

Prediction of MPE at a given distance

1. Limits

According 1.1310 (d)

For operations within the frequency range of 300 kHz and 6 GHz (inclusive), the limits for maximum permissible exposure (MPE), derived from whole-body SAR limits and listed in Table 1 in paragraph (e)(1) of this section, may be used instead of whole-body SAR limits as set forth in paragraphs (a) through (c) of this section to evaluate the environmental impact of human exposure to RF radiation as specified in § 1.1307(b) of this part, except for portable devices as defined in § 2.1093 of this chapter as these evaluations shall be performed according to the SAR provisions in § 2.1093.

Table 1 to § 1.1310(e)(1)—Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*(100)	≤6
3.0-30	1842/f	4.89/f	*(900/f ²)	≤6
30-300	61.4	0.163	1.0	≤6
300-1,500			f/300	≤6
1,500-100,000			5	≤6
(ii) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	<30
1.34-30	824/f	2.19/f	*(180/f ²)	<30
30-300	27.5	0.073	0.2	<30
300-1,500			f/1500	<30
1,500-100,000			1.0	<30
f = frequency in MHz. * = Plane-wave equivalent power density.				

According to 447498 D04 Interim General RF Exposure Guidance v01

1-mW Test Exemption

A single RF source is exempt RF device (from the requirement to show data demonstrating compliance to RF exposure limits, as previously mentioned) if the available maximum time-averaged power is no more than 1 mW, regardless of separation distance.

This exemption applies to all operating configurations and exposure conditions, for the frequency range 100 kHz to 100 GHz, regardless of fixed, mobile, or portable device exposure conditions. This is a standalone exemption, and it cannot be applied in conjunction with any other test exemption.

1-mW Test Exemption for Multiple Sources

The 1-mW exemption intended for single transmitters may be also applied to simultaneous transmission conditions, within the same host device, according one of the following criteria:

a) When maximum available power each individual transmitting antenna within the same time averaging period is ≤ 1 mW, and the nearest parts of the antenna structures of the simultaneously operating transmitters are separated by at least 2 cm.

b) When the aggregate maximum available power of all transmitting antennas is ≤ 1 mW in the same time-averaging period.

This exemption may not be combined with any other exemption.

SAR-Based Exemption

This exemption is applicable to the frequency range between 300 MHz and 6 GHz, with test separation distances between 0.5 cm and 40 cm, and for all RF sources in fixed, mobile, and portable device exposure conditions.

Accordingly, a RF source is considered an RF exempt device if its available maximum time-averaged (matched conducted) power or its effective radiated power (ERP), whichever is greater, are below a specified threshold. This exemption threshold was derived based on general population 1-g SAR requirements.

This method shall only be used at separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by follow Formulas

$$ERP_{20\text{ cm}} (\text{mW}) = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

$$P_{th} (\text{mW}) = \begin{cases} ERP_{20\text{ cm}} (d/20\text{ cm})^x & d \leq 20\text{ cm} \\ ERP_{20\text{ cm}} & 20\text{ cm} < d \leq 40\text{ cm} \end{cases}$$

$$x = -\log_{10} \left(\frac{60}{ERP_{20\text{ cm}} \sqrt{f}} \right)$$

“ f ” is in GHz, “ d ” is the separation distance (cm)

Simultaneous Transmission with SAR-based Exemptions

For these cases, a device with multiple RF sources transmitting simultaneously will be considered an RF exempt device if the condition of following Formula is satisfied.

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

$$P_{th} = ERP_{20cm} * (d/20)^{-\log(60/(ERP_{20cm} * \sqrt{f}))} = 3060 * (0.5/20)^{-\log(60/(3060 * \sqrt{2.440}))} = 2.752mW$$

As this equipment:

$$EIRP = P_m + G_i \text{ (if } G_i < 0, \text{ to treat } G_i \text{ value as 0)}$$

$$P_t = 10^{(EIRP/10)}$$

where:

P_m = measured transmitter output power in dBm,

P_t = transmitter output power in milliwatts,

G_i = numeric gain of the transmitting antenna (unit-dBi),

2. Test Procedure

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{P \times G}{4 \times \pi \times R^2}$$

Where:

S = power density

P = power input to the antenna

G = numeric gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

3. Result

Worse case is as below:

Mode	Frequency (MHz)	Fundamental Emission (dBμV/m)	Electric field strength (V/m)	Limi (V/m)	SAR Test Exclusion
NFC	13.56	46.94	0.000222	60.77	Yes

Mode	Frequency (MHz)	Prediction distance (cm)	Rated Peak RF power output		MPE (mW/cm ²)	Limit (mW/cm ²)	SAR Test Exclusion
			dBm	mW			
2.4G WIFI	2412	20	13.863	24.3388	0.00869	1	Yes

2.4G WiFi Antenna Gain: 2.54dBi, 1.79(numeric)

Use distance is 20cm, Maximum Simultaneous transmission MPE Ratios for 2.4GWiFi+NFC:

Max MPE ratio 2.4G WiFi/Limit	Max MPE ratio NFC/Limit	Σ MPE ratios	Limit	Result
0.00869	0.000222	0.008912	1	PASS

Then SAR evaluation is not required.