3.8 Safety distance requirements (compliance boundaries)

This section describes compliance with reference levels (based on basic restrictions) for general public and occupational exposure to radio frequency electromagnetic fields.

Ensuring public safety

This equipment generates radio frequency energy, which has a thermal effect when absorbed by the human body. For this reason compliance boundaries specific to this equipment have been established. The thermal effects of radio frequency energy can exceed safety levels when a person is inside the established compliance boundaries. Observe the compliance boundary, and make sure the general public has no access to areas inside the established boundaries. The information shown in the *Warnings and cautions provided* section below is taken from the relevant section of Nokia Siemens Networks product documentation containing warnings and cautions specific to the equipment.

Installing base stations to ensure installer safety

Installation engineers need to be aware of the potential risk of the thermal effects of radio frequency energy and how to protect themselves against undue risk. The information shown in the *Warnings and cautions provided* section is taken from the relevant section of Nokia Siemens Networks product documentation containing warnings and cautions specific to the equipment.

Warnings and cautions provided

Reference safety distances

When working close to transmitter antennas, the proper safety distances must be observed. The minimum safe distance from an antenna is measured in metres.

The antenna generates electromagnetic fields at radio frequencies. Do not cross the compliance boundary.

This equipment generates electromagnetic fields. If performing installation or maintenance procedures on the antenna systems, make sure that all the transmitters in the area are switched off.

When assessing the applicable boundaries, the European standards EN 50383, EN 50384, EN 50385 and Council Recommendation 1999/519/EC for occupational and general public electromagnetic exposure limits - **see Annex A** - have been applied.

The statements shown below are taken from the Nokia Siemens Networks product documentation containing warning and cautions specific to the equipment.

Assessment applying Specific Absorption Rate (SAR) measurements

European standards EN 50383, EN 50384 and EN 50385 do not include specifications for whole body SAR measurements. Whole body SAR measurements are not required for transmitters that have maximum output power levels too low to result in exposure levels that can reach the whole body SAR compliance limits under any conditions.

Whole body SAR exclusion power levels have been based on the worst case assumptions. For details, see the table below.

Exposure category	Maximum output power (rms)
General public	Max power [W] = general public whole body SAR limit [W/kg] * 12.5 kg: 4-year-old child body mass = 1 W
Occupational	Max power [W] = occupational whole body SAR limit [W/kg] * 42 kg: 16-year-old worker body mass = 16.8 W

Table 18 Whole body SAR exclusion power levels

Localised SAR measurements can only be used when:

1. The separation between the phantom and the outer surface of the energy generating element is 40 cm (15.6 in.) or less.
2. The surface area of the energy generating element is less than 60 cm (23.6 in.) by 30 cm (11.8 in.).
3. The frequency is in the range of 800 to 3000 MHz.

For the reasons above, SAR measurements are not applicable to **Flexi Multiradio Base Station**.

Assessment of compliance boundary

The compliance boundary is defined as the area around the antenna shown in the following *Area around the antenna* figure. The antenna is located at the origo. Distances from the antenna are shown. The top and side views are shown in the following *Antenna side and top view* figure, in Picture 1 and Picture 2.

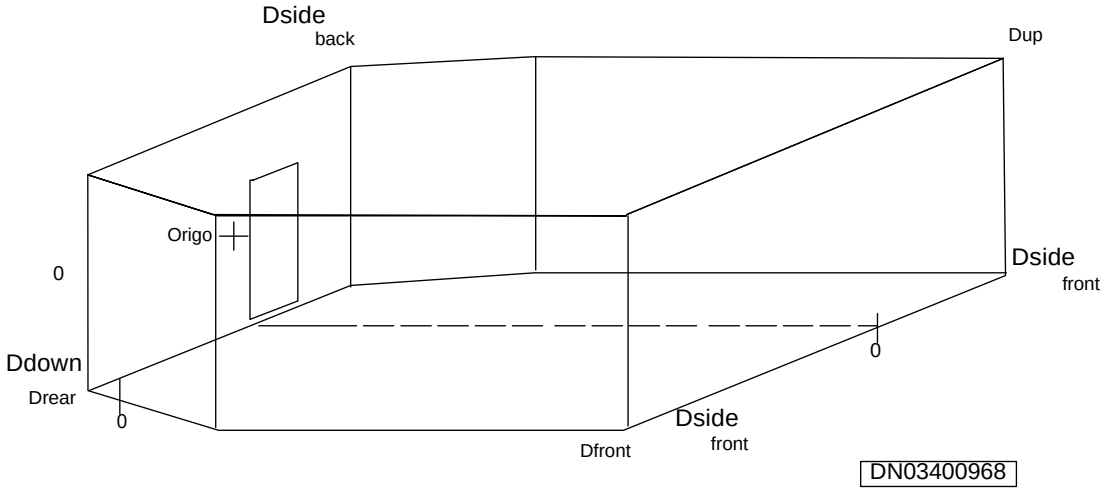

Figure 3 Area around the antenna

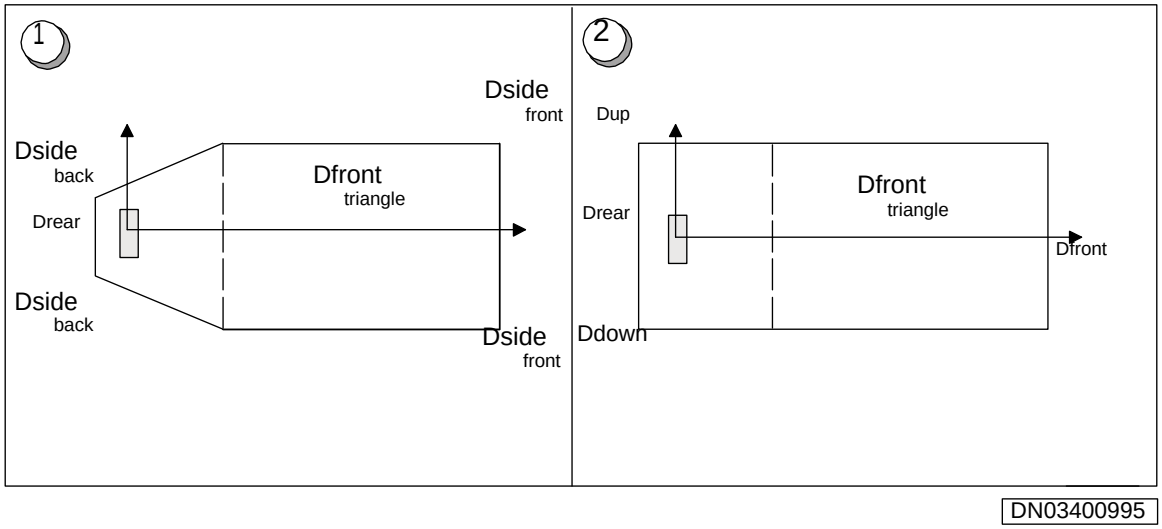

Figure 4 Antenna side and top view

The compliance boundaries for Flexi Multiradio Base Station are given in the tables below for worst case power levels at the antenna input. Worst case power level configurations for **general public (GP)** and **occupational (O)** exposure limits are included in the tables below.

		Dfront	**Dfront** **triangle**	**Drear**	**Dside** **back**	**Dside** **front**	**Dup**	**Ddown**
Freq. (MHz)	Power at antenna input	GP	GP	GP	GP	GP	GP	GP
1700	40	4.4	1.2	0.1	0.2	1.5	0.6	0.6
1700	2 * 60	7.7	2.4	0.1	0.7	3.0	0.8	1.8
2100	40	4.7	1.5	0.1	0.4	1.5	0.6	0.6
2100	60	5.7	2.0	0.1	0.5	1.85	1.6	1.0
2100	2 * 60	7.8	3.0	0.1	0.8	2.8	2.1	1.4

Table 19 Dimensions of compliance boundary in meters (General Public)

		Dfront	**Dfront** **triangle**	**Drear**	**Dside** **back**	**Dside** **front**	**Dup**	**Ddown**
Freq. (MHz)	Power at antenna input	O	O	O	O	O	O	O

Table 20 Dimensions of compliance boundary in meters (occupational)

		Dfront	Dfront triangle	Drear	Dside back	Dside front	Dup	Ddown
1700	40	1.9	1.1	0.1	0.2	0.45	0.48	0.48
1700	2 * 60	2.6	0.8	0.1	0.2	0.7	0.7	0.75
2100	40	1.95	0.7	0.1	0.25	0.5	0.6	0.6
2100	60	1.1	0.4	0.1	0.1	0.3	1.0	1.0
2100	2 * 60	1.8	0.6	0.1	0.2	0.55	0.9	0.7

Table 20 Dimensions of compliance boundary in meters (occupational) (Cont.)

Typical configuration

The antenna is connected through a connector and cable(s) to the base station as shown in the following figure.

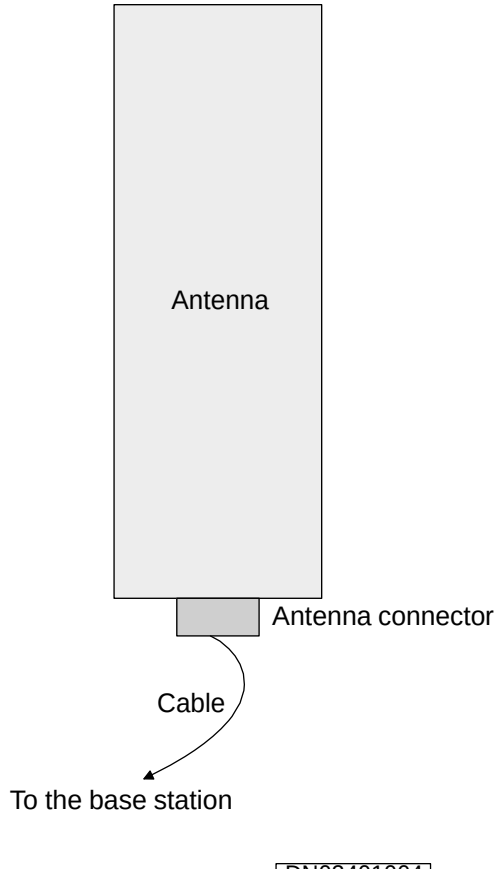

Figure 5 Antenna connection to the BTS

Power (P_{out})	20/40/60 W
Total connector loss	0.0 dB
Total cable loss	0.0 dB
Total Loss (L) = Total connector loss + Total cable loss	0.0 dB
Number of transmitter unit (N)	1
Power at antenna input = $P_{out}N10^{-L/10}$	20/40/60 W

Table 21 A detailed description of the components

The worst-case power level configuration is when the power at antenna input is 60 W with 2100 MHz frequency variant and 40 W with others.

Frequency	2100 MHz	1700MHz	1800/1900/ 2100 MHz
Gain	17.2 dBi	17 dBi	17.2 dBi
Half-power beam width	H-plane: 68 deg.	H-plane: 60 deg.	H-plane: 68deg.
	E-plane: 10 deg.	E-plane: 10 deg.	E-plane: 10 deg.
Electrical downtilt	0 deg.	0 deg.	0 deg.
Height/width/depth	1000 / 200 / 100 mm	1100 / 200 / 100 mm	1100 / 200 /100 mm

Table 22 A typical antenna specification

When using different configurations

IMPORTANT:

- **In tables 'Dimensions of compliance boundary in meters for general public (GP)' and 'Dimensions of compliance boundary in meters (Occupational)' the compliance boundaries are given for worst case power levels. If an exposure limit, antenna, and/or configuration is used which does not correspond to the levels given in tables 'Dimensions of compliance boundary in meters for general public (GP)' and 'Dimensions of compliance boundary in meters (Occupational)', the compliance boundary must be re-calculated according to EN50383.**
- **The formula for calculating the compliance boundary using the far-field model, which is referenced in EN50383, is given in ANNEX B later in this section. This model is applicable for calculating the compliance boundary for the far-field region and over estimates the compliance boundary for the radiating near-field region, but is not applicable for calculating the compliance boundary for the reactive near-field region where the distance from the antenna is less than or equal to $\lambda / 4$.**

ANNEX A: Council recommendation 1999/519/EC for occupational and general public electromagnetic exposure limits

Exposure characteristics	Frequency range	Whole body average SAR W kg^{-1}	Localised SAR (head and trunk) W kg^{-1}	Localised SAR (limbs) W kg^{-1}
Occupational exposure	10 MHz - 10 GHz	0.4	10	20
General public exposure	10 MHz - 10 GHz	0.08	2	4

Table 23 Basic restrictions

Note that all SAR values are to be averaged over any period of 6 minutes. Localised SAR averaging mass is any 10 g of contiguous tissue: the maximum SAR so obtained should be the value used for the estimation of exposure.

Basic restrictions between 10 GHz and 300 GHz are given in power densities. For occupational exposure, it is 50 Wm^{-2} and for general public exposure 10 Wm^{-2}.

Exposure characteristics	Frequency range	Electric field strength V/m	Equivalent plane wave power density S (W m^{-2})
Occupational exposure	10 - 400 MHz 400 - 2000 MHz 2 - 300 GHz	61 $3f^{1/2}$ 137	10 f/40 50
General public exposure	10 - 400 MHz 400 - 2000 MHz 2 - 300 GHz	28 $1.375f^{1/2}$ 61	2 f/200 10

Table 24 Reference values calculated from basic restrictions

- f is frequency in MHz
- for frequencies between 100 KHz and 10 GHz, S is to be averaged over any period of 6 minutes
- for frequencies exceeding 10 GHz, S is to be averaged over any period of $68/f^{1.05}$ minutes (f in GHz)

ANNEX B: Far-field calculation method

This model is applicable for calculating the compliance boundary for the far-field region and over estimates the compliance boundary for the radiating near-field region, but is not applicable for calculating the compliance boundary for the reactive near-field region where the distance from the antenna is less than or equal to $\lambda/4$, which is 3.75 cm at 2000 MHz. Therefore, all calculations are valid when the compliance boundary is greater or equal to the antenna dimensions plus $\lambda/4$.

The minimum safety distance (compliance boundary) in metres, or 'r_{min}', is calculated according to the following equation:

$$r_{\min} = \sqrt{\frac{N 10^{(G-L)/10} P_{out}}{4\pi S}}$$

DN02152589

Figure 6 Formula for safety distances

The meaning of each formula component is as follows:

- N is the number of transmitter units per one antenna
- G is the antenna gain (in dB)
- L is the minimum cable losses (in dB)
- P_{out} is the maximum power of one transmitter unit (in W)
- S is the maximum power density limit (in W/m²)

Note that in the far-field, the field calculation does not take into account the antenna size, which is assumed to be a point source. Therefore, when calculating the compliance boundary, the far-field data, antenna size and reactive field criteria have to be taken into account.