

Research and Assessment of Safety Distance of TV Electromagnetic Fields

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The evaluation covers the strengths of electric field and magnetic flux density measured in frequency ranges of 5 Hz–2 kHz and 2–400 kHz of selected TV sets. The dependence of the electromagnetic field on the distance is addressed with reference to ergonomics and safety. Ten TV sets (5 tube and 5 LCD) were measured. There were 16 measurements for each one. The aim was to evaluate electric field and magnetic flux density versus the distance from the tested device with regard to exposure levels. In addition, the distance and the strengths of electric field and magnetic flux density emitted by tube and LCD TVs were compared. The results are presented in charts.

electric field strength magnetic flux density electromagnetic field safety distance

1. INTRODUCTION

We are surrounded by electromagnetic emissions, noise and other kinds of physical pollution from the day we are born and this covers all spheres of human activities [1]. The impact of electromagnetic emissions on human health began receiving increasing attention in the 1970s when more electromagnetic equipment entered the workplace. An electromagnetic field, like noise, is a special form of matter [2]. Recently, a new term, electric smog, has come into common use [3]. This term defines electromagnetic fields created in the environment by high-voltage electric transmission lines, electrified railways, low-voltage electric grids, TV and radio sets, computers, copying machines or mobile telephones [4, 5]. Unlike visible and directly felt smog, electric smog, i.e., environmental pollution with electromagnetic fields, is invisible and intangible but this does not mean that it is not harmful to the human body [6, 7].

TV sets like other electrical appliances emit electromagnetic fields of different frequencies.

The frequency of TV-emitted fields is lower than that of visible light [8].

TV sets are commonly used at workplaces; they can be a hazard to people working in porters' lodges, service stations, shops or fairs. The main principle of ergonomics is that technology should be comfortable and safe for human. The best solution to make electromagnetic fields safe is to ensure safe distance if electromagnetic fields exceed hygienic norms [8].

TV visual display units use alternating voltage of 50 Hz (60 Hz in some countries) [9]. Fields of such frequency are encountered everywhere [10]. They are emitted by electric installations, electronic and electrical equipment in schools and at work [11]. There an emitted wave is not very long: 50 Hz corresponds to 6000 km, 60 Hz to 5000 km [12].

As the strength of fields radiated by any device or conductor depends on the level of current or voltage that generated them, it is natural to assume that devices that use more electric energy emit stronger electromagnetic fields [13]. These include

colour tube TVs and TVs of high-resolution power [14, 15]. The longer the distance to the screen, the weaker the electromagnetic field [16]. Consequently, their impact on persons present in the vicinity of a TV depends on how close to the device they are [17]. Electromagnetic fields generated by TV sets have frequency components in the range of 5 Hz–400 kHz [18]. Voltage inside TV sets is divided and alternated many times as it requires higher frequencies and other forms of electrical current—not only the sine one but also saw-toothed and in the form of rectangular impulses as well as individual impulses, etc. [19]. When flowing via conductors, the current of various forms creates respective electromagnetic fields spreading outside the source [20, 21]. The correlation of fields predetermines the origination of fields with complicated forms [22]. Due to their nature, TVs and especially their tubes emit electromagnetic fields [23, 24].

Stronger electromagnetic fields in tube TVs are created by electromagnetic coils, which are equipped on a tube (electron gun) and are used to direct an image ray. Magnetic flux density

is generated by the TV set's transformer, line transformer and demagnetization loop. The electric field is generated by power supply, impulsive power supply. Flat-screen tube TV sets do not contain elements generating increased electromagnetic fields. In these TV sets a cold cathode lamp and a liquid crystal matrix are used, whereas the screen is lit from the back with the lamp and the matrix itself either conducts light or it does not. Other reasons may include a power supply unit of poorer quality, which does not filter electromagnetic fields very well.

The aim of this work was to investigate and evaluate electric field and magnetic flux density emitted by TVs and to assess safe distance. A plugged-in TV, like any other electrical appliance, emits a certain electromagnetic field (this field exists even when a TV set is turned off; it is enough to leave it plugged in).

2. OBJECT AND METHODOLOGY

Measurements covered electromagnetic fields of 10 TV sets denominated further as A, B, C, D, E, F, G, H, I and J¹. The first 5 were tube and

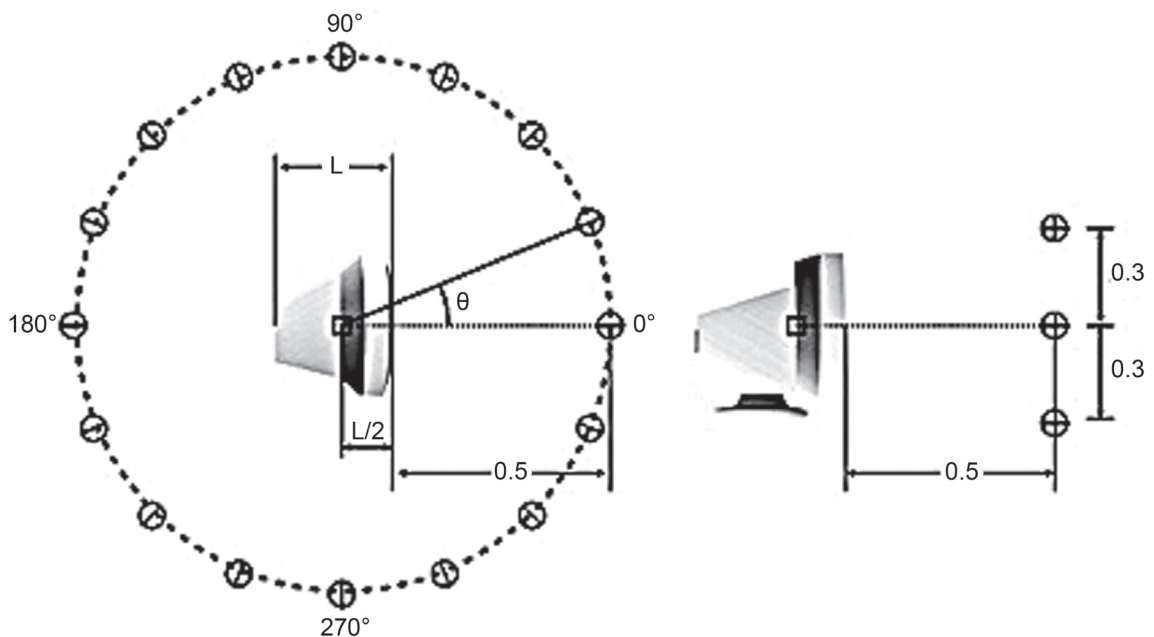


Figure 1. Measurement scheme of electric and magnetic fields.

¹ Information on the TV sets is available from the corresponding author.

the other 5 ones were LCD TVs. A measuring instrument was positioned so that the centre of the TV screen matched the measuring head's centre and it was withdrawn by 50 cm from the surface of the screen.

After the first measurement, the TV set was revolved around its axis. The readings of the measuring instrument were recorded every 22.5° when measuring the alternating electric field and alternating magnetic flux density (Figure 1).

With the distance from the TV screen increasing, the electric field and magnetic field flux density changed. A 0.5–3 m distance selected for the study again confirmed the view that distance provides the best protection. The longer it is, the weaker the electric strength and the density of magnetic flux.

An ESM-100 electric and magnetic field meter (Maschek, Germany) was used for the measurements (Figure 2). Frequency range 5 Hz–400 kHz, measuring range 1 nT–20 mT and 0.1 V/m–100 kV/m, display range 0 nT–20 mT and 0.0 V/m–100 kV/m for filter 50 or 16.7, 10 nT–20 mT and 1.0 V/m–100 kV/m for a “high” or “low” filter, 15 nT–20 mT and 1.5 V/m–100 kV/m for an “all” filter. Accuracy: $\pm 5\%$ (sine, 50 nT–20 mT, 5 V/m–100 kV/m), ± 5 digits. Measuring rate: decimal display 2 Hz, bargraph 10 Hz with a 3-s peak hold. Operation: H-field: coils, isotropic E-field: field plates, isotropic. Display: liquid crystal display with illumination, H and E fields displayed simultaneously in 3 dimensional values. Functions: minimum and maximum value memory, 1D measurement. Dimensions: $365 \times 83 \times 56$ mm. Weight: 560 g.

The meter takes measurements regardless of the direction of the antenna, i.e., isotropically. This is important to avoid errors because electric and magnetic fields spread from different directions and their values may fluctuate all the time. The measurements were taken in two frequency ranges, isolated from each other: 5 Hz–2 kHz and 2–400 kHz.

Sixteen measurements for each TV set were taken at the low frequency of 5 Hz–2 kHz. Similar measurements were made at the high frequency of 2–400 kHz. At least three



Figure 2. Electric and magnetic field strength meter.

measurements were taken at each measurement point. The result is the arithmetic average of those measurements.

3. RESULTS AND DISCUSSION

Table 1 shows electric field strength and magnetic flux density measured 0.5 m from the screen of the TV set. The range of electric field strength is 1.0 V/m–100 kV/m and magnetic flux density emission is 10 nT–20 mT for each TV set. The natural background emission for the measured electric field strength (5 Hz–2 kHz) is 2 V/m and for magnetic flux density (5 Hz–2 kHz) is 30 nT; electric field (2400 kHz) is 0.1 V/m and magnetic flux density (2–400 kHz) is 1 nT. The reference levels have been taken from Standard No. TN 01:1998 [11].

The strength of the electric field of TV E in the range of 5 Hz–2 kHz exceeded the reference limit of 25 V/m and reached 27.8 V/m, whereas that of the remaining LCD and tube TVs did not exceed the reference level. The electric field strength of tube TV sets in the range of 2–400 kHz considerably exceeded the reference

TABLE 1. Electric Field Strength and Magnetic Field Flux Measured 0.5 m From the TV Set Screen

TV Set	Electric Field Strength (V/m)		Magnetic Field Flux (nT)	
	5 Hz–2 kHz ^a	2–400 kHz ^b	5 Hz–2 kHz ^c	2–400 kHz ^d
A	15.6	5.2	98.4	35.3
B	20.3	8.5	58.7	26.7
C	12.0	10.3	54.1	25.9
D	12.7	4.1	105.3	15.6
E	27.8	13.1	210.5	33.5
F	8.9	0.9	57.3	9.8
G	5.5	0.5	65.9	7.4
H	4.1	1.0	64.6	8.2
I	6.6	0.8	59.7	3.5
J	5.8	0.8	58.8	5.6

Notes. Information on the TV sets is available from the corresponding author; a—reference level 25 V/m, b—reference level 2.5 V/m, c—reference level 250 nT; d—reference level 25 nT.

limit of 2.5 V/m. That limit was not reached by the LCD sets.

According to data on magnetic flux density of both tube and LCD TVs in the frequency range of 5 Hz–2 kHz the reference limit of 250 nT was not exceeded.

In the 2–400 kHz range nearly all tube TVs, except for D, exceeded the reference limit of magnetic flux density of 25 nT. The magnetic flux density of LCD TVs did not go over that norm.

As Figure 3 shows, the electric field strength measured in the frequency range of 5 Hz–2 kHz at 0.5–3 m decreased about twofold: that of TV set A decreased from 15.6 to 3 V/m, B from 20.3 to 11 V/m, C from 12 to 7 V/m, D from 12.7 to 4 V/m, E from 27.8 to 14 V/m, F from 8.9 to 4 V/m, G from 5.5 to 2 V/m, H from 4.1 to 2 V/m, I from 6.6 to 3 V/m, J from 5.8 to 3 V/m.

A distance of 1.5 m from all those TV sets is safest as electric field strength in a frequency range of 5 Hz–2 kHz does not exceed the reference limit.

Very similar data was obtained when electric field strength was measured in the 2–400 kHz frequency range (Figure 4) and magnetic flux density at 5 Hz–2 kHz (Figure 5). Even 0.5 m from all the TV sets was safe. For magnetic flux density in the 2–400 kHz frequency range (Figure 6) 3 m was safest, with magnetic flux density not exceeding the reference limit.

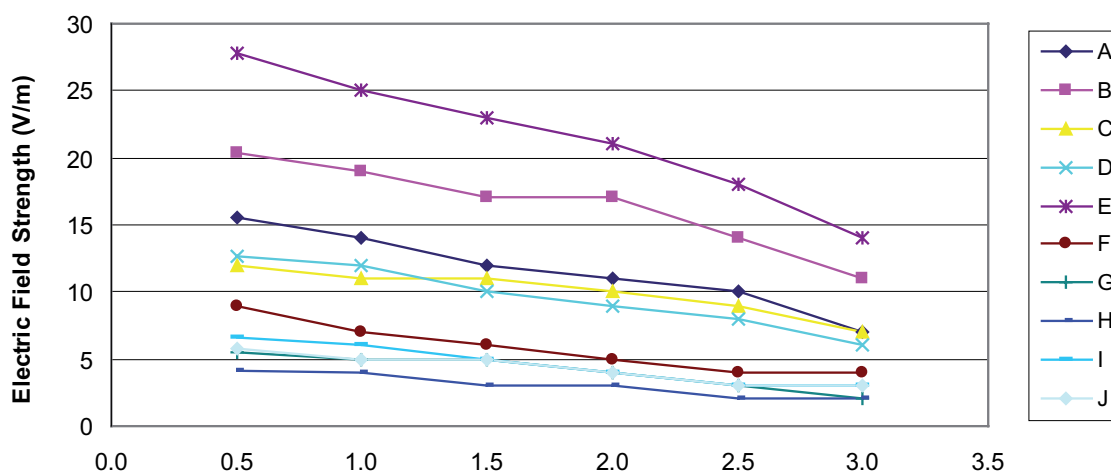


Figure 3. Change in electric field strength at 0.5–3 m from the TV set screen in the 5 Hz–2 kHz frequency range.

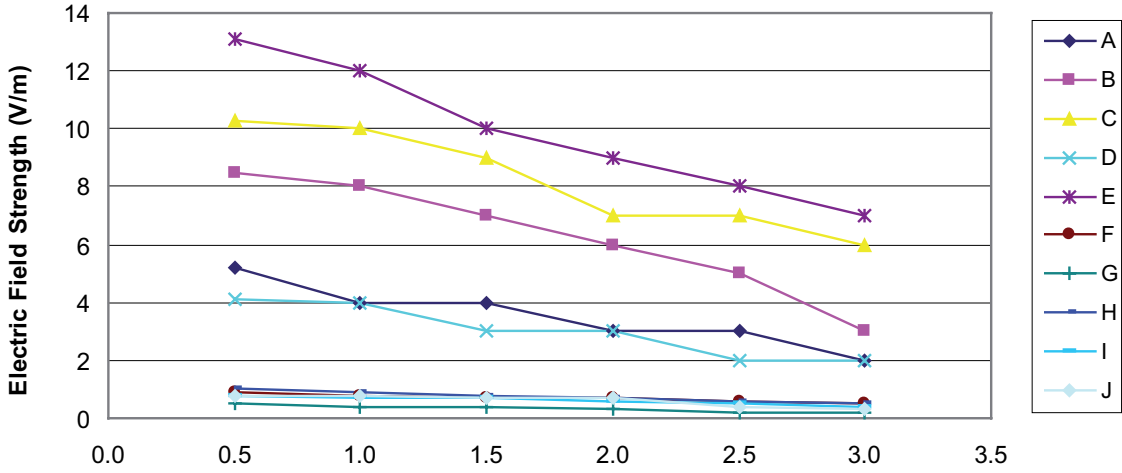


Figure 4. Change in electric field strength at 0.5–3 m from the TV set screen in the 2–400 kHz frequency range.

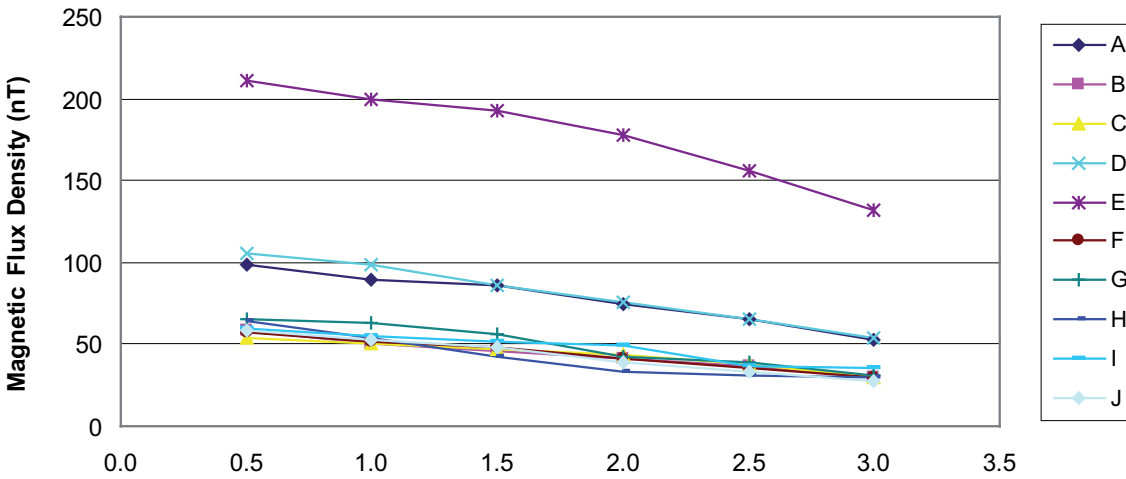


Figure 5. Change in magnetic flux density at 0.5–3 m from the TV set screen in the 5 Hz–2 kHz frequency range.

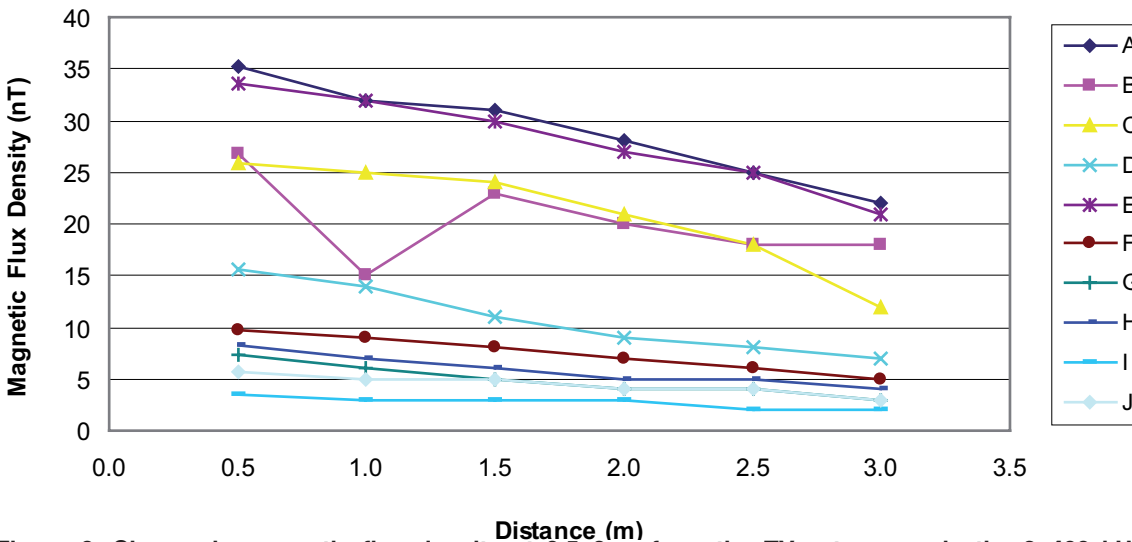


Figure 6. Change in magnetic flux density at 0.5–3 m from the TV set screen in the 2–400 kHz frequency range.

For ergonomics to decrease the negative impact of TV electromagnetic fields on human health, it is necessary to select a proper location in a room and a light regime for the TV. There should be at least 1 m from the floor to the lower edge of the screen of the TV set. A safe distance from the viewer's eyes to the screen depends on the size of the screen: the bigger the screen diagonal, the longer the distance. Normally this distance is between 3 and 5 m.

4. CONCLUSIONS

1. The electric field strength of TV sets in the range of 5 Hz–2 kHz varied from 4.1 to 27.8 V/m; the reference safety limit of 25 V/m was exceeded by tube TV E: 27.8 V/m.
2. Tube TV sets generate a strong electric field in the range of 2–400 kHz, so they are not as safe as LCD TVs, which did not exceed the reference norm of 2.5 V/m.
3. For tube and plasma TV sets, the magnetic flux density in the frequency range of 5 Hz–2 kHz did not exceed the reference limit of 250 nT, and their corresponding main criteria of ergonomics: efficiency, safety and convenience.
4. Magnetic flux density of tube TVs, except for D, in the range of 2–400 kHz exceeded the reference limit of 25 nT, magnetic flux density of LCD TVs was more than twofold weaker compared to tube TV sets and the reference safety norm was never exceeded.
5. With the distance from the TV screen increasing, electric field strength and magnetic flux density changed: at 3 m electric field strength and magnetic flux density decreased nearly twofold and did not exceed the reference safety norm.

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