



## **EPCglobal Recommended Occupational Use Best Practices for Complying with Limits on Human Exposure to Electromagnetic Fields (EMF)**

### **1) Introduction**

These best practices have been developed by EPCglobal, Inc to provide RFID system installers and users with additional information on human exposure to electromagnetic fields (EMF). The recommended best practices are based on guidelines and limits recommended by the various national and international regulatory agencies and standards bodies responsible for EMF safety. Suggested best practices are provided as part of EPCglobal's ongoing educational program to support users in their efforts to ensure safe operations at their facilities. Users are reminded of their obligations to ensure compliance with all applicable local regulations. A recommended resource for national EMF standards is the World Health Organization (WHO) worldwide database: <http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/Worldmap5.htm>

Though this document provides guidance on some product compliance issues, it was not produced with the intention of being used to develop a test plan for product approval or as a substitute for any regulatory requirements or guidelines. Further, it does not address Specific Absorption Rate (SAR) levels for individual products. These best practices were written considering current EPCglobal standards and current EPC technology applications. This document will evolve as new standards and applications are developed.

#### **Brief Overview of Electromagnetic Fields (EMF)**

EMF is the term used to describe the invisible electric and magnetic fields radiating away from man-made alternating electrical current, for example from electrical appliances in the home, office or factory; from wiring and other electrical items in cars, trucks and buses, and in mobile phones and power transfer lines.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has developed recommended exposure limits for both workers and the general public. These limits have also been adopted by the World Health Organization (WHO) and are the basis for the development of many national regulations and guidelines.

### **2) RFID and Health**

Questions have been raised about whether EMF generated by power lines, mobile phones and other wireless devices such as wireless local area networks (WLAN's) and RFID readers may be harmful to health. The main conclusion from the World Health Organization (WHO), as well as from the results of many science based studies carried out to date, show that EMF exposures below the limits recommended in internationally adopted guidelines are not proven to have any known negative health effects.

### 3) EPCglobal Recommended Best Practices

In addressing the issue of recommended best practices regarding EMF, the discussion can be broken down into the following categories:

- A. International Exposure Limits
- B. Product Compliance
- C. Best Practices for Installation and Operation

#### A) International Exposure Limits

In order to ensure a uniform benchmark for compliance, EPCglobal recommends the use of the limits for human exposure to EMF as developed by ICNIRP and recommended by the WHO.

A number of countries and regions, including most EU countries, have adopted the ICNIRP limits within their own regulations; some other countries have adopted limits developed by American National Standards Institute (ANSI). The version of the ANSI standards in general use was written in 1999 and updated in 2005 to align itself more closely with the ICNIRP guidance. To date, however, no country currently using ANSI limits has adopted the 2005 version.

In addressing the ICNIRP limits, EPCglobal recommends that the default requirement for most installations worldwide is the ICNIRP “Reference levels for general public exposure to time-varying electric and magnetic fields” – as seen in Table 1. These limits were developed for a more general environment where a user or member of the general public has no ability to control the level of their exposure.

In areas where there is no access to the general public and the degree of exposure can be controlled by appropriate means EPCglobal recommends adherence to the ICNRP “Reference levels for occupational exposure to time-varying electric and magnetic fields” – as seen in Table 2.

**Table 1: Reference levels for general public exposure to time-varying electric and magnetic fields (unperturbed rms values)**

Frequency range (f)	Electric field (E) V/m	Magnetic field (H) A/m	Power density ( $S_{eq}$ ) W/m <sup>2</sup>
<1Hz	—	$3.2 \times 10^4$	—
1 - 8Hz	10,000	$3.2 \times 10^4 / f^2$	—
8 - 25Hz	10,000	$4000 / f$	—
25 - 800Hz	$250 / f$	$4 / f$	—
0.8 - 3KHz	$250 / f$	5	—
3 - 150KHz	87	5	—
0.15 - 1MHz	87	$0.73 / f$	—
1 - 10MHz	$87 / f^{\frac{1}{2}}$	$0.73 / f$	—
10 - 400MHz	28	0.073	2
400 - 2000Mhz	$1.375 f^{\frac{1}{2}}$	$0.0037 f^{\frac{1}{2}}$	$f / 200$
2 - 300GHz	61	0.16	10

**Table 2: Reference levels for occupational exposure to time-varying electric and magnetic fields (unperturbed rms values)**

Frequency range (f)	Electric field (E) V/m	Magnetic field (H) A/m	Power density ( $S_{eq}$ ) W/m <sup>2</sup>
<1Hz	—	$1.63 \times 10^5$	—
1 - 8Hz	20,000	$1.63 \times 10^5 / f^2$	—
8 - 25Hz	20,000	$2 \times 10^4 / f$	—
25 - 820Hz	$500 / f$	$20 / f$	—
0.82 - 65KHz	610	24.4	—
0.65 - 1MHz	610	$1.6 / f$	—
1 - 10MHz	$610 / f^{\frac{1}{2}}$	$1.6 / f$	—
10 - 400MHz	61	0.16	10
400 - 2000Mhz	$3f^{\frac{1}{2}}$	$0.008f^{\frac{1}{2}}$	$f/40$
2 - 300GHz	137	0.36	50

Notes:

1.  $f$  as in the frequency range column.
2. For frequencies between 100KHz and 10GHz -  $S_{eq}$ ,  $E^2$ , AND  $H^2$  are to be averaged over 6 minutes

For other limitations of use see ICNIRP guidelines.

**B). Product Compliance**

Though this document was not developed specifically for guidance on product compliance for RFID equipment manufacturers, the general issue still needs to be addressed.

It is the responsibility of the equipment manufacturer to determine which standards their RFID products must comply with before placing them on the market. Products must comply with all applicable regulations. This includes compliance with all applicable technical standards for EMF human exposure limits.

EPCglobal encourages manufacturers to use good engineering practice to design products that not only comply with the requirements of appropriate standards but also subject the users of the equipment and general public to the lowest achievable RF emission profile.

It is also recommended that prior to installing or operating an RFID system, the system installers and end users review the product literature and manuals to determine if the products being supplied meet the applicable country regulations, including any EMF requirements.

### **C). Best Practices for Installation and Operation**

In addressing EMF issues, concerns are focused not only on the emissions from an individual device but also on the exposure to emissions from entire systems. Since each individual installation varies, the following recommendations may not be applicable in all situations. In some cases additional mitigation techniques may be required to ensure or maintain compliance. EPCglobal recommends that when in doubt, refer to the RFID equipment manufacturer or system installer for guidance.

#### **EPCglobal Recommended Best Practices**

- 1) Only purchase RFID equipment that complies with all applicable regulations.
- 2) Augment the manufacturer's basic guidelines for installation with guidance from international bodies such as the ITU, WHO, IEEE, and ICNIRP.
- 3) Use qualified installers who understand and have experience of the requirements for compliance with EMF exposure limits.
- 4) Follow the manufacturer's guidelines for basic installation and operation to maintain compliance with EMF guidelines.
- 5) Prior to use of the equipment, ensure that a complete audit has been carried out to determine EMF levels being emitted and that these levels comply with the local regulatory limits.
- 6) Make sure the systems are properly maintained to ensure proper operation post installation.
- 7) Test compliance in operational environments on a regular basis using a third party organization such as a certified audit company. In addition, compliance testing should be done when changes in equipment occur.
- 8) Train users on the proper use of equipment including instruction on how to limit exposure from these systems.
- 9) Where appropriate, post information signs in work areas where RF is in use to provide specific alerts where relevant.
- 10) Follow the ALARA principle –operate “as low as reasonably achievable” with good read accuracy. Where possible, use engineering solutions such as photocells or proximity switches to ensure that readers only transmit when transmission is required.

#### **4) Additional sources of information**

<http://www.fcc.gov/oet/rfsafety>

<http://www.fda.gov/>

<http://www.who.int/>

<http://www.etsi.org/>

<http://www.icnirp.de>

<http://www.osha.gov>

<http://www.cdc.gov/niosh/topics/emf/>

<http://www.ieee.org/portal/site> note “Recommended Practice for RF Safety Programs C 95.7-2005”

<http://www.ansi.org/>

<http://www.itu.int/home/index.html>

[http://ec.europa.eu/health/ph\\_determinants/environment/EMF/emf\\_en.htm](http://ec.europa.eu/health/ph_determinants/environment/EMF/emf_en.htm)

[http://ec.europa.eu/information\\_society/activities/health/policy\\_action\\_plan/emf/index\\_en.htm](http://ec.europa.eu/information_society/activities/health/policy_action_plan/emf/index_en.htm)

## 5) Glossary of terms

<b>ANSI</b>	American National Standards Institute
<b>EMF</b>	Electromagnetic Fields
<b>ICNIRP</b>	International Commission On Non-Ionizing Radiation Protection
<b>IEEE</b>	Institute of Electrical & Electronic Engineers (USA)
<b>ITU</b>	International Telecommunications Union
<b>RF</b>	Radio Frequency
<b>RFID</b>	Radio Frequency Identification
<b>rms</b>	Root Mean Squared
<b>SAR</b>	Specific Absorption Rate –measure of the rate of absorption of RF energy
<b>WHO</b>	World Health Organization
<b>WLAN</b>	Wireless Local Area Network

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[best\\_practices@lists.epcglobalinc.org](mailto:best_practices@lists.epcglobalinc.org)