Sujet : [INTERNET] Projet éolien de Marcillac-lanville
De : guy monique Bizard <bizard.guymon@gmail.com>
Date : 27/09/2023 11:39
Pour : pref-eolien-marcillac-lanville@charente.gouv.fr

Monsieur et Madame Guy BIZARD
38 rue de La Rochefoucault Aizet
16140 Marcillac-Lanville

Mail: bizard.guymon@gmail.com

à

Monsieur le Commissaire Enquêteur.

Je suis contre le projet Abowind de Marcillac-Lanville pour les raison suivantes.

* Ce projet contribue à l'effet de saturation visuelle et d'encerclement dans le Nord-Charente où les quotas donnés par l'état sont déjà dépassés (l'état se doit de respecter ses engagements, ou les citoyens doivent-ils faire des manifestations très violentes comme la bretagne ? où je n'ai vu aucune éolienne dans le sud Finistère et pourtant ce n'est pas le vent qui manque)

* Non respect de l'opposition de la population et des élus.

* Effets nocifs sur la santé des riverains : pollutions lumineuses , sonores, ondes

* Dépréciation immobilière trop proche des maisons (dans hameau où l'on attend d'abord que soit fait le kilomètre et demi du tout à l'égout qui aurait dû être fait il y a 60 ans pour relier à la commune d'Aigre)

*La covisibilité avec le site du prieuré de Lanville classé patrimoine historique.

Fait à Marcillac- Lanville

le 27 septembre 2023

Guy et Monique BIZARD

Sujet : [INTERNET] Enquête Publique projet éolien de Marcillac Lanville
De : Marcel Puygrenier <marcel.puygrenier@gmail.com>
Date : 27/09/2023 10:03
Pour : pref-eolien-marcillac-lanville@charente.gouv.fr

Monsieur le Commissaire Enquêteur,

Ci-dessus, la production électrique du parc éolien de Guérande, 2 unités de 240 MW.

- du 25 septembre à 12 h au 26 à 3 h, production totalement nulle.

- ensuite une production en dents de scie proche de 0.

Il s'agit d'une centrale électrique en mer, au large de Saint Nazaire dont le rendement est supérieur à l'éolien terrestre.

En ce qui concerne le projet de Marcillac-Lanville, on peut prévoir un rendement encore plus bas.

Pour cette raison entre-autres, je vous prie de donner un avis défavorable à ce projet éolien.

Je vous prie d'agréer, Monsieur le Commissaire Enquêteur, à mes sincères salutations.

Marcel Puygrenier
4 lieu dit Bachellerie
16420 Saulgond

Sujet : [INTERNET] Étude de la Fed.
De : John Hunter <charivari16@gmail.com>
Date : 27/09/2023 17:54
Pour : pref-eolien-marcillac-lanville@charente.gouv.fr

L enquêtrice a contacté l Anses en personne qui n a pas bougé.
Ils n acceptent pas de discuter et surtout pas de prendre en compte le danger des eoliennes et de leurs emissions deleteres pour le vivant.
Terrorisés par le gouvernement et ses represailles.
En revanche le ministère de l agriculture lance une enquête sur les courants vagabonds des fermes d eleveurs.
Les champs de torsion levogyres. Pour les non ignoramus....
Physique cartesienne et non Newtonienne.

Pièces jointes :

Imputabilite-eoliennes-sante-fed_(1).pdf-reflow - Copy.epub 30 octets

Sujet : [INTERNET] Le graphique de Raines.
De : John Hunter <charivari16@gmail.com>
Date : 27/09/2023 17:54
Pour : pref-eolien-marcillac-lanville@charente.gouv.fr

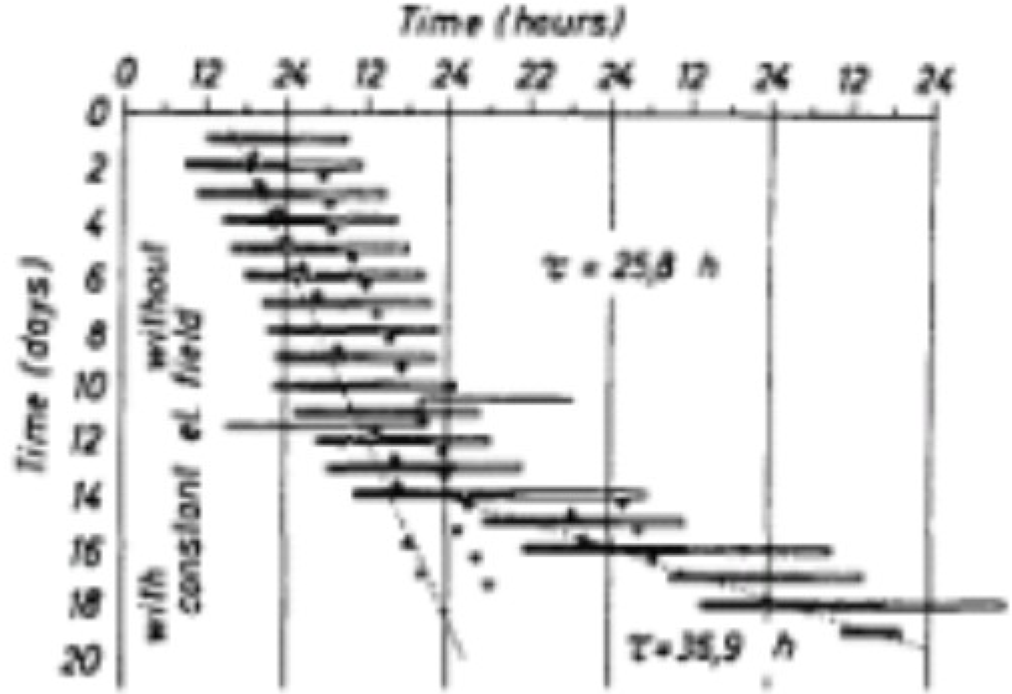
En ordonnée les jours
En abscisse led heures

Les rythmes circadiens d'un individu dans un contexte où il n'y a aucun acces aux repères du temps, calendrier, montre etc.

Voyez la section 1.
Protection complete des émissions naturelles et artificielles.
Section 2.
Les fréquences electro magnetiques pleuvent. On a 2.5 V/m. Et 10 Hz.
Recherche Persinger.

Plus les jours passent et plus le rythme circadien est perturbé.
Donc l'horloge biologique est faussée.
Les riverains des eoliennes ont recours aux benzodiazepines pour dormir.
Ce que les promoteurs trouvent normal.
La nature humaine n est pas faite pour être perturbée.
Ceux qui l acceptent sont des criminels.
Donc une innovation qu on maintient contrairement à la santé.
Il n y a pas de besoin d énergie qui cautionne ce manque de respect de l humain.

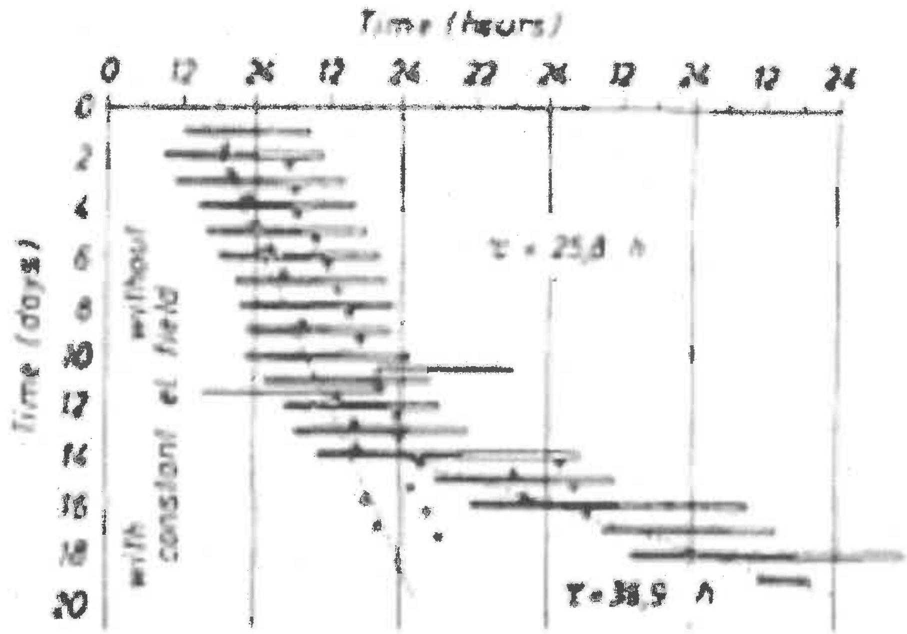
Screenshot_20221030-082232.png



Free-running circadian rhythm of a subject living under strict isolation from environmental time cues, during the first section protected from natural and artificial electromagnetic fields, during the second section under the influence of a continuously operating artificial electric DC-field.

Pièces jointes :

Screenshot_20221030-082232.png	304 Ko



Free-running circadian rhythm of a subject living under strict isolation from environmental time cues, during the first section protected from natural and artificial electromagnetic fields, during the second section under the influence of a continuously operating artificial electric DC-field.

EFFECTS OF 2.5 VOLT/METER, 10-HERTZ AND
STATIC ELECTRIC FIELDS ON CIRCADIAN RHYTH
IN PERSINGER, 1974).

41.

Sujet : [INTERNET] Résumé de l etude Weichenberger 2015.
De : John Hunter <charivari16@gmail.com>
Date : 27/09/2023 17:54
Pour : pref-eolien-marcillac-lanville@charente.gouv.fr

Le cortex est stimulé par les infrasons.
Sommeil difficile près des éoliennes.

Pièces jointes :

resume.français weichenberger.pdf	30 octets
weich original.pdf	30 octets

La connectivité altérée dans les régions du cortex et du sub-cortex à cause d'une émission infrasonique administrée près du seuil de l'audition. La preuve avec l'imagerie par résonance magnétique IRM.

Markus Weichenberger et al. Université de Medecine de Berlin. 2017

RÉSUMÉ

Dans cette étude, la réponse du cerveau à la stimulation infrasonique près du seuil de l'audition ou au delà, IS, pour des fréquences inférieures à 20 Hz, à été investiguée dans des conditions où le sujet est au repos et subit un examen d'imagerie à résonance magnétique IRM. Il y eut deux sessions consécutives. Dans la première session 15 participants sains ont eu un test de seuil d 'audition et des mesures pour déterminer leur sensibilité au son sur une échelle croissante dans lesquelles leur perception individuelle du son pour la stimulation infrasonique, à été évaluée selon différents niveaux de pression sonore. (SPL. Sound pressure levels) Dans la seconde session ces participants reçurent trois acquisitions au repos, une sans stimulation auditive, sans tonalité, une pour une oreille seulement à 12 Hz, près du seuil de l'audition, et une de tonalité similaire au dessus du seuil de l'
individu, ce qui correspond à une sensation d'écoute de force moyenne et au delà du seuil.

L'analyse des données se situa surtout sur les mesures de connectivité locales au moyen de l'homogénéité régionale (ReHo) mais comprenait aussi l' analyse de composants indépendants (ICA) pour investiguer la connectivité inter- régionale. L'analyse ReHo à révélé une connectivité supérieure locale dans la convolution temporale supérieure droite. STG superior temporal gyrus. Qui est adjacente au cortex primaire de l'audition, dans le cortex antérieur cingulaire. ACC. Anterior cigular cortex. Et, quand il permet de plus petites concentrations, aussi dans l'amygdale droite (rAmyg) pendant presque le seuil de l'audition si on le compare au seuil au dessus de l'audition et à la condition sans tonalité.

Une analyse de composants additionnelle et indépendante (ICA) à révélé des changements importants de connectivité fonctionnelle qui se traduit par l'activation plus forte de l'amygdale droite (rAmyg) dans le contraste opposé (pas de tonalité >seuil de l'audition presque atteint) tout comme la convolution frontale supérieure droite(rFSG) pendant la condition où on atteint presque le seuil de l'audition.

En résumé cette étude est la première à démontrer que l'in frason près du seuil de l'audition peut induire des changements de l'activité neurale tout au long de plusieurs régions du cerveau dont certaines sont sollicitées lors du processus auditif, tandis que d'autres jouent un grand rôle dans le contrôle émotionnel ou le système autonome. Ces découvertes nous invitent à faire des spéculations sur la façon dont l'exposition continue à un niveau subliminal par l 'infrason peut exercer une influence pathogène sur l' organisme mais d'autres études en particulier des études longitudinales sont requises pour donner plus de substance à ces découvertes.

RESEARCH ARTICLE

Altered cortical and subcortical connectivity due to infrasound administered near the hearing threshold – Evidence from fMRI

Markus Weichenberger[1]*, Martin Bauer[2], Robert Kühler[2], Johannes Hensel[2], Caroline Garcia Forlim[3], Albrecht Ihlenfeld[2], Bernd Ittermann[2], Jürgen Gallinat[3], Christian Koch[2], Simone Kühn[3]

1 Department of Psychiatry and Psychotherapy, Charité-Universitätsmedizin Berlin, Berlin, Germany, **2** Physikalisch-Technische Bundesanstalt (PTB), Braunschweig and Berlin, Germany, **3** University Clinic Hamburg-Eppendorf, Clinic and Policlinic for Psychiatry and Psychotherapy, Hamburg, Germany

* markus.weichenberger@charite.de

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Data Availability Statement: Data are available on the Max Planck Institute for Human Development data server for researchers who meet the criteria for access to confidential data. These restrictions are imposed by the German Psychology Association (DGP). As all the data is being stored on password-protected internal servers of the Max Planck Institute for Human Development, the authors would very much appreciate if any request for the data could be send directly to Prof. Kühn. Please find below the relevant contact information

Abstract

In the present study, the brain's response towards near- and supra-threshold infrasound (IS) stimulation (sound frequency < 20 Hz) was investigated under resting-state fMRI conditions. The study involved two consecutive sessions. In the first session, 14 healthy participants underwent a hearing threshold—as well as a categorical loudness scaling measurement in which the individual loudness perception for IS was assessed across different sound pressure levels (SPL). In the second session, these participants underwent three resting-state acquisitions, one without auditory stimulation (no-tone), one with a monaurally presented 12-Hz IS tone (near-threshold) and one with a similar tone above the individual hearing threshold corresponding to a 'medium loud' hearing sensation (supra-threshold). Data analysis mainly focused on local connectivity measures by means of regional homogeneity (ReHo), but also involved independent component analysis (ICA) to investigate inter-regional connectivity. ReHo analysis revealed significantly higher local connectivity in right superior temporal gyrus (STG) adjacent to primary auditory cortex, in anterior cingulate cortex (ACC) and, when allowing smaller cluster sizes, also in the right amygdala (rAmyg) during the near-threshold, compared to both the supra-threshold and the no-tone condition. Additional independent component analysis (ICA) revealed large-scale changes of functional connectivity, reflected in a stronger activation of the right amygdala (rAmyg) in the opposite contrast (no-tone > near-threshold) as well as the right superior frontal gyrus (rSFG) during the near-threshold condition. In summary, this study is the first to demonstrate that infrasound near the hearing threshold may induce changes of neural activity across several brain regions, some of which are known to be involved in auditory processing, while others are regarded as keyplayers in emotional and autonomic control. These findings thus allow us to speculate on how continuous exposure to (sub-)liminal IS could exert a pathogenic influence on the organism, yet further (especially longitudinal) studies are required in order to substantialize these findings.

for Prof. Kühn. Prof. Dr. Simone Kühn, Zentrum für Psychosoziale Medizin, Klinik und Poliklinik für Psychiatrie und Psychotherapie, Martinistraße 52, 20246 Hamburg, Telefon +49 (0) 40 7410 – 55201, E-Mail: skuehn@uke.de, Website: https://www.uke.de/.

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Competing interests: The authors have declared that no competing interests exist.

Introduction

The question, whether infrasound (IS; sound in the very low-frequency range– 1 Hz $<$ frequency $<$ 20 Hz) can pose a threat to physical and mental well-being remains a much debated topic. For decades, it has been a widely held view that IS frequencies are too low to be processed by the auditory system, since the human hearing range is commonly quoted to only span frequencies from about 20 to 20000 Hz [1]. This view was supported by a number of studies conducted in animals as well as in humans demonstrating that the auditory system is equipped with several shunting and attenuation mechanisms, which are already involved in early stages of signal processing and make hearing at low frequencies quite insensitive [2–7]. However, the notion that IS cannot be processed within the auditory system has been contested by several studies, in which IS-induced changes of cochlear function in animals [8] as well as in normally hearing human participants [9]) have been documented. In fact, it has been shown repeatedly that IS can also be perceived by humans, if administered at very high sound pressure levels (SPLs) [10–17]). More recently, two fMRI studies also revealed that exposure to a monaurally presented 12-Hz IS tone with SPLs of $>$ 110 dB led to bilateral activation of the superior temporal gyrus (STG), which suggests that the physiological mechanisms underlying IS perception may share similarities with those involved in 'normal hearing', even at the stage of high-level cortical processing [18–19].

Meanwhile, there seems to be a growing consensus that humans are indeed receptive to IS and that exposure to low-frequency sounds (including sounds in the IS frequency spectrum) can give rise to high levels of annoyance and distress [20]. However, IS also came under suspicion of promoting the formation of several full-blown medical symptoms ranging from sleep disturbances, headache and dizziness, over tinnitus and hyperacusis, to panic attacks and depression, which have been reported to occur more frequently in people living close to wind parks [21–23]. While it has been established that noise produced by wind turbines can indeed have a considerable very low-frequency component, IS emission only reaches SPL-maxima of around 80 to 90 dB [24–27], which may not be high enough to exceed the threshold for perception. Taking into consideration such results, Leventhall [1] thus concluded that "if you cannot hear a sound and you cannot perceive it in other ways and it does not affect you". Importantly, this view also resonates well with the current position of the World Health Organisation (WHO), according to which "there is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects" [28]. However, it appears that the notion, according to which sound needs to be perceived in order to exert relevant effects on the organism, falls short when aiming at an objective risk assessment of IS, especially if one takes into consideration recent advances in research on inner ear physiology as well as on the effects of subliminal auditory stimulation (i.e. stimulation below the threshold of perception). For example, 5-Hz IS exposure presented at SPLs as low as 60–65 dB has been shown to trigger the response of inner ear components such as the outer hair cells in animals [29] and it has been suggested that outer hair cell stimulation may also exert a broader influence on the nervous system via the brainstem [30–31]. In addition, there is the well documented effect in cognitive science that brain physiology and behavior can be influenced by a wide range of subliminally presented stimuli, including stimuli of the auditory domain [32–34].

We therefore set out to address the question, whether IS near the hearing threshold can also exert an influence on global brain activity and whether the effects of stimulation significantly differ from those induced by supra-threshold IS. In our experiment, IS stimuli were applied during the so called resting-state, in which participants were asked to lie calmly in the scanner with eyes closed, while being passively exposed to the sound. During resting-state, a characteristic pattern of endogenous large-scale brain activity emerges, which commonly involves the co-activation of multiple brain regions such as medial prefrontal cortex (MPFC), posterior cingulate cortex (PCC), precuneus, inferior parietal lobe (IPL), lateral temporal cortex (LTC), and hippocampal formation (HC) [35–36]. This activity causes fluctuations of the blood oxygen dependent (BOLD) signal, which can then be visualized using resting-state functional magnetic resonance imaging (rsfMRI). The fact that these brain regions consistently show a decrease in activity during task performance and an increase during fixation or rest has also led to the notion of a so-called default mode network [37]. Since a large portion of the IS that we are exposed to in our daily environment is produced by continuous sources such as wind-turbines, traffic (cars and planes) or air-conditioning systems, we reasoned that IS may rather exert influences on the nervous system as a constant and subtle source of (sub-)liminal stimulation, than a source of punctual stimulatory events. In contrast to an event-related approach, which would be characterized by short alterations of stimulus presentation and data aquisition (so called 'sparse sampling'), rsfMRI allows us to study the brain's response to IS under conditions, which more closely resemble those found outside of the laboratory, where IS is often presented over long periods of time without dicontinuities in stimulus administration. One may argue that the way in which the term resting-state is used throughout the present article is at odds with the common understand of resting-state as a measure of baseline brain activity in the absence of experimental stimulation or task. However, researchers are becoming increasingly sensitive to the fact that rsfMRI cannot only be used as a suitable tool for measuring stable, trait-like characteristics, such as differences due to sexual dimorphism or health conditions. In fact, spontaneous, self-generated mental processes manifesting as moment-to-moment fluctuations of the participant's mood or the „affective coloring"of thoughts and memories are an inevitable feature of any rsfMRI measurement and it has been argued repeatedly that a considerable portion of the statistical variance obtained during data aquisition can actually be explained by the heterogenity of the participant's mental states [38–39]. Therefore, it is precisely this type of data–enriched with diverse experiental aspects gathered across a long stimulus interval, in contrast to short snippets of the brain's immediate response to a novel stimulus–that allows us to best address the research questions presented above.

In order to obtain a more robust signal for the comparison of different resting-state conditions, our analysis focussed on regional homogeneity (ReHo), a measure that captures the synchrony of resting-state brain activity in neighboring voxels–so-called local connectivity. In contrast to functional connectivity, which reveals synchronization of a predefined brain region, ReHo measures the local synchronization of spontaneous fMRI signals [40–42]. Importantly, ReHo circumvents the necessity to apriori define seed regions and therefore allows for an unbiased whole-brain analysis of resting-state data. Furthermore, it has also been shown that ReHo is higher in the major regions of the default mode network [43]. In order to obtain a more comprehensive assessment of the effect of IS, independent component analysis (ICA) was performed as an auxiliary analysis [44]. Similar to ReHo, ICA represents a data-driven method, which relinquishes any initial assumptions about the spatial location of brain activations, while allowing to explore the temporal dynamics between more spatially segregated independent areas. Both methods are thus complementary in the sense that they allow for a characterization of the brain's response to IS both on the local as well as on the network level in an unbiased fashion.

Experimental procedures

Participants

Fourteen healthy subjects (6 female) aged 18 to 30 years (mean = 23.4 years; SD = 3.0) participated in the study on the basis of written informed consent. The study was conducted according to the Declaration of Helsinki with approval of the ethics committee of the German Psychological Association (DGP). All participants had normal or corrected-to-normal vision and normal hearing (as assessed by means of the ISO (2009) [45] questionnaire filled out by all participants). No participant had a history of neurological, major medical, or psychiatric disorder. All participants were right-handed as assessed by the Edinburgh handedness questionnaire [46].

Acoustic characterization

Prior to the fMRI session, sound pressure levels (SPLs) for the test stimuli were calibrated individually according to the results of hearing threshold—[47] and categorical loudness scaling measurements [48].

Assessment of the participant's hearing thresholds comprised the presentation of 14 pure tones ranging from 2.5 to 125 Hz, presented monaurally to the right ear. The experiment was split into two parts separated by a 15 min break. At the beginning of each part, sounds with standard audiometer frequencies of 125 Hz (part 1) and 80 Hz (part 2) were presented as the first stimulus, which allowed participants to accomodate to the experimental setting. The remaining test stimuli were presented in a pseudo-randomized fashion, which ensured that the frequency of two consecutive runs differed by more than an octave. Assessment of the individual hearing thresholds resembled an unforced weighted up-down adaptive procedure as described by Kaernbach [49], in which trials consisting of a pair of time intervals (denoted A and B) separated by a pause of 200 ms were presented. During each trial the test stimulus was allocated randomly to either interval A or B and it was the participants' task to indicate which interval contained the stimulus via keyboard or computer mouse, while receiving visual feedback about the accuracy of their responses. Due to the non-linear characteristics of the human hearing curve, i.e. sounds at different frequencies also need to be administered at different SPLs in order to give rise to the same loudness perception (see equal-loudness contours; ISO (2003) [50] and [51]), each test stimulus was initially presented at 20 phon. This means that the dB SPL of each test stimulus had been chosen in order to give rise to the same loudness as a 1000 Hz tone presented at 20 dB SPL (by definition, 20 phon equals 20 dB SPL at 1000 Hz). In doing so, we ensured that threshold assessment for each frequency started with the same stimulus intensity and that the initial tone presentation was easily audibility for the participants. Upon a correct response, stimulus intensity was decreased by one step (initial step size 4 dB), whereas a wrong response led to an increase by three steps. If participants were unsure, stimulus intensity was increased by one step. After every second reversal (i.e. a response leading to a downward step (correct answer) followed by a response leading to an upward step (incorrect or unsure), or vice versa)), the step size was halfed until a final step size of 1 dB was reached. After 12 reversals, the hearing threshold for the respective test frequency was calculated as the arithmetic mean of all (adaptive) values following the fourth reversal (1 dB step size).

Categorical loudness scaling comprised the presentation of pure tones with frequencies of 8, 12, 16, 20, 32, 40, 63 and 125 Hz and a duration of 1600 ms, administered monaurally to the participant's right ear. It was the participant's task to rate the loudness of a given test stimulus according to 11 response alternatives with predefined categories ranging from 'not heard', 'soft', 'medium', to 'loud' and 'extremely loud' using a computer mouse. The experiment resembled an adaptive procedure [52] divided into two phases. During the first phase, test stimuli were presented at 80 phon and stimulus intensity was increased in adaptive step sizes ranging from 5 to 15 dB in 5 dB steps until the stimuli were perceived as "extremely loud" or a predefined maximum level of stimulus intensity was reached (for frequencies below 32 Hz the maximum sound intensity had been set to 124 dB SPL to protect participants from harmful sound exposure). Intensity was then decreased until the stimuli became inaudible and increased until they became audible again. During the second phase, the remaining categorial loudness levels were estimated via linear interpolation and presented in a random fashion, which enabled us to collect more data for the "medium" loudness level. Loudness scaling was performed twice by each participant with a minimum break of an hour in between sessions.

The results of the hearing threshold measurements were then used to define stimuli for the near-threshold condition, while categorical loudness scaling ensured that the supra-threshold stimulus was perceived as equally loud across participants. For the present study, a pure sinusoidal stimulus with a frequency of 12 Hz was selected. The average (median) monaural hearing threshold for a 12-Hz pure tone was 86.5 dB SPL, ranging inter-individually from 79 to 96.5 dB SPL. For the near-threshold condition, participant-specific stimuli with SPLs 2 dB below the individual hearing threshold were chosen. The average (median) SPL for a 'medium-loud' tone determined in the categorical loudness scaling sessions was 122.3 dB SPL with an applied minimum of 111 dB and a maximum of 124 dB across participants (for a detailed description, see Table 1). For the hearing threshold—and the categorical loudness scaling measurements, stimuli were presented via the same sound source that was also used in the subsequent fMRI session and experiments were run in a soundproof booth next to the scanner room.

Scanning procedure

Images were collected on a 3T Verio MRI scanner system (Siemens Medical Systems, Erlangen, Germany) using an 12-channel radiofrequency head coil. First, high-resolution anatomical images were acquired using a three-dimensional T1-weighted magnetization prepared gradient-echo sequence (MPRAGE), repetition time = 2300 ms; echo time = 3.03 ms; flip angle = 9˚; 256 × 256 × 192 matrix, $(1\ mm)^3$ voxel size. Whole-brain functional images were collected using a T2*-weighted EPI sequence sensitive to BOLD contrast (TR = 2000 ms, TE = 30 ms, image matrix = 64 × 64, FOV = $(224\ mm)^2$, flip angle = 80˚, slice thickness = 3.5

Table 1. Acoustical characterization of 14 participants according to hearing threshold and categorical loudness scaling measurements for an IS-pure tone at 12 Hz.

Participants (n = 14)	*HT (dB SPL)*	*ST (dB SPL)*
1	93	123
2	86	124
3	89	124
4	86	124
5	93	124
6	79	123
7	92	119
8	85	121
9	91	124
10	96	121
11	82	123
12	87	124
13	80	119
14	85	119

HT, hearing threshold in dB SPL; ST, supra-threshold stimulus in dB SPL, corresponding to 'medium' perceived loudness. (Maximum stimulus level was limited to 124 dB SPL).

https://doi.org/10.1371/journal.pone.0174420.t001

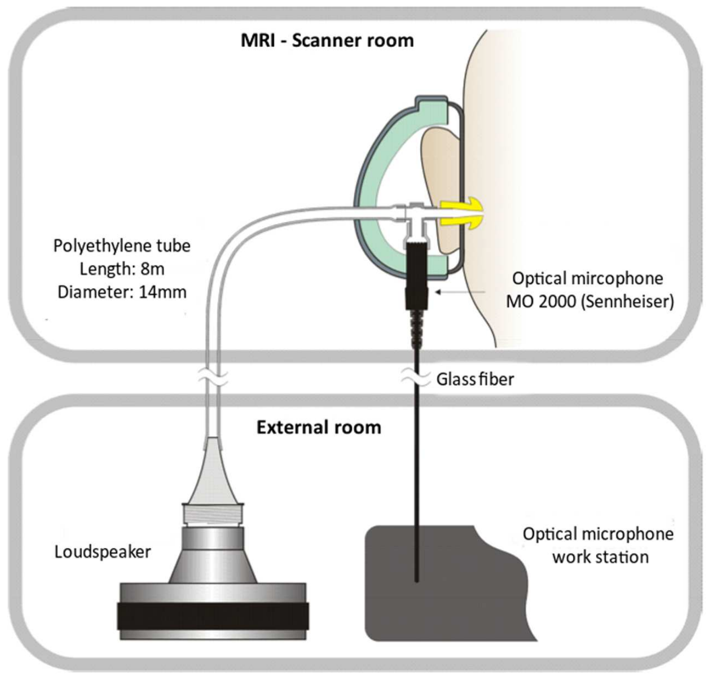

Fig 1. Schematic drawing of the experimental setup.

https://doi.org/10.1371/journal.pone.0174420.g001

mm, 35 near-axial slices, aligned with the AC/PC line). Before the resting-state data acquisition started, participants had been in the scanner for about 10 minutes. During those 10 minutes, a localizer was run and other images were aquired so that participants could get used to the scanner noise.

fMRI stimulus protocol

Sound signals were generated by a 24 bit DAC-device (RME Fireface UC), connected to a personal computer, amplified or attenuated and fed to a modified loudspeaker system outside of the scanner room. The loudspeaker system was attached to a polyethylene tube (length 8 m, inner diameter 14 mm) leading to the participant's right ear (Fig 1). In order to avoid audible transients, the 12-Hz pure tones used for stimulation were faded in and out with a $\cos^2$ on- and offset ramp of 250 ms (3 cycles) and had a total duration of 200 s. A regular earplug (E-A-R One Touch, 3M, St. Paul, USA) with a Noise Reduction Rating (NRR) of 33 dB was used for the left ear. In addition, both ears were covered with a Silverline 140858 ear defender (NRR: 22 dB) in order to minimize the interference of scanner noise with auditory processing. The infrasound source was designed to exhibit particularly low harmonics generation, i. e the amplitudes of all harmonics are significantly below the hearing threshold [47]. In order to control for higher harmonics in the present study, SPLs were measured via an optical, metal-free microphone (Sennheiser MO-2000) coupled to the sound path by means of a T-fitting 20 cm upstream of the ear. Participants were instructed to listen attentively and to avoid movements of their bodies [53]. During the scan session, each participant underwent one unstimulated and two stimulated acquisitions (runs), each run lasting 200 s. The unstimulated run involved no auditory stimulation (no-tone), while during the two stimulation runs a 12-Hz IS tone was presented either at 2 dB below the individual hearing threshold (near-threshold) or at 'medium' perceived loudness (supra-threshold). Before the start of each run, subjects were instructed to keep their eyes closed, relax and not think of anything in particular. The sequence of the three resting-state runs was counterbalanced across participants and participants were not informed about the order in which the runs were conducted.

Data analysis–Regional homogeneity (ReHo)

The first five volumes of each run were discarded to allow the magnetisation to approach a dynamic equilibrium. Part of the data pre-processing, including slice timing, head motion correction (a least squares approach and a 6-parameter spatial transformation) and spatial normalization to the Montreal Neurological Institute (MNI) template (resampling voxel size of 3 mm × 3 mm × 3 mm) were conducted using SPM5 and the Data Processing Assistant for Resting-State fMRI (DPARSF, [54]). A spatial filter of 4 mm FWHM (full-width at half maximum) was used. Participants showing head motion above 3 mm of maximal translation (in any direction of *x*, *y* or *z*) and 1.0˚ of maximal rotation throughout the course of scanning would have been excluded. After pre-processing, linear trends were removed. Then the fMRI data was temporally band-pass filtered (0.01–0.08 Hz) to reduce low-frequency drift and high-frequency respiratory and cardiac noise [55]. ReHo analysis was performed using DPARSF [56–59]. ReHo is based on previous reports that fMRI activity is more likely to occur in clusters of several spatially contiguous voxels than in a single voxel [60–61]. Therefore, ReHo assumes that a given voxel is temporarily similar to that of its neighbors. ReHo was originally invented for the analysis of (slow) event-related fMRI data (Zang et al., 2004) [59], but is equally suited for block-design and resting-state fMRI. For each participant, ReHo analysis was performed on a voxel-wise basis by calculating the Kendall's coefficient of concordance (KKC, [62]) of the time series of a given voxel with those of its neighbors (26 voxels). The KCC value was assigned to the respective voxel and individual KCC maps were obtained. ReHo was calculated within a brain-mask, which was obtained by removing the tissues outside the brain using the software MRIcro [63]

Whole-brain comparisons between conditions were computed on the basis of the resulting ReHo maps. A height threshold of $p < 0.001$ and cluster-size corrected by means of Monte Carlo simulation (10000 iterations) was used. Significant effects were reported when the volume of the cluster was greater than the Monte Carlo simulation determined minimum cluster size for the whole-brain volume (> 22 voxels), above which the probability of type I error was below 0.05 (AlphaSim; [64]). From the resulting clusters, ReHo values were extracted for all three conditions. Coordinates are reported according to the MNI space. Brain regions were defined using the the SPM-based automated anatomical labeling (AAL) atlas toolbox [65] and reported as Brodmann areas (BA).

Data analysis—Independent Component Analysis (ICA)

Independent component analysis (ICA) is an exploratory analysis tool in which source signals are blindly recovered [44] from mixtures of sources. ICA was performed using GIFT software (http://icatb.sourceforge.net/; [66]) using an Infomax algorithm. Preprocessed data from all sessions and all individuals were used. The optimal number of spatially independent resting-state networks (N) to be extracted was estimated by the software (N = 21). The networks were identified automatically using predefined templates in GIFT and later by one of the co-authors. From the 21 components, 12 were identified as resting state networks and taken to the second level analysis in SPM12 (paired t-test, FWE p<0.01 and mean framewise displacement [67] as a covariate).

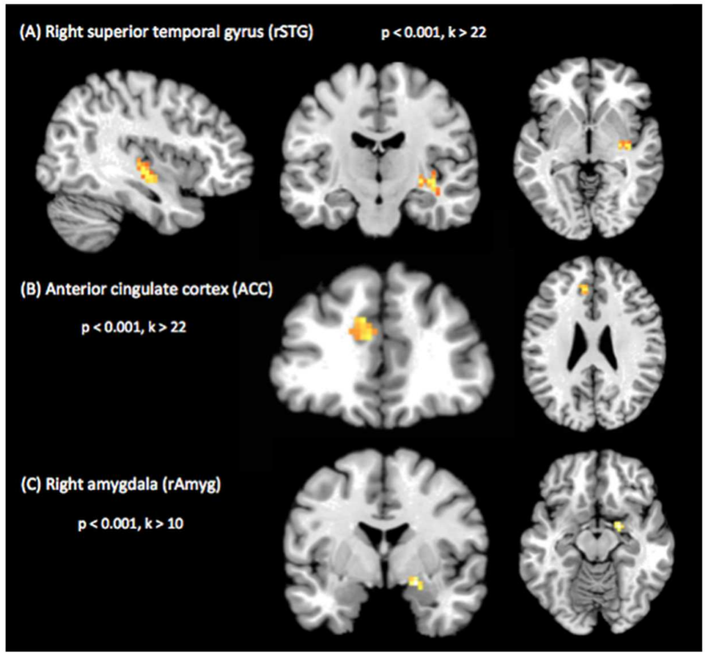

Fig 2. Results of whole-brain contrast regional homogeneity (ReHo) maps acquired during near-threshold vs. no-tone condition. Higher local connectivity in: (A) Right superior temporal gyrus (rSTG) in a sagittal (left), coronal (middle) and transversal (right) slice, as well as in (B) Anterior cingulate cortex (ACC) ($p < 0.001$, cluster-size corrected by means of Monte Carlo simulation, $k > 22$). (C) Higher local connectivity in right amygdala (rAmyg) when using a more lenient cluster threshold of $k > 10$.

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Results

ReHo

When computing a whole-brain analysis comparing ReHo as derived from resting-state acquisitions for different stimulation conditions, we found significantly higher local connectivity in right superior temporal gyrus (rSTG) (30, -15, -6) adjacent to primary auditory cortex during the near-threshold compared to the no-tone condition. The only other significant difference between all possible pairwise contrasts of ReHo maps was observed when comparing the near-threshold condition with the supra-threshold condition. Here, we found significantly higher ReHo in anterior cingulate cortex (ACC) (-12, 27, 33) during the near-threshold condition. Interestingly, when using a more lenient cluster extent threshold of $k > 10$, we also found higher ReHo in the right amygdala (rAmyg) (21, -3, -15) (results are summarized in Fig 2 and Table 2). In order to explore the ReHo pattern across all three conditions, we extracted beta-values from the respective clusters observed in the whole-brain contrasts. These values are depicted as box plots in Fig 3 and all parameters of the statistical analysis are also summarized in Table 3. Im summary, it could be demonstrated that prolonged supra-threshold IS stimulation clearly perceived by all participants did not result in statistically significant activations anywhere in the brain. In contrast, near-threshold stimulation led to higher local connectivity in multiple brain areas, compared to both the no-tone as well as the supra-threshold condition. Note, however that the extraction of beta-values was only chosen for illustrative purposes and inferences were taken from the original analysis.

Table 2. Results of the whole-brain analysis comparing regional homogeneity (ReHo) as derived from resting-state acquisitions during near-threshold vs. no-tone condition.

Area	*BA*	*Peak coordinates (MNI)*	*T-score*	*Extent*
Right superior temporal gyrus (rSTG)	48	30, -15, -6	4.16	37
Anterior cingulate cortex (ACC)	32	-12, 27, 33	4.28	33
Right amygdala (rAmyg)		21, -3, -15	4.26	12

BA, Brodmann area; MNI, Montreal Neurological Institute. (p < 0.001, k > 22 for rSTG and ACC; p < 0.001, k > 10 for rAmgy).

https://doi.org/10.1371/journal.pone.0174420.t002

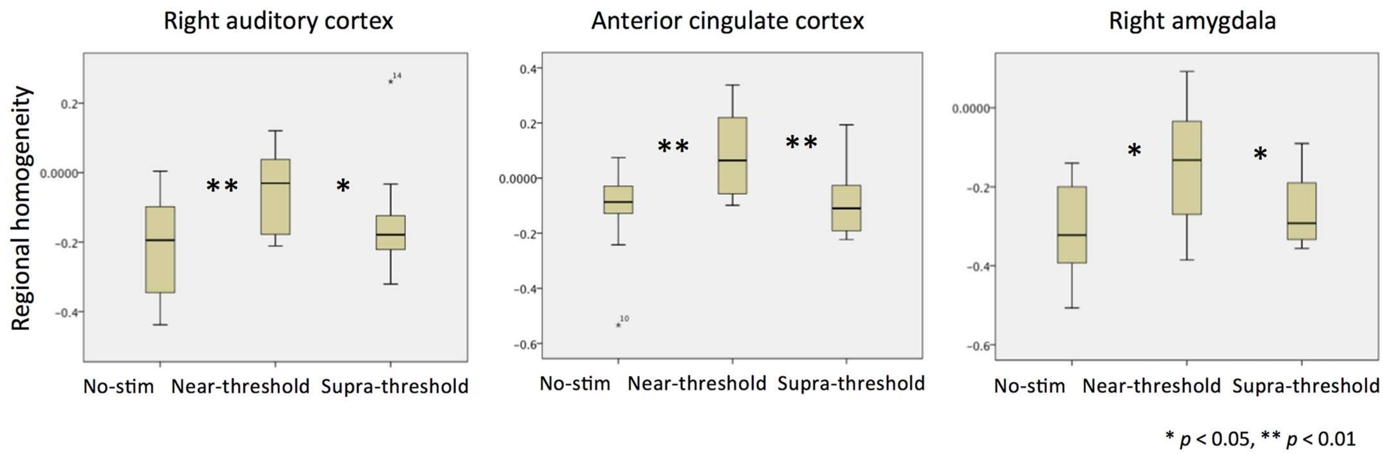

Fig 3. Box plot showing regional homogeneity (ReHo) differences across conditions.

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ICA

From the 21 components of the ICA analysis, 12 were identified as resting state networks: three dorsal default mode networks (DMN; R = 0.4, 0.3 and 0.2), two ventral DMNs (R = 0.5 and 0.3), two left executive control networks (R = 0.27 and 0.25), one sensorimotor network (R = 0.3), one basal ganglia network (R = 0.24), one visuospatial network (R = 0.31), one posterior salience network (R = 0.15) and one auditory network (R = 0.16). Significant condition differences are shown in Table 4. Decreased functional connectivity–as compared to the no-tone condition–was found during resting state with near-threshold tone presentation in the right amygdala (rAmyg) in the sensorimotor network. Resting state sessions with near-threshold tone presentation were associated with increased functional connectivity in the right superior frontal cortex (rSFG) in the left executive control network when compared to the no-tone

Table 3. ReHo results. Statistical analysis of beta values extracted from the respective clusters observed in the whole-brain contrasts.

	no-tone vs. near-thr.	*no-tone vs. supra-thr.*	*near- vs. supra-thr.*
rSTG	$t(13) = -9.03$, $p < 0.001$	$t(13) = -1.66$, $p = 0.12$	$t(13) = 2.55$, $p < 0.05$
ACC	$t(13) = -3.48$, $p < 0.01$	$t(13) = -0.43$, $p = 0.67$	$t(13) = 6.19$, $p < 0.001$
rAmyg	$t(13) = -2.62$, $p < 0.05$	$t(13) = -1.31$, $p = 0.21$	$t(13) = 2.41$, $p < 0.05$

https://doi.org/10.1371/journal.pone.0174420.t003

Table 4. Significant condition differences in resting state fMRI of the ICA.

Network	*Label*	*Coordinates*	*T-score*	*Cluster size (voxels)*	*P-value*
- no-tone > near-threshold -					
Sensorimotor	rAmgy	28, -6, -18	6.43	74	0.003 (cluster level FWE)
- no-tone < near-threshold -					
Left executive control	rFSG	22, 12, 64	4.9	63	0.009 (cluster level FWE)
- near-threshold > supra-threshold -					
Dorsal DMN	Cerebellum IV-V	16, -42, -18	5,36	87	0.008 (peak level FWE)

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condition. In addition, there was increased functional connectivity in the lobule IV and V of the left cerebellum in the DMN for near-threshold sessions compared to supra-threshold ones.

Discussion

The results of the present study can be summed up in the following way: Prolonged IS exposure near the participants' individual hearing threshold led to higher local connectivity in three distinct brain areas–rSTG, ACC and rAmyg–, while no such effect was observed for stimulation above the hearing threshold. Our data also shows that near-threshold IS was associated with connectivity changes on the network level, emphasizing the role of the rAmyg in IS processing. To our knowlegde, this study is the first to demonstrate that near-threshold IS does not only produces physiological effects, but that the neural response involves the activation of brain areas, which are important for auditory processing but also for emotional and autonomic control. These findings thus allow us to reflect on how (sub)-liminal IS could give rise to a number of physiological as well as psychological health issues, which until now have only been loosely attributed to noise exposure in the low- and very low-frequency spectrum.

Thus far, evidence regarding the influence of IS on brain activity is limited to two fMRI-studies. Dommes et al. [18] were the first to show that monaural stimulation with a 12-Hz IS tone led to an activation of the bilateral STG, when stimuli were applied at SPLs of 110 as well as 120, but not at 90 dB. However, this pioneering study suffered from the methodological drawback that during 12-Hz stimulation 36-Hz harmonics had been present, which left some room for doubt whether it had really been the IS component that triggered the neural response. In addition, Dommes et al. (2009) were not able to draw reference to psychophysical data about the participants' hearing thresholds or verbal reports and could therefore only speculate that IS exposure at 110 and 120 dB must have led to a hearing sensation, whereas stimulation with 90 dB should not have exceeded the hearing threshold. Recently, Weichenberger et al. [19] also reported bilateral STG activation in response to supra-threshold IS stimulation, however, in this study an improved setup that prevented higher harmonics from reaching the participants' ear in combination with acoustically well-characterized participants giving verbal reports after the scan session were employed. Suprisingly, we are facing an entirely different situation in the present study, as STG activation was absent during supra-threshold stimulation, but clearly present when IS was administered near the hearing threshold. These results are particularly noteworthy, since not only the experimental setup but also 11 out of the 14 participants were identical across Weichenberger et al.'s [19] and the present investigation. It thus appears that the seemingly contradictive results cannot be attributed to different instrumentation or participants, but rather point towards truely different neural responses which have been uncovered due to the nature of data acquisition as well as the time course of stimulus application chosen in this study. Since we were interested in studying the brain's response to IS under conditions, which more closely resemble those found outside of the laboratory, we chose significantly longer stimulus intervals (200 s) and also provided a constant level of stimulation throughout the entire interval. This is in contrast to the aforementioned studies, in which short stimulus intervals consisting of multiple successive tone bursts (1 and 3 s respectively) with interleaved image aquisitions were employed. The absence of STG activation during supra-threshold IS exposure could therefore be the result of stimulus-specific adaptation, according to which the BOLD signal gradually decreases in response to ongoing stimulus administration [68–69]. However, although stimulus-specific adaptation times of up to tens of seconds have been reported in the auditory cortex of animals [70], nothing is known about adaptation over comparable time-scales in humans. In addition, this explanation cannot account for why near-threshold stimulation would be affected to a lesser extent by such mechanisms. In contrast, we hypothesize that our results rather reflect the complex involvement of different physiological processes in response to near-threshold and supra-threshold IS, as well as the interference of attentional effects, which may play an increasingly important role when stimuli are presented over longer durations. Several studies provide evidence for the existence of a 'subconscious hearing route' for IS, according to which IS may exert effects on the organism via outer hair cells, even if presented at SPLs below the hearing threshold [71, 31]. While inner hair cells–the main signal transducers involved in 'conscious hearing'–connect with fusiform cells of the cochlear nucleus from which the signal is then relayed to higher levels of the auditory system, outer hair cells terminate in the granule cell regions of the cochlear nucleus [72] and from there on connect to numerous auditory as well as non-auditory cortical processing sites [73]. Importantly, since some of these centers are involved in attentional control and arousal [74], it has been suggested that activation of this pathway could for example wake people up at night, while leaving them unable to pin down what it actually was that caused them to waken [75]. Similarly, in our experiment, participants were constantly left guessing, whether stimulation actually occurred or not when near-threshold IS was presented, whereas during supra-threshold stimulation, participants were clearly able to allocate attention towards or away from the percept throughout the entire stimulus interval. We therefore suggest that persistent exposure to supra-threshold IS may have led to a top-down attenuation of the signal via attentional mechanisms, whereas in the absence of a clearly identifiable percept, STG activation remained high. However, it needs to be mentioned that the average (median) SPL of the supra-threshold stimulus (122,3 dB SPL, as determined via individual loudness scaling) was very close to the safety limit of 124 dB SPL, which probably points towards the presence of a ceiling effect. We therefore cannot rule out that participants may have reported a medium-loud hearing sensation at even higher SPLs, if our ethical guidelines would have allowed us to apply stimuli at such intensities. The ceiling effect may have led to slight discrepancies with respect to inter-individual loudness perception during the supra-threshold runs and thus have produced additional variability in our imaging data. Nevertheless, we conclude that the effect was probably not pronounced enough to suppress an otherwise significant effect. It also needs to be noted that in contrast to the aforementioned studies on IS processing, near-threshold stimulation led to a cortical response of the ispilateral side, as compared to a bi-hemispheric, yet also stronger response of the contralateral side (i.e. the left auditory cortex) when supra-threshold stimulation was employed [18–19]. This touches on the aspect of a presumed lateralization of the auditory system, the true nature of which is still part of an ongoing debate, as evidence both in favor of a contralateral dominance for monaurally presented sounds [76–77], as well as a left hemispherical preference irrespective of which ear is stimulated (Devlin et al., 2003) [78] has been put forward. It thus appears that while the preceeding accounts seem to support the notion of "contralateral dominance" extending to sounds in the infrasound spectrum, the results of the present studies could rather be explained by the fact that evoked otoacoustic emissions (which are generated via outer hair cells) also tend to be more pronounced on the right ear [79–80]. However, more information needs to be gathered on how OHC signals are processed up-stream on the level of the brainstem, and in what way OHC activation influences the activity of auditory (and possibly non-auditory) centers.

The ACC is generally regarded as a key player in the monitoring and resolution of cognitive [81–83], as well as emotional conflicts [84–87]. Interestingly, a recent meta-analysis by Meneguzzo et al. [88] also revealed that the ACC reliably exhibits activation in response to both sub- as well as supraliminally presented arousing stimuli, which led the authors to suggest that this brain area may function as a gateway between automatic ('pre-attentive') affective states and higher order cognitive processes, particularly when affect and cognition are in conflict. In addition, the authors explicitly gave credit to the fact that the term 'conflict' may also include unexpected perturbations of the body's physiology in the absence of conscious awareness. Moreover, another line of research also highlights the ACC's involvement in autonomic control via its extensive connections with the insula, prefrontal cortex, amygdala, hypothalamus and the brainstem [89–90]. ACC activation in response to near-threshold IS stimulation could therefore be interpreted as a conflict signaling registration of the stimulus which, if not resolved, may lead to changes of autonomic function.

Similarily, the amygdala is well know for its involvement in emotional processing, especially with respect to fear conditioning, but also in the broader context of stress- and anxiety-related psychiatric disorders [91]. Several studies have documented activation of the amygdala in response to aversive sensory stimuli across different modalities, such as odorants [92], tastes [93], visual stimuli [94–96], as well as in response to emotional vocalization [97–99] and unconditioned sounds that are experienced as aversive [100–102]. Activation of the rAmyg during near-threshold IS exposure may be of particular interest for a risk assessment regarding IS, because the amygdala is known to be involved in auditory processing and may also play a major role in debilitating tinnitus and hyperacusis [103]. It is a fairly established finding that auditory input can be processed along two separate neural pathways, the classical (lemniscal) and the non-classical (extralemniscal) pathway [104–105]. While signals travelling along the classical pathway are relayed via ventral thalamic nuclei mostly to the primary auditory cortex, signals traveling along the non-classical pathway are bypassing the primary auditory cortex as dorsal thalamic nuclei project to secondary- and association cortices and also to parts of the limbic structure such as the amygdala. Importantly, the non-classical pathway (frequently called the 'low route') allows for direct subcortical processing of the stimulus in the amygdala, without the involvement of cortical areas [106–107] and may therefore play a crucial role in the subliminal registration of 'biologically meaningful' stimuli, such as near-threshold IS. In fact, it has been suggested that in certain forms of tinnitus, activation of the non-classical pathway can mediate fear without conscious control [108] and, via its connections to the reticular formation [109], also exert influences on wakefulness and arousal. Additional evidence for the amygdala's involvement in subliminal processing and autonomic control comes from a study conducted by Gläscher and Adolphs [110], in which patients with unilateral as well as bilateral lesions of the amygdala were presented emotional visual stimuli of varying arousal sub- as well as supraliminally, while skin conductance responses (SCRs) were recorded as a measure of autonomic activation. Interestingly, it could be shown that the left amygdala decodes the arousal signaled by the specific stimulus (linked to a conscious fear response), whereas the rAmyg provides a global level of autonomic activation triggered automatically by any arousing stimulus (linked to a subconscious fear response). It is particularily noteworthy that while the rAmyg exhibited increased local connectivity in response to near-threshold IS, ICA revealed a decoupling of the rAmyg from the sensorimotor network in comparison to the no-tone condition. It has been repeatedly argued that decoupling of the amydgala from areas involved in executive control may enable an organism to sustain attention and supports working memory [111], thus potentially aiding cognitive control processes in the aftermath of stress [112]. Interestingly, the fact that functional connectivity of the rSFG was higher during near-threshold stimulation further substantiates this claim. Again, several studies demonstrate that rSFG and rAmyg share functional connections and that activity between the two regions tends to be negatively correlated [113, 112]. Thus, partipants who were left guessing whether stimulation occured, may have enganged in effortful regulation of affect, trying to minimize the consequences of stress on cognitive control networks.

Finally, our results also allow us to draw some preliminary conclusions on potential long-term health effects associated with (sub-)liminal IS stimulation. It has been reported in several studies that sustained exposure to noise can lead to an increase of catecholamine- and cortisol levels [114–116]. In addition, changes of bodily functions, such as blood pressure, respiration rate, EEG patterns and heart rate have also been documented in the context of exposure to below- and near-threshold IS [117–118]. We therefore suggest that several of the above mentioned autonomic reactions could in fact be mediated by the activation of brain areas such as the ACC and the amygdala. While increased local connectivity in ACC and rAmyg may only reflect an initial bodily stress response towards (sub-)liminal IS, we speculate that stimulation over longer periods of time could exert a profound effect on autonomic functions and may eventually lead to the formation of symptoms such as sleep disturbances, panic attacks or depression, especially when additional risk factors, such as an increased sensibility towards noise, or strong expectations about the harmfulness of IS are present. Also, while in this discussion, we put a strong emphasize on the physiological implications of prolonged IS exposure, it would also be interesting to see, whether our rsfMRI paradigm could be used to relate IS-induced changes of global-brain states and changes in the experiental domain.

Conclusion

To our knowledge, this study is the first to document changes of brain activity across several regions in response to prolonged near-threshold IS using fMRI. ReHo analysis revealed higher local connectivity of rSTG, ACC and the rAmyg only when IS was administered near the hearing threshold and ICA showed that effects can also be found on the inter-regional level. On the one hand, these results seem to support the hypothesis that (sub-)liminal IS can exert an influence on the organism via a subconscious processing route (which supposedly involves outer hair cell-mediated signal transduction). On the other hand, though clearly audible, prolonged stimulation with IS above the hearing threshold did not lead to changes of brain activity, which could indicate that the signal processed along the conscious hearing route may have been attenuated in a top-down fashion via attentional mechanisms. Also, since the brain's response to prolonged near-threshold IS involves the activation of brains areas, which are known to play a crucial role in emotional and autonomic control, a potential link between IS-induced changes of brain activity and the emergence of various physiological as well as psychological health effects can be established. Transient upregulation of these brain areas in response to below- or near threshold IS may thus reflect an initial stress response of the body, eventually promoting symptom formation as stimulation occurs repeatedly and additional risk factor come into play. Nevertheless, further research, in particular longitudinal exposure research, is needed in order sustantiate these findings and contribute to a better understand of IS-related health effects.

Author Contributions

Conceptualization: CK BI JG SK RK JH.

Data curation: SK AI.

Formal analysis: SK CGF RK.

Funding acquisition: CK.

Investigation: MW MB RK AI.

Methodology: CK BI JG SK RK JH.

Project administration: CK.

Resources: CK RK JH BI AI.

Supervision: CK SK.

Validation: CK SK.

Visualization: SK MW.

Writing – original draft: MW.

Writing – review & editing: MW.

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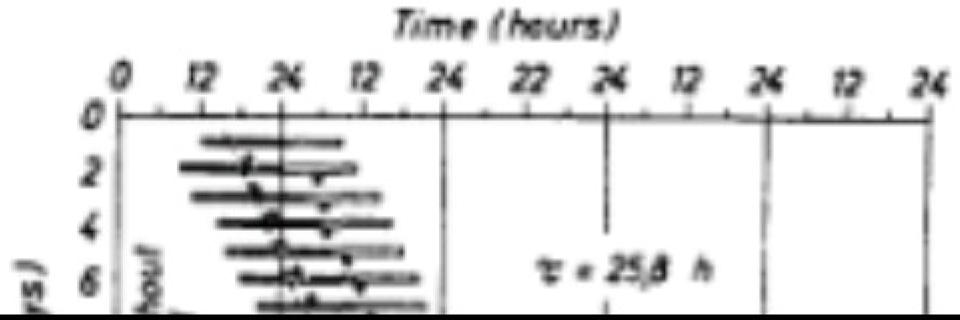

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RL-TR-94-53
In-House Report
June 1994

ROME LABORATORY

RADIOFREQUENCY/MICROWAVE RADIATION BIOLOGICAL EFFECTS AND SAFETY STANDARDS: A REVIEW

Scott M. Bolen

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Rome Laboratory
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13. ABSTRACT (Maximum 200 words)
The study of human exposure to radiofrequency/microwave (RF/MW) radiation has been the subject of widespread investigation and analysis. It is known that electromagnetic radiation has a biological effect on human tissue. An attempt has been made by researchers to quantify the effects of radiation exposure on the human body and to set guidelines for safe exposure levels. A review of the pertinent findings is presented along with the American National Standards Institute (ANSI) recommended safety standard (C95.1-1982) and the United States Air Force permissible exposure limit for RF/MW radiation (AFOSH Standard 161-9, 12 Feb 87). An overview of research conducted in the Soviet Union and Eastern Europe is also included in this report.

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Radiofrequency/Micowave Radiation Biological Effects and Safety Standards: A Review

Scott M. Bolen
June 1988

Abstract

The study of human exposure to radiofrequency/microwave radiation has been the subject of widespread investigation and analysis. It is known that electromagnetic radiation has a biological effect on human tissue. An attempt has been made by researchers to quantify the effects of radiation on the human body and to set guidelines for safe exposure levels. A review of the pertinent findings is presented along with the American National Standards Institute (ANSI) recommended safety standard (C95.1-1982) and the United States Air Force permissible exposure limit for RF/MW radiation (AFOSH Standard 161-9, 12 February 1987). An overview of research that was conducted in the Soviet Union and Eastern Europe is also included in this report.

I. INTRODUCTION

In 1956, the Department of Defense (DOD) directed the Armed Forces to investigate the biological effects of exposure to radiofrequency/microwave (RF/MW) radiation. The Army, Navy, and Air Force Departments commissioned a Tri-Service Program under the supervision of the Air Force to meet the DOD directive [14], [15]. The Rome Air Development Center and the Air Research and Development Headquarters were ultimately given responsibility to manage the program. On July 15-16, 1957 the first of four Tri-Service Conferences was held to discuss the effects of RF/MW radiation. These conferences were the first major effort put forth by the scientific community to explore the biological effects of exposure to RF/MW radiation [14]. Since then, researchers have discovered a number of biological dysfunctions that can occur in living organisms. Exposure of the human body to RF/MW radiation has many biological implications. The effects range from innocuous sensations of warmth to serious physiological damage to the eye [1], [2], [5], [6], [8], [15]. There is also evidence that RF/MW radiation can cause cancer [8].

The absorption of RF/MW radiated energy causes biological reactions to occur in the tissue of the human body. In order to determine safe exposure levels and to understand the effect of RF/MW radiation it is necessary to know the absorption characteristics of the human tissue. The National Institute for Occupational Safety and Health (NIOSH) [8] has reported several physical properties that account for energy absorption in biological materials. Factors which govern energy absorption include: (1) strength of the external electromagnetic (EM) field, 2) frequency of the RF/MW source, 3) the degree of hydration of the tissue, and 4) the physical dimensions, geometry, and orientation of the absorbing body with respect to the radiation EM field [8]. There is some disagreement among researchers in determining a specific measure for the dose of RF/MW radiation contracted by biological materials. The most commonly accepted measure is the Specific Absorption Rate (SAR). The SAR is defined as the rate at which RF/MW radiated energy is imparted to the body - typically in units of watts per kilogram (W/Kg) [4]. The deposition of energy specified in terms of milliwatts per square centimeter (mW/cm^2) over the irradiated surface is also widely accepted [9].

Based on the known absorption rates and the inherent biological effects of RF/MW radiated energy, researchers have put forth a number of standards regarding safe exposure levels. In some instances standards recommended by different examining authorities are in conflict. For example, the USAF Standard 161-9 (enacted 12 February 1987) allows for a permissible exposure level of 10 mW/cm^2 for persons working in restricted areas and 5 mW/cm^2 for persons working in unrestricted areas [10]. The ANSI guideline specifies a maximum safe exposure level of 5 mW/cm^2 over the whole-body area for anyone in contact with RF/MW radiation [9]. These differences reflect the way in which each examining authority has interpreted the available RF/MW radiation exposure data.

II. BIOLOGICAL EFFECTS

Exposure to RF/MW radiation is known to have a biological effect on animals and humans. Damage to major organs, disruption of important biological processes, and the potential risk of cancer represent the dangers of RF/MW radiation to living organisms. Pulsed radiation appears to have the greatest impact on biological materials [8].

The response of biological materials to the absorption of thermal energy is the most perceptible effect of exposure to RF/MW radiation [7]. The energy emitted from an RF/MW source is absorbed by the human tissue primarily as heat. In this case, the radiated energy is disposed in the molecules of the tissue. Dipole molecules of water and protein are stimulated and will vibrate as energy is absorbed throughout the irradiated tissue area. Ionic conduction will also occur in the same area where the radiation is incident. It is from these two natural processes that radiant energy is converted into heat [11]. The thermal effect of continuous wave (CW) and pulsed radiation is considered to be the same [13].

Nonthermal responses can be less noticeable and are often more difficult to explain than thermal effects. These responses are related to the disturbances in the tissue not caused by heating. Electromagnetic fields can interact with the bioelectrical functions of the irradiated human tissue [8]. Research conducted in the Soviet Union and Eastern Europe suggests that the human body may be more sensitive to the <u>nonthermal</u> effects of RF/MW radiation [3].

There are many reported biological effects to humans and animals that are exposed to RF/MW radiation. A review of the important findings is given in the following:

A. Heating Effect on the Skin

Most RF/MW radiation penetrates only to the outer surface of the body. This is especially true for RF/MW frequencies greater than 3 GHz where the likely depth of penetration is about 1-10 mm [3]. At frequencies above 10 GHz the absorption of energy will occur mostly at the outer skin surface. Since the thermal receptors of the body are contained primarily in this region, the perception of RF/MW radiation at these frequencies may be similar to that of infrared (IR) radiation [3], [6].

In 1937, J. Hardy and T. Oppel published an investigative paper on the thermal effects of IR radiation. Their findings were used by Om Gandhi and Abbas Riazi [6] to explain the thermal effect of RF/MW radiation on the human body (the reference for Hardy and Oppel can be found in [6]). Figure 1 shows the results obtained from the 1937 report. As described by Gandhi and Riazi, the findings presented by Hardy and Oppel show that sensations of warmth begin to occur when the whole-body is irradiated at a CW power density of about 0.67 mW/cm^2. Hardy and Oppel based their work on exposure to IR radiation. From other published reports, Gandhi and Riazi noted that there is a correlation between the radiating frequency of the incident RF/MW energy and the threshold for perception. For example, on an exposed area of the forehead of 37 cm^2 a perception of warmth was reported for incident power densities of 29.9 and 12.5 mW/cm^2 from sources radiating at 3 and 10 GHz respectively [6].

Other observations made by Hardy and Oppel showed that when smaller body areas were irradiated, larger power densities were required to stimulate the thermal receptors in the skin. Gandhi and Riazi were able to confirm this result with reports from recent papers. They found that irradiation of an exposed body area of 40.6 cm^2 to a power density of about 21.7 mW/cm^2 yielded the same thermal perception as did the irradiation of a smaller body area of 9.6 cm^2 to a power density of about 55.9 mW/cm^2. Hardy and Oppel reported that thermal sensations occurred within about 3 seconds after irradiation of the body tissue. More recent findings indicate a reaction time of closer to 1 second [6].

Gandhi and Riazi [6] have also reported that the depth of penetration of RF/MW radiation has an impact on the power density threshold needed to stimulate the perception of warmth. As a comparison, IR radiation will not penetrate the outer body surface as deeply as RF/MW radiation emitted at a frequency of 2.45 GHz. Clinical observations have shown that irradiation of the ventral surface of the arm by an RF/MW source radiation at 2.45 GHz will cause a sensation of warmth when the incident power density is about 26.7 mW/cm^2. For incident IR radiation a perception of warmth occurs at a power density of 1.7 mW/cm^2. They estimated that at millimeter wavelengths the perception of warmth may occur at a power density level of about 8.7 mW/cm^2.

Exposure to higher levels of radiation can cause serious biological effects. Because of the physical dimensions and geometry of the human body, RF/MW radiated energy is nonuniformily deposited over the whole-body surface. Some areas on the skin and outer body surface will absorb higher amounts of the radiated energy. These areas will be marked by "hot spots" of high temperatures [7], [11], [16]. Experiments conducted on laboratory animals have shown, that skin burns typically occur in the areas of hot spots. The penetration of RF/MW radiation also causes skin burns to be relatively deep [11]. In experiments sponsored by the Tri-Service Commission, it was reported that RF/MW radiation burns over the rib cages of dogs caused severe subcutaneous damage that did not visibly appear for weeks after the injury was sustained [20]. Burns can cause increased vascular permeability. This can lead to significant losses of body fluids and electrolytes. Serious burns can suffer fluid losses for a few days. Blood circulation can be altered in the effected area and other biological functions could be indirectly affected [12].

B. Whole-Body Hyperthermia

Thermal energy absorbed by the whole-body can cause a rise in body temperature. When the human body is irradiated by an RF/MW source at an incident power density of 10 mW/cm^2 there will be a rise in body temperature of about 1° C. The total thermal energy absorbed at this power density is about 58 watts. Typically, at rest the human basal metabolic rate is about 80 watts and it is about 290 watts during periods of moderate activity. Exposure of the human body to low power RF/MW radiation does not appear to impose any appreciable thermal hazard. These figures were reported by The U.S. Department of Health, Education and Welfare [3].

Adverse biological effects can occur when the body is subjected to high doses of RF/MW radiation [16]. In this instance large amounts of thermal energy can be absorbed by the body. A dramatic influx of energy can overburden thermoregulatory mechanisms. If excess heat cannot be exhausted the core temperature of the body will rise to a dangerous level resulting in hyperthermia [12], [16]. The biological response to excess heat buildup is the dilation of blood vessels at the surface of the skin and the evaporation of water through sweating. These are the primary mechanisms for heat dissipation. Hyperthermia can cause severe dehydration and the loss of electrolytes such as sodium chloride. Other harmful effects include fever, heat exhaustion, and heat fatigue. Heat stress is the most serious consequence of hyperthermia. Cardiac failure and heat stroke can result from heat stress [12].

It has also been noted that hyperthermia may cause injury to blood-brain barrier (BBB) [19]. This barrier refers to the several biological materials that separate the essential elements of the central nervous system from the blood [18]. High cerebral temperatures exceeding 43°C may damage the BBB. The result can be a disruption of blood vessel continuity or integrity and degradation of the flow of blood and other body fluids in the brain [19].

C. Local Hyperthermia

The nonuniform deposition of RF/MW radiated energy over the whole-body surface causes the body to be heated unevenly. Local areas where temperatures rise above 41.6°C can experience damage to the tissue [16]. In these areas it is possible that harmful toxins could be released as result of the high temperatures. Heating can cause cell membranes and blood capillaries to become more permeable. An increase in capillary permeability can lead to a loss of plasma proteins. The denaturation of proteins can also occur within cells [11], [16]. This can lead to changes in the physical properties and biological functions of proteins [18]. Denaturation of proteins can also cause polypeptide and histamine-like substances to become active [11], [16]. Histamines can stimulate gastric secretion, accelerate the heart rate, and cause the dilation of blood vessels resulting in lower blood pressure [18]. Areas of the body where blood circulation is poor or where thermal regulation is insufficient, are more susceptible to injury [11].

D. Carcinogenic Effects

The carcinogenic effects of exposure to RF/MW radiation are not well known. It is difficult to clinically establish a link to cancer. The problem that researchers have in linking

RF/MW radiation to cancer is that the disease itself is prevalent and can be caused by a variety of environmental factors. In fact cancer is the second leading cause of death in the United States. There are, however, published reports that reveal some insights into the carcinogenic nature of RF/MW radiation. Nonthermal effects may provide important clues to the understanding of carcinogenic reactions in the human body [8],[32].

i. Pathological Reports

In 1962, S. Prausnitz and C. Susskind reported experimental results that showed an increase in cancer among test animals exposed to RF/MW radiation. In the experiment, 100 male Swiss albino mice were irradiated by a 10 GHz RF/MW source at an incident power density of about 100 mW/cm^2. The mice were exposed for 4.5 minutes/day, 5 days/week for a total of 59 weeks. It was noted that irradiation caused the whole-body temperature of the mice to rise about 3.3°C. Upon examination, it was found that 35% of the mice had developed cancer of the white blood cells. The disease was observed as monocytic or lymphatic leucosis or lymphatic or myeloid leukemia. Only 10% of a similar control group had developed cancer [21].

There have been a few allegations that RF/MW radiation has induced cancer in humans [8], [15]. The NIOSH Technical Report [8] cites charges made in the early 1970's against Philco-Ford and The Boeing Corporation that occupational exposure to RF/MW radiation caused cancer among employees. One incident was reported at each company. At Philco-Ford it was claimed that exposure caused a rare form of brain cancer to manifest in one worker that eventually resulted in death. In each case, there was no scientific proof that RF/MW radiation had induced cancer in the company employees. There was also a report that EM fields induced cancer in an individual that worked at the U.S. Embassy in Moscow. Again, there was no scientific evidence that supported the claim [8].

Recently, the Observer Dispatch, a local newspaper published in Utica, New York, reported that a major study has just been completed in Sweden. The study concluded that children who live near high power lines have a greater risk of developing leukemia than children who live farther away from the power lines. The study involved 500,000 people and provided some evidence to link the electromagnetic fields produced by low frequency power lines to cancer. The researchers, however, cautioned against drawing firm conclusions as a result of the research [33]

ii. Effect on Chromosomes

It has been observed that disturbances in chromosomic activity can cause cancerous aberrations to occur in the human body. In 1974, a paper published by K. Chen, A. Samuel, and R. Hoopingarner (reference found in [8]) reported that chromosomal abnormalities can be linked to chronic myeloid leukemia. Serious genetic mutations can also result from such abnormalities that can lead to malignancies in the tissue [8].

In 1976, A. A. Kapustin, M. I. Rudnev, G. I. Leonskaia, and G.I. Knobecva (reference found in [17]) reported alterations in the chromosomes of bone marrow cells in laboratory animals that were exposed to RW/MW radiation. They exposed inbred albino rats to a 2500 MHz RF/MW source at incident power density levels of 50 and 500 uW/cm^2. Irradiation lasted for 7 hours/day for 10 days. Upon examination of the animals, they observed chromosomal anomalies that appeared in forms described as polyploidy, aneuploidy, chormatic deletion, acentric fragments and chromatic gaps [17].

The NIOSH Technical Report [8] summarizes the findings of several researchers. Chromosomal and mitotic anomalies have been observed in a variety of animal and human cells for varying exposures to RF/MW radiation. Pulsed and CW radiation ranging in frequency from 15 to 2950 MHz and power densities from 7 to 200 mW/cm^2 have caused abnormalities to occur in chromosomes. The reported affects include: linear shortening of the chromosomes, irregularities in the chromosomal envelope, abnormal bridges and stickiness, translocations, chromosomal breaks and gaps, chromatid breaks, acentric chromosomes, dicentric chromosomes, deletions, fragmentation, and ring chromosomes [8].

iii. Mutagenic Effects

Reported evidence indicates that biological interaction with EM fields can cause the formation of mutagens in cells. In 1974, three Soviet researchers, Danilenko, Mirutenko, and Kudrenko (reference found in [8]) published results showing a mutagenic effect of RF/MW radiation. Mutagens were observed to form in cells that were irradiated by a pulsed RF/MW source operating at 37 GHz and 1 mW/cm^2 power intensity. They concluded that irradiation of tissue by pulsed RF/MW sources causes cell membranes to become more permeable to destructive chemical mutagens [8].

Results published in 1963 by G. H. Mickey (reference found in [8]) showed hereditary changes to occur in drosphila germ cells that were exposed to pulsed modulated RF/MW radiation for carrier frequencies between 5-40 MHz [8]. Evidence of RF/MW induced teratogenesis in animals has also been reported by researchers. The effect of exposure to CW radiation was observed by Rugh and McManaway in 1976 (reference found in [8]). They found gross congenital abnormalities in rodent fetuses that were irradiated by a 2450 MHz RF/MW source at an incident power intensity of 107.4 mW/g [8].

iv. Lymphoblastoid Transformations

Lymphoblastoid Transformations refer to changes in the physical nature of lymphoblasts. Mature lymphoblast cells (i.e. lymphocytes) participate in the immune system of the body [18]. Lymphoblastoid transformations induced by RF/MW radiation appear to be similar to transformations present in disorders contributing to abnormal growth in lymphoid tissues and in certain types of leukemia. RF/MW radiation induced transformations, however, do not appear to be malignant and are not likely to spread among healthy cells [8].

W. Stodlink-Baranska reported (reference found in [8]) lymphoblastoid transformations to occur when human lymphocyte cells were exposed to a 2950 MHz pulsed RF/MW source at power density levels of 7 and 20 mW/cm^2. In 1975, P. Czerski also reported (reference found in [8]) observing lymphoblastoid transformations after irradiation of purified human lymphocyte suspensions by an RF/MW source radiating at 2950 MHz for variable power density levels. In addition, Czerski reported acute transformations occurring in adult mice and rabbits that were irradiated by a pulsed RF/MW source radiating at 2950 MHz and at low power density levels of 0.5 and 5 mW/cm^2 respectively [8].

v. Oncogenic Effects

Oncogenic effects have been linked to imbalances in the regulatory mechanisms of the body. A 1974 report published by E. Klimkova-Deutschova (reference found in [8]) claimed that persons exposed to RF/MW radiation experience biochemical reactions. The report indicated alterations in fasting blood sugar levels, a decrease in the ability to dispose of normal metabolic waste, and depressed serum levels of pyruvate and lactate. These biochemical reactions point to the possibility of regulatory malfunctions occurring in the body. It has been suggested that certain regulatory imbalances may promote the growth of tumors. A change in hormonal levels has been observed to cause oncogenic effects in tissues that require hormonal balances to function properly. The presence of hormones in other tissue areas may effect the development of existing tumors in those areas [8].

E. Cardiovascular Effects

Most of the cardiovascular effects of RF/MW radiation have been reported by researchers in the Soviet Union and Eastern Europe. Soviet investigators claim that exposure to low levels of RF/MW radiation that are not sufficient to induce hyperthermia can cause aberrations in the cardiovascular system of the body [7].

One experiment performed on rabbits indicates that several types of cardiovascular dysfunctions could be possible. An RF/MW source radiating at 2375 MHz was used to irradiate rabbits for a test period of 60 days under varying field intensities. For field strengths ranging from 3-6 V/M researchers noted a sharp increase in the heart rate of the animals. This effect was observed to subside with time. Exposure to field strengths of 0.5-1.0 V/M caused the heart rate to become slower than normal. No effect was reported for rabbits that were exposed to EM field intensities below 0.2 V/M [17]. Other effects that have been observed by Soviet researchers, are alterations in EKG and low blood pressure [7], [17].

The NIOSH Technical Report [8] references a Soviet study published in 1974 by M. N. Sadcikoiva that suggests some connection between RF/MW radiation exposure and the potential for cardiovascular disturbances in humans. Researchers examined 100 patients suffering from radiation sickness. It was found that 71 of the patients had some type of cardiovascular problem. Most of these patients had been exposed to RF/MW radiation for periods ranging from 5-15 years. A smaller group of patients exposed for shorter time periods also experienced cardiovascular irregularities. The study concluded that there is a probable link between exposure to RF/MW radiation and cardiovascular disease [8].

F. The North Karelian Project

In response to earlier Soviet reports, the World Health Organization (WHO) decided to conduct a comprehensive study on the biological effects of exposure to RF/MW radiation. In 1976, M. Zaret published the results of the study (reference found in [8]). The WHO investigation focused on the population of North Karelia, a remote area of Finland that borders the Soviet Union. This region was selected because of its close proximity to a then Soviet early warning radar station. North Karelia is geographically located in the path of intercontinental ballistic missiles that would originate from the midwest United States. To detect these missiles, the Soviets constructed a number of high power tropospheric scattering radar units adjacent to nearby Lake Ladoga. The operation of these units exposes the residents of North Karelia to large doses of ground and scatter radiation. The WHO investigation found evidence linking exposure of RF/MW radiation to cardiovascular disease and cancer. The North Karelian population suffered from an unusually high number of heart attacks and cases of cancer. In addition, it was found that the affliction rate of these diseases was much higher among residents living closest to the radar site [8].

G. Hematologic Effects

There is evidence that RF/MW radiation can effect the blood and blood forming systems of animals and humans. Experiments conducted in the Soviet Union have indicated changes in blood cell levels and alterations in the biological activities of hematologic elements. Other investigators have reported similar effects [7], [8], [17].

The results of an experiment reported in 1979 by V. M. Shtemier showed a decrease in the biological activity of butyryl cholinesterase in rats that were exposed to pulsed RF/MW radiation (reference found in [17]). The experiment subjected 15 rats to a 3000 MHz pulsed RF/MW source with an incident power density of 10 mW/cm^2. The rats were irradiated for 1 hour/day over several days. After 42 days, there was a loss of biological activity of the butyryl cholinesterase enzyme caused by a decrease in the concentration of the enzyme in the bloodstream of the rats [17]. Cholinesterase is a catalyst in the hydrolysis of acetylcholine into choline and an anion. Choline is a useful enzyme that prevents the deposition of fat in the liver [18].

In another experiment, 20 male rats were exposed to a 2376 MHz pulsed RF/MW source with an incident power density of 24.4 mW/cm_2. Each rat was exposed for 4 hours/day, 5 days/week for 7 weeks. Blood samples were taken periodically and examined for anomalies. After repeated exposures, it was discovered that the number of lymphocytes and leukocytes (white blood cells) in the bloodstream of the rats was lower than normal. The biological activity of alkaline phosphatase in neutrophil leukocytes was also found to increase when the rats were irradiated [17].

The results of several other experiments are summarized in the NIOSH Technical Report [8]. RF/MW radiation has been observed to cause: an increase in the amount of exudate in bone marrow, the transient disappearance of fat cells from bone marrow, destruction and loss of essential bone marrow cells, underdeveloped marrow, a decrease in the number of red blood cells, and an imbalance in the number of lymphocytes in the bloodstream [8].

H. Effect to the Central Nervous System

There is documented evidence that exposure to RF/MW radiation can cause a disturbance in the central nervous system (CNS) of living organisms [3], [8], [11], [17]. Soviet investigators claim that exposure to low-level radiation can induce serious CNS dysfunctions. Experiments conducted in the Soviet Union and Eastern Europe have exposed live subjects to radiation levels that are near or below the recommended safe levels prescribed by the ANSI Standard and the USAF AFOSH Standard [17].

i. Pathological Report

Soviet investigators claim that the central nervous system (CNS) is highly sensitive to RF/MW radiation [3], [8], [11], [17]. The NIOSH Technical Report [8] summarized the results of a pathological study published by A. A. Letavet and Z. V. Gordon in 1960. The researchers reported that several CNS related disorders were discovered among 525 workers exposed to RF/MW radiation. The symptoms were listed as: hypotension, slower than normal heart rates, an increase in the histamine content of the blood, an increase in the activity of the thyroid gland, disruption of the endocrine-hormonal process, alterations in the sensitivity to smell, headaches, irritability, and increased fatigue. Other researchers have acknowledged similar biological responses [8].

ii. Soviet Union Experimental Results

Several experiments have been performed in the Soviet Union and Eastern Europe that demonstrate a variety of biological effects that can occur in living organisms. observations of laboratory animals subjected to low power EM fields showed alterations in the electrical activity of the cerebral cortex and disruptions in the activity of neurons [17].

L. K. Yereshova and YU. D. Dumanski (reference found in [17]) exposed rabbits and white male rats to a continuous wave 2.50 GHz RF/MW source. The animals were irradiated for 8 hours/day over a period of 3 to 4 months at power density levels of 1, 5, and 10 uW/cm^2. It was observed that rabbits exposed to the 5 and 10 uW/cm^2 power density levels suffered alterations in the electrical activity of the cerebra cortex and disturbances to the conditioned reflex response. They concluded that exposure to RF/MW radiation caused perturbations in the higher functioning centers of the CNS in the laboratory animals [17].

An experiment conducted by V. R. Faytel'berg-Blank and G. M. Perevalov demonstrated the biological effects of RF/MW radiation on the activity of neurons (reference found in [17]. They subjected chinchilla rabbits to a 460 MHz RF/MW source at incident power densities of 2 and 5 mW/cm^2. Only the heads of the rabbits were irradiated and exposures lasted for 10 minutes. Exposure at the 2 mW/cm^2 power density level caused neuronal activity to increase and evoked an electroencephalogram (EEG) activation reaction. Neuronal activity was observed to decrease at the higher power density level. These results indicated that RF/MW radiation can cause neurophysiological alterations in animals. These biological responses may be dependent on the intensity of the radiation [17].

iii. Behavioral Effects

Exposure to RF/MW radiation has been observed to cause a disruption in the behavior of animals. Experiments conducted on rats and nonhuman primates indicates that conditioned responses can be altered as a result of irradiation. Researchers indicate that behavior may be the most sensitive biological component to RF/MW radiation [1], [7], [9], [29].

D. R. Justesen and N. W. King (reference found in [7]) reported experimental results that demonstrated a degenerative behavioral effect in laboratory animals that were exposed to RF/MW radiation. The results were published in 1970. They exposed rats to a 2450 MHz multimodal resonating cavity system. Exposure was periodic with irradiation times lasting for 5 minutes and recurring every 5 minutes. This cycle as sustained for 60 minutes. The experiment tested the effect of irradiation at whole-body energy absorption rates of 3.0, 6.2, and 9.2 W/Kg. It was observed that for a SAR of 6.2 W/Kg the behavioral performance of the rats degraded significantly and activity usually terminated at the end of the 60 minute exposure period [7].

In 1977, James Lin, Arthur Guy, and Lynn Caldwell [29] reported experimental results that showed alterations in the behavioral response of rats that were exposed to RF/MW radiation. White female rats were trained to execute a "head raising" movement in return for a food pellet. The total number of such movements was counted during each exposure session in order to quantify the effect of irradiation. The animals were exposed to a 918 MHz RF/MW source at power density levels of 10, 20, and 40 mW/cm^2. Clinical observations showed that baseline responses remained unchanged for irradiation at the lower power density levels of 10 and 20 mW/cm^2. At 40 mW/cm^2, however, behavioral responses decreased rapidly after 5 minutes of continuous exposure. After about 15 minutes of exposure, behavioral activity terminated. It was determined that the peak energy absorption at 40 mW/cm^2 was about 32 W/Kg and the average absorption was 8.4 W/Kg over the whole-body surface [29].

iv. Synergetic Effect of Drugs RF/MW Radiation

In 1979, J. R. Thomas et al. reported that psychoactive drugs and RF/MW radiation may have a synergetic effect on living organisms (references for Thomas can be found in [1]). Experiments were conducted on laboratory animals. Male albino rats were administered dextroamphetamine and irradiated with a pulsed 2450 MHz RF/MW source at 1 W/cm^2 power intensity for periods of 30 minutes. It was found that the number of clinical responses observed per minute in the rats diminished more rapidly under the stimulus of both agents than in the control condition where just the drug was administered. This indicates that the effects of RF/MW radiation may be enhanced by certain drugs [1].

v. Analeptic Effect in Animals

Pulsed RF/MW radiation was reported to have an analeptic effect in laboratory animals. Experimental results presented by R. D. McAfee in 1971 showed that anethesized animals could be awakened by irradiation from a pulsed 10 GHz RF/MW source. The energy incident on the test animals was estimated to have a power density of between 20-40 mW/cm^2. Experiments conducted on rats showed that these animals were aroused from states of deep sleep by irradiation. It was observed that the blood pressure of a rat decreased simultaneously with the arousal response and that laryngeal spasms would occur when the rat was awakened. McAfee reported that the laryngeal spasms would obstruct the airway causing convulsions, asphyxiation, and eventually death. Other experiments performed on rabbits, cats, and dogs showed that these animals could also be awakened by irradiation. The larger animals, however, did not asphyxiate themselves, The blood pressure of the dogs and cats was observed to rise as they were awakened. In all cases, the arousal response was stimulated only when the head of the animal was irradiated. The body temperature of the test animals was not observed to rise as a result of irradiation. This indicates that the analeptic effect of RF/MW radiation may be nonthermal in nature [20].

I. Immunological Effect

Exposure to RF/MW radiation has been observed to cause physical alterations in the essential cells of the immune system and a degradation of immunologic responses [7], [17]. Experimental results published by Soviet and Eastern European researchers indicate that irradiation can cause injury and trauma to the internal body organs that comprise the immune system. Even exposure to low levels of RF/MW radiation can impair immunologic functions [17].

As discussed earlier, lymphoblasts can undergo physical alterations as a result of irradiation. Lymohiblastoid mutagens are similar in structure to leukemia cells [8]. Lymphoblasts are the precursors to leukocyte cells that participate in the immune system [18].

In 1979, N. P. Zalyubovskaya and R. I. Kiselev (reference found in [17]) reported that exposure to RF/MW radiation caused serious damage to the immune system of laboratory animals. They exposed mice to an RF/MW source radiating at 46.1 GHz with an incident power intensity of 1 mW/cm^2 for 15 minutes/day for 20 days, it was observed that the number of leukocytes in the bloodstream of the mice decreased as a result of irradiation. Effective quantities of enzymatic proteins in serum that combine with antigen-antibody complex and antibacterial agents such as lysozyme were also reduced. Zalyubovskaya and Kiselev reported a decrease in the phagocytic activity of neutrophils and a diminished resistance to infections caused by tetanic toxins. Immunity to typhoid and other tetanic toxins induced by vaccination or by the administration of antitoxins was rendered ineffective. Further examination of the mice revealed injury and trauma to the internal body organs. Irradiation had caused physical alterations in the thymus, spleen, and lymph nodes. The lymphoid organs suffered a total loss of mass [17].

J. Effect on the Eye

Clinical studies indicate that exposure to RF/MW radiation causes physiological damage to the eye that can result in loss of sight. It has been observed that irradiation causes the formation of cataracts in the lens of the eye. Tissue damage appears to be the result of thermal trauma induced by the heating property of RF/MW radiation. Experiments conducted on laboratory animals have demonstrated severe ocular damage as a result of exposure [30], [31].

i. Ocular Sensitivity

Exposure of the eye to RF/MW radiation causes physical duress that can lead to damage of the ocular tissue. The incident power intensity and the duration of radiation exposure are factors that determine the amount of tissue damage. The lens of the eye appears to be most susceptible to RF/MW energy radiated at frequencies between 1-10 GHz. For this frequency range, it has been observed that lens fibers will suffer irreversible damage to a greater extent than other ocular elements [30]. Lens fibers are elongated, thread-like structures that form the substance of the lens [18]. In 1979, Stephen Cleary reported [30] that cataracts are formed in the lens as a result of alterations in the paracystalline state of lens proteins. Physical, chemical or metabolic stress may be responsible for opacification of the lens [30].

ii. Experiments on Rabbits

Severe tissue damage has been observed in rabbits that have been exposed to RF/MW radiation. Stephen Cleary [30] reports that intense radiation exposure can cause "immediate tearing, injection, pupillary constriction, and anterior turbity" in the rabbit eye. Lens opacities can occur when the eye is irradiated by a 2450 MHz RF/MW source at incident power density levels of 100-300 mW/cm^2. At this exposure level, cataracts have been observed to form 24-48 hours after irradiation [30]. In 1976, Kramer, Harris, Emery, and Guy (reference found in [30]) reported observing the formation of cataracts in rabbit eyes that were exposed to 2450 MHz RF/MW radiation at an incident power density level of 180 mW/cm^2 for an exposure time of 140 minutes [30].

Acute ocular damage and the formation of cataracts appears to be the result of local hyperthermia of the eye. It has been observed, however, that trauma induced by heating of the ocular tissue may be unique to the exposure effects of RF/MW radiation [30]. In 1975, Kramer, Harris, Emery, and Guy (reference found in [30]) reported subjecting rabbits to hyperthermia not induced by exposure to RF/MW radiation. Heating caused the intra-ocular temperature of the eye to rise above normal. The retrolental temperature was reported to be about 42°C during the test period. Hyperthermia was sustained for approximately 30 minutes. Despite heating conditions that were similar to exposure from RF/MW radiation, lens opacities did not occur in the rabbit eyes [30]. Similar results have been reported by other researchers [30]. These results indicate that hyperthermia alone may not be sufficient to cause the formation of cataracts. Direct exposure to RF/MW radiation may be necessary to induce opacities in the lens [30].

iii. Cataracts in Humans

Exposure to RF/MW radiation is known to cause cataracts in the human eye. Several cases have been documented that report RF/MW induced cataracts in humans. Typically, lens opacities have resulted from exposure levels that are greater than specified by the various safety standards. However, minimum exposure levels sufficient to cause ocular damage are not certain [30].

In 1970, Zaret, Kaplan and Kay (reference found in [30]) reported a large number of cataracts induced in humans as result of occupational exposure. This report cited 42 cases of chronic exposure to RF/MW radiation. They reported that workers suffered damage to the posterior lens capsule. In one case, exposure periods lasted about 50 hours/week for 4 years. During most of the 4 year period the incident average power density level was approximately 10 mW/cm^2. For one 6 month period, however, power density levels may have reached 1 W/cm^2 [30].

In 1966, S. Cleary and B. Pasternack (reference found in [30]) published the results of an epidemiological study of military and industrial microwave workers. It was reported that minor alterations had occurred in the ocular lenses of the workers as a possible result of chronic RF/MW radiation exposure. Defects were found in the posterior pole of the lens. Cleary and Pasternack noted that the number of minor ocular defects was related to the specific occupational duties of the workers. The greatest number of defects was found among persons working in research and development jobs. The results of the study were based on a comparison of the microwave workers with a similar control group. The researchers concluded that exposure to RF/MW radiation had caused the lens of the eye to age faster than normal [30].

Similar cases of RF/MW radiation induced ocular damage have been reported by other researchers. In one case, a 22 year old microwave technician was exposed 5 times over a 1 month period to a 3 GHz radiation source. The incident power density level was about 300 mW/cm^2 and irradiation lasted approximately 3 minutes during each exposure time. It was reported that the technician had developed bilateral cataracts as a result of irradiation [30]. In another case, M. Zaret (reference found in [30]) reported that a 50 year old woman had developed cataracts after intermittent exposure to a 2.45 GHz microwave oven. The incident power density levels were about 1 mW/cm^2 during operation of the oven and as high as 90 mW/cm^2 when the oven door was opened [30].

K. Auditory Effect

Individuals exposed to pulsed RF/MW radiation have reported hearing a chirping, clicking or buzzing sound emanating from inside or behind the head. The auditory response has been observed only for pulsed modulated radiation emitted as a square-wave pulse train. The pulse width and pulse repetition rate are factors that appear to determine the type of sound perceived [1], [31].

James Lin [31] reports that the sensation of hearing in humans occurs when the head is irradiated at an average incident power density level of about 0.1 mW/cm^2 and a peak intensity near 300 mW/cm^2. Auditory responses have been observed for a frequency range of 200-3000 MHz and for pulse widths from 1-100 us [32].

III. RF/MW ENERGY DEPOSITION

The absorption of RF/MW radiated energy
causes biological reactions to occur in living organisms. In order to understand the potential effects of RF/MW radiation, it is important to quantify the absorption characteristics of biological materials. Researchers have identified several principal factors that govern the absorption of RF/MW energy by the human body. Experimental results have indicated that clothing thickness, physical dimensions, degree of hydration, and the resonance frequency of the human body are important parameters that determine the amount of energy absorbed by the body [1], [8], [9], [16], [22].

A. Specific Absorption Rate (SAR)

The specific absorption rate (SAR) is a measure of the dose of RF/MW energy absorbed by biological materials. It is intended to give a quantitative understanding to the absorption of energy. The SAR is defined as the amount of energy that is imparted to the body as a function of body mass [4]. SAR's are usually expressed in terms of watts of incident power per kilograms of irradiated body mass (W/Kg) [4], [9].

B. Depth of Energy Penetration

It is known that RF/MW radiated energy will be absorbed by the tissue of the human body. The depth of energy penetration into he tissue depends primarily on the wavelength of the incident radiation and the water content of the tissue [3], [6].

Energy emitted in the millimeter-wave band is not likely to penetrate to more than about 1 or 2 mm into the tissue [6]. Essentially, RF/MW energy radiated at wavelengths less than 3 centimeters will be captured in the outer skinsurface. RF/MW wavelengths from 3 to 10 centimeters will penetrate to a depth of about 1 to 10 mm. The greatest depth of penetration into the body will occur at wavelengths between 25 to 200 centimeters. At these wavelengths RF/MW radiated energy can directly effect internal body organs and cause serious injury. The human body is reported to be "transparent" to RF/MW radiated energy emitted at wavelengths greater than 200 centimeters. Also, at frequencies above 300 MHz it has been observed that the depth of energy penetration fluctuates rapidly with changes in frequency. In general, the depth of energy penetration into the body will decline as the frequency of the incident radiation increases. At 10 GHz, the absorption of RF/MW energy will be similar to IR radiation [3]. These figures were published by the U. S. Department of Health, Education and Welfare [3].

The water content of the human tissue will also influence the depth of energy penetration into the body. Millimeter-wave radiation is reported by Ghandi and Riazi [6] to penetrate less than 2 mm into the body because of the "Debye relaxation of the water molecules" in the tissue [6]. The Debye Effect was observed by a Dutch physicist named Peter Debye [23]. He discovered that EM waves are absorbed by a dielectric because of molecular dipoles present in the dielectric material [24]. Water molecules are essentially dipoles constructed from atoms of hydrogen and oxygen. Biological materials such as skin are dielectrics that consist mostly of water. Hence, these dielectrics are rich in molecular dipoles and are able to quickly absorb millimeter-wave radiation. High frequency radiation emissions are not expected to penetrate deeply into the human body [6].

C. Effect of Geometry

The orientation of the human body with respect to the incident EM field will determine the amount of RF/MW energy that is absorbed by the tissue. Experimental results published by Om Gandhi in 1980 indicate that the condition for maximum absorption occurs when the electric field is parallel to the major axis of the body and the direction of the field propagation is from arm to arm. Figure 2 shows the amount of energy absorbed versus the radiating frequency for various EM field orientations [22].

D. Effect of the Resonance Frequency

Researchers have reported that the human body will absorb the greatest amount of RF/MW energy from sources radiating at the whole-body resonance frequency [1], [9], [22], [25], [27]. The ANSI Standard [9] reports that the human body will absorb 7 times more energy from radiation emitted at the resonance frequency than at a frequency of 2450 MHz [9]. Experiments conducted on fabricated human models have been used to determine the resonance frequency of the human body [22]. Partial-body resonances have also been observed by researchers. Computer simulation techniques have been used to estimate the resonance frequency of the human head [26].

The free space whole-body resonance frequency is reported to be between 61.8-77 MHz for a Standard Model of Man [9], [22], [25]. The standard model depicts an average man standing 175 cm tall [9]. Experimental results tend to differ somewhat from numerical calculations. The ANSI Standard [9] reports the whole-body resonance frequency to be 70 MHZ [9]. Similarly, experimental results presented by Hagman, Gandhi, and Durney [25] indicate the resonance frequency to be between 68-71 MHz. However, calculations put forth by the same researchers place the whole-body resonance at 77 MHz [25]. In 1980, Om Gandhi reported that the maximum absorption of energy will occur at frequencies where the free space wavelength (λ) of the incident radiation is about 2.50-2.77 times greater than the major length (L) of the body (i.e. λ>23.50L-2.77L). This formula puts the value of the resonant frequency between 61.8-68.5 MHz for a standard model of man. When the human body is in contact with the electrical ground, the whole-body resonance frequency is reduced to about 47 MHz [22]. Figure 3 shows the SAR versus the incident EM field frequency for conditions of free space and grounding [22].

Numerical calculations have been presented by Hagman, Gandhi, D'Andrea, and Chatterjee [26] that indicate the free space resonance frequency of the human head to be about 375 MHz [26]. In a separate report, Gandhi determined that the head resonance will occur when the free space wavelength of the incident radiation is about 4 times the diameter of the head [22]. The condition for maximum energy absorption occurs when the direction of the EM field propagation is parallel to the long axis of the body. This orientation differs from the condition determined for RF/MW energy absorption by the whole-body. Figures 4 and 5 show the absorption of energy versus frequency for different EM field orientations [26].

E. Effect of Clothing

Clothing can act as an impedance matching transformer for RF/MW radiation. In 1986, Gandhi and Riazi [6] reported that the coupling efficiency of clothing may be as high as 90-95 percent for incident radiation in the millimeter-wave band. They determined that the thickness of the clothing and frequency of the incident radiation are important factors in the coupling condition. Figure 6 shows the relationship between clothing thickness and coupling efficiency as a function of frequency. The authors note that wet or damp clothing may actually reduce the amount of energy absorbed by the body because of the Debye relaxation of the water molecules [6].

IV. RF/MW RADIATION EXPOSURE STANDARDS

Exposure of living organisms to RF/MW radiation can have a potentially dangerous biological effect. To ensure the public safety and to safeguard the workplace against unnecessary RF/MW radiation exposure, protective guidelines have been adopted by the United States and several other nations. The maximum safe exposure levels recognized by individual examining authorities tends to vary as a result of differing interpretations of the available RF/MW exposure data. There is a large distinction between permissible exposure levels observed in the United States and the Soviet Union. East Block countries have set more stringent standards than nations in the West [3], [8], [11], [22].

A. ANSI Standard C95.1-1982

In response to the need for a national RF/MW radiation protection guide, the American Standards Association commissioned the Department of the Navy and The Institute of Electrical and Electronics Engineers to cooperate in formulating an acceptable standard for safe radiation exposure levels. In 1960, the Radiation Hazards Standards Project was established to coordinate the efforts of researchers. Since then, work has progressed and in 1982 a modern RF/MW radiation protection guide was established. The American National Standards Institute (ANSI) designated this guide as C95.1-1982 [9]. Presently, a new ANSI guide is due for publication in May 1993. The new guide is entitled "ANSI/IEEE C95.1-1992". This guide will supersede C95.1-1982 when it is published.

i. Recommendations

The ANSI C95.1-1982 Standard specifies the maximum recommended RF/MW radiation exposure levels over a frequency range of 300 KHz to 100 GHz. Typically, the standard calls for an exposure of no more than 5 mW/cm^2 for frequencies between 1500 MHz to 100,000 MHz. The reader should consult with the actual ANSI publication for the detailed recommendations. In addition, the standard limits the whole-body SAR to 0.4 W/Kg and indicates that the spatial peak SAR should not exceed 8.0 W/Kg over any one gram of tissue. For both CW and pulsed EM fields the exposure time should not exceed 6 minutes at the recommended levels. These maximum safe levels are not intended to apply to the medical treatment of patients where irradiation is sometimes useful in combating diseases like cancer. The standard does pertain to the general public and to persons that work in electromagnetic environments. There are two exceptions to the recommendation: 1) at frequencies between 100 KHz and 1 GHz the maximum exposure levels may be exceeded as long as the stated SAR values are not violated and 2) at frequencies between 300 KHz and 1 GHz the exposure levels may be exceeded if the output power of the radiating device is less than 7 W [9].

ii. Philosophy

An explanation of the recommended maximum exposure levels is given as part of the protection guide. The ANSI Standard is intended to afford the best possible protection of human life against RF/MW radiation exposure. The biological effect on the human body for all RF/MW frequencies and modulation schemes is not known, therefore, investigators sought to interpret the available data in a way that would allow for the construction of the best possible RF/MW radiation protection guide. Investigators emphasized studies that reported harmful or potentially serious biological effects. Unlike past standards, researchers agreed that the modern protection guide would also account for the nonthermal effects of RF/MW radiation [9].

The safe exposure levels expressed by the ANSI guideline were determined for far field exposures. The plane wave model used to specify the maximum exposure levels may not be accurate to describe conditions in the near field. However, the power density levels expressed in the protection guide are not considered great enough to induce EM fields with sufficient energy intensities capable of exceeding the recommend SAR's [9].

In selecting a measure for the dose of RF/MW radiation, it was recognized that the SAR does not encompass all of the important factors necessary to determine safe exposure levels. The modulation frequency and peak power of the incident EM field should also be considered. Some of the investigators warned that extra care should be taken by persons that are subjected to pulsed EM fields or by fields that are modulated near the whole-body resonance frequency [9]

In assessing the biological effects, it was found that behavior was the most sensitive biological component to RF/MW irradiation. It was observed that behavioral effects were reversible for exposure to carrier frequencies between 600 MHz and 2450 MHz when whole-body SAR's were limited to between 4 and 8 W/Kg. For these SAR's, power densities were calculated or measured to range from 10 mW/cm^2 to 50 mW/cm^2. Behavioral effects were considered to be among the most serious consequences of exposure to RF/MW radiation [9].

It was established that in order to ensure an acceptable margin of safety the whole-body average SAR should not exceed 0.4 W/Kg. Most of the researchers concluded that this was a necessary and reasonable standard. The exceptions cited in the recommendations were justified on the basis of the total rate of energy absorption by the human body. The Standard reports that small radio transceivers are able to emit EM fields that exceed the prescribed power density levels. Such devices, however, are not expected to compromise the prescribed maximum SAR levels. In general, compliance with the ANSI RF/MW protection guide is the best safeguard against harmful biological effects [9].

B. USAF PEL (AFOSH Standard 161-9, 12 February 1987)

Since the early investigations of the Tri-Service Commission, the United States Air Force has recognized the need to establish an RF/MW protection standard. The USAF permissible exposure level (PEL) is specified in AFOSH Standard 161-9 enacted 12 February 1987. This standard stipulates maximum safe RF/MW radiation exposure levels over a frequency range of 10 KHz to 300 GHz. The PELs are shown in Figures 7 and 8 [10].

In general, the USAF protection guideline agrees with the ANSI Standard except that a distinction is made between exposure to persons in restricted and unrestricted areas. No explanation for this policy is given in the USAF Standard. The PEL for restricted areas shows only a slight alteration from the ANSI recommendation. For a frequency range of 1500-300,000 MHz the USAF PEL is given as 10 mW/cm^2. The PEL put forth by the USAF is intended to protect personnel from harm by limiting the whole-body SAR to 0.4 W/Kg. Exposure periods at the maximum safe levels should be limited to 6 minutes. It is also recommended that exposure in the near zone to RF/MW sources radiating at less than 30 MHz may require a separate evaluation to determine safe exposure levels of irradiation [10].

C. Canada Western Europe

Concern over safe RF/MW radiation exposure levels has sparked controversy and sharp debate in many countries around the world. The ANSI Standard is currently recognized by most countries of the Free World including Canada, the United Kingdom, Sweden, France, and West Germany [8], [22].

D. Soviet Union & Eastern European Standards

The RF/MW radiation exposure standards prescribed in the Soviet Union and Eastern Europe are more conservative than standards adopted by countries in the West [3], [8], [11]. In the Soviet Union, permissible exposure levels for whole-body irradiation are specified for various time intervals. RF/MW radiation exposures may not exceed 0.01 mW/cm^2 for 3 hours/day, 0.1 mW/cm^2 for 2 hours/day, and 1.0 mW/cm^2 for 15-20 minutes provided that safety goggles be worn [3]. Czechoslovakia has recommended a maximum exposure level of 0.025 mW/cm^2 for an average working day [8].

Investigators in the Soviet Union and Eastern Europe have placed a great emphasis on the nonthermal effects of biological exposure to RF/MW radiation. They contend that electromagnetic interactions with the bioelectrical and biochemical functions of the body constitute a more serious health risk than effects from thermal heating. Nonthermal disruptions have been observed to occur at power density levels that are much lower than are necessary to induce thermal effects. Soviet researchers have attributed alterations in the central nervous system and the cardiovascular system to the nonthermal effect of low level RF/MW radiation exposure [3], [8].

The U. S. Department of Health, Education and Welfare [3] reports that the differing standards put forth by the East and West may be attributed to philosophical differences in basic research. Soviet investigators were intent on examining the effect of RF/MW radiation on the conditioned reflex response of living organisms whereas their counterparts in the West do not view this effect as an appropriate endpoint to research [3]. Recently, however, researchers in the West have sought to account for nonthermal effects in modern permissible RF/MW radiation exposure standards [9].

V. CONCLUSION

Exposure to RF/MW radiation is known to have a biological effect on living organisms. Research conducted over the past 30 years has provided a basis for understanding the effect of irradiation of biological materials. Experimental evidence has shown that exposure to low intensity radiation can have a profound effect on biological processes. The nonthermal effects of RF/MW radiation exposure are becoming important measures of biological interaction with EM fields. Modern RF/MW radiation protection guides have sought to account for the effects of low level radiation exposure. Adherence to the ANSI Standard [9] should provide protection against harmful thermal effects and help to minimize the interaction of EM fields with the biological processes of the human body [9].

It is essentially the absorption of RF/MW energy that causes stress and trauma to biological systems. The greatest amount of energy will be absorbed when the incident radiation is emitted at the resonance frequency of biological material [9], [22]. In this regard, RF/MW radiation emitted at nonresonant frequencies should be absorbed to the greatest extent when the radiating mode is a pulsed signal. The generation of such signals creates transient responses that will match the resonant frequencies of biological materials. Nonresonant pulsed RF/MW radiation may be more harmful to living organisms than CW radiation emitted at nonresonant frequencies.

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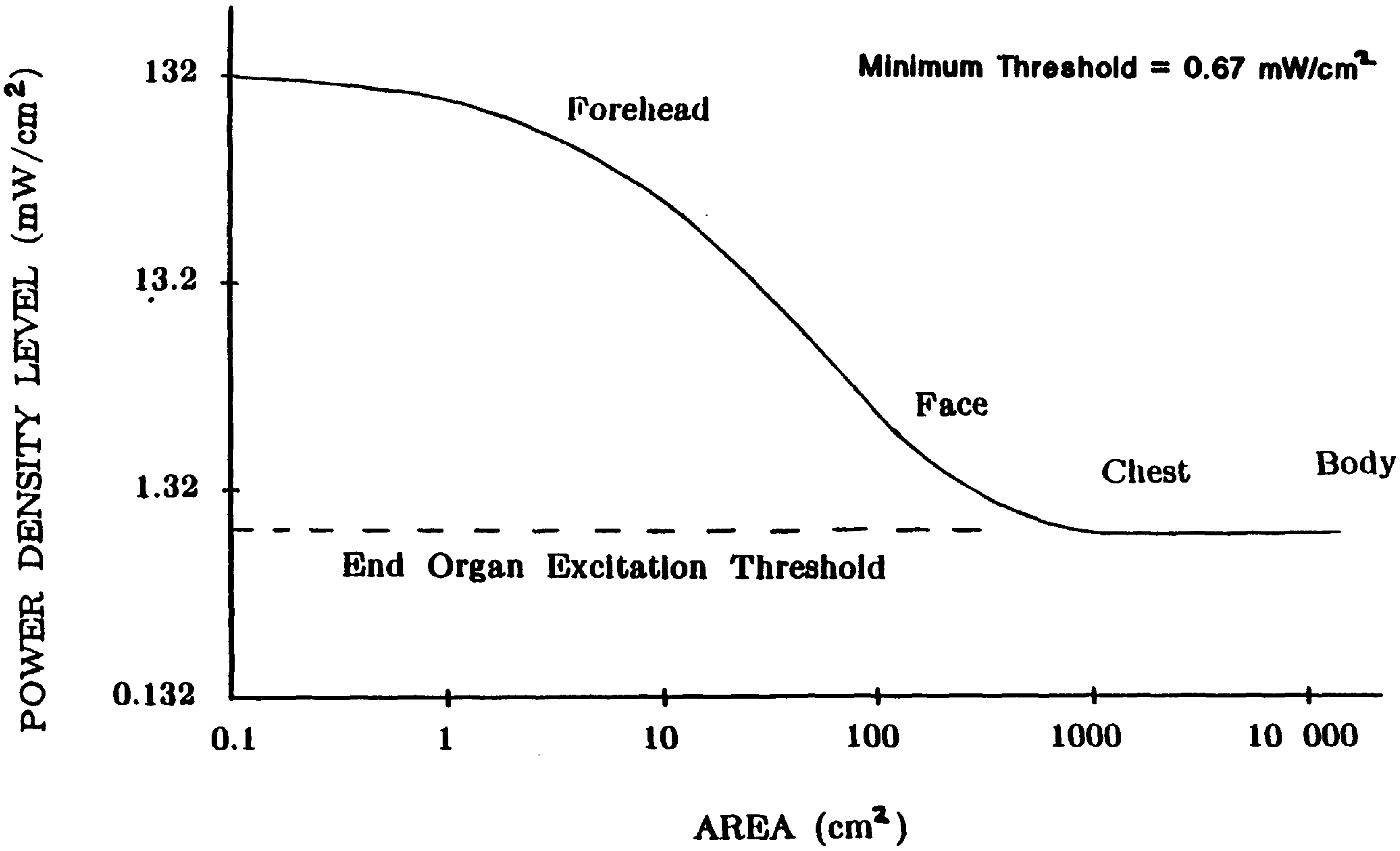

Figure 1: Observed threshold of infrared perception.
Absorbed continuous wave intensity versus exposed body area.

(ref: J. Hardy & T. Oppel, results reported by Om Gandhi and Abbas Riazi, IEEE MTT-34, pp. 228-235, Feb 1986)

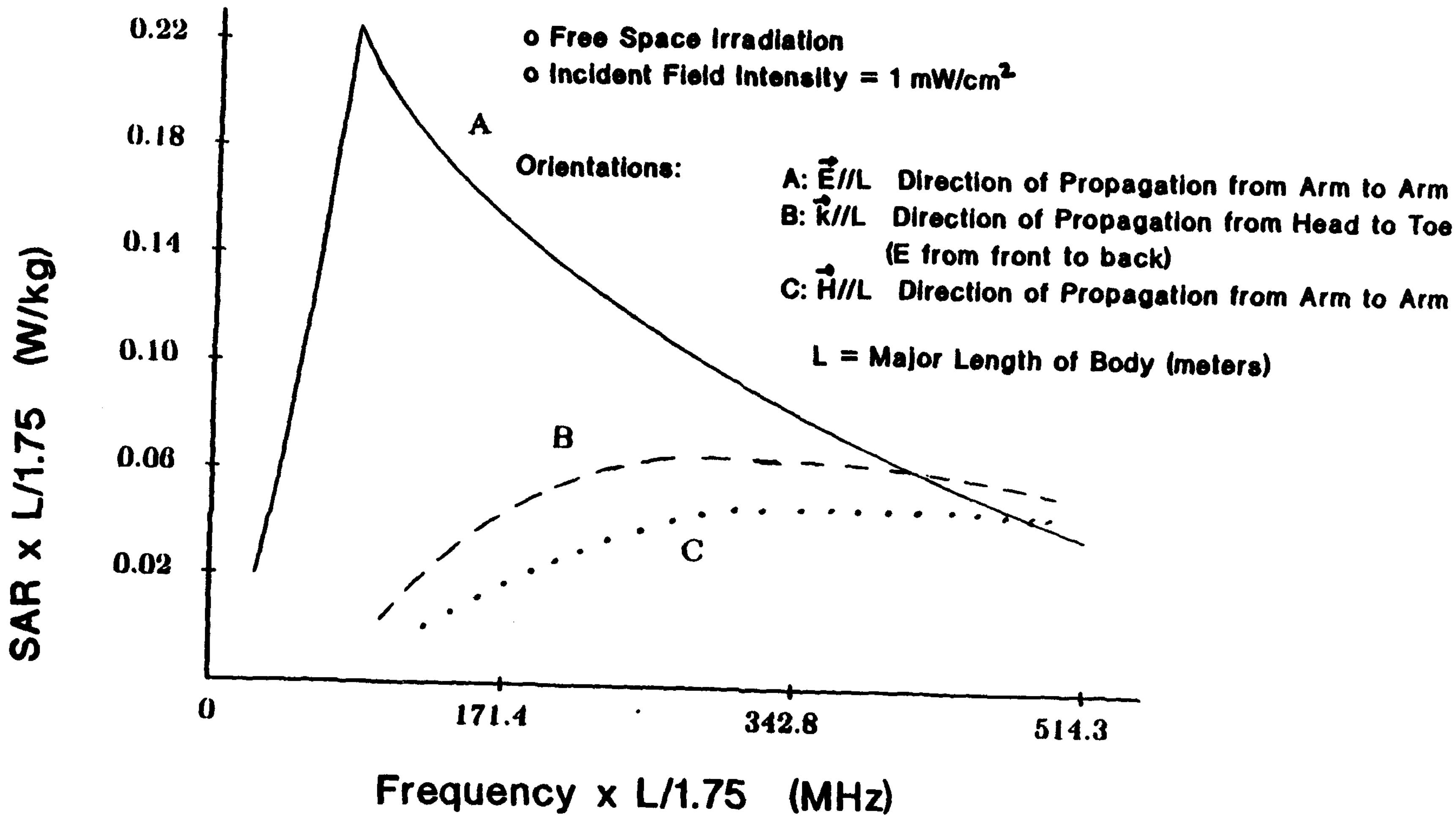

Figure 2: Comparison of field orientations for whole-body exposure of humans. Normalized SAR versus normalized radiated wave frequency.

(ref: Om Gandhi, Proceedings IEEE, Vol. 68, pp. 24-32, Jan 1980)

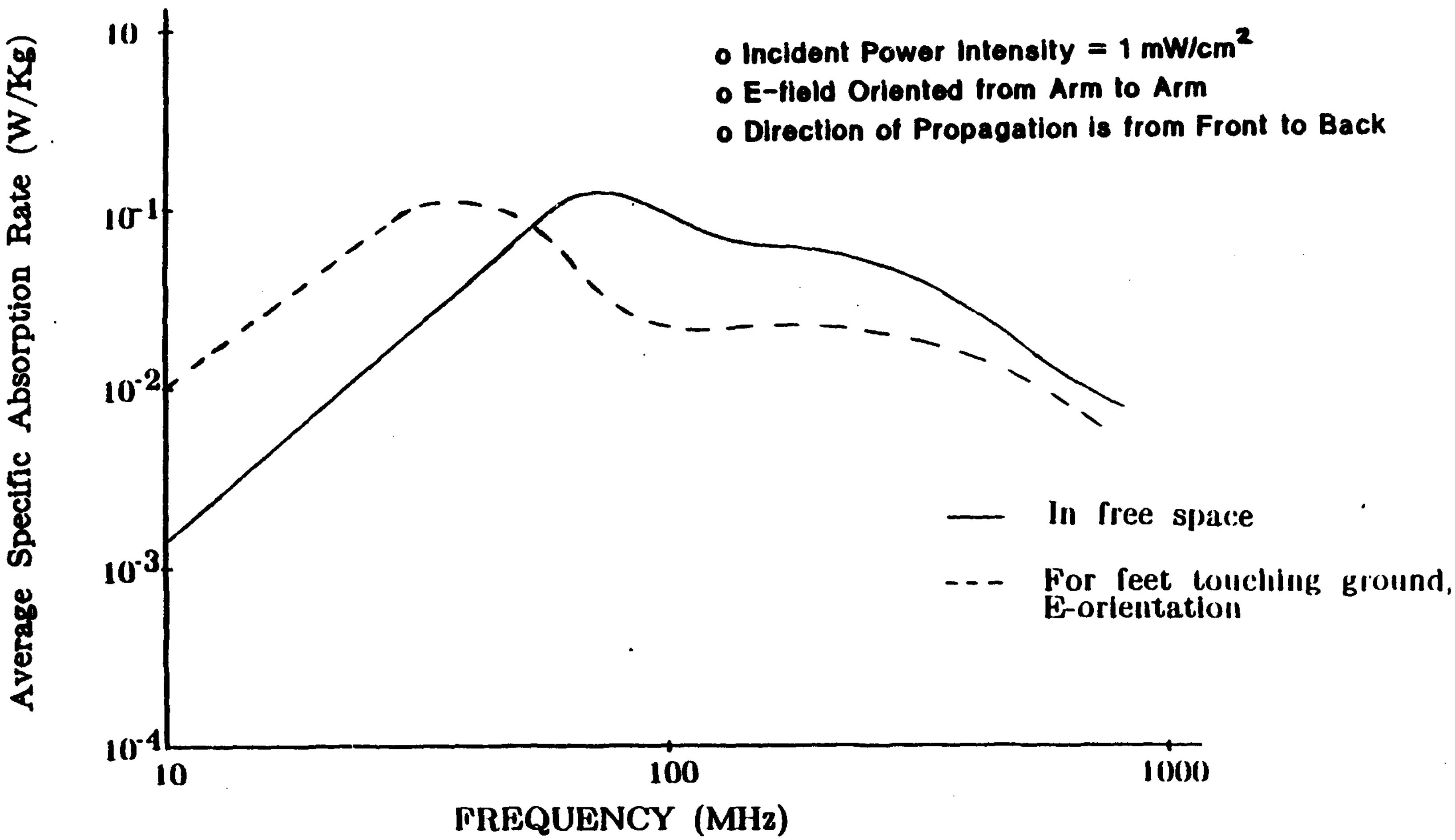

Figure 3: SAR versus frequency of incident radiation for a homogenous model of man.

(ref: OM Gandhi, Proceedings IEEE, Vol. 68, pp. 24–32, Jan 1980)

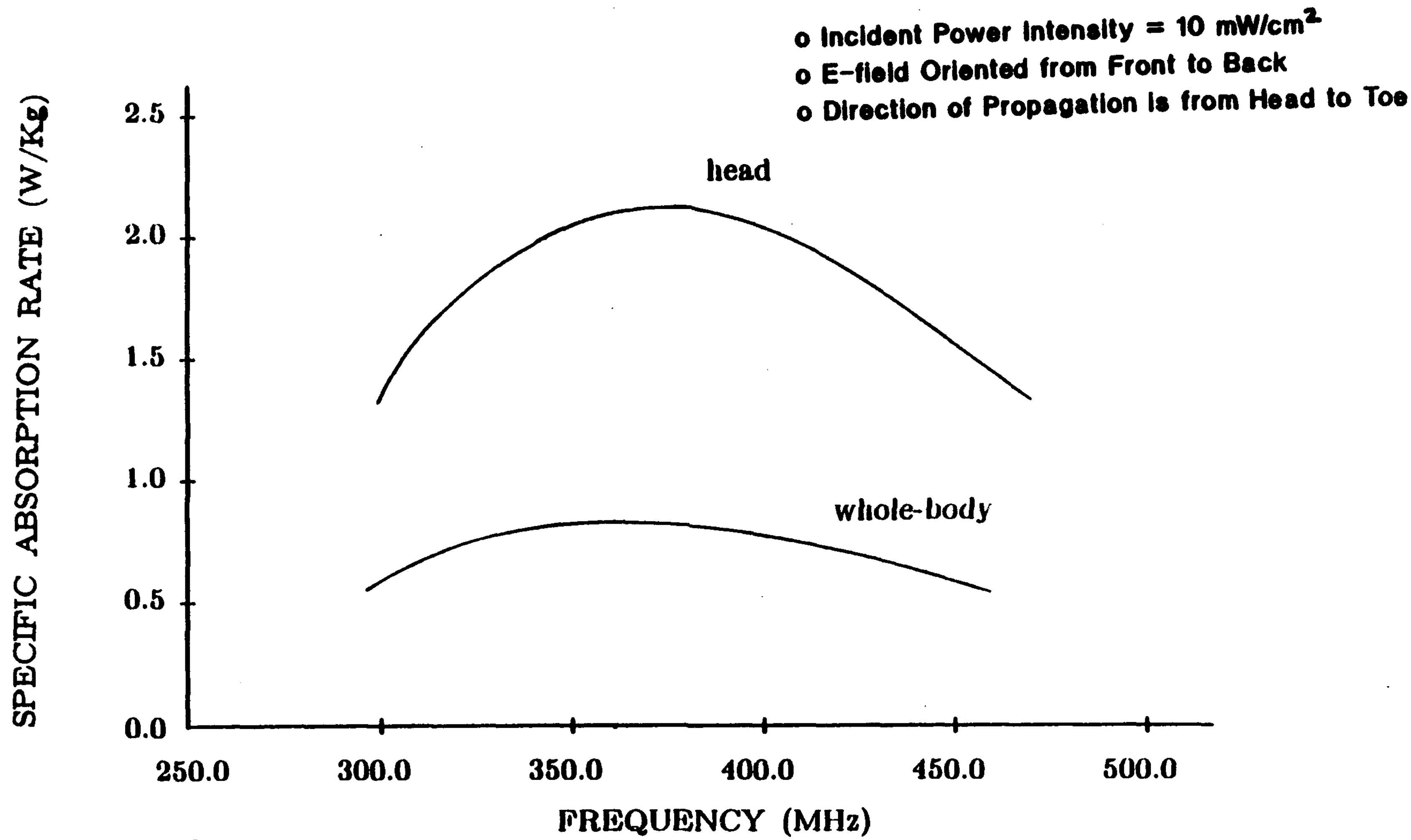

Figure 4: Head and whole-body energy absorption. SAR versus frequency of incident radiation.

(ref: Hagmann, Gandhi, D'Andera, and Chatterjee, IEEE MTT-27, pp. 809-813, Sep 1979))

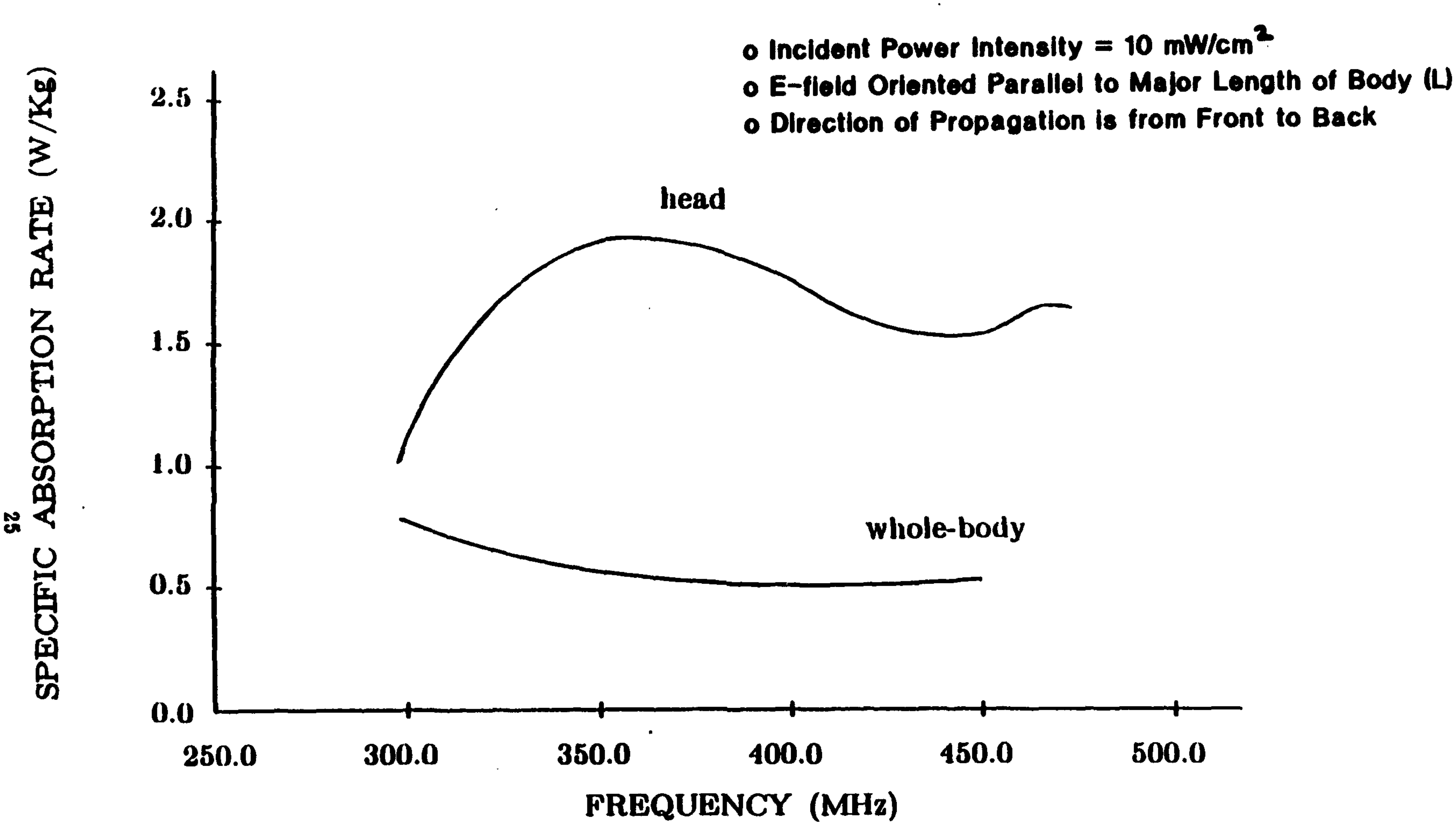

Figure 5: Head and whole-body energy absorption for $\vec{E}$//L. SAR versus frequency of incident radiation.

(ref: Hagmann, Gandhi, D'Andera, and Chatterjee, IEEE MTT-27, pp. 809-813, Sep 1979)

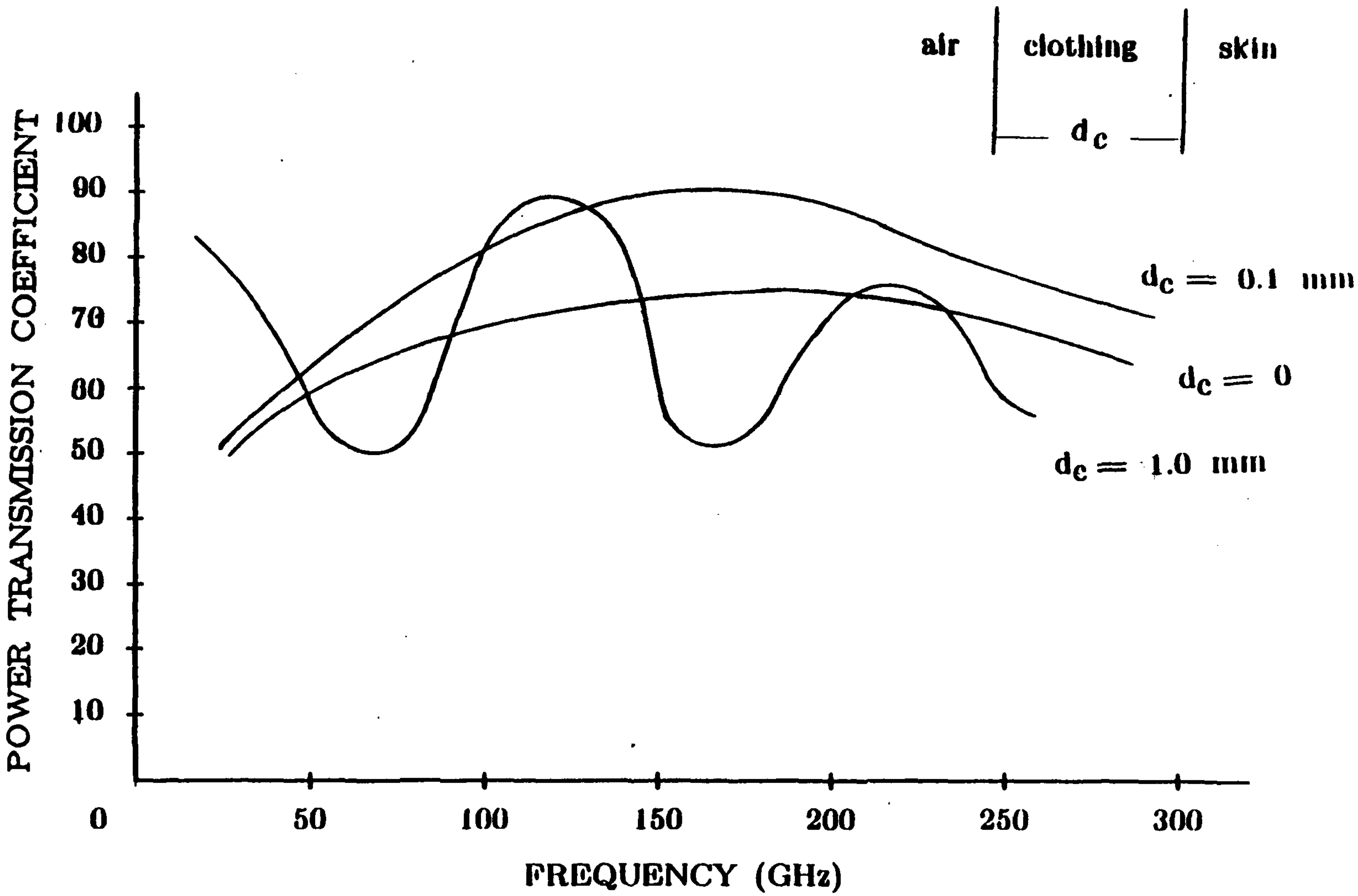

Figure 6: Comparison of transmission coefficient with and without clothing; no air gap between skin and exterior clothing.

(ref: Om Gandhi and Abbas Riazi, IEEE MTT-34, pp. 228-235, Feb 1986)

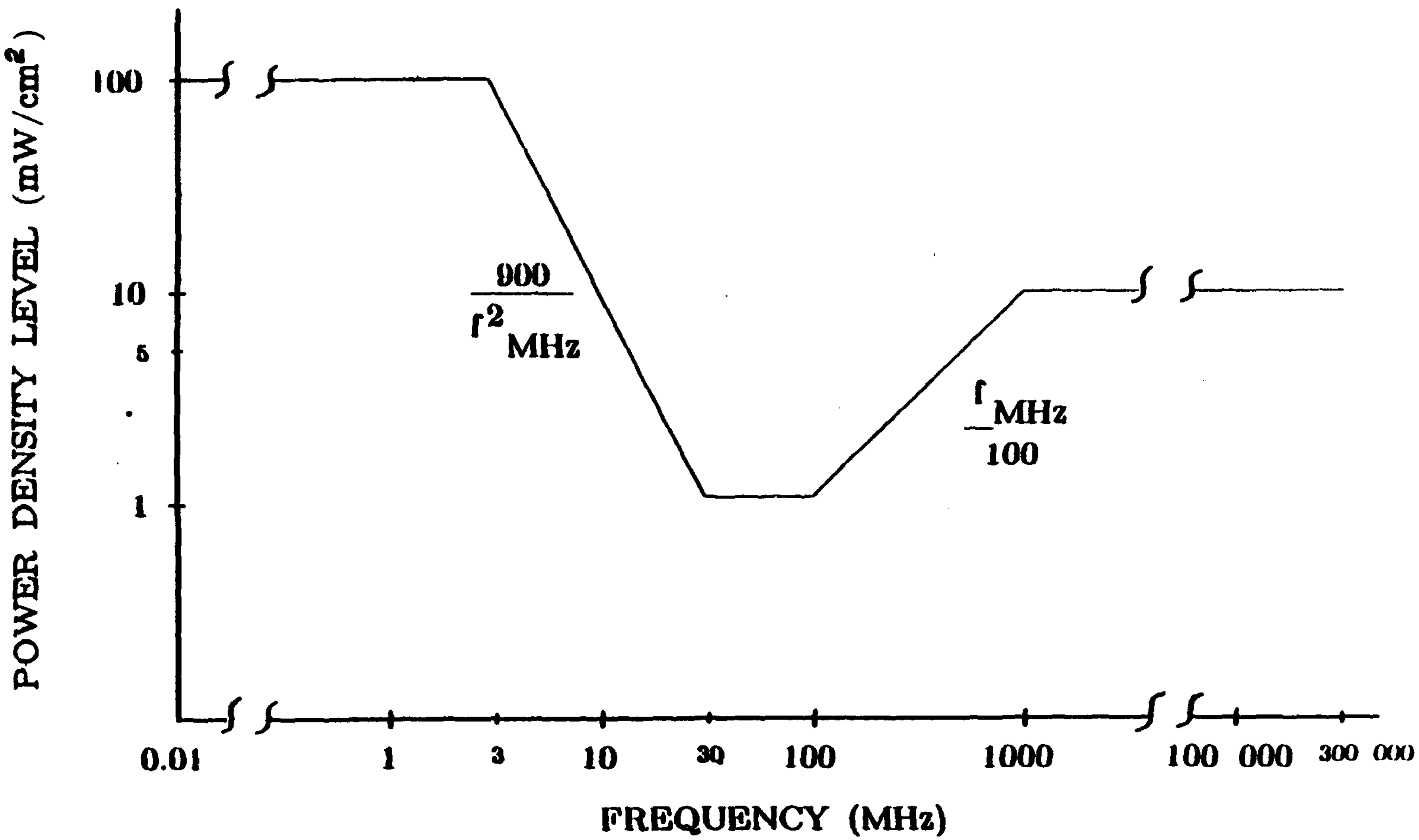

Figure 7: USAF RF/MW radiation permissible exposure limit (PEL) for humans working in restricted areas.

(ref: AFOSH Standard 161-9, 12 Feb 1987)

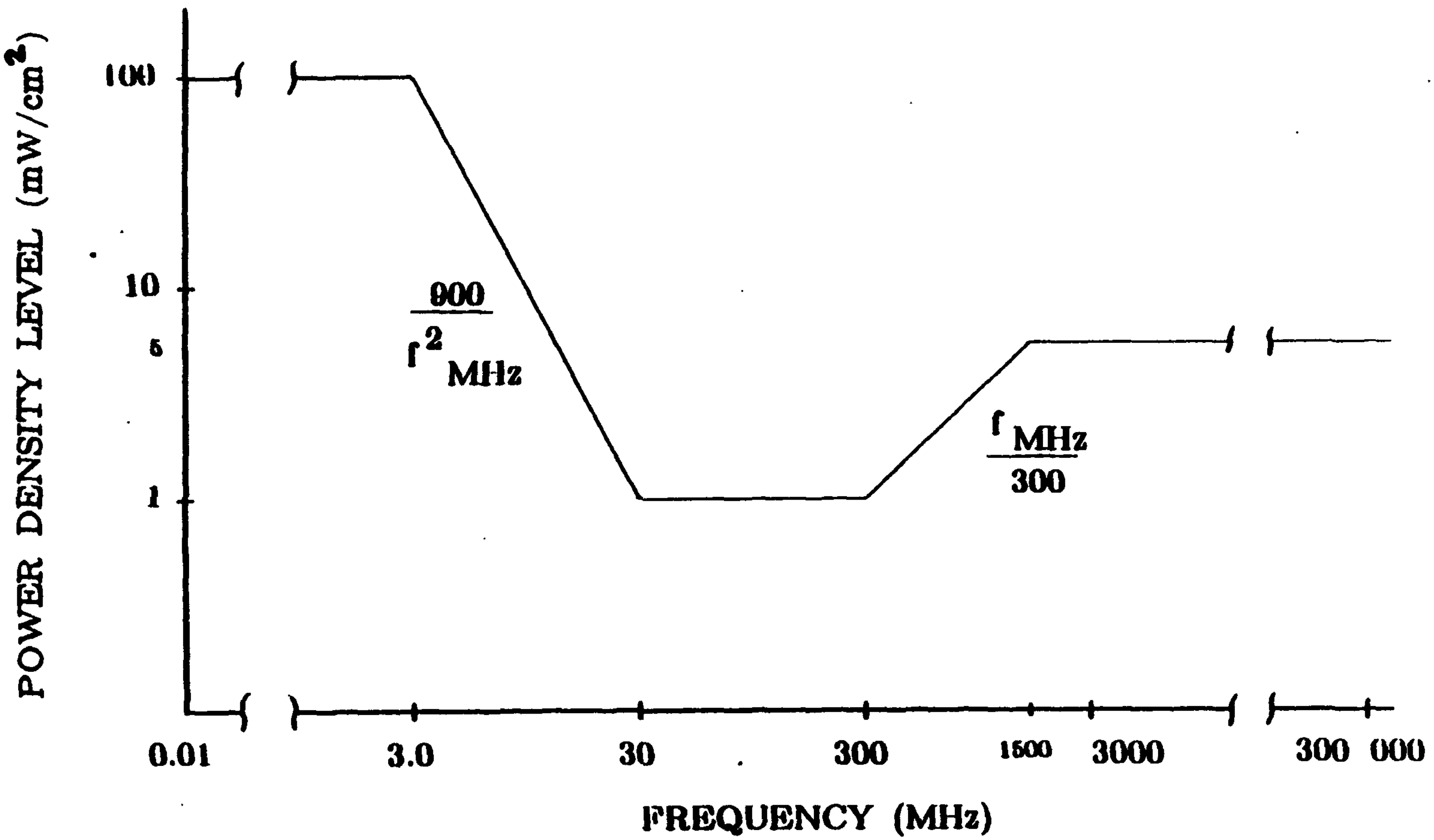

Figure 8: USAF RF/MW radiation permissible exposure limit (PEL) for humans working in unrestricted areas.

(ref: AFOSH Standard 161-9, 12 Feb 1987)

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Sujet : [INTERNET] Les pathologies de l eolien.
De : John Hunter <john2400hunter@yandex.com>
Date : 27/09/2023 17:57
Pour : pref-eolien-marcillac-lanville@charente.gouv.fr

D après la Nasa.

A peu pres comprehensible en français.
Noter que les electrosensibles sont en augmentation sur le territoire.
Linky, eolien, objets connectés c est la colique aux champs electromagnetiques et cela tue.
En Chine, il y a des robots dans les hotels de luxe marchant au bluetooth.
Ceci n'est pas acceptable tant l Electrosmog est dominant et irradie le vivant.

--
Sent from Yandex Mail for mobile

Screenshot_20221030-080956.png

08:09

Nasa et cem

Language Choose ...

	Crib death (Sudden Infant Death Syndrome).
	Functional disorders of central nervous system, hyperacidity, epi-gastric pain, disorders of cardio-vascular system, leukopenia of blood, esinophobia of blood.
	Changes in electroencephalogram, loss

Pièces jointes :

Screenshot_20221030-080956.png	353 Ko

Sujet : [INTERNET] Projet d'Implantation d'éoliennes
De : Paulette Blanchon <sepajad16@gmail.com>
Date : 27/09/2023 19:30
Pour : pref-eolien-marcillac-lanville@charente.gouv.fr

bonjour,

Je désire apporter mon soutien au *Collectif pour la Sauvegarde de l'Environnement, du Patrimoine et du cadre de vie de Marcillac-Lanville, Aigre et Mons, les habitants et le conseil municipal de Marcillac-Lanville dans leur majorité, dans leur lutte CONTRE l'implantation massive d'éoliennes sur notre territoire charentais et plus particulièrement sur leur lieu de vie.*

Après le projet d'Aunac, (Bayers, Chenon, Moutonneau), puis celui de Couture, plus proches encore, nous sommes de plus en plus menacés d'encerclement, de saturation visuelle et environnementale.
Comme nous l'avons déjà dit et redit, nous sommes au Nord Charente saturés et avons déjà bien assez contribué à l'implantation de ces mâts gigantesques qui polluent nos sites et dévalorisent nos habitations.

STOP STOP STOP. Respectez notre santé, notre patrimoine culturel, nos églises, nos châteaux. STOP STOP STOP

Cordialement,

P. BLANCHON
Chanteloube
8, rue des Fontenelles
16460 Saint-Front