



EMF mitigation of mobile networks

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Nokia & GSMA position about 5G and EMF

Publicly available resources

Position Statement

(www.nokia.com/sustainability)

NOKIA

Exposure to radio waves

Position statement

Nokia designs wireless network products that both transmit and receive radio frequency (RF) energy. We ensure that our product portfolio — including macro cells, small cells, which support 2G/3G/4G/5G mobile radio access technologies and other technologies such as Wi-Fi — comply with established national and international standards and regulations on RF exposure. We provide installation procedures and training to those working for and with Nokia to ensure that equipment is installed correctly and that the resulting radio wave exposure levels comply with established exposure limits.

We engage with customers and partners about RF exposure from our products and provide detailed instructions to ensure they are knowledgeable to operate equipment appropriately to keep both the general-public and workers' exposure levels below the established exposure limits.

Since the 1990s we have supported the development of global RF exposure assessment standards through participation in international standardization bodies such as the International Electrotechnical Commission (IEC), the International Telecommunication Union (ITU) and the European Committee for Electrotechnical Standardization (CENELEC).

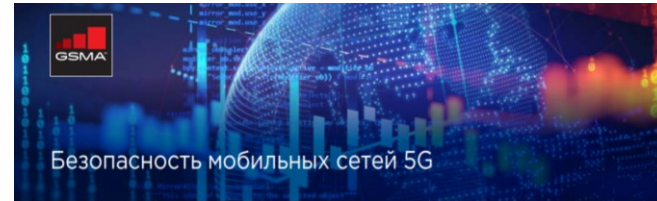
We track the reports published by expert committees mandated by national and international authorities to assess the advancement of scientific knowledge about human exposure to radio waves. These reports have been consistent in concluding there is no established health effect from exposure to RF fields below the limits set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the international commissions recognized by the World Health Organization (WHO) or similar recommendations from the Institute of Electrical and Electronics Engineers (IEEE).

The following WHO statements apply to mobile and wireless network technologies implemented by Nokia:

- WHO's Fact Sheet 304 extracts:

GSMA brochures & leaflets

(www.gsma.com/publicpolicy/emf-and-health/safety-of-5g-networks)



5G — это новое поколение мобильных технологий, которое преобразит роль мобильной связи в жизни общества, изменив нашу повседневную и рабочую деятельность. Радиосигналы, используемые в 5G, схожи с используемыми в современных технологиях; кроме того, в их отношении действуют те же международные стандарты безопасности, которые стоят на защите всех людей и окружающей среды.

5G — эволюционная технология мобильной связи, которая открывает множество новых возможностей
5G — это новое поколение мобильной связи. Благодаря гибкой скорости передачи данных, низкому времени задержки и высокой степени надежности эта технология делает возможной работу с новыми сервисами. Кроме того, сеть обеспечит эффективную поддержку большого количества подключений, раскрывая потенциал технологий Интернета вещей (Internet of Things, IoT). Интеллектуальные технологии 5G сделают нашу повседневную жизнь и работу удобнее и проще. Первые сети 5G были запущены в 2018 году, а к 2025 году планируется перевести на 5G-технологии примерно 15% глобального рынка связи.

В отношении 5G действуют современные международные стандарты безопасности
Радиосигналы, используемые технологиями мобильной связи, тщательно изучаются на протяжении нескольких десятилетий. Именно результаты этих научных исследований легли в основу международных стандартов безопасности, действующих в отношении радиосигналов. Эти стандарты также рассматривают все виды частот, характерные для 5G.
Государственные организации здравоохранения и группы экспертов не имеют оснований считать, что обеспечить защиту всех людей (включая детей) от всех установленных рисков для здоровья можно путем соблюдения международных стандартов.

Согласно заключению государственных организаций здравоохранения, использование 5G-технологий не связано с риском для здоровья

Австралия:
«Несмотря на то что сеть мобильной связи 5G является новшеством для нас, это никак не повлияло на соблюдение ограничений, связанных со стандартами безопасности, на наше понимание того воздействия, которое эти технологии могут оказывать на здоровье, а также на необходимость расширения научно-исследовательской деятельности в этом направлении». (ARPANSA, 2019 г.)

Европейский союз:
«Строгие и надежные ограничения по воздействию электромагнитных полей, рекомендованные на уровне ЕС, распространяются на все частотные диапазоны, которые в настоящее время предусмотрены для 5G». (Европейская комиссия, 2017 г.)

Норвегия:
«Измерения показывают, что общий объем воздействия на нас от мобильных и радиопередающих устройств является слабым, мы используем новые технологии, считающиеся оптимальными для здоровья. У нас нет

Exposure to Radio Waves and 5G Competent Authority Statements

“From all evidence accumulated so far, no adverse short- or long-term health effects have been shown to occur from the RF signals produced by base stations.”

“Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak radio frequency signals from base stations and wireless networks cause adverse health effects.”



“Contrary to some claims, there are no established health effects from the radio waves that the 5G network uses.”

“Protection of public health is of a paramount importance and is always taken into account in the Commission’s proposals and initiatives, including those on 5G.

In particular, the strict and safe exposure limits for electromagnetic fields recommended at EU level by Council

Recommendation 1999/519/EC on the exposure of the general public to electromagnetic fields apply for all frequency bands currently envisaged for 5G.”



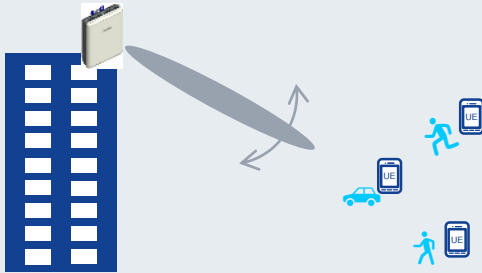
EUROPEAN
COMMISSION

“The ICNIRP RF EMF guidelines (...) protect against all potential adverse health effects relating to exposure to RF EMFs from 5G technologies.”

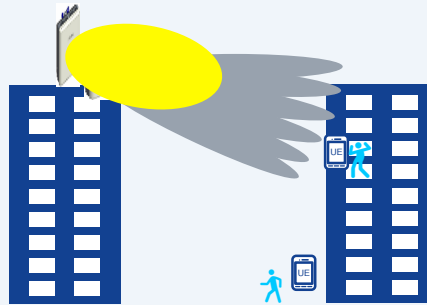
EMF exposure mitigation constraints with the introduction of 5G

Challenges

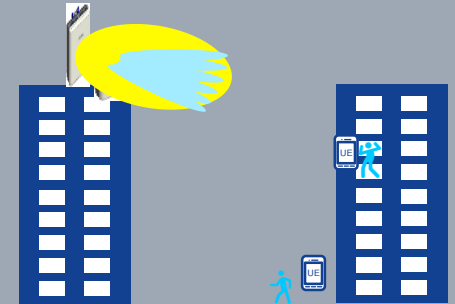
Beamsteering antennas using narrow beams
with high gain



Compliance using Pmax (today)



Towards compliance using the actual max
approach (International Electrotechnical
Commission - IEC)



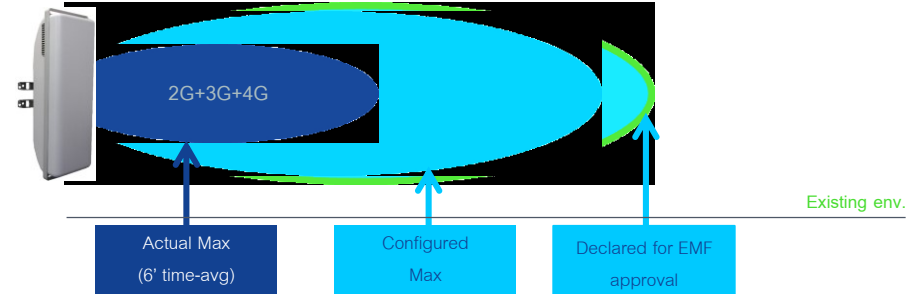
Impacts RF compliance of all equipment on site → BS with fixed and steerable beams

Traditional compliance assessment prevents adding 5G to the sites

Max nominal power vs actual max power

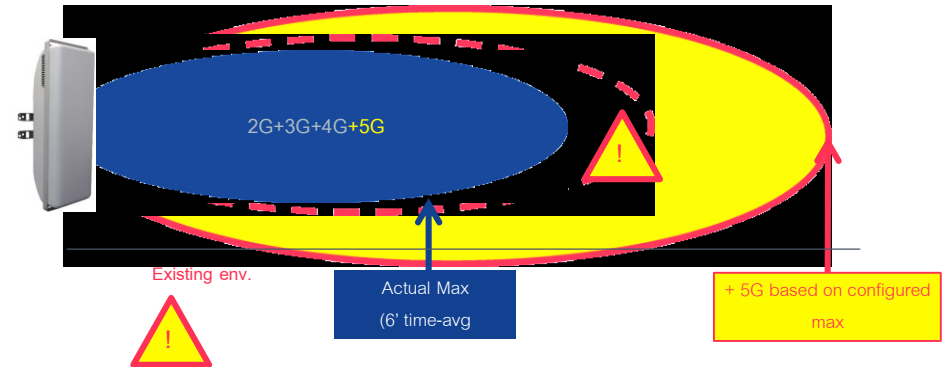
Today

- IEC 62232:2017 assessment method based on Pmax
- Declared compliance boundary and EIRP budget are full with 2G+3G+4G
- Conservative approach, as base stations transmit with **much lower power due to load variation (average load <100 %)**



With 5G

- EIRP budget based on Pmax is exceeded
- Actual EIRP based on 6-minute time-averaging is still compatible with previous compliance boundaries



RF exposure compliance standardization

Governing rules

RF exposure limits

ICNIRP and IEEE

ICNIRP guidelines “remain protective”

Basic restrictions

- Related to tissue absorptions
- SAR (<6 GHz) and S (>6 GHz)

Reference levels

- E-field / power density (S)
- More restrictive in some countries

Time averaging

- 6 or 30 minutes

Compliance assessment

IEC 62232:2017

Types

- Product compliance (vendor)
- Product installation compliance (operator)
- In-situ survey (regulator, all)

Assessment methods

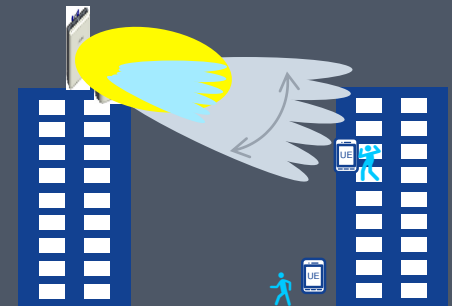
- In-situ & lab measurements
- Computations
- Time & spatial averaging tech.
- Introduction of statistical approaches for compliance based on actual max power

Compliance approach based on actual

max

IEC TR 62669:2019

- General guidelines and steps
- Better represent real service (incl. time averaging)
- Address massive MIMO challenges



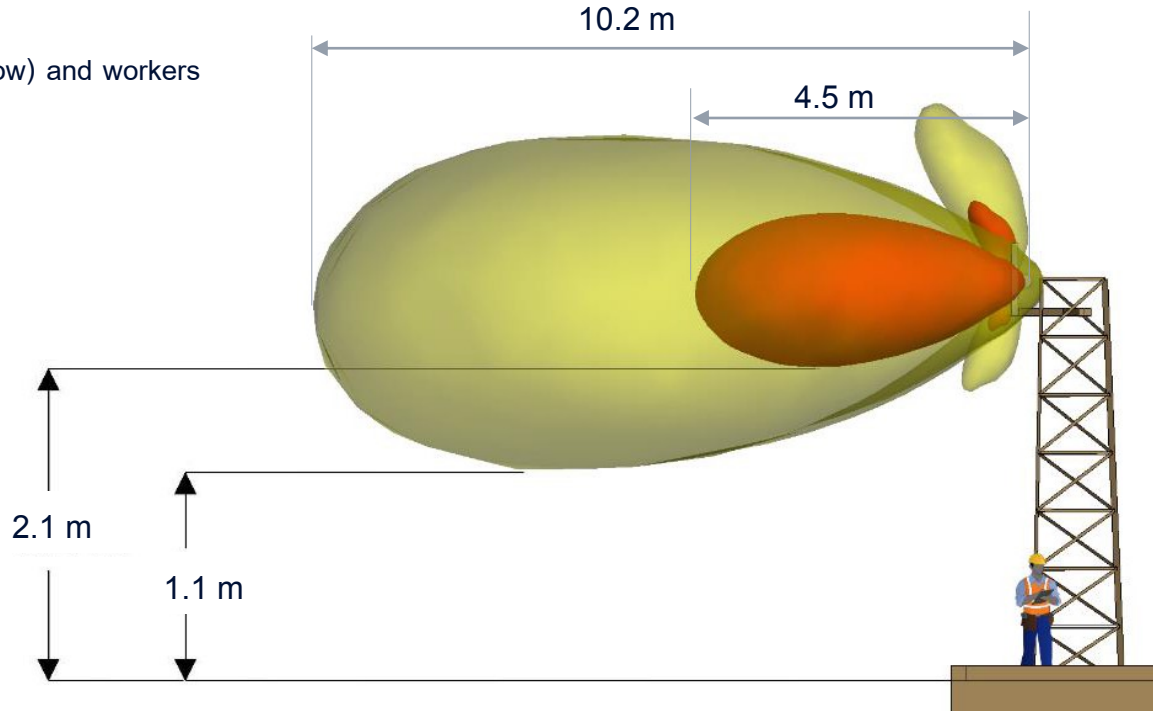
Example: exclusion zones for the general public and workers for 5G BS

IEC TR 62669:2019

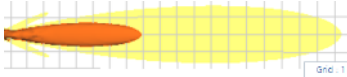
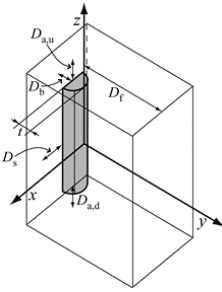
Compliance boundaries for the general public (yellow) and workers (red) around the 5G 3.5 GHz base station

Actual max power 50 W of 5G BS (averaged over 6 minutes) @

- 200 W rated max power
- duty cycle of 0.75 (DL ratio)
- power reduction factor of 0.32 (due to load variation)



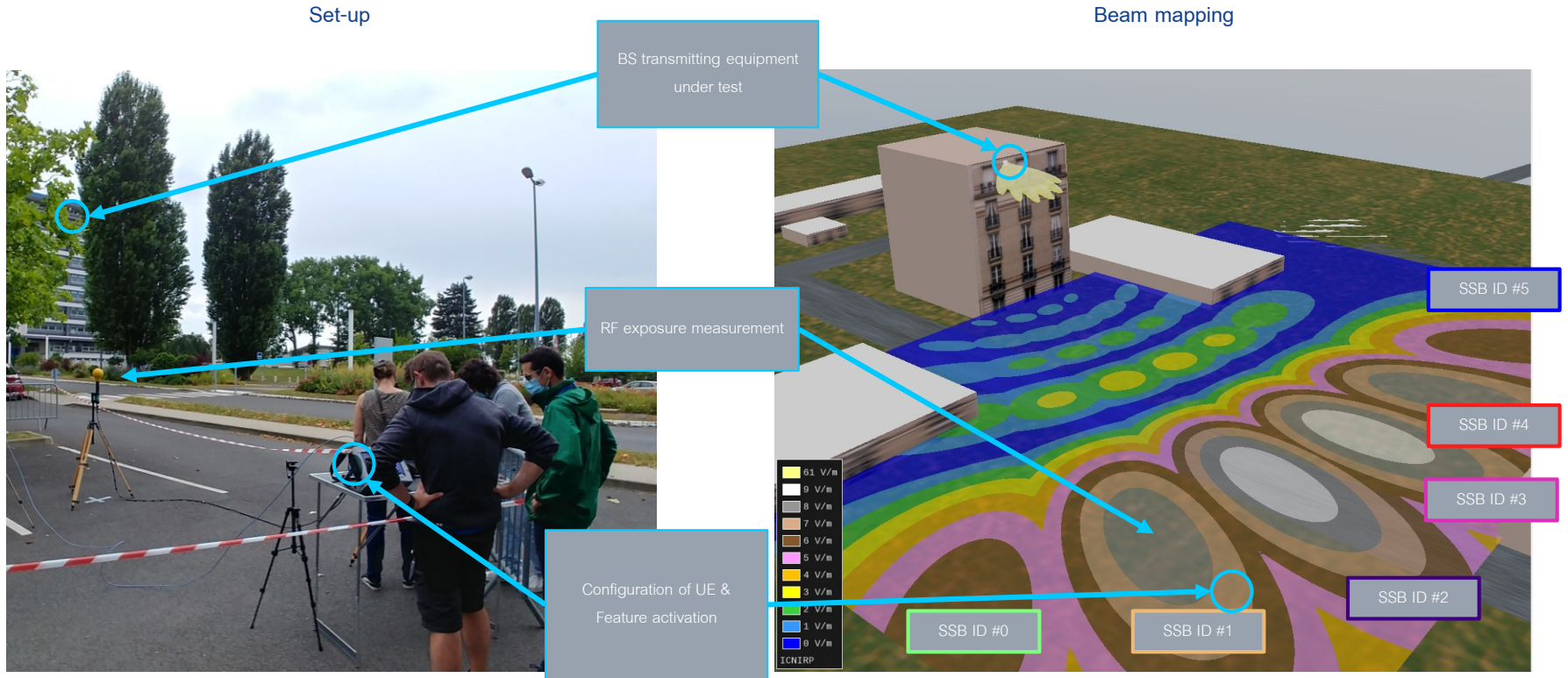
Compliance distances provided for rated max power and actual max power performed for certification (FCC, IC, CE, ARPANSA) and delivered to customers



	Rated max Tx power 200 W		Actual max Tx power 50 W	
	General Population /Uncontrolled Exposures	Occupational /Controlled Exposures	General Population /Uncontrolled Exposures	Occupational /Controlled Exposures
RF-EMF power density exposure limits	10 W/m ²	50 W/m ²	10 W/m ²	50 W/m ²
Distance in front (Df)	20.5 m	9.1 m	10.2 m	4.5 m
Distance to the side (Ds)	9.8 m	4.3 m	4.8 m	2.0 m
Distance below and above (Da,d and Da,u)	4.8 m	2.1 m	2.1 m	1.1 m
Distance to the side (Dsc)	10.0 m	4.5 m	5.0 m	2.2 m
Distance below and above (Ddc and Duc)	5.2 m	2.5 m	2.5 m	1.5 m

Field performance tests

Test set-up and beam mapping



Field performance tests

EMF test mode vs. testing with CPE



EMF Test Mode (100% PDSCH load)

Beam-IDs	E-field
2	8,4 V/m
1,2	5,9 V/m
1,2,3,6	4,0 V/m
0,1,2,3,4,5,6,7	3,1 V/m
0% PDSCH load	0,2 V/m

Actual maximum approach
6 dB power reduction factor

UE download with iPerf

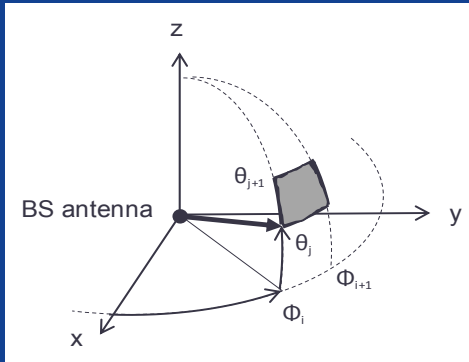
Download duration	File size	Time-averaged E-field (6 min)
0	0	0,28 V/m
19 s	1 GB	1,6 V/m
190 s	10 GB	4,8 V/m
6 min	max	8,2 V/m

Nokia EMF mitigation features

Monitoring and control of the actual EIRP in 3G, 4G and 5G

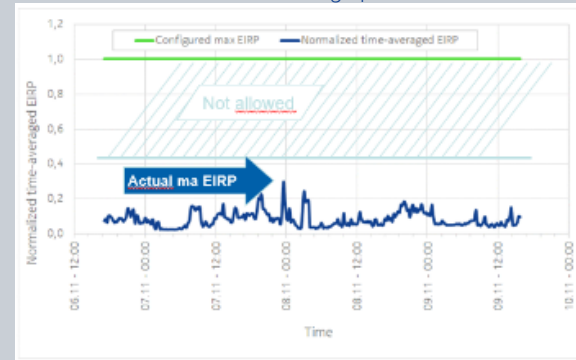
Nokia EMF monitoring

Actual EIRP counters are available per cell segment



Nokia EMF control

Ensure that actual EIRP thresholds per cell segment are not exceeded during operation

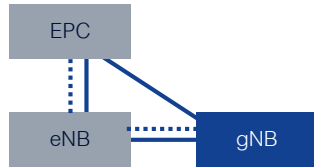


5G Architecture Flexibility

Ready for easy introduction

5G Non-Standalone Architecture (NSA)

Reuse existing infrastructure



- Mainstream
- No site densification

- 4G/5G dual connectivity
- Leveraging existing 4G deployments
- Tight interworking with 4G
- 4G core reuse
- Uplink improvement with existing 4G coverage

5G Standalone Architecture (SA)

New use cases



- 5G core (5GC)
- High performance
- Low latency
- Network slicing

