



## The evaluation of electromagnetic field influence on workers while using an Internet of Things (IoT) RadioFrequency Identification (RFID) devices

P. Zradziński<sup>(1)</sup>, J. Karpowicz<sup>(1)</sup>, K. Gryz<sup>(1)</sup>, A.M. Trillo<sup>(2)</sup>, J.A. Hernandez<sup>(3)</sup>, S.D. Suarez<sup>(3)</sup>, F. Falcone<sup>(4)</sup> and V. Ramos<sup>(5)</sup>

(1) Central Institute for Labour Protection – National Research Institute (CIOP-PIB), Warszawa, Poland, e-mail: jokar@ciop.pl; pazra@ciop.pl; krgry@ciop.pl

(2) University Hospital Ramón y Cajal-IRYCIS, Madrid, Spain, e-mail: angeles.trillo@hrc.es

(3) University Hospital of Canarias, Tenerife, Spain, e-mail: jherarmy@gobiernodecanarias.org; dsuaroda@gobiernodecanarias.org

(4) Public University of Navarre, Spain, e-mail: francisco.falcone@unavarra.es

(5) Instituto de Salud Carlos III, Madrid, Spain, e-mail: vramos@isci.iii.es

### Extended Abstract

Internet of Things (IoT) systems may use various wireless communication protocols, including the RadioFrequency Identification (RFID) – to exchange of information and energy between readers and electronic chips (recognised as tags) attached to a monitored objects [1]. Additionally the hybrid system working in IoT is often used, including an RFID reader combined with a device for wireless data transmission such as a Wi-Fi (Wireless Fidelity) modem [2]. The most commonly used UHF (ultra-high frequency) RFID systems in the world operate in the frequency range 860-965 MHz (in Europe: 865-868 MHz). They may use fixed or handheld readers, recognised as RFID guns (usually with antennas smaller than 20 centimetres), which are built into small portable electronic devices or used as a kind of periphery accessory with tablets, palmtops or smartphones.

Exposure level to electromagnetic field (EMF) near the UHF RFID readers may be significant with respect to the limits for occupational exposure (Directive 2013/35/EU). While workers are present close to UHF RFID readers and even holding RFID guns close to the body, the EMF exposure evaluation should cover direct biophysical effects of exposure, characterized by specific absorption rate (SAR).

Our investigations are covering various exposure scenarios near UHF RFID readers (wall mounted, gates and handheld) modelled by numerical simulations with the use of anthropoid high resolution body models for SAR evaluation in exposed workers and measurements of EMF distribution near RFID readers. The worst-case exposure scenarios are related to the use of UHF RFID handheld readers.

Obtained results showed that localized 10g SAR values in limbs may exceed occupational limits during 6 minute exposure in the case of using UHF RFID readers with emission exceeding 5 W. General public limits may be exceeded when radiated power is exceeding 1 W. In Europe, regular use of RFID devices is allowed for their emission up to 2 W, but with special administrative permission also devices of stronger emission may be used. Localized 10g SAR values in head and torso, exposed to EMF from fixed and handheld UHF RFID readers located at distance of 5 cm from the closest surface of body, may be not compliant with limits when the reader emission exceed 12 W.

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### References

- [1] P. Zradziński, J. Karpowicz, K. Gryz, V. Ramos "An Evaluation of Electromagnetic Exposure While Using Ultra-High Frequency Radiofrequency Identification (UHF RFID) Guns", *Sensors*, **20**, 2020, No 202, doi: 10.3390/s20010202
- [2] F. Salinas Gómez, N.E. Suárez Escobar., J. Vázquez "RFID + Wi-Fi system to control the location of biomedical equipment within hospital areas and linked to an intelligent inventory", *Health and Technology*, 2019, doi: 10.1007/s12553-019-00393-6