Assessment of the Hazard of the Radiation of Wireless Communication Devices in Humanitarian Demining

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***Abstract*—In this document, the hazard of unintended activation of electric IEDs due to the radiated power of wireless communications devices is assessed. The variability of the firing circuit of IEDs is considered using Monte Carlo technique. Four communication services are considered: VHF and UHF mobile radio and GSM cellular mobile at 850 MHz and 1900 MHz. The expected induced power in the IEDs due to each disturbance is compared with the detonation threshold for different scenarios of transmitted power and distances.**

I. Methodology

The electromagnetic susceptibility of IEDs is studied from the comparison between the induced power in the firing circuit of the IED due to the external disturbance and the power threshold of the EED, which is the igniter of the IED. The EED ignition power threshold for a continuous excitation can be considered as 0.5 W [1].

In Fig. 1, transfer function of several realizations of IEDs is presented. This transfer function, T_{IED}, corresponds to the power delivered to a typical EED as a load of ignition circuits with arbitrary geometries due to an excitation of a 1 V/m plane wave. The figure shows the results of measurements of 176 wiring configurations with different geometries [2]. The power presented in Fig. 1 was calculated using a Norton equivalent circuit considering the firing circuit as the current source and the EED as its load [1]. The short circuit current and the input impedance of each firing circuit was measured using an excitation of 1 V/m as explained in [2] and the input impedance of the EED was represented by the model presented in [3]. To obtain the induced power, P_d, for other excitations the electric field should be scaled.

$$P_d = T_{IED} E_{inc}^2 \quad (1)$$

The communication devices assessed are UHF radios and GSM cellphones. For the analysis, four frequency bands were considered: 200 MHz, 436 MHz, 850 MHz, and 1900 MHz. In addition, two power levels were considered: 5 W and 40 W for low power and high power devices, respectively. The incident electric field generated by each source was calculated using

$$E_{inc} = \frac{\sqrt{60 G_t P_t}}{r}. \quad (2)$$

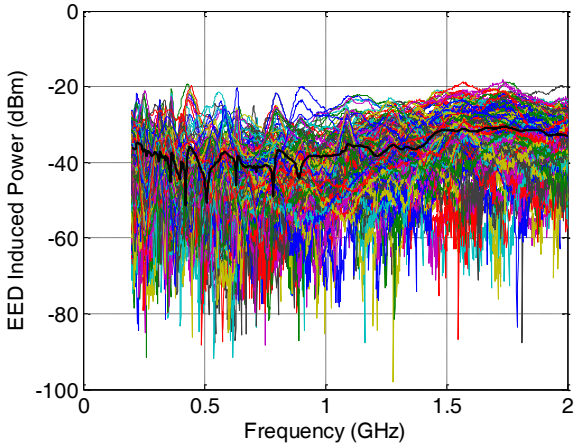

Fig. 1. Mean received power in a typical EED connected to wires with arbitrary configurations and length due to an incident plane wave of $|E_i| = 1\,\mathrm{V/m}$. Wires lengths range from 10 cm to 1 m.

II. Results

Fig. 2 presents the induced power in the IEDs radiated for communication devices with different power and at different distances. In all the considered cases, the induced power is lower than the detonation threshold. Fig. 2(a) shows the case of a low power device, such as a personnel radio, at 1 m of distance. In this case, 18.7 dB of difference with the detonation threshold is obtained. Fig. 2(b) shows the case of a high power device, such as a base station or an on-board radio, at 10 m of distance. In this case, 30 dB of difference with the detonation threshold is obtained. Fig. 2(c) shows the case of a high power device at 1 m of distance. In this case, the safety margin is reduced to 9.6 dB.

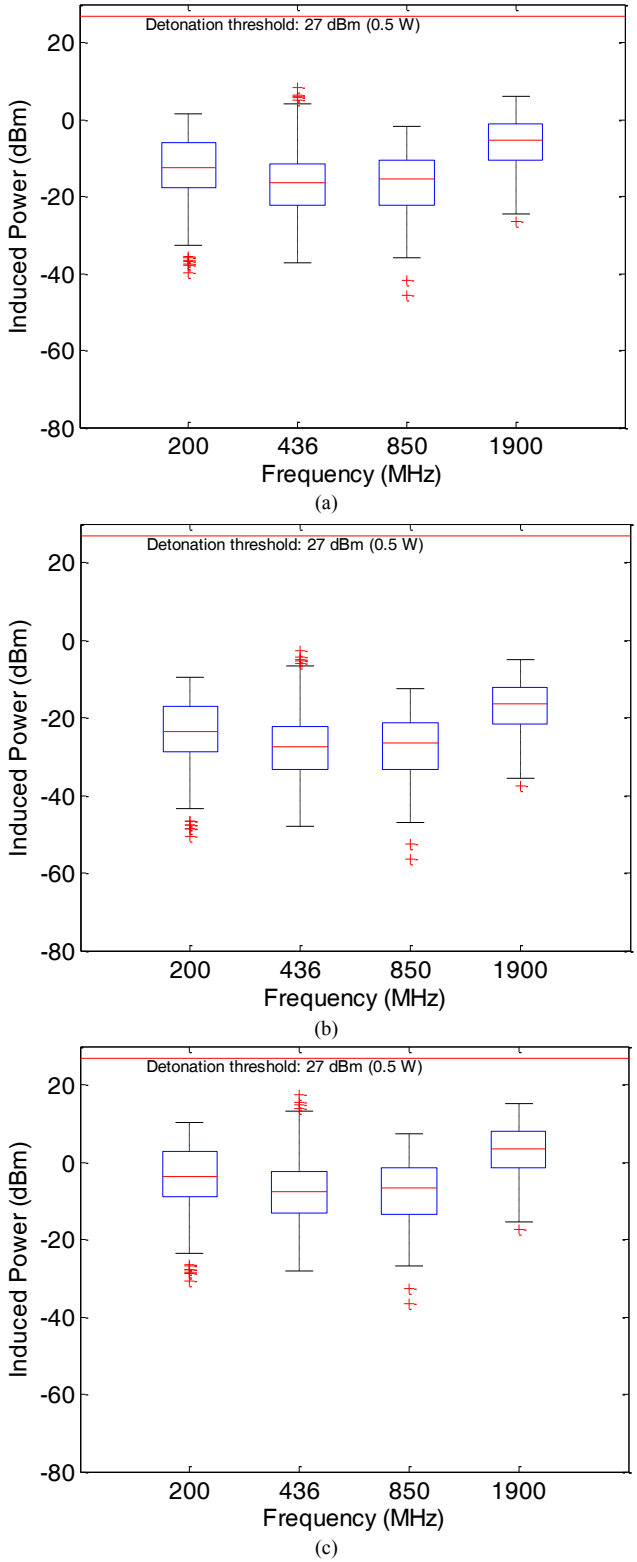

Fig. 2. Box plot of the calculated power in an IED due to the radiated power of four wireless communication services compared with the detonation threshold. The transmitter gain is 2 and the transmitter power and distance are (a) 5 W and 1 m, (b) 40 W and 10 m, and (c) 40 W and 1 m, respectively.

III. Conclusions

Results show that the distances and powers of wireless communication devices used in humanitarian demining operations does not represent a risk of unexpected detonations of IEDs. To guarantee a 10 dB power safety margin, it is not recommended to have high power communication devices at distances lower than 10 m of possible IED locations.

Although in the presented analysis IEDs are considered in free space to represent a worst case scenario, work is in progress to analyze the susceptibility of buried devices.

References

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[3] J. J. Pantoja, F. Vega, F. Román, N. Peña and F. Rachidi, "On the Differential Input Impedance of an Electro-Explosive Device," in *IEEE Transactions on Microwave Theory and Techniques*, vol. PP, no. 99, pp. 1-7.