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EMF Test Report: Ericsson AIR 6419 B41 LTE (FCC)

Document number:	GFTL-21:001254 Uen Rev B	**Date of report:**	2022-03-07
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Tests performed by:	Paramananda Joshi	**Dates of tests:**	2021-09-14 (Rev A) 2022-03-03 (Rev B)
Manufacturer and market name(s) of device:	Ericsson AIR 6419 B41		
Testing has been performed in accordance with:	FCC OET Bulletin 65 IEC 62232:2017		
Test results:	RF exposure compliance boundaries (exclusion zones) related to the limits in FCC 47 CFR 1.1310 to be included in the Customer Product Information (CPI) for Ericsson AIR 6419 B41.		
Additional information:			

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Summary of EMF Test Report[1]

Equipment under test (EUT)

Product name	AIR 6419 B41		
Product number	KRD 901 212/11, KRD 901 212/1		
Supported bands, Tx frequency range (MHz) and standards	B41	2496 – 2690	LTE
Duplexing technology and fraction of downlink transmission time to total time	TDD (75%)		
Exposure environment	General public/uncontrolled, Occupational /controlled		

Results

RF exposure compliance boundaries, outside of which the exposure is below the general public (GP) and occupational (O) exposure limits, are listed below.

Dimensions of the box-shaped compliance boundary for general public (GP) and occupational (O) exposure for AIR 6419 B41 applicable in the USA and markets employing the FCC RF exposure limits. The compliance boundaries are determined for maximum configured output power levels with output power tolerance and TDD downlink duty cycle included.

Mode and output power for AIR 6419						**Dimensions of the box-shaped compliance boundary (m)**							
						Distance in front of EUT		**Width**		**Height**		**Distance behind EUT**	
Band	**Standard**	**Maximum configured output power from the radio**	**Power tolerance**	**TDD DL duty cycle**	**IEC 62232 installation class**	**GP**	**O**	**GP**	**O**	**GP**	**O**	**GP**	**O**
B41	LTE	60 W	1.0 dB	75 %	E+	10.4	4.7	12.1	5.4	5.2	2.3	0.2	0.2
B41	LTE	80 W	1.0 dB	75 %	E+	12.0	5.4	13.9	6.3	5.9	2.7	0.2	0.2
B41	LTE	120 W	1.0 dB	75 %	E+	14.7	6.6	17.1	7.7	7.3	3.3	0.2	0.2
B41	LTE	160 W	1.0 dB	75 %	E+	17.0	7.6	19.7	8.8	8.4	3.8	0.2	0.2
B41	LTE	240 W	1.0 dB	75 %	E+	20.8	9.3	24.1	10.8	10.3	4.6	0.2	0.2
B41	LTE	320 W	1.0 dB	75 %	E+	24.0	10.8	27.8	12.5	11.8	5.3	0.2	0.2

For the power levels specified in the table with tolerances added, and the upward rounding of compliance boundary dimensions to the nearest decimeter, the specified results are conservative.

[1] This page contains a summary of the test results. The full report provides a complete description of all test details and results.

1 General information

The test results presented in this report define compliance boundaries for AIR 6419 B41 LTE. Outside of these compliance boundaries, the radio frequency (RF) exposure levels are below the limits specified by the Federal Communications Commission (FCC) [1]. The tests were performed by calculations in accordance with the Ericsson RF exposure calculation procedure for base stations [2], which is in conformity with the FCC OET Bulletin 65 [3] and IEC 62232:2017 [4].

It should be noted that the test results presented in this test report are valid for the frequency range specified in Table 1, for the antenna properties specified in Table 2, and for the power level, the power tolerance, and TDD downlink duty cycle specified in Table 3. These data as well as the applied antenna pattern files were supplied by the client and may affect the validity of the results.

Proposed EMF health and safety information for inclusion in the Customer Product Information (CPI) is provided in Appendices A, B and C.

2 Equipment under test

Table 1 and Table 2 below summarize the technical data for the equipment under test (EUT) and the properties of the integrated antenna. Table 3 lists the maximum nominal output power from the radio unit and the total time-averaged power delivered to the antenna for the specified configuration. The total time-averaged power delivered to the antenna includes output power tolerance and TDD downlink duty cycle.

The EUT related data in Tables 1-3 were supplied by the client. The product supports LTE, NR and LTE+NR mixed mode. This report is applicable only for LTE. For LTE+NR mixed mode, the report for NR [5] is applicable.

Table 1 Technical data for the EUT.

Product name and product number	AIR 6419 B41	KRD 901 212/11, KRD 901 212/1	
Supported bands, Tx frequency range (MHz), and standards	B41	2496 – 2690	LTE
Antenna	KRE 108 15		
Dimensions, H × W × D (mm)	863.3 × 506 × 162.6		
Maximum nominal output power (W)	320		
Duplexing technology and fraction of downlink transmission time to total time	TDD (75 %)		
Exposure environment	General public/uncontrolled, Occupational/controlled		
IEC 62232 installation class [4][2]	E+		

[2] The stated IEC 62232 installation class was determined based on the total EIRP without power tolerance included and considering the TDD downlink duty cycle. The total EIRP was obtained using the antenna patterns provided by the client.

Table 2 Properties of the antenna.

Product number	KRE 108 15
Type	Internal AAS
Antenna configuration (no. of subarray rows, subarray columns and polarizations)	4×8×2 ports
Gain[3] (dBi)	24.8
Antenna pattern files	1/15570-KRD901212/1 (MasterRev5813)
Maximum scan range in horizontal plane (degrees)	± 60
Maximum scan range in vertical plane (degrees)	83 - 109

Table 3 EUT configurations with maximum nominal output power levels and the total time-averaged power levels including an output power tolerance and TDD downlink duty cycle.

Band	Standard	Maximum configured output power from the radio (dBm/W)	Power tolerance (dB)	TDD downlink duty cycle	Total time-averaged power delivered to antenna (dBm/W)
B41	LTE	47.8 / 60	1.0	75%	47.5 / 56.7
B41	LTE	49.0 / 80	1.0	75%	48.8 / 75.5
B41	LTE	50.8 / 120	1.0	75%	50.5 / 113.3
B41	LTE	52.0 / 160	1.0	75%	51.8 / 151.1
B41	LTE	53.8 / 240	1.0	75%	53.6 / 226.6
B41	LTE	55.1 / 320 (maximum nominal)	1.0	75%	54.8 / 302.1

3 Exposure conditions

The EUT is intended to be installed on roof-tops, masts, walls, poles and similar structures making it possible to ensure that the general public has no access to the EMF compliance boundary. Other installation related exposure conditions are not reasonably foreseeable for the EUT.

The maximum TDD downlink duty cycle was considered to obtain the maximum time-averaged power delivered to the antenna.

Other factors, such as beam scanning in elevation and azimuth, RBS utilization, and scheduling time are reasonably foreseeable and will significantly reduce the time-averaged power and the RF exposure. A theoretical maximum exposure condition assessment was conducted, in which these factors were not considered, which makes the obtained compliance boundaries very conservative.

[3] The stated gain value is the maximum antenna gain within B41 obtained using the antenna patterns provided by the client. The patterns used are based on theoretical modelling of the antenna and may differ slightly from the measured ones.

4 EMF compliance boundary calculations

The RF exposure was evaluated using calculations performed according to the Ericsson RF Exposure Calculation Procedure for Base Stations [2], which conforms to FCC OET Bulletin 65 [3] and IEC 62232 [4]. The calculations were made using the Ericsson in-house MATLAB-based tool called MSI compliance analyzer (release 2022-02) [6]. The first step in calculating the compliance boundary was to use the spherical far-field formula to estimate power density:

$$S_{\mathrm{sph}}(\theta,\phi)=\frac{P_{\mathrm{a}}G(\theta,\phi)}{4\pi r^2},$$

where S,P_{a}, G, r, θ, and ϕ denote the power density, the total time-averaged power accepted by antenna, the antenna gain, the distance from the antenna, and the angular variables in a spherical coordinate system, respectively. The total time-averaged power delivered to the antenna include tolerances and the TDD downlink duty cycle.

Part of the transmit power, corresponding to 25% of P_{a} is used for the broadcast beam whereas the remaining 75% is used for traffic:

$$S_{\mathrm{sph,broadcast}}(\theta,\phi)=\frac{0.25P_{\mathrm{a}}G_{\mathrm{broadcast}}(\theta,\phi)}{4\pi r^2},$$

$$S_{\mathrm{sph,traffic}}(\theta,\phi)=\frac{0.75P_{\mathrm{a}}G_{\mathrm{traffic}}(\theta,\phi)}{4\pi r^2},$$

where $G_{\mathrm{broadcast}}$ and G_{traffic} denote the antenna gain for the broadcast and traffic beams. While the beam for the broadcast channel is fixed[4], the traffic beam is steered in different directions depending on the location of the users requesting service. Therefore, G_{traffic} in the equation above corresponds to the envelope of the antenna gain for all possible beams. The antenna gain patterns for broadcast beams and the envelope of antenna gains for all possible traffic beams were provided by the client based on theoretical modelling of the antenna. The use of these antenna gain patterns, together with the applied tolerance, provides an upper bound for the compliance boundary. Such patterns were provided for three different frequencies, specifically 2496 MHz, 2593 MHz, and 2690 MHz within Band 41. Maximum gain values corresponding to the maximum of all the broadcast beam patterns and envelope traffic beam patterns, respectively, were used in the above equations to estimate power density. The maximum gain value of the envelope traffic beams was found to be 24.8 dBi. The maximum gain value of the broadcast beams was found to be 17.9 dBi.

The total power density as estimated by the spherical far-field formula is thus given by

$$S_{\mathrm{total,sph}}=S_{\mathrm{sph,broadcast}}+S_{\mathrm{sph,traffic}}.$$

The compliance distance for the spherical model, $\mathrm{CD}_{\mathrm{sph}}(\theta,\phi)$ was obtained by solving the following equation for r:

$$\frac{S_{\mathrm{total,sph}}(r,\theta,\phi)}{S_{\mathrm{gp,o}}^{\mathrm{lim}}}=1,$$

where $S_{\mathrm{gp,o}}^{\mathrm{lim}}$ denotes the FCC power density limits [1] for general public and occupational exposure. RF EMF exposure limits are given in Table 4.

[4] The AIR 6419 B41 broadcast beam can be configured to handle three different UE distribution scenarios, denoted Macro, Hotspot , High-rise, and Macro HSLS (high sidelobe suppression). Each of these configurations is characterized by different gain values, beamwidths and electrical tilt angles. The assessment in this report is based on all possible broadcast beam patterns.

Table 4 RF EMF exposure limits on power density for the frequency band used by the EUT [1].

Band	S_{gp}^{lim} (W/m^2)	S_{o}^{lim} (W/m^2)
B41	10	50

Based on the calculated compliance distances, a box-shaped compliance boundary was determined. To comply with the FCC requirement of a minimum test separation distance for a non-portable device of 20 cm, the minimum distance from the EUT to the compliance boundary was set to 20 cm.

5 Results

A box-shaped compliance boundary is used, characterized by its width, height, and the compliance distances behind and in front of the EUT, see Figure 1. Outside of this box, the RF exposure is below the exposure limits.

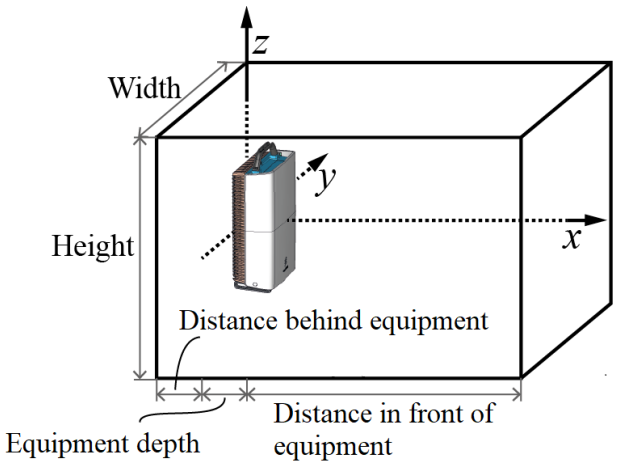

Figure 1 Box-shaped structure specifying the compliance boundary for the tested RBS product.

When applied in the near field, for instance behind the antenna, the spherical far-field formula provides very conservative results. Given the relatively large distance from the antenna array elements to the back of the antenna, and based on extensive experience from a large set of numerical EMF tests for products and antennas with similar geometrical configurations and power levels, it is possible to state that the compliance distance behind the antenna measured from its back plane is 0 m. From measurements of a typical 3.5 GHz AAS testbed transmitting with nominal total output power of 36 dBm, the maximum power density behind was found to be 0.02 W/m^2 [7]. For a total output power of 54.8 dBm, this power density value scales to 1.52 W/m^2, which is far below the general public and occupational power density limits listed in Table 4.

In Figure 2 through Figure 7, the compliance distance results for general public (blue line) and occupational (red line) exposure are given for different tested configurations. The results are provided for the FCC exposure limits. Also shown are the resulting compliance boundaries (black lines, solid for general public, dashed for occupational exposure). The resulting compliance boundary dimensions are given in Table 5 rounded upwards to the nearest decimeter.

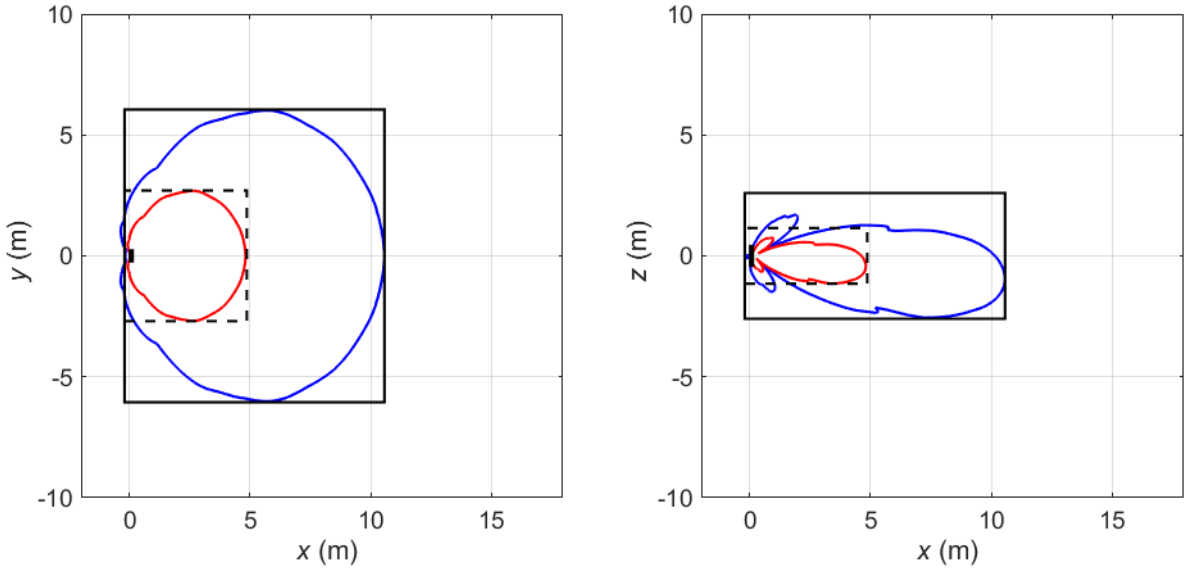

Figure 2 **Compliance boundaries for general public (black solid line) and occupational (black dashed line) exposure for the USA and markets where the FCC exposure limits apply. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical models. The solid red lines indicate the corresponding compliance distance results for occupational exposure. The EUT is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B41 (LTE). Total time-averaged power delivered to the antenna: 56.7 W.**

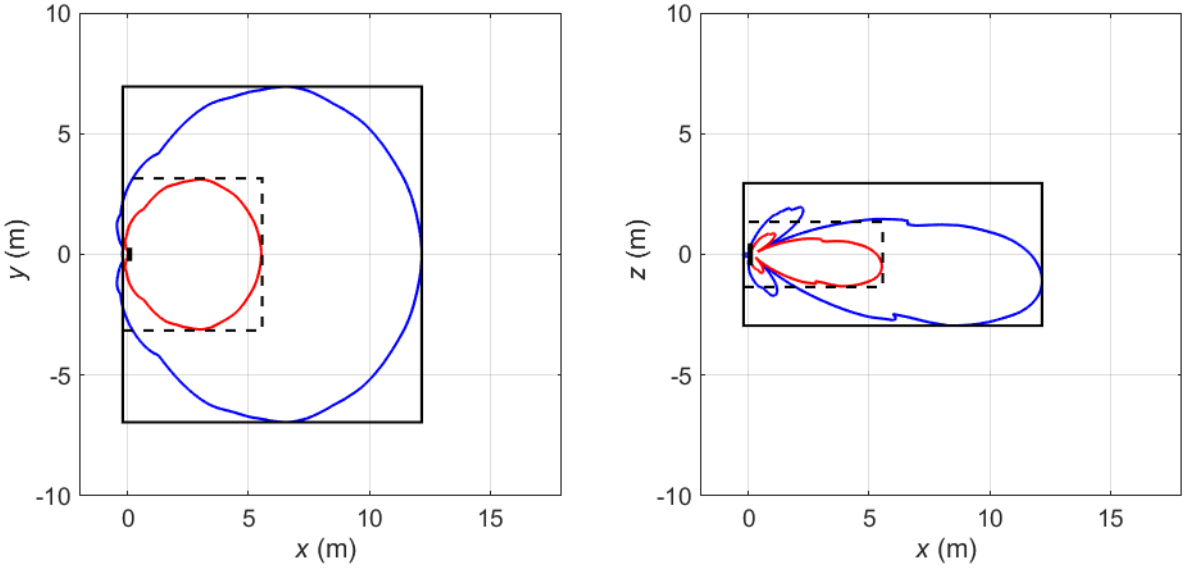

Figure 3 **Compliance boundaries for general public (black solid line) and occupational (black dashed line) exposure for the USA and markets where the FCC exposure limits apply. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical models. The solid red lines indicate the corresponding compliance distance results for occupational exposure. The EUT is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B41 (LTE). Total time-averaged power delivered to the antenna: 75.5 W.**

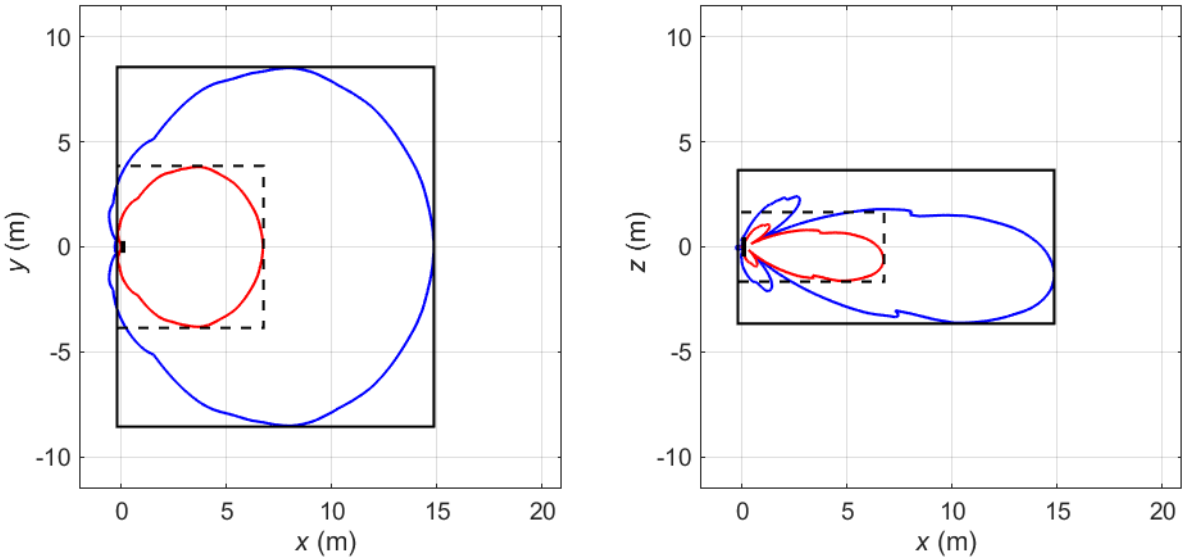

Figure 4 **Compliance boundaries for general public (black solid line) and occupational (black dashed line) exposure for the USA and markets where the FCC exposure limits apply. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical models. The solid red lines indicate the corresponding compliance distance results for occupational exposure. The EUT is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B41 (LTE). Total time-averaged power delivered to the antenna: 113.3 W.**

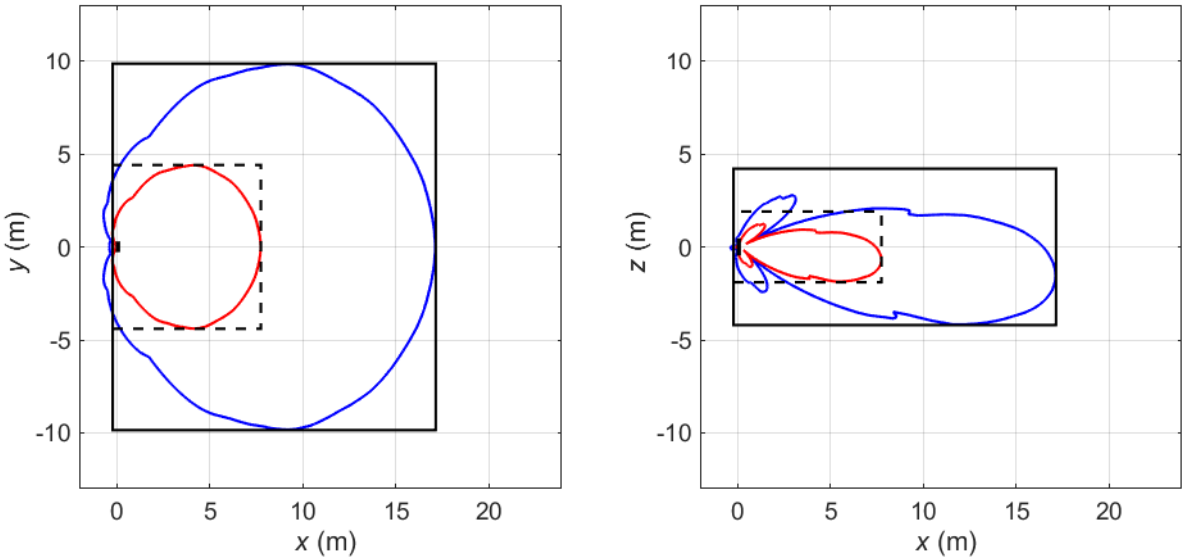

Figure 5 **Compliance boundaries for general public (black solid line) and occupational (black dashed line) exposure for the USA and markets where the FCC exposure limits apply. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical models. The solid red lines indicate the corresponding compliance distance results for occupational exposure. The EUT is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B41 (LTE). Total time-averaged power delivered to the antenna: 151.1 W.**

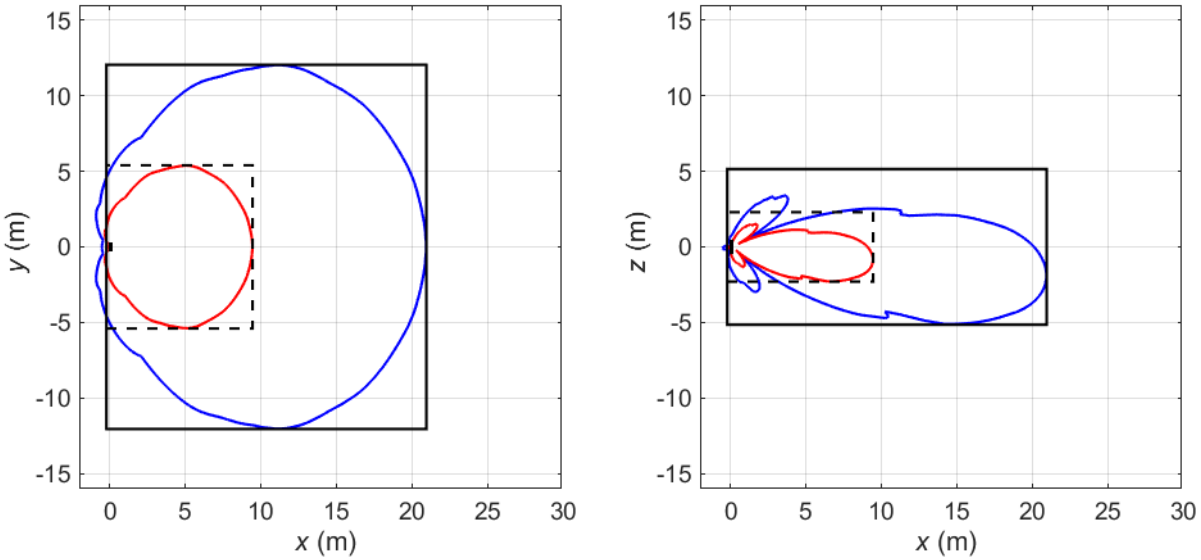

Figure 6 **Compliance boundaries for general public (black solid line) and occupational (black dashed line) exposure for the USA and markets where the FCC exposure limits apply. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical models. The solid red lines indicate the corresponding compliance distance results for occupational exposure. The EUT is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B41 (LTE). Total time-averaged power delivered to the antenna: 226.6 W.**

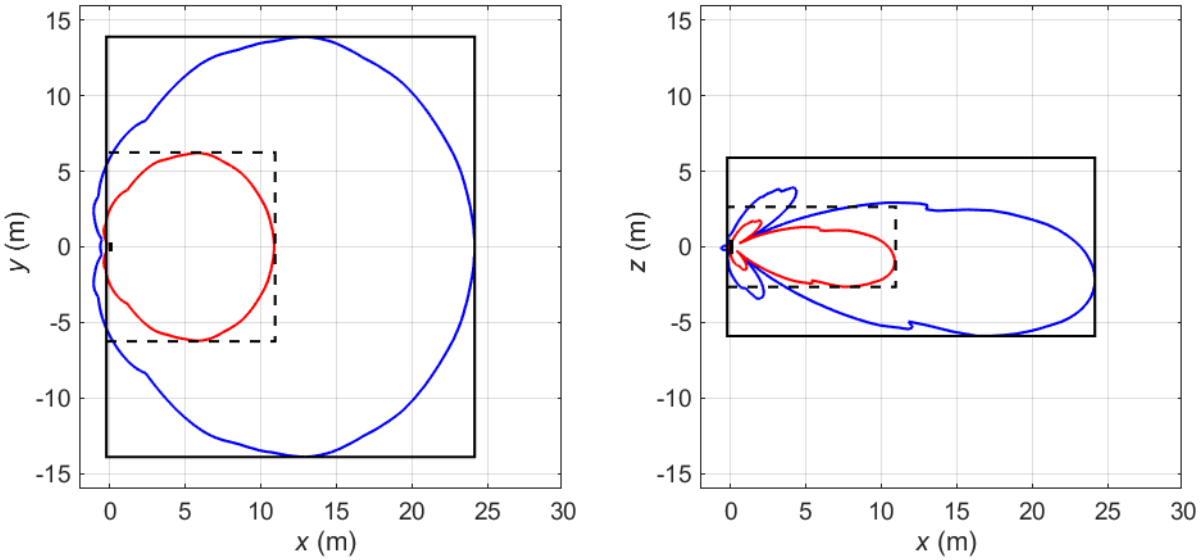

Figure 7 **Compliance boundaries for general public (black solid line) and occupational (black dashed line) exposure for the USA and markets where the FCC exposure limits apply. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical models. The solid red lines indicate the corresponding compliance distance results for occupational exposure. The EUT is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B41 (LTE). Total time-averaged power delivered to the antenna: 302.1 W.**

Table 5 Dimensions of the box-shaped compliance boundary for general public (GP) and occupational (O) exposure for AIR 6419 B41 applicable in the USA and markets employing the FCC RF exposure limits. The compliance boundaries are determined for maximum configured output power levels with output power tolerance and TDD downlink duty cycle included.

Mode and output power for AIR 6419						Dimensions of the box-shaped compliance boundary (m)							
						Distance in front of EUT		Width		Height		Distance behind EUT	
Band	Standard	Maximum configured output power from the radio	Power tolerance	TDD DL duty cycle	IEC 62232 installation class	GP	O	GP	O	GP	O	GP	O
B41	LTE	60 W	1.0 dB	75 %	E+	10.4	4.7	12.1	5.4	5.2	2.3	0.2	0.2
B41	LTE	80 W	1.0 dB	75 %	E+	12.0	5.4	13.9	6.3	5.9	2.7	0.2	0.2
B41	LTE	120 W	1.0 dB	75 %	E+	14.7	6.6	17.1	7.7	7.3	3.3	0.2	0.2
B41	LTE	160 W	1.0 dB	75 %	E+	17.0	7.6	19.7	8.8	8.4	3.8	0.2	0.2
B41	LTE	240 W	1.0 dB	75 %	E+	20.8	9.3	24.1	10.8	10.3	4.6	0.2	0.2
B41	LTE	320 W	1.0 dB	75 %	E+	24.0	10.8	27.8	12.5	11.8	5.3	0.2	0.2

For the power levels specified in the table with tolerances added, and the upward rounding of compliance boundary dimensions to the nearest decimeter, the specified results are conservative.

6 Uncertainty

For the input parameters defined in the test report, the calculated compliance boundary dimensions determined according the approach described in Section 4 results in an exposure assessment which is conservative. The compliance boundary dimensions were determined by comparing the evaluated RF exposure directly with the limits.

7 Conclusion

The Ericsson AIR 6419 B41 has been tested using methods and procedures specified in FCC OET Bulletin 65 [3] and IEC 62232:2017 [4]. The results in Section 5 show the compliance boundary dimensions for the considered configuration of the product. Outside of these compliance boundaries, the RF exposure is below the limits specified in [1].

8 References

[1] FCC, Code of Federal Regulations CFR title 47, part 1.1310 “Radiofrequency radiation exposure limits”, Federal Communications Commission (FCC), April 2020.

[2] GFTE-16:001718 Uen, “Ericsson RF exposure calculation procedure for base stations”.

[3] FCC, “Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields. OET Bulletin 65. Edition 97-01.” Federal Communications Commission (FCC), Office of Engineering and Technology, August 1997.

[4] 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”, June 2017.

[5] Ericsson, GFTL-21:001252 Uen, “EMF Test Report: Ericsson AIR 6419 B41 NR (FCC)”.

[6] Ericsson, GFTL-19:000424 Uen, “User manual of MSI compliance analyzer”.

[7] Ericsson, GFTB-18:001016 Uen, “EMF assessments of the Ericsson 5G Testbed V1.0 RRU 3.5 GHz”.

[8] Ericsson, LME-12:001904 Uen, “Exposure to radio frequency electromagnetic fields”.

9 Revision history

Rev.	Date	Description
A	2021-09-22	First revision.
B	2022-03-07	Added results for configured output power levels of 60, 80, 120, 160 and 240 W. Deleted results for actual maximum exposure condition.

Appendix A. Information to be included in the CPI

Table A.1 below lists the compliance boundaries (exclusion zones), outside of which the RF EMF exposure from AIR 6419 B41 is below the limits applicable in:

- USA (47 CFR 1.1310)

Information is provided for the theoretical maximum exposure condition.

Table A.1 Dimensions of the box-shaped compliance boundary for general public (GP) and occupational (O) exposure applicable in the USA and markets employing the FCC exposure limits.

Mode and output power						Dimensions of the box-shaped compliance boundary[1][2][3] (m)							
						Distance in front of EUT		Width		Height		Distance behind EUT	
Product	Stand-ard	Maximum configured output power from the radio	Power tolerance	TDD DL duty cycle	IEC 62232 installation class	GP	O	GP	O	GP	O	GP	O
AIR 6419 B41	LTE	60 W	1.0 dB	75 %	E+	10.4	4.7	12.1	5.4	5.2	2.3	0.2	0.2
		80 W	1.0 dB	75 %	E+	12.0	5.4	13.9	6.3	5.9	2.7	0.2	0.2
		120 W	1.0 dB	75 %	E+	14.7	6.6	17.1	7.7	7.3	3.3	0.2	0.2
		160 W	1.0 dB	75 %	E+	17.0	7.6	19.7	8.8	8.4	3.8	0.2	0.2
		240 W	1.0 dB	75 %	E+	20.8	9.3	24.1	10.8	10.3	4.6	0.2	0.2
		320 W	1.0 dB	75 %	E+	24.0	10.8	27.8	12.5	11.8	5.3	0.2	0.2

(1) The compliance boundaries are determined for maximum output power with power tolerance and TDD downlink duty cycle included.
(2) For LTE, the compliance boundaries are determined for 75% of the power allocated to traffic beams and 25% to the broadcast beam.
(3) For NR+LTE mixed mode, the results for NR apply.

Appendix B. Guidelines on how to install the product

The AIR 6419 B41 product (KRD 901 212/11, KRD 901 212/1) shall be installed to make sure that the general public does not have access to the applicable RF EMF compliance boundary. The compliance boundary dimensions were determined for the product transmitting in free space.

Appendix C. Guidelines for workers during installation, maintenance, and repair of the product

For AIR 6419 B41 product (KRD 901 212/11, KRD 901 212/1), if work needs to be performed within the compliance boundary applicable for workers, the radio equipment shall be powered off, or the power be reduced to a level ensuring that the RF EMF exposure is below the relevant exposure limit for workers.

If work is conducted on behalf of Ericsson, minimum EMF related requirements are provided in [8].

Appendix D. Photograph/Sketch of the EUT

Figure D.1. A photo of AIR 6419 B41.