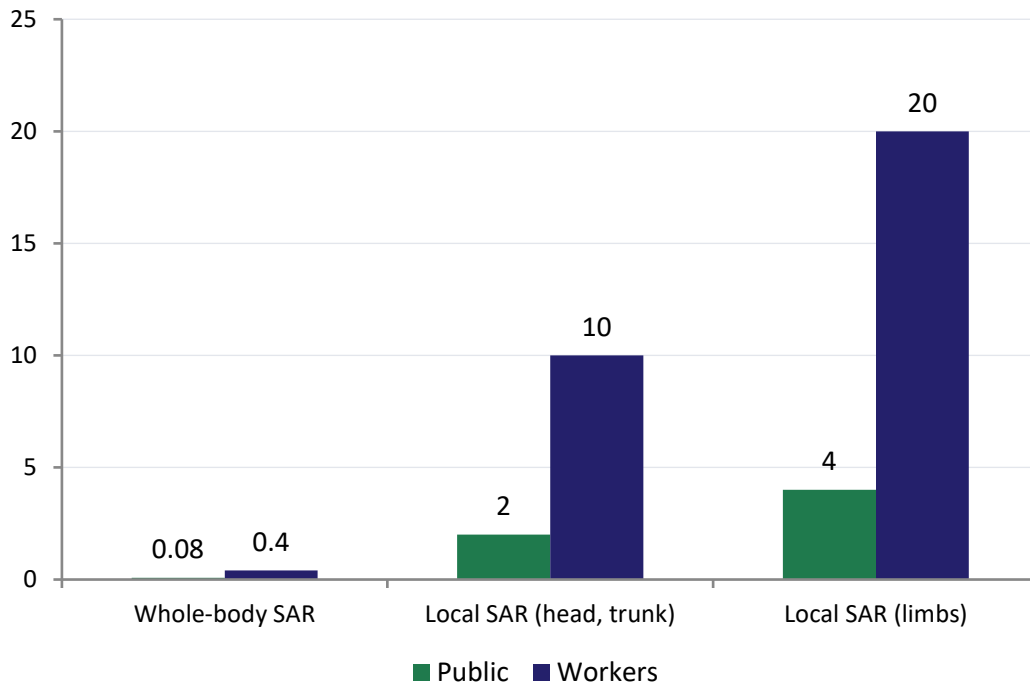
ICNIRP 2020: Public vs Occupational Basic Restrictions

Exposure quantity (frequency range)	GENERAL PUBLIC	OCCUPATIONAL (controlled exposure)	
 Whole-body SAR (100 kHz – 300 GHz) 30-minute averaging (whole body)	0.08 W/kg	0.4 W/kg	Basic Restrictions (inside the body) Based on established adverse health effects (heating and nerve stimulation)
 Local head/torso SAR (100 kHz – 6 GHz) 6-minute averaging (10 g tissue)	2 W/kg	10 W/kg	
 Local limb SAR (100 kHz – 6 GHz) 6-minute averaging (10 g tissue)	4 W/kg	20 W/kg	
 Local APD (> 6 GHz – 300 GHz) 6-minute averaging (4 cm ²)	20 W/m ²	100 W/m ²	
 Incident power density (> 2 GHz – 300 GHz) 30-minute averaging (whole body)	10 W/m ²	50 W/m ²	Reference Levels (measurable outside) Used for compliance screening

Whole-body averaging: 30 min • Local SAR: 6 min • APD: applicable spatial/temporal rules

Basic restrictions: public and workers

SAR limits, 100 kHz–10 GHz (W/kg, 6-min average)



Whole-body incident power density (>2–300 GHz)

Public: 10 W/m²

Workers: 50 W/m²

SAR: what is it?

$$\text{SAR} = \sigma E^2 / \rho$$

Absorbed RF power per kg of tissue. It is not the antenna's transmitted power.
 σ conductivity, E field in tissue, ρ density

Where the numbers come from

Public: $4 \div 50 = 0.08$ W/kg
 Workers: $4 \div 10 = 0.4$ W/kg
 (effect threshold 4 W/kg)

ICNIRP 2020: The Important 6 GHz Transition

Different quantities are used for local absorption below and above 6 GHz

100 kHz – 6 GHz

>6 GHz – 300 GHz

LOCAL SAR

W/kg • absorbed energy per tissue mass

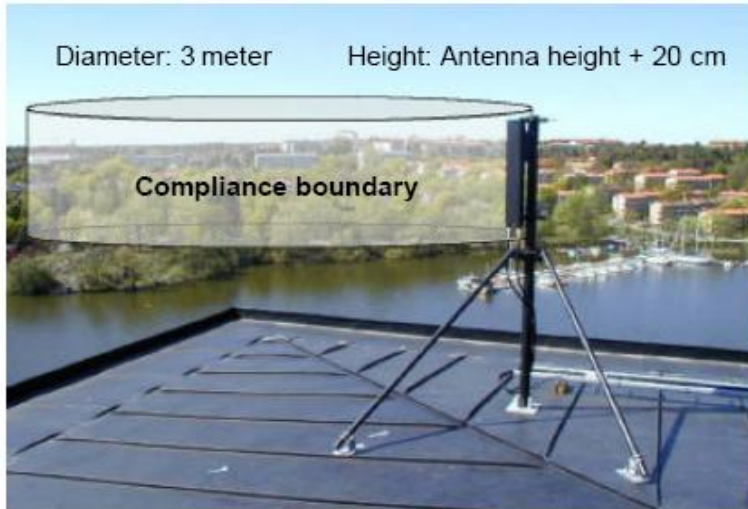
ABSORBED POWER DENSITY

W/m² • local superficial absorption

Whole-body SAR remains a Basic Restriction; the 6 GHz threshold does not define near/far field.

Occupational RF Safety: The Antenna Rooftop Is a Worksite

A person is not automatically an “RF worker” merely because they are employed



BEFORE WORK

- Identify active operators and antennas
- Define restricted/exceedance zones
- Train workers and control access
- Permit-to-work and coordinated shutdown
- Include electrical and fall hazards

“TRA is responsible to set standards and technical requirements applicable to all Telecom Equipment in order to prevent any harm to telecom networks and hazards to public health or safety”

- ❑ TRA drafted EMF regulation to protect the public and workers from adverse health effects arising from EMF exposure and to establish limits on human exposure to EMF in the frequency range 3 kHz to 300 GHz
- ❑ TRA issued Import and Type Approval certificates for “Radio Telecom & Terminal Equipment (RTTE)” that should be comply with the guidelines and limits set in TRA’s **“Human EMF exposure limit regulation”**
- ❑ TRA is following the recommendations of the “International Commission of Non-Ionizing Radiation Protection” (ICNIRP) adopted by WHO and ITU

Legal framework and the path to issuing the regulation

Law 431/2002, Article 21

TRA ensures telecom equipment does not cause damage to networks, safety or public health.

Law 431/2002, Article 23

TRA specifies and publishes the health impact of EMF exposure and the safety requirements equipment must meet to be used in Lebanon.

Path to issuing the “Human EMF Exposure Limit Regulation”



Who does what: operator duties and TRA powers

Operator duties

- 1 Wireless stations comply with the TRA's RTTE technical requirements
- 2 Consider all relevant factors; fully responsible for the accuracy of the evaluation
- 3 Measure at traffic peak; re-evaluate after any change in power or antenna gain
- 4 Mark restricted areas and post warnings around high-radiation sites
- 5 Respect the reference levels outside restricted areas
- 6 Reduce power or shut down, or provide effective protective equipment, for work in high fields
- 7 Act immediately: cut transmission power when high exposure is found

TRA powers

Verify

Direct measurement, type testing, calculation and modelling, or via an approved body

Require proof

Simulation or field measurement, declaration of compliance, or certificate from an approved body

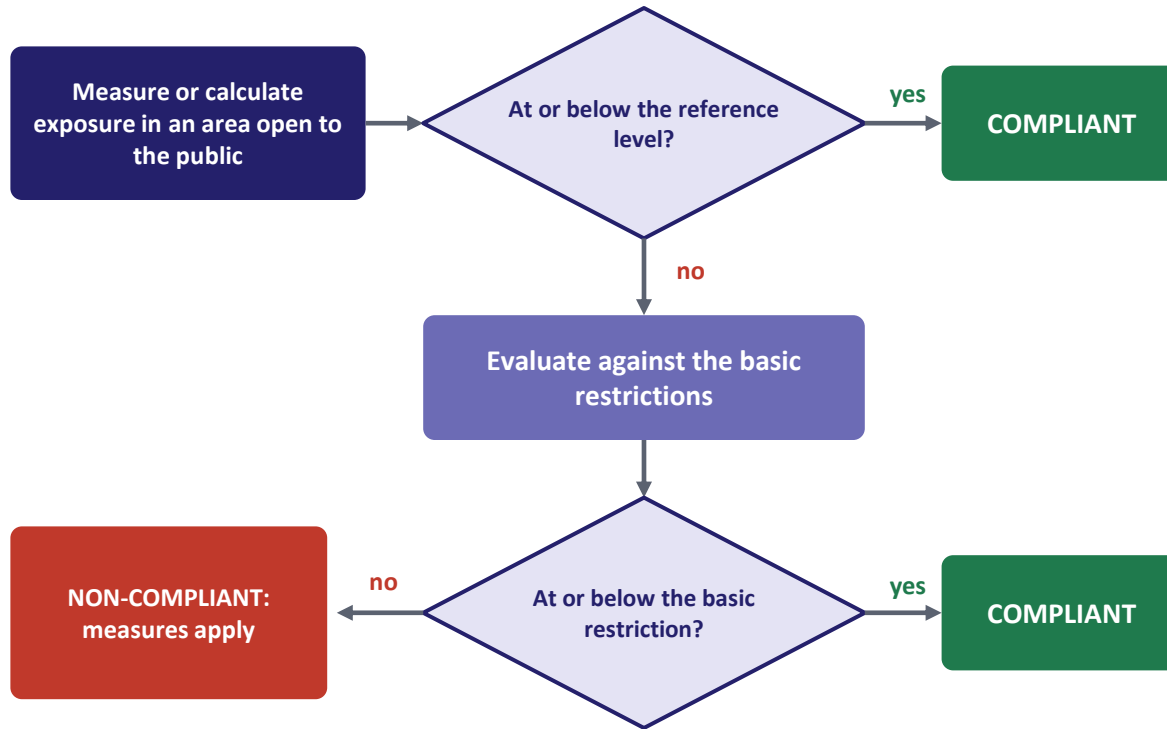
Enforce

Restrict public access, signs and warnings, engineering or administrative controls, penalties under Law 431, Section 7

Inform

Keep a compliance record, publish measurement studies, owners train exposed workers

How compliance is decided



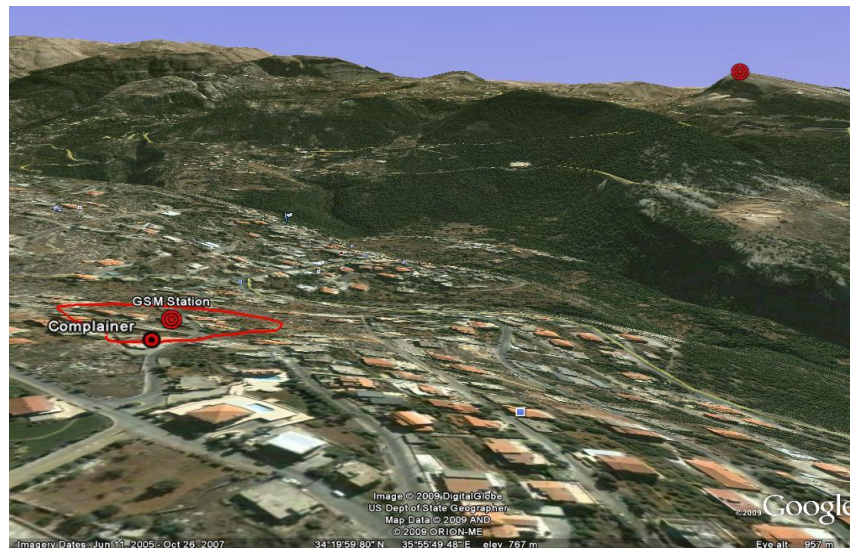
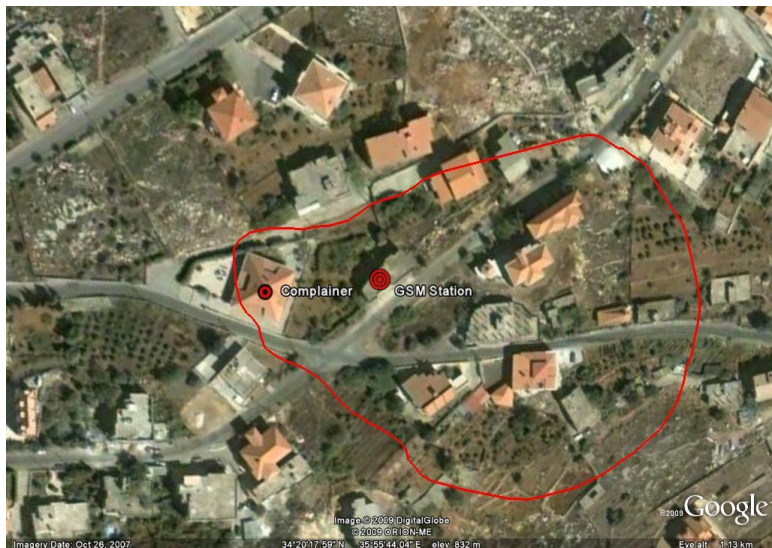
Workers held to the public limits

unless an evaluation shows no risk:

- Workers who share an area with the public
- Women who declared pregnancy
- Workers with metallic implants, pacemakers
- Workers without appropriate training

TRA Field Evidence: A Lebanese Village Case

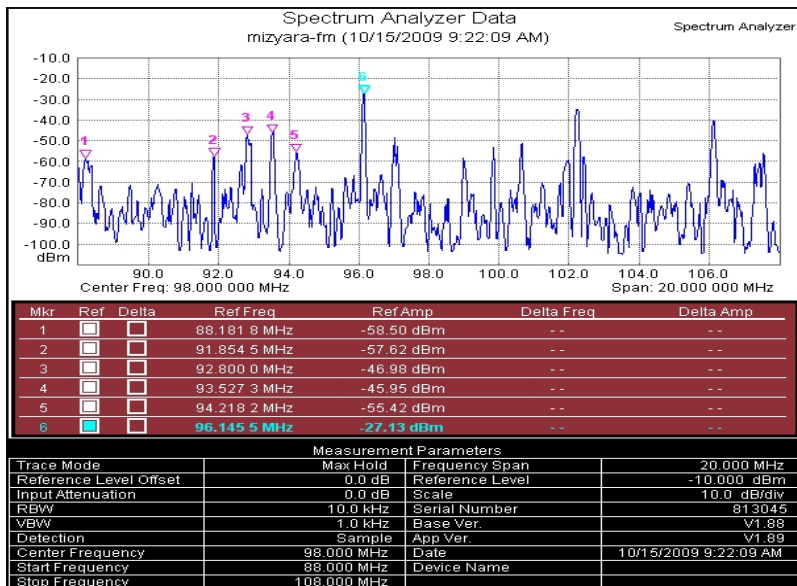
Historical field investigation — preserve as 2009 evidence, not a current national baseline



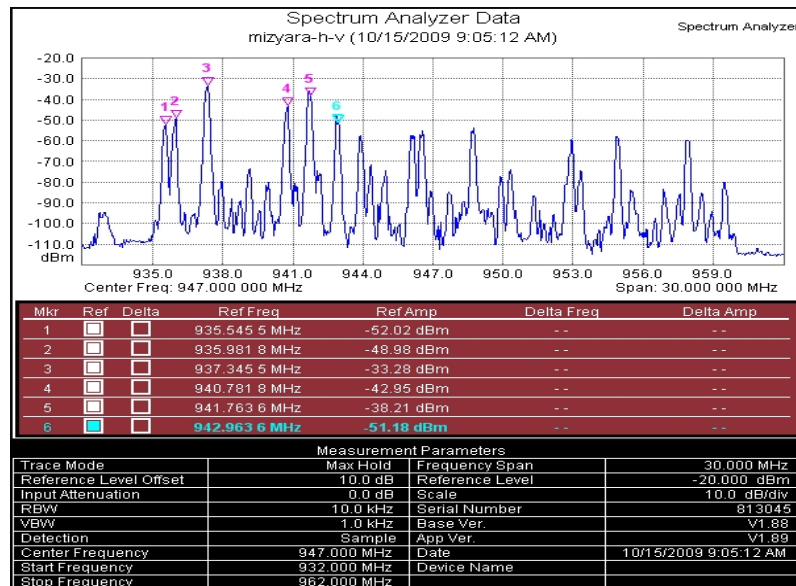
GSM site ~50 m • FM transmitters ~4.5 km • Both sources assessed

TRA Field Evidence: What the Spectrum Analyzer Found

Original historical frequency-selective measurements: FM and GSM were measured separately



GSM channels



FM channels

Electric Field Limit per Service

Electric Field Exposure limits based on ICNIRP 1998

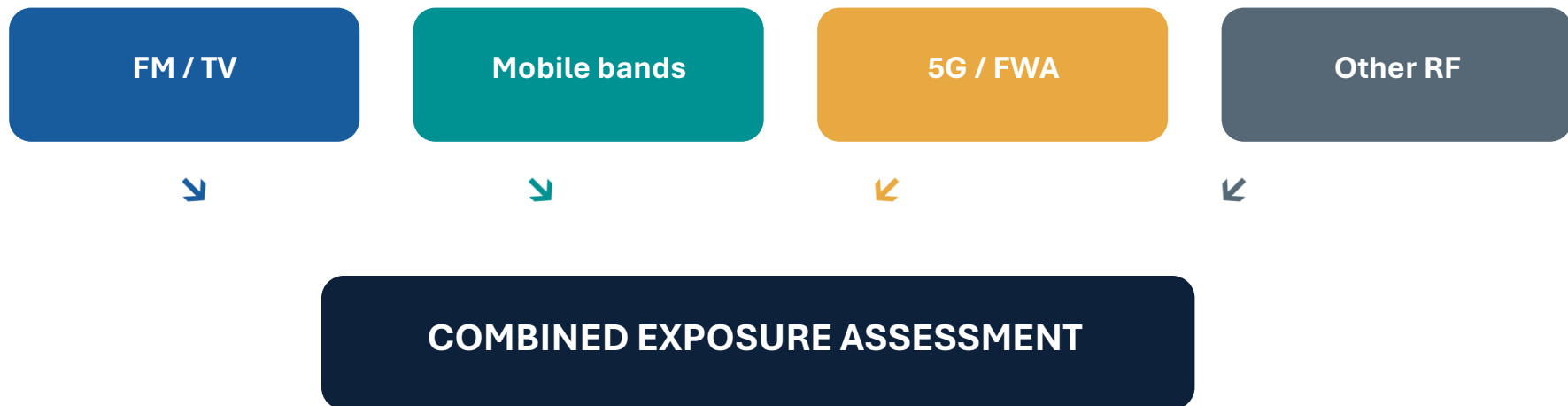
Service	Frequency range (MHz)	ICNIRP electric field limit V/m
FM	87 - 108	28
VHF	174 - 230	28
UHF	470 - 862	] 29.80 – 40.36 [
GSM 900	935 - 960	] 42.04 – 42.60 [
GSM 1800	1710 - 1785	] 58.85 – 58.09 [
UMTS	2210 - 2170	61
MBWA	2300 - 2400	61
Wimax 802.16e (MBWA)	2500- 2690	61
Wimax 802.16d (FBWA)	3400 - 3600	61

Case Study-Results

ARFCN #	dBm	E (v/m)	x^2	FM Ch#	dBm	E (v/m)	y^2
1	-33	0.12	0.0144	1	-27	0.025	0.00063
2	-38	0.065	0.0042	2	-35	0.01	0.0001
3	-43	0.035	0.0012	3	-41	0.005	2.5E-05
4	-49	0.017	0.0003	4	-46	0.0045	2E-05
5	-51	0.015	0.0002	5	-47	0.004	1.6E-05
6	-52	0.015	0.0002	6	-49	0.0038	1.4E-05
7	-56	0.008	6E-05	7	-51	0.0035	1.2E-05
8	-57	0.007	5E-05	8	-53	0.003	9E-06
9	-57	0.007	5E-05	9	-55	0.001	1E-06
10	-58	0.007	5E-05	10	-56	0.0009	8.1E-07
11	-59	0.006	4E-05	11	-58	0.00075	5.6E-07
12	-59	0.006	4E-05	12	-58	0.00075	5.6E-07
13	-60	0.005	3E-05	13	-58	0.00075	5.6E-07
		Total	0.0209	14	-58	0.00075	5.6E-07
				15	-59	0.00065	4.2E-07
$E_{\text{resultant}} = \sqrt{\sum_1^n E_n^2}$						Total	0.00083
		EGSM resultant	0.1446 v/m			EFM resultant	0.02875 v/m
	ICNIRP limit	42	290 Less		ICNIRP limit	28	974 Less

Cumulative Exposure: One Site, Several Sources

The combined assessment matters even when each transmitter appears compliant



$\sum (E_i / E_{RL,i})^2 \leq 1$ — where the applicable E-field summation rule is used

Combined, both sources

$W_t = \sum (E_i / E_{L,i})^2 \approx 0.000013$ (about 0.001% of the limit)

A phone at call set-up (0 dBm at 900 MHz) measured about 6 V/m, still below 41.25 V/m.

$$W_t = \left(\frac{0.1446}{41.25} \right)^2 + \left(\frac{0.02875}{28} \right)^2$$

$$W_t \approx 0.0000133$$

Non-Compliant Sites



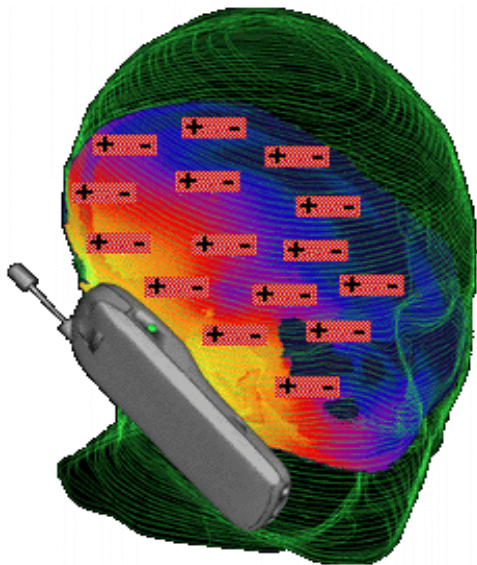
FM & TV stations broadcasting in front of residential Buildings Bad Connector out from FM transmitter

Where problems were actually found

- FM/TV transmitters broadcasting in front of residential buildings
- A faulty connector on an FM transmitter

Lesson: check broadcast sites and installation faults, not only mobile base stations.

Measurements with GSM Mobile Phone on 900 MHz



A max level of 0 dBm was measured during call set-up, which is equivalent to 6 v/m, compared to ICNIRP level (42 v/m)

International benchmark: key figures

Regulator	What is set	Status / date
ICNIRP (reference)	Public reference level above 2 GHz: about 61 V/m (10 W/m ²)	Guidelines 2020
Brussels (Belgium)	6 V/m, then 14.57 V/m outdoors and 9.19 V/m indoors	5G blocked in 2019; relaxed in 2021
Switzerland	No national ban; installation limits stricter than ICNIRP; adaptive-antenna guidance	FOEN guidance 23 Feb 2021; OFCOM validation 8 Jul 2021
Italy	15 V/m limit	(D.Lgs 48/2024)
WHO	No adverse health effect causally linked to wireless exposure below guidelines	5G Q&A; evidence reviews ongoing

Were 5G networks “banned”? The more accurate story

What actually happened

- Some local or regional permit freezes
- Very strict pre-existing limits (Brussels: 6 V/m)
- Delays pending validated measurement methods
- Not permanent national findings that 5G was unsafe

What happened later

- Methods validated; adaptive-antenna guidance issued (Switzerland 2021)
- Brussels relaxed its standard (14.57 V/m outdoors, 2021)
- Exposure monitoring and public reporting expanded
- Deployment proceeded under updated rules

Lesson for the TRA

- When a new technology does not fit an old method, update the method
- Do not confuse a measurement gap with a new health hazard
- Be transparent: publish measurements

WHO: no adverse health effect has been causally linked with exposure to wireless technologies; provided exposure stays below international guidelines, no public-health consequences are anticipated. Few studies exist at the higher 5G (mmWave) frequencies, so research continues.

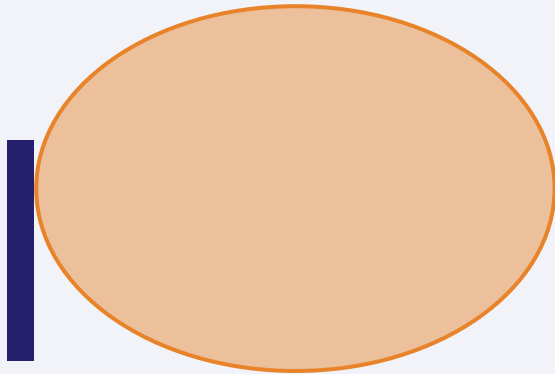
Lebanon 2026: new bands, new exposure questions

Band	Use today / proposed	EMF angle
700 / 800 / 900 MHz	Low bands: wide-area 2G/3G/4G coverage	Existing sites; cumulative budget
1800 / 2100 MHz	4G / 3G capacity	Existing sites; cumulative budget
2.3 / 2.6 GHz	Proposed refarming: 4G/5G FWA and mobile	More carriers per site
3.3 – 3.8 GHz	5G core band: about 100–200 MHz per baseline operator (proposal)	Massive MIMO, beamforming
26 GHz	mmWave: 1200 MHz (proposal)	Above 6 GHz: power-density limits

All licensees must comply with the EMF Exposure Limit and Radio Site regulations once duly issued.

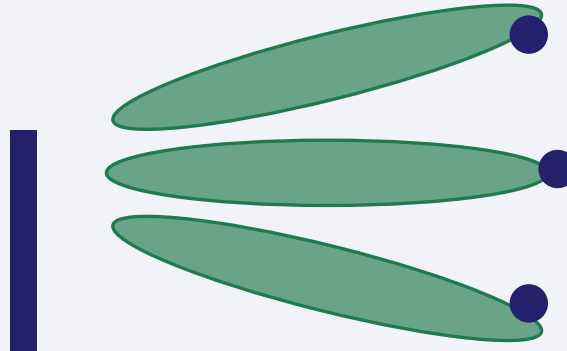
5G active antennas: the main new assessment challenge

Traditional sector antenna



Fixed wide pattern: the worst case is stable

5G massive MIMO / beamforming



Narrow beams follow users: exposure varies with traffic, direction and time

Base station site



Regulatory implication: exposure varies with traffic, beam direction, user distribution and time, so assessment needs conservative assumptions, extrapolation and time/space averaging, not a single instantaneous reading.

New technologies: same health framework, different scenarios

5G massive MIMO

Beam direction, traffic and time variability

→ Active-antenna modelling, extrapolation, time/space averaging

26 GHz / mmWave

More superficial absorption; metrics above 6 GHz

→ Incident / absorbed power density and suitable instruments

IoT / M2M

Many low-power devices with new duty cycles

→ Classify by power, duty cycle, separation; low-power exclusions

Wearables

Very small separation from the body

→ SAR or power-density metrics under realistic use

Small cells

Dense networks, lower individual powers

→ Simplified assessment where justified, plus the cumulative environment

Private 5G / Wi-Fi 7

More indoor, non-operator deployments

→ Apply EMF obligations to all relevant site operators

Key principle: technology-aware assessment methods.

What the health evidence says today

What the limits protect against

- RF heating of tissue (SAR)
- Nerve stimulation at low frequencies
- Limits sit 10 to 50 times below the effect threshold

Latest reviews (2024–2025)

- WHO-commissioned systematic reviews: mobile phone use near the head likely does not increase brain and head-and-neck cancer risk
- ICNIRP: the 1998 restrictions remain protective

Still under study

- WHO is preparing an updated RF-EMF health-risk assessment
- IARC: Group 2B (2011); re-evaluation planned in 2025–2029
- Research focus: mmWave, long-term exposure, active antennas, close-to-body devices, 6G

The TRA verifies compliance with international limits, publishes results and follows the evidence.

ICNIRP 2020: what changed from 1998?

Topic	ICNIRP 1998 (TRA 2010)	ICNIRP 2020
Range	0 – 300 GHz	RF part: 100 kHz – 300 GHz
Whole-body SAR	Public 0.08, workers 0.4 W/kg	Retained; applies up to 300 GHz
Local SAR (head, trunk)	Public 2, workers 10 W/kg	Retained, up to 6 GHz
Above the transition	Incident power density above 10 GHz: 10 / 50 W/m ²	Absorbed power density above 6 GHz: 20 / 100 W/m ²
Averaging time	6 minutes	Whole body 30 min; local 6 min
Short exposures	Not specified in detail	New restrictions for exposures under 6 minutes
Reference levels	Whole-body focus	Expanded: near field and local

ICNIRP's conclusion

The main 1998 restrictions remain protective and were mostly retained.

For the TRA

Keep the ICNIRP-based approach. Update the numbers, terms and averaging, especially for 26 GHz and above 6 GHz.

TRA EMF modernization program

1 Regulation

ICNIRP 2020, updated scope,
worker-safety provisions

2 5G / active antennas

Beamforming and active-antenna
procedure

3 Measurements

Lebanon baseline plus repeat
audits

4 Cumulative

Multi-operator, multi-site
exposure index

5 26 GHz

mmWave / above-6 GHz annex

6 IoT

Wearable / close-body pathway
(K.160)

7 Transparency

EMF database, map and
complaint workflow

8 Future-proof

Technical review every 2–3 years

Technology limits + technology-aware methods + cumulative monitoring + transparent enforcement

How the TRA can assess a base station today



The key is not “measure everywhere”: it is a proportionate, documented compliance process.

The TRA already built the regulatory foundation.

The task now is not to reinvent EMF regulation, but to update annexes, methods and monitoring for today's networks.

RETAIN

- Article 23 mandate and ICNIRP-based approach
- Public vs occupational exposure
- Basic restrictions and reference levels
- Multiple-source (cumulative) assessment
- Operator responsibility, TRA verification and enforcement
- Restricted areas, signage and worker controls

UPDATE AND ADD

- ICNIRP 2020 limits and averaging rules
- Current ITU-T and IEC references
- 4G/5G active-antenna and beamforming procedures
- IoT, Wearables, Satellite Communications and the Evolution Toward 6G
- Standard operator submissions, risk-based audits
- EMF database and public reporting
- Consider national exposure levels, where needed, in coordination with the Ministry of Public Health and relevant authorities

Protect public health • Enable modern networks • Verify compliance • Communicate transparently