EXHIBIT 13

RF EXPOSURE ASSESSMENT

Section 27.52 RF Exposure Requirement

Licensees and manufacturers are subject to the radio frequency radiation exposure requirements specified in sections 1.1307(b), 2.1091, and 2.1093 of this chapter, as appropriate. Technical information showing the basis for this statement must be submitted to the Commission upon request.

Section 1.1307 (b) Environmental Assessment Requirement for Equipment Authorization

Commission actions granting construction permits, licenses to transmit or renewals thereof, equipment authorizations or modifications in existing facilities, require the preparation of an Environmental Assessment (EA) if the particular facility, operation or transmitter would cause human exposure to levels of radiofrequency radiation in excess of the limits in §§ 1.1310 and 2.1093 of this chapter.

Response

The RF exposure assessment report is attached.

RF exposure compliance assessment

LTE massive MIMO Adaptive Antenna Products – AAHC & AAHE

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1 General content

This test report is addressing human exposure to radiofrequency electromagnetic fields (RF-EMF) transmitted by the following LTE massive MIMO Adaptive Antenna (MAA) Products (see §2.2):

- Nokia AirScale MAA 64T64R 128 AE B41 120 W AAHC
- Nokia AirScale MAA 64T64R 128 AE B41 120 W AAHE

It provides the RF exposure compliance boundaries for these products regarding both general population and occupational exposure. Outside of these compliance boundaries, human exposure to RF-EMF is below the limits defined by the Federal Communications Commission (FCC) (see §2.1).

2 References

2.1 Applicable RF exposure standards and regulations

[1] US FCC 47CFR 1.1310 “Radiofrequency radiation exposure limits”.

[2] US FCC OET Bulletin 65, “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields and its supplements”, edition 97-01, August 1997.

[3] IEC 62232:2017, “Determination of RF field strength, power density and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure”.

2.2 Product and assessment method

[4] Nokia, “Massive MIMO Adaptive Antenna Product Description” DN207523773, Issue 02, 16-04-2018.

[5] Nokia, “AAHC – Antenna Test Report”, D562226014, 28-06-2018.
[Note: this report is also applicable to AAHE]

[6] Microwave Vision Group (MVG), “EMF Visual Version 3.03 User Manual”, EMF/11 - 01.135/A – v3.

[7] Z. Altman, B. Begasse, C. Dale, A. Karwowski, J. Wiart, M. Wong and L. Gattoufi, “Efficient models for base station antennas for human exposure assessment”, IEEE Trans. Electromagnetic Compatibility, Nov 2002, vol.44, pp. 588-592.

[8] P. Baracca, A. Weber, T. Wild and C. Grangeat, “A Statistical Approach for RF Exposure Compliance Boundary Assessment in Massive MIMO Systems”, WSA 2018, https://arxiv.org/abs/1801.08351.

[9] IEC TR62669, “Case studies supporting the implementation of IEC 62232” (under development by IEC TC106 MT3).

3 RF exposure limits

The applicable RF exposure limits are derived from [1]. The RF compliance assessment is performed using the Maximum Permissible Exposure (MPE) levels recalled in Table 1.

Table 1 – Applicable Maximum Permissible Exposure levels in B41 band (from [1])

	General Population/Uncontrolled Exposures	Occupational/Controlled Exposures
Power density	10 W/m²	50 W/m²

4 Description of the equipment under test (EUT)

The main technical characteristics of AAHC and AAHE products are reproduced in Table 2 and Table 3.

Table 2 – AAHC product general technical characteristics

Product name	AirScale MAA 64T64R 128AE B41 120W
Model number	474155A
Rated max Tx power	120 W
Number of TXRX	64TX64RX
Beamforming	Yes
SW supported techno.	TD-LTE
Frequency range	2496 – 2690 MHz (3GPP Band 41)
Nb of antenna elements	8 (horizontal) x 8 (vertical)
Distance between AE	57.5 mm (horizontal) x 80 mm (vertical)
Gain	24 dBi
EIRP	74.8 dBm

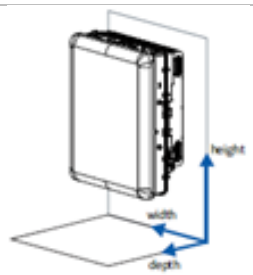
Beam steering range	± 60° (horizontal) and ± 20° (vertical)	
Dimensions	Height: 651 mm (25.6 in.) Depth: 245 mm (9.6 in.) Width: 501 mm (19.7 in.) Note: includes front covers.	
Technology duty cycle factor	75 %	
Transmitted power tolerance	1.5 dB	

Table 3 – AAHE product general technical characteristics

Product name	AirScale MAA 64T64R 128 AE B41 120 W AAHE
Model number	474658A
Frequency range	2630 – 2690 MHz
The other characteristics are the same as AAHC (see Table 2).	

Antenna pattern characteristics provided in Table 4 have been derived from the antenna test report [5].

Table 4 – Measured antenna gain characteristics for various beam steering directions (from [5])

Azimuth	Elevation	Gain (dBi)		
		2496 MHz	2605 MHz	2690 MHz
0°	**-3°**	23.1	**23.4**	**23.4**
0°	-17°	20.7	21.4	21.1
0°	-23°	20.0	20.6	20.4
10°	-17°	20.8	21.6	21.6
10°	**-23°**	20.0	20.9	**21.0**
60°	**-3°**	20.5	20.48	**20.7**
60°	-13°	19.3	19.3	19.3

In order to provide a conservative assessment on the frequency range, we performed the calculation at the central frequency (i.e. 2605 MHz) scaled to the maximum gain over the whole frequency band (indicated in bold letters in Table 4). The compliance boundary is defined by the box shape perimeter shown in Figure 4 of IEC 62232:2017 [3] and displayed in Figure 1. The distances Df, Ds, Da,u and Da,d are taken from the nearest point of the antenna. For convenience, the distances Dsc, Duc and Ddc (respectively) taken from antenna center are also provided.

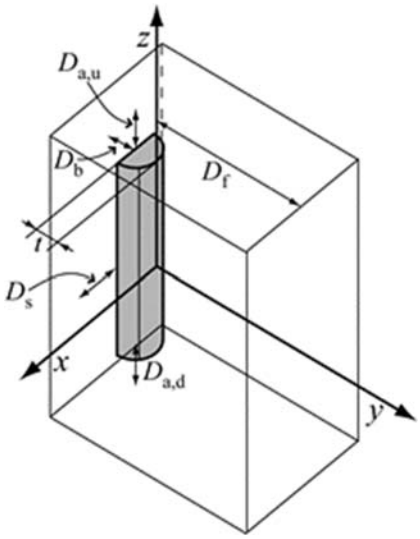


Figure 1 – Shape of the compliance boundary used for the RF exposure compliance assessment (from [3]).

5 RF exposure assessment method

RF exposure assessment is performed using the synthetic model computation method defined in B.4.4.1 of IEC 62232:2017 [3]. Calculations are performed with the "EMF Visual" software release 3.03 (see [6] and [7]).

The validation of the model is performed in the configuration with the beam in front (azimuth = 0° and elevation = 0°). The validation results are provided in Table 5.

Table 5 – Validation of the antenna model at 2605 MHz

	Product (from [5])	Model	Deviation
Gain	23.4 dBi	23.4 dBi	0
Horizontal half-power beamwidth	12.7°	15°	2.3°
Vertical half-power beamwidth	9.2°	10°	0.8°

For each configuration, the directivity pattern is derived from the simulation model and the antenna gain is adjusted to match exactly the measured values for accurate scaling.

The RF compliance distances are provided for the time-averaged maximum transmitted power of 127 W and, for information, the time-averaged actual maximum transmitted power of 32 W taking a 95th percentile approach as defined in [8] and [9]. These values include a technology duty cycle factor of 75 % (see Table 2) for time averaging and a power tolerance of 1.5 dB due to electronic component dispersion and operational environmental conditions (temperature).

6 RF exposure computation results

The computed power density distributions are displayed in Figure 2 to Figure 7.

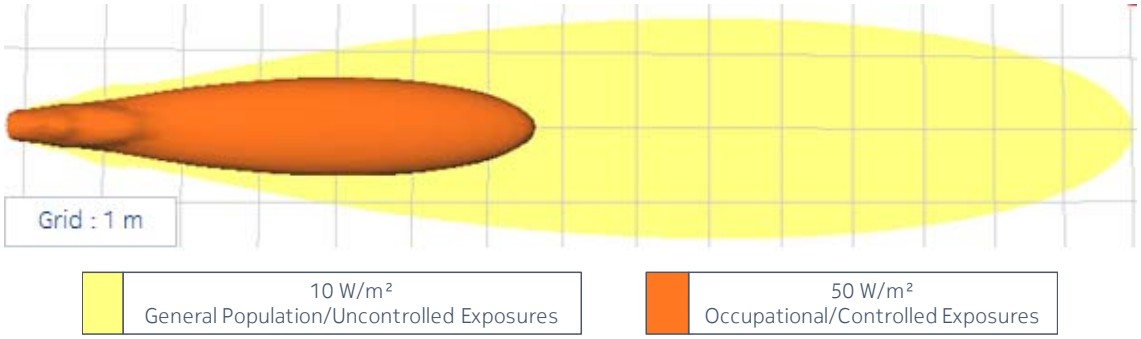


Figure 2 – Top view of the power density for the time-averaged maximum transmitted power of 127 W and the beam oriented in azimuth = 0° & elevation = - 3°

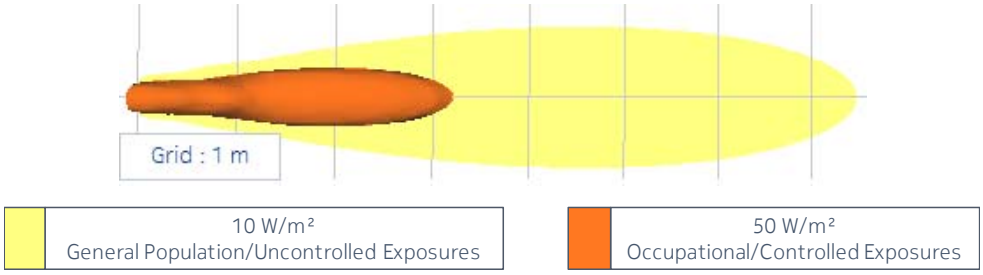


Figure 3 – Top view of the power density for the time-averaged actual maximum transmitted power of 32 W and the beam oriented in azimuth = 0° & elevation = - 3°

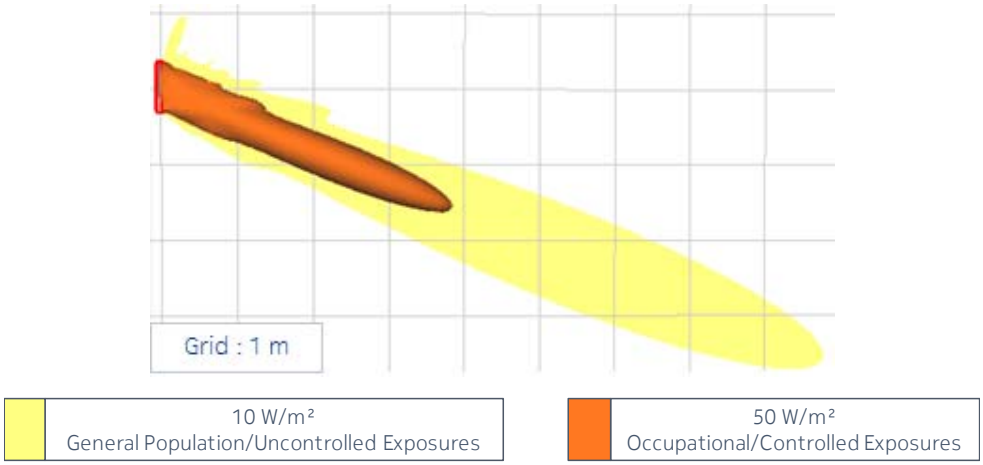


Figure 4 – Side view of the power density for the time-averaged maximum transmitted power of 127 W and the beam oriented in azimuth = 10° & elevation = - 23°

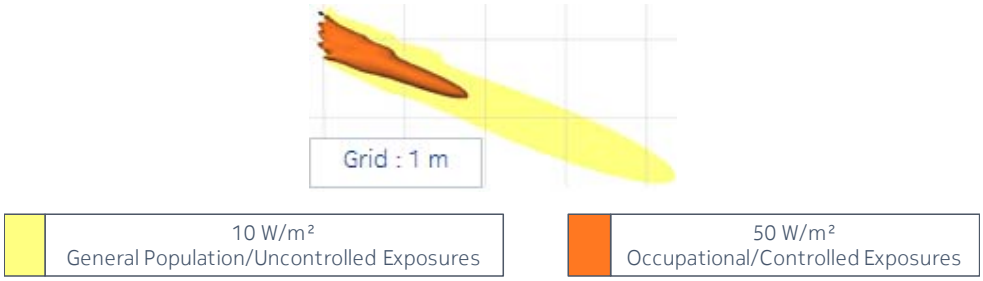


Figure 5 – Side view of the power density for the time-averaged actual maximum transmitted power of 32 W and the beam oriented in azimuth = 10° & elevation = - 23°

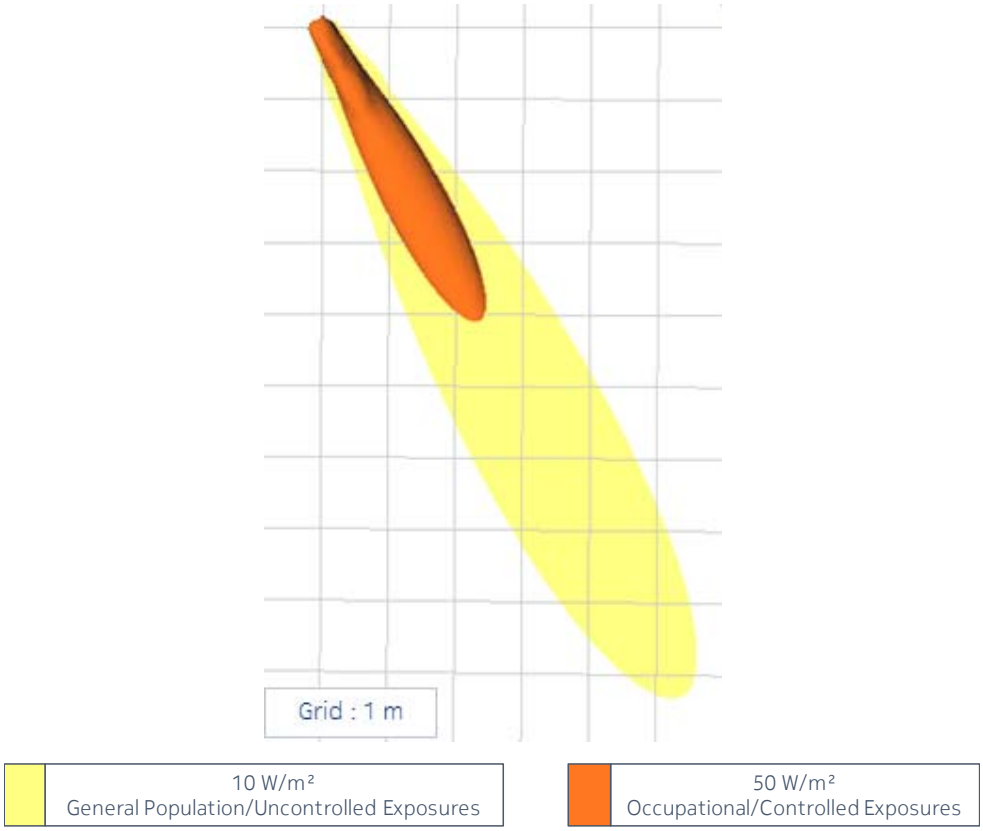


Figure 6 – Top view of the power density for the time-averaged maximum transmitted power of 127 W and the beam oriented in azimuth = 60° & elevation = - 3°

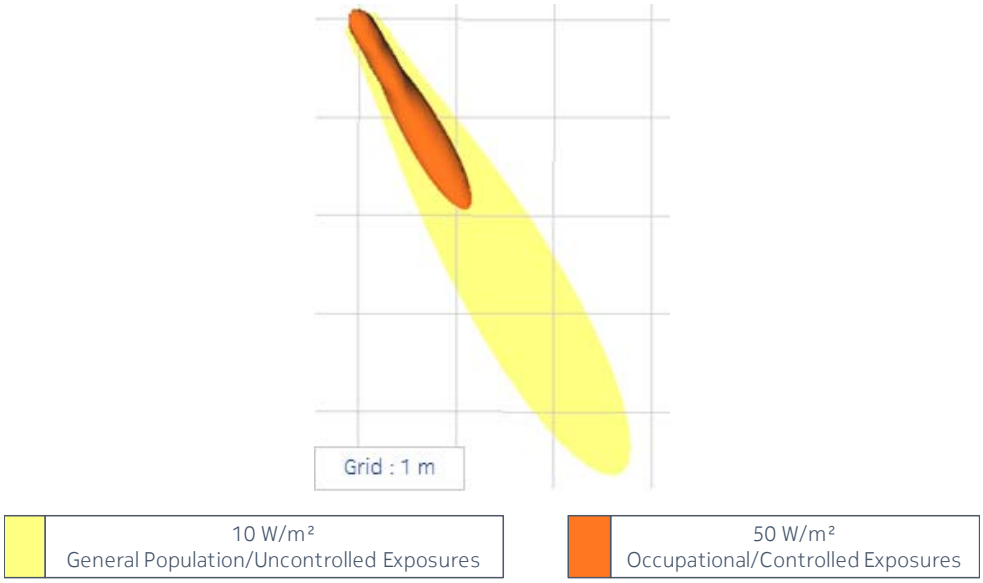


Figure 7 – Top view of the power density for the time-averaged actual maximum transmitted power of 32 W and the beam oriented in azimuth = 60° & elevation = - 3°

7 Conclusion and installation recommendations

The RF exposure compliance distances for the Nokia AirScale MAA 64T64R 128 AE B41 120 W AAHC and AAHE products according to FCC requirements [1] are summarized in Table 6.

Table 6 – RF exposure compliance distances based on the time-averaged maximum transmitted power of 127 W (corresponding to 120 W rated max transmitted power)

	General Population/Uncontrolled Exposures	Occupational/Controlled Exposures
	10 W/m²	50 W/m²
Distance in front (Df)	15 m	6.6 m
Distance to the side (Ds)	9.1 m	3.9 m
Distance below and above (Da,d and Da,u)	3.4 m	1.3 m
Distance to the side (Dsc)	9.3 m	4.1 m
Distance below and above (Ddc and Duc)	3.7 m	1.6 m

The RF exposure compliance distances based on the actual maximum transmitted power considering a 95th percentile approach are summarized in Table 7. These values are provided for information about the RF exposure levels that may be reached in operational conditions considering a time-averaging window of 6 minutes according to [8] and [3].

Table 7 – RF exposure compliance distances based on the time-averaged actual maximum transmitted power of 32 W (corresponding to 120 W rated max transmitted power)

	General Population/Uncontrolled Exposures	Occupational/Controlled Exposures
	10 W/m²	50 W/m²
Distance in front (Df)	7.5 m	3.2 m
Distance to the side (Ds)	4.5 m	1.8 m
Distance below and above (Da,d and Da,u)	1.6 m	0.5 m
Distance to the side (Dsc)	4.7 m	2.0 m
Distance below and above (Ddc and Duc)	1.9 m	0.8 m

Installation of the Nokia AirScale MAA 64T64R 128 AE B41 120 W AAHC and AAHE products shall be performed in accordance with all applicable manufacturer's recommendations and national laws and regulations related to human exposure to radiofrequency fields. In particular:

- The operator or entity putting the equipment into service shall take the necessary measures to ensure that the general population cannot access the area within the general population/uncontrolled compliance boundary in the vicinity of the transmitting antennas (see Table 6).
- Depending on the site installation configuration, the operator or the entity putting the equipment into service determines the most suitable place to display the appropriate warning signs and any other necessary information or precautionary measures.
- Workers that are required to operate in the close proximity of the transmitting antennas connected to the equipment, for example installation and maintenance personnel, need to be informed about the potential risks of human exposure to RF fields and how to protect against them. They should strictly follow instructions provided by their employer. They should stand-off the occupational/controlled exposure compliance boundary defined in the vicinity of transmitting antennas (see Table 6). If it is necessary to operate within this compliance boundary, workers shall make sure that the transmitters contributing to exposure in this area are all switched off, or they must contact the relevant operator(s) to switch off emissions during operation period.