CAICT 中国信通院

Recent Research Activities and the Update of EMF Standards in China

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Contents

- Selected recent Chinese EMF studies (measurement campaign, epidemiology, volunteer & dosimetry)
- Current national limits and measurement protocols
  - -environmental EMF
  - -mobile products
- Recent revision on national EMF standards

EMF measurement campaigns

EMF measurement campaigns

-8 elementary and middle schools in Chongqing & Sichuan : 561 points

Major contribution of EMF in the campus is ELF E and M field;

Level in urban campus is much higher than those in the rural campus;

Measured field strength is far below the ICNIRP guidelines.

-5 residential areas in Beijing and Chongqing, close to the high voltage power transmission lines: 688 points

In-house ELF MF level corresponds to the electricity consumption of the household appliance;

Less affected by the environmental ELF MF level.

-827 base stations: 6207 points within 50 m to base stations

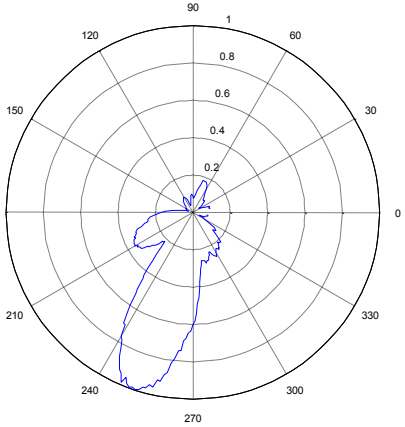
The measured values are very low even compared with the stringent domestic standard;

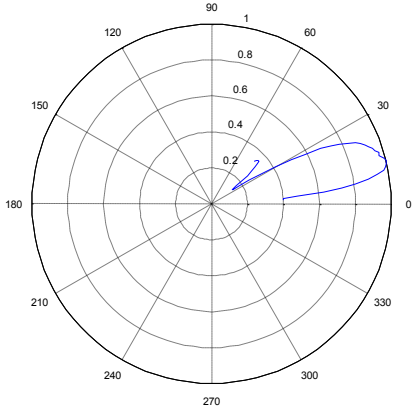
Risk communication effectively eliminates the unnecessary concerns on EMF exposure of the habitants.

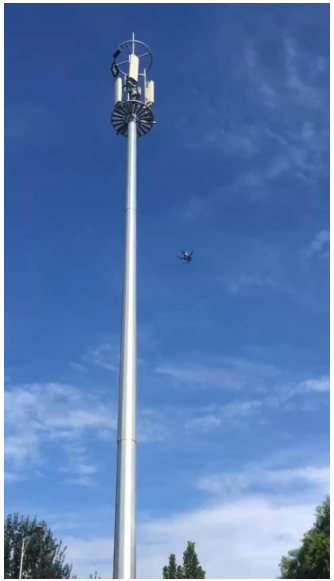
Zhang et al., Sci Total Environ. 2013; Bioelectromagnetics. 2014; Miao et al., Int J. Radiat Biol.2013; Gao et al., Environ Res. 2014; Wu et al., Radiat Prot Dosim. 2013

EMF measurement campaigns

- Progress in measurement instrumentation







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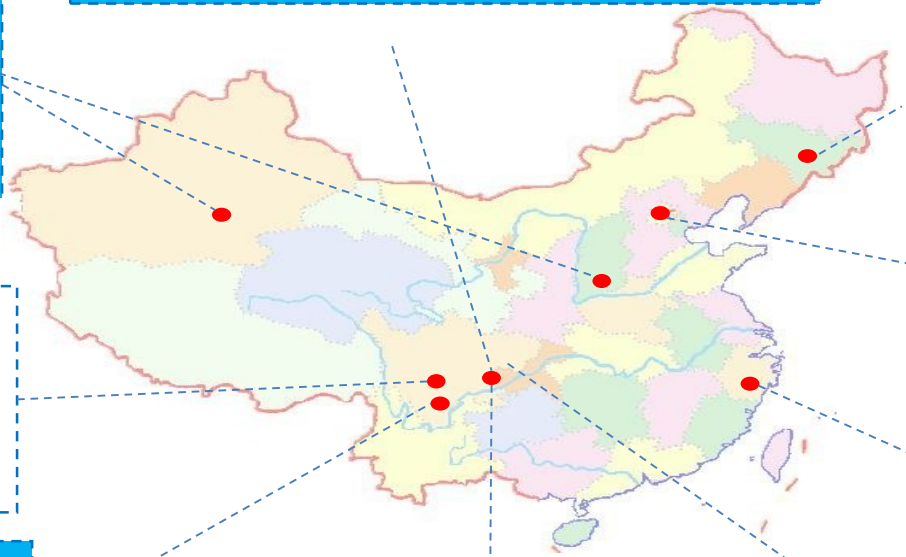
Lin et al., Radiation Protection Dosimetry 2018

Multi-center, large-scale epidemiological studies on occupational and public exposure

Chongqing: 2450 people in residential areas

Xinjiang, Shanxi : 684 workers from metallurgical Industry

Jilin: 1868 workers from machinery manufacturing industry



Beijing: 1760 workers from electric power industry

Sichuan: 11380 students from elementary and middle schools

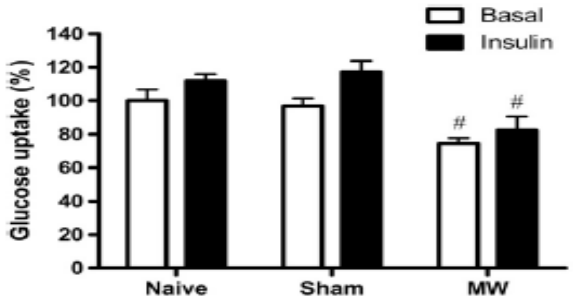
Zhejiang: 2250 workers from electric power industry

Sichuan: 1160 workers from electric power industry

Chongqing: 1810 workers from electric power industry

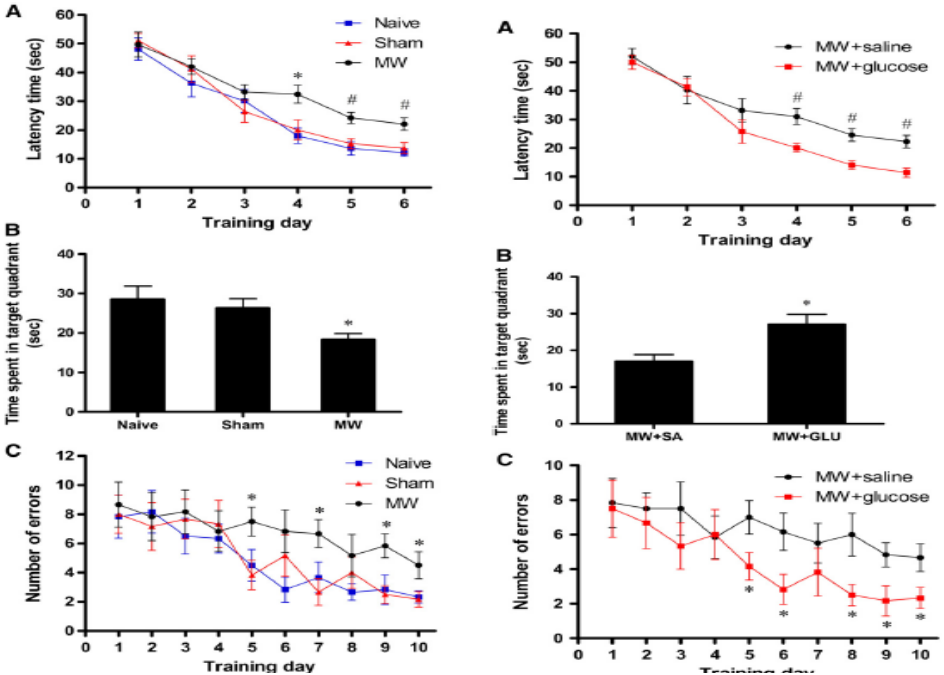
Impaired glucose tolerance

The glucose tolerance test showed increased abnormality in occupational exposed population. Nerve functional study using laboratory animals confirmed that the abnormal blood glucose induced by electromagnetic exposure was significant.



RF-EMF resulted in decreased intake capacity of in rat hippocampus

Lu et al., Physiol Behav 2012;
Zhang et al., Int J Radiat Biol 2013.



RF-EMF induced a decrease in learning and memory ability in rats, and glucose intake could alleviate injury

Decreased sleep quality

Electromagnetic exposure significantly reduced sleep quality ,which was associated with exposure time (exposure duration / daily occupational exposure time).

Association of sleep quality with various electromagnetic exposures(n=854)

Variables		Sleep Quality		Grade		Adjustments*	
		Poor. N(%)	Good. N(%)	CM(95%CI)	*P* Value	CM(95%CI)	*P* Value
Daily Occupational Exposure Time (hour)	T1	150(28.2)	132(40.9)	1.00	-	1.00	-
	T2	194(36.5)	94(29.1)	1.82(1.29,2.55)	<0.003	1.68(1.18,2.37)	<0.004
	T3	187(15.2)	97(30.0)	1.70(1.21,2.30)	0.002	1.57(1.50,2.20)	0.012
Occupational Exposure Duration (years)	<23	270(50.2)	177(54.8)	1.00	-	1.00	-
	≤23	261(49.2)	146(45.2)	1.17(0.89,1.55)	0.262	1.26(0.91,1.75)	0.167
Electric fee (yuan/month)	<150	207(19.0)	129(39.9)	1.00	-	1.00	-
	≥150	324(61.0)	194(60.1)	1.04(0.70,1.33)	0.782	1.04(0.78,1.39)	0.790
Mobile-phone service (years)	<12	242(45.6)	144(44.6)	1.00	-	1.00	-
	≥12	289(54.4)	179(55.4)	0.96(0.73,1.27)	0.778	1.00(0.75,1.34)	0.962

The cut points of testers of daily occupational exposure time (DOET) were ≤1.5 hour/day for T1, 1.5<DOET ≤4 hour/day for T2 and >4 hour/day for T3.

Association of DOET with sleep quality stratified by occupational exposure duration

DOET(hours)	Short Occupational Exposure Duration (years) (N=447)			Long Occupational Exposure Duration (years) (N=407)		
	No.(Poor Sleeper[%])	OR(95%CI)	*P* Value	No.(Poor Sleeper[%])	OR(95%CI)	*P* Value
T1	102(55.1)	1.00	-	48(49.5)	1.00	-
T2	91(65.0)	1.34(0.82,2.18)	0.243	103(69.6)	2.12(1.23,3.66)	0.007
T3	77(63.1)	1.30(0.79,2.15)	0.308	110(67.9)	1.83(1.07,3.15)	0.0288

The cut points of testers of daily occupational exposure time (DOET) were ≤1.5 hour/day for T1, 1.5<DOET ≤4 hour/day for T2 and >4 hour/day for T3.
Short occupational exposure duration means less than or equals 23 years, while long occupational exposure duration means more than 23 years.

Liu et al., PLoS One 2014; Li et al., Neurochem Int 2014.

Decreased secretion of sex hormones

The serum testosterone level and testosterone / estradiol ratio were significantly lower than those in the control group. This result is consistent with the changes of sex hormones observed in laboratory animals.

Effects of electric industry occupational EMF exposure on blood hormone level

Variable	Occupational exposure		b(SE)	P value
	High (*N*=77), Mean ±SD	low (*N*=77), Mean ±SD		
Plasma hormones				
T. nmol/L	6.1 ±0.7	6.3±0.7	-0.3(0.1)	0.015
E2. Pmol/L	25.9 ±3.0	25.7±3.1	0.4(0.6)	0.530
T/E2	239.4 ±39.8	250.2±40.5	-15.6(7.4)	0.037
MT. ng/L	17.9 ±1.4	17.8±1.2	0.1(0.2)	0.652
Inflammatory pathway biomarkers				
NF-kB. ng/L	1030.4±57.3	1039.8±55.2	-20.8(10.3)	0.045
HSP70. ng/L	265.5±34.2	261.7±31.6	4.4(3.5)	0.216
HSP27. ng/L	2057.5±146.9	2037.0±155.1	14.2(16.7)	0.396
TET1. ng/L	26.6±2.0	27.1±2.0	-0.5(0.4)	0.175

T testerone. *E2* estradiol. *MT* metabtonin. *HSP* heat-shock protein
[A] Adjustment for BMI. Labor intensity. Work pressure. Sleep quality. Cigarette smoking. Alcohol drinking. And tea drinking (without adjusting sleep quality for MT)

Combined effects of EMF exposure of different sources on plasma testosterone and testosterone / estradiol

Wang et al., Int Arch Occup Environ Health 2015; Chen et al., Bioelectromagnetics 2013.

Increased miscarriage incidence

The effect of occupational exposure on reproductive function mainly focused on increase of miscarriage incidence.

Abortion incidence of female workers exposed to occupational exposure

	Front Door MF Measurements as Exposure Index					Maximum Alley Measurements as Exposure Index				
Group	Subject(N)	Observation(PY)	Miscarriage(N)	CI(%)	ID(100PY)	Subject(N)	Observation(PY)	Miscarriage(N)	CI(%)	ID(100PY)
The controls	347	231.4	29	8.36	12.53	312	207.7	21	6.73	10.11
The exposed	66	45.0	8	12.12	17.78	101	68.7	16	15.84	23.29
Group A (0.1μT-0.4 μT)	46	31.0	6	13.04	19.35	67	45.3	8	11.94	17.66
Group B (0.4μT-4.2 μT)	20	14.0	2	10.00	14.28	34	13.4	8	23.53	34.19

Note: CI, cumulative incidence; ID, incidence density; PY, person years, tested by chi-square.$p<0.05$

Association of abortion Incidence of female workers exposed to occupational exposure with electromagnetic exposure factors

	Front Door MF Measurements as Exposure Index				Maximum Alley MF Measurements as Exposure Index			
Risk factors	β	SE	Hazard Ratio(95% CI)	P value	β	SE	Hazard Ratio(95% CI)	P value
Depression (yes vs no)	1.381	0.578	3.98(1.28-12.35)	0.017	1.542	0.509	4.68(1.53-14.28)	0.017
History of abnormal pregnancy (yes vs no)	2.212	0.468	9.14(3.65-22.87)	<0.001	2.103	0.475	8.19(3.23-20.19)	<0.001
Exposure to 50Hz MF (per mT increase)	0.514	0.966	1.67(0.25-11.11)	0.595[2]	0.543	0.228	1.72(1.10-2.69)	0.017

Note: β, regression coefficient; SE, standard error; exposure to 50Hz MF in the Cox regression is the measured values at the front door or in the alley in front of the subjects houses. Multivariate analysis was conducted using Cox regression analysis . [2] the front door MF exposure was retained in the model.

Wang et al., Plos One 2015; Liu et al., Report Health 2015.

Health hazard characteristics of adolescents exposed to EMF exposure

Study on association of mobile phone electromagnetic radiation with adolescent health and nervous system function

Sample size: 15148

- elementary students (11.3 years old , 2356 people)
- middle school students (14.8 years old , 9551 people)
- college students (20.1 years old , 3241 people)

Research contents:

- Epidemiological questionnaire survey
- Evaluation of health and nervous system symptoms
- Neurocognitive function assessment

Health hazard characteristics of adolescents exposed to EMF exposure

- 9-12 years old ~ self reported healthy symptoms

The highest incidence was sleep disorder (17.83%), followed by fatigue (13.94%) and dizziness (12.73%). Fatigue is significantly related to mobile phone use and length of using mobile phone.

- 13-18 years old ~ inattention hyperactivity

The occurrence of inattention hyperactivity in adolescents was significantly correlated with mobile phone use and length of using mobile phone.

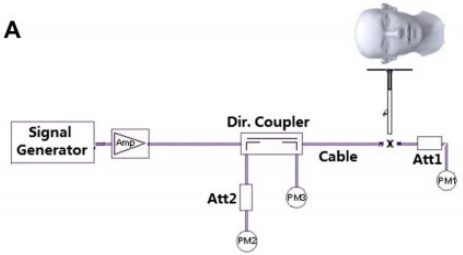
- 20-25 years old ~ media hints related self reported healthy symptoms

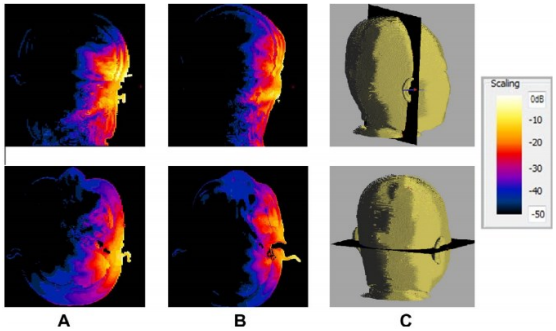
Excessive publicity of health hazards caused by electromagnetic exposure can significantly increase public concerns and uneasiness. The reporting rates of headache, fatigue, memory loss, inattention and blurred vision were higher in the EMH group than in the control group.

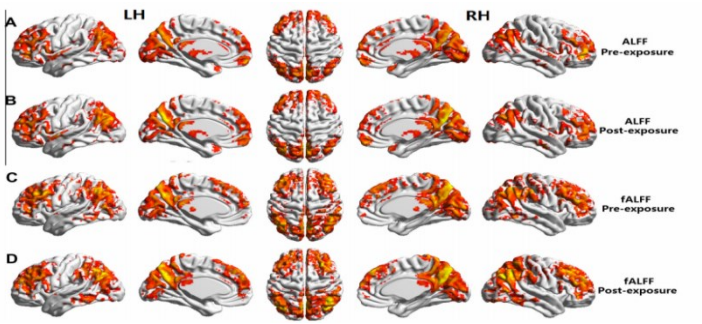
Zheng et al., BMJ Open 2015; Liu et al. Plos One 2015; Zheng et al., BMC Pubilc Health 2015; Huang et al., Plos One 2013; Zheng et al. J Epidemiol 2015

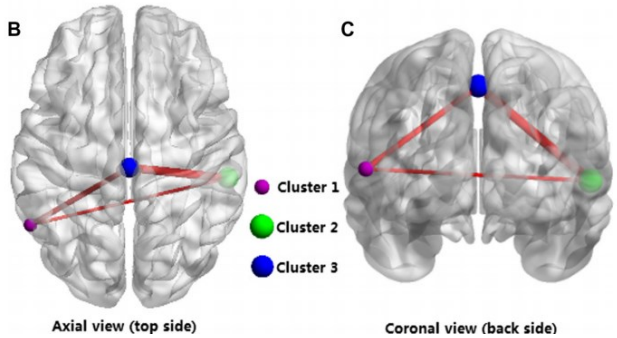
Neurological study on 3G/4G EMF exposure

30 min LTE RF-EMF exposure modulated the spontaneous low frequency fluctuations in some brain regions (12 males and 6 females)



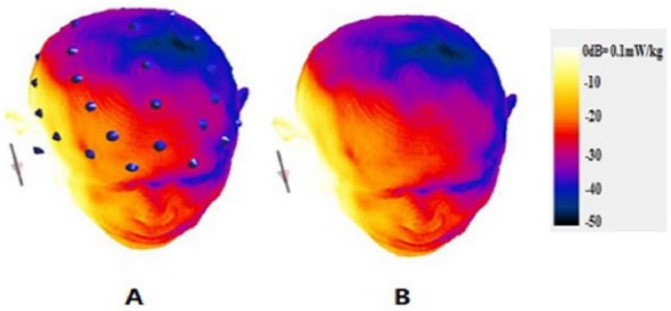


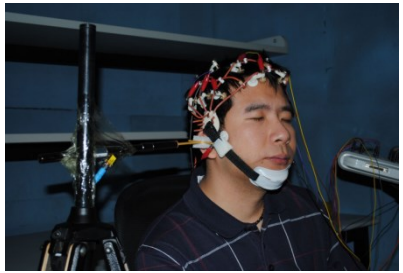




Wu et al., EMC EUROPE 2012; Lv et al., Clinical Neurophysiology 2014;

Exposure to LTE EMF reduced the spectral power and the interhemispheric coherence in the alpha and beta bands of the frontal and temporal brain regions. No significant change was observed in the spectral power and the inter-hemispheric coherence in different timeslots during and after the exposure. These findings also corroborated those of our previous study using functional magnetic resonant imaging (25 males)



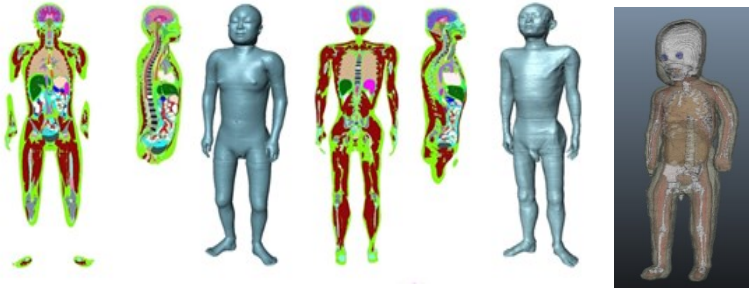


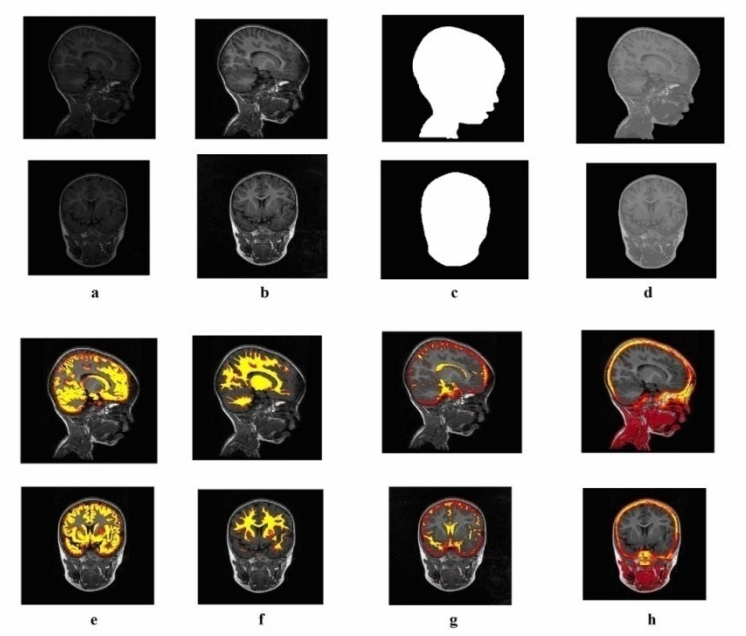
		sub1	sub2	sub3	sub4	sub5
PWR: L FR (α)	Exposure	64.12 ± 6.37	43.92 ± 8.51	49.22 ± 7.24	50.98 ± 6.23	51.22 ± 7.81
	Sham	69.54 ± 4.90	63.91 ± 7.72	64.20 ± 9.7	60.54 ± 5.52	62.82 ± 6.04
PWR: L FR (β)	Exposure	56.37 ± 7.57	42.15 ± 6.60	40.16 ± 8.61	38.38 ± 7.53	40.23 ± 6.12
	Sham	57.39 ± 9.90	54.64 ± 7.18	56.98 ± 8.12	56.79 ± 8.64	59.88 ± 9.22
PWR: R TR (β)	Exposure	78.10 ± 11.62	56.47 ± 10.69	54.99 ± 10.15	56.91 ± 9.67	54.09 ± 10.72
	Sham	74.77 ± 12.99	73.05 ± 11.55	74.93 ± 17.35	77.03 ± 10.11	76.13 ± 11.18
IHC: L-R FR (β)	Exposure	0.77 ± 0.08	0.58 ± 0.07	0.58 ± 0.07	0.51 ± 0.07	0.53 ± 0.07
	Sham	0.71 ± 0.08	0.77 ± 0.08	0.79 ± 0.09	0.75 ± 0.08	0.78 ± 0.08
IHC: L-R TR (α)	Exposure	0.87 ± 0.05	0.74 ± 0.03	0.73 ± 0.04	0.76 ± 0.03	0.73 ± 0.03
	Sham	0.88 ± 0.09	0.87 ± 0.06	0.84 ± 0.07	0.85 ± 0.08	0.86 ± 0.06

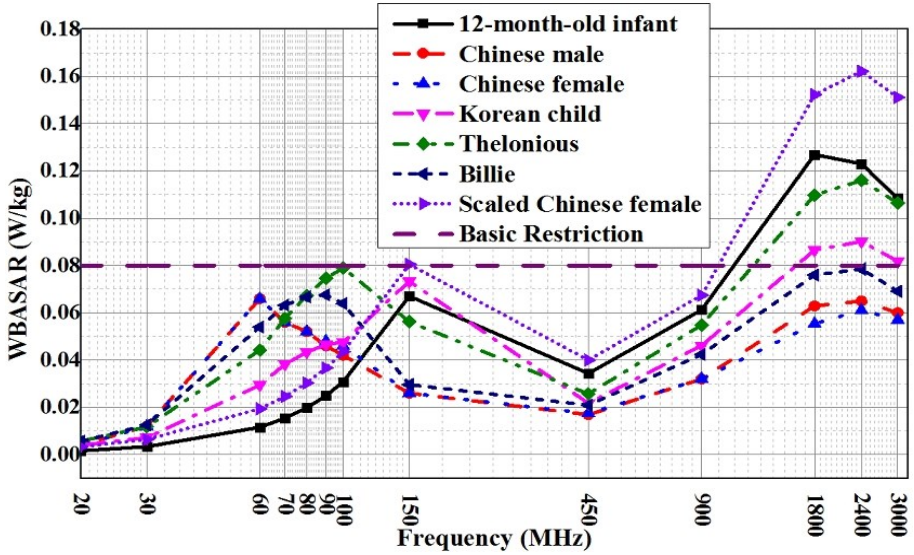
	sub1		sub2		sub3		sub4		sub5	
	t	*P*	*t*	*P*	*t*	*P*	*t*	*P*	*t*	*P*
PWR:L FR (α)	−0.48	.63	−1.91	.05	−2.20	.04	−4.44	.00	−3.03	.00
PWR: L FR (β)	−1.04	.31	2.47	.02	−2.50	.02	−3.55	.00	−2.65	.01
PWR: R TR (β)	−0.27	.79	3.92	.00	−2.49	.02	−5.15	.00	−2.06	.04
IHC: L-R FR (β)	1.61	.12	−4.04	.00	−7.81	.00	−2.91	.01	2.30	.03
IHC: L-R TR (α)	−1.39	.18	2.47	.02	−3.66	.00	−2.12	.04	2.78	.01

Yang et al., Clinical EEG and Neuroscience 2016

Human modeling and dosimetry



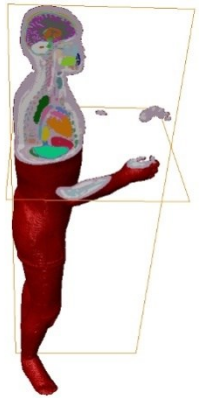


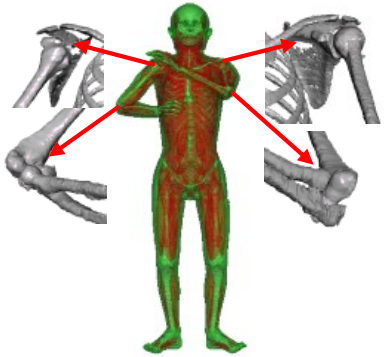


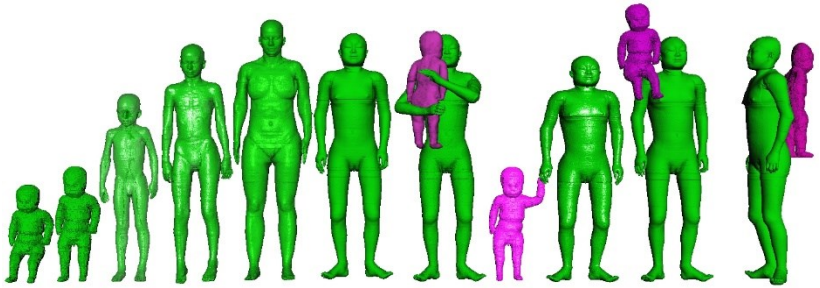
✓ Significant differences in the physical and anatomical features between adult and child models demonstrated the importance of creating realistic infant models;

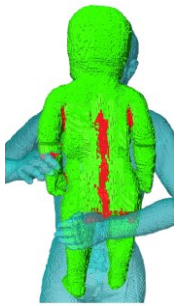
✓ Current safety guidelines for infant exposure to radiofrequency electromagnetic fields may not be conservative.

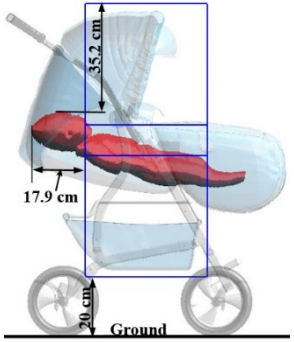
Wu et al., Phys med Biol 2011 ;Wu et al., Radiat Prot Dosim,2013a-c; Li et al., Bioelectromagnetics, 2014

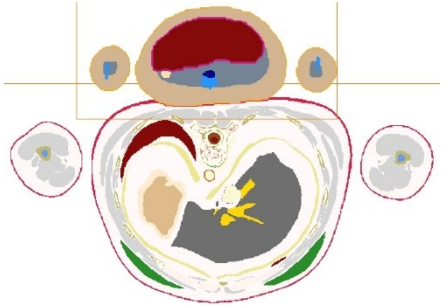


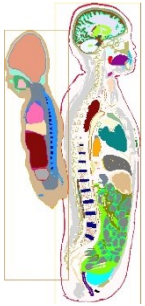












The results indicated the importance of thoroughly investigating the conservativeness of the current safety guideline for the case of skin-to-skin contact, especially, with the infants.

Li and Wu et al., Bioelectromagnetics 2015; Liu et al., Radio Science, 2017

Revision of domestic EMF standards

Major EMF standard system in China

- public environmental exposure

- **limits:** GB 8702-2014：《Controlling limitis for electromagnetic environment》
- **measurement method:**

➢ HJ/T10.2-96,《Guideline on Management of Radioactive Environmental Protection – Electromagnetic Radiation Monitoring Instruments and Methods》

➢ HJ/T10.3-96,《Guideline on Management of Radioactive Environmental Protection – Enviromental Impact Assessment Methods and standard on Electromagnetic Radiation》

- mobile product’ s near-field exposure

- **limits:** GB 21288-2007:《Limits for human local exposure to electromagnetic field emitted by mobile phones》
- **measurement method**:

➢ YD/T 1644.1-2007《Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices Human models, instrumentation, and procedure》Part1: Procedure to determine the specific absorption rate (SAR) for hand-held devices

used in close proximity to the ear(frequency range of 300 MHz~3GHz)；

➢ YD/T 1644.2-2011 part 2:Procedure to determine the specific absorption rate(SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)

Revision of GB 8702 《 Methods of Electromagnetic Radiation Monitoring for Mobile Communication Base Station 》

— Add public exposure control limits for electric and magnetic fields in the 1Hz~100kHz band ;

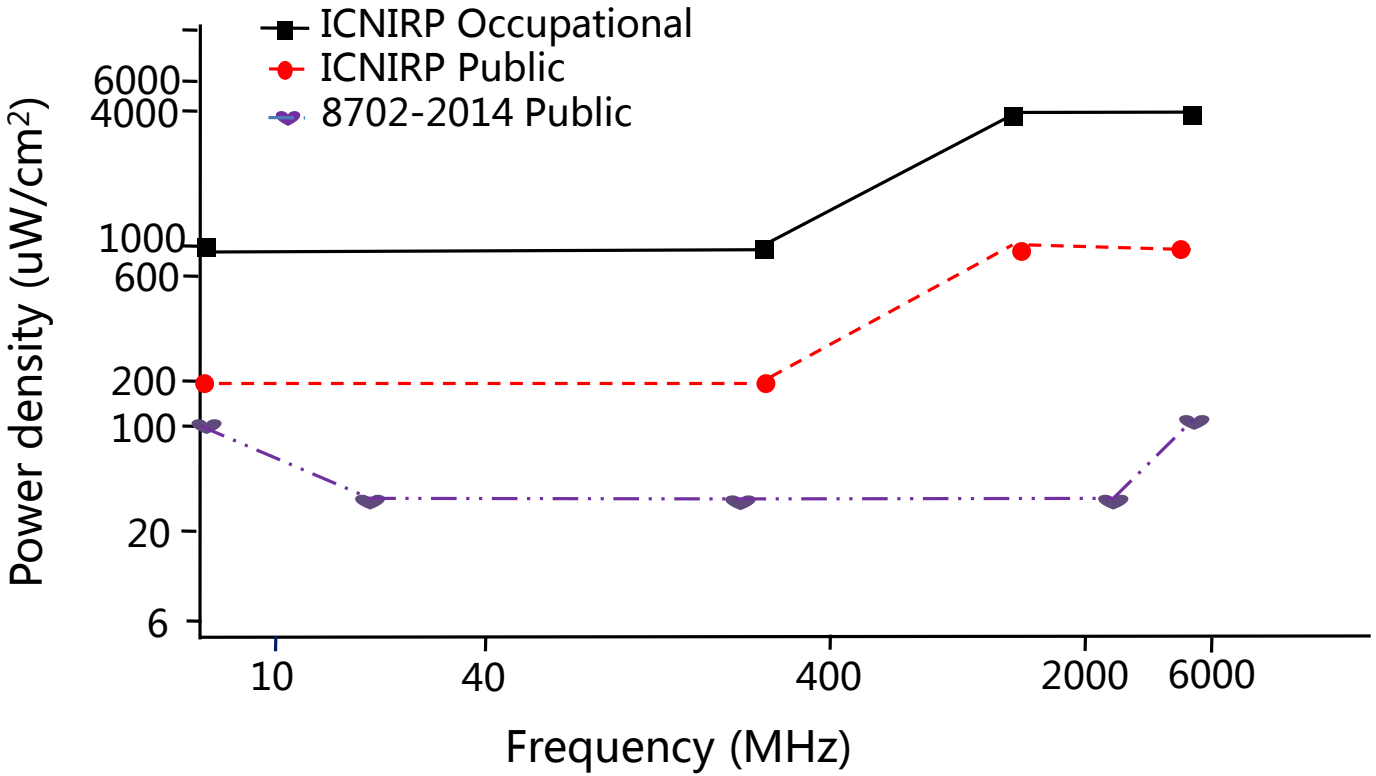
— Delete the occupational exposure limits;

— Eliminate management content requirements;

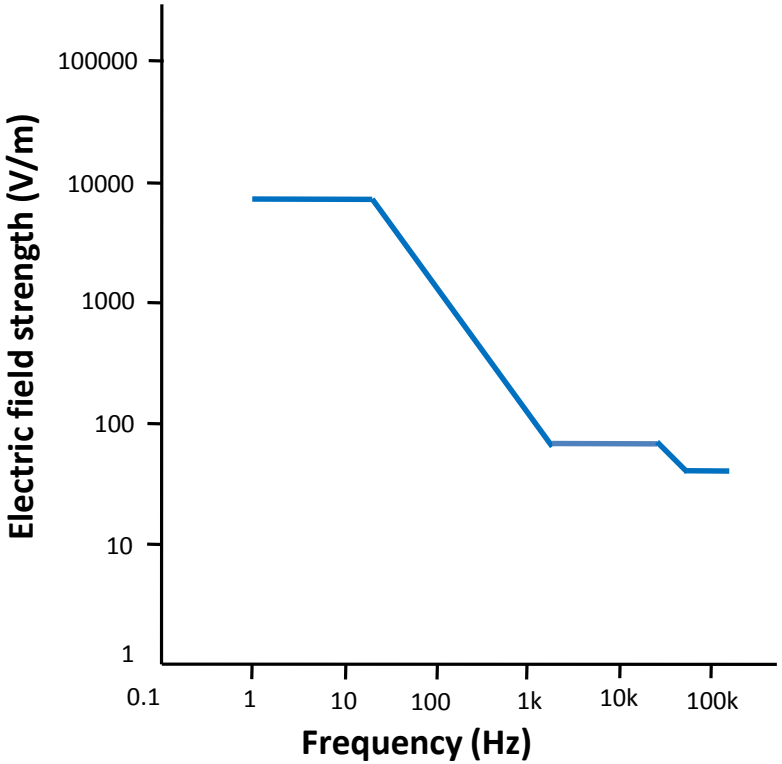
— Adjust the monitoring requirements;

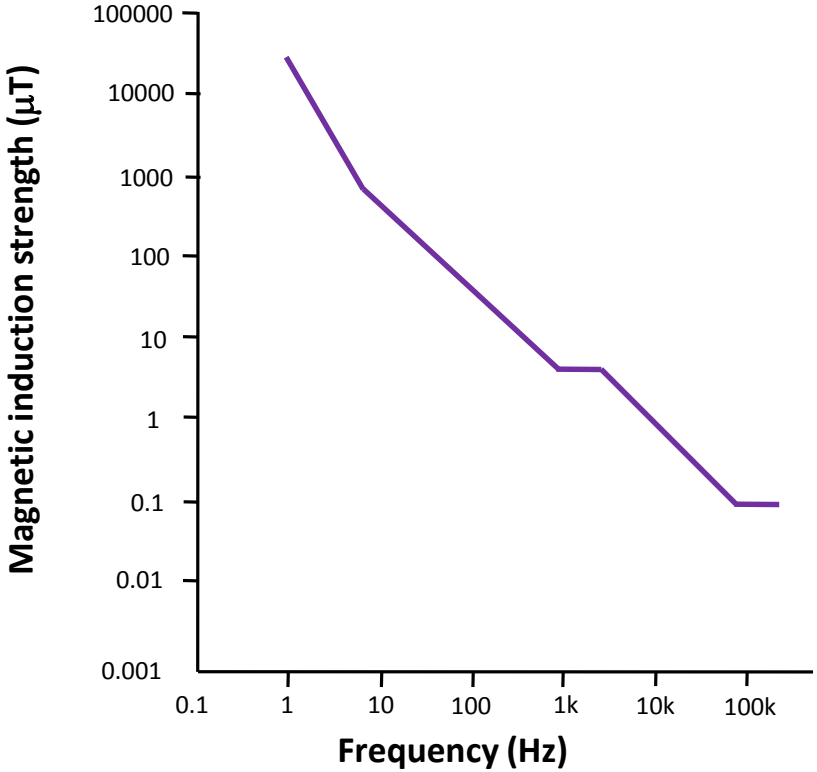
— Supplement the scope of exemption for AC transmission and transformation facilities.

Current GB 8702-2014



Current GB 8702-2014(1Hz~100kHz)





Methods of Electromagnetic Radiation Monitoring for Mobile Communication Base Station》

Compilation basis :

（1）GB 8702-2014:《Controlling limitis for electromagnetic environment》

（2）GB/T 2900.1:《Eiectrotechnicalterminology--Fundamentalterms》

（3）HJ/T10.2-96:《Guideline on Management of Radioactive Environmental Protection – Electromagnetic Radiation Monitoring Instruments and Methods》

（4）HJ/T10.3-96 ,《Guideline on Management of Radioactive Environmental Protection – Environmental Impact Assessment Methods and standard on Electromagnetic Radiation》

（5）HJ 565—2010 《Technical guideline for drafting and publishing on environmental protection standard》

（6）《Environmental monitoring regulation》（Order 39 of Ministry of Ecology and Environment)

（7）《 Regulation of revision of national environmental protection standards 》（ [2017] No.1 ）

Committee of experts on the review of nuclear and radiation safety standards of Ministry of Ecology and Environment put forward the latest amendments to the "electromagnetic radiation environment monitoring method for mobile communication base stations " in December 13th 2017 :

- **Further refine monitoring points and record requirements ;**
- **Improve data processing methods ;**
- **Add selection of electromagnetic radiation monitoring methods for non selective frequency selection and frequency selection in the compilation instructions.**

《Methods of Electromagnetic Radiation Monitoring for Mobile Communication Base Station》 revised table

chapter	Document issued by State Environmental Protection Administration[2007]No.114	Latest version
5.3 Selection of monitoring points	The monitoring points are generally located at the affected protection target within the range of 50 m with the center radius of the transmitting antenna. The monitoring points can be adjusted appropriately according to the field environment. The preferential specific point is set at the distance within public reach.	➢The scope of monitoring points is further defined, and the description of "cylindrical space" is supplemented. The position of monitoring points is modified as "the representative sensitive target of electromagnetic radiation environment which is located in cylindrical space with the ground projection point of mobile communication base station transmitting antenna as the center and the radius ". ➢In order to avoid ambiguity in the monitoring range, delete the description "appropriate adjustments can be made to the points according to the environmental conditions on the spot"。 ➢"When monitoring, the distance between the probe (antenna) and the operator's trunk is not less than 0.5m, avoid or minimize the occasional interference of other electromagnetic radiation sources around " Adjust to 5.5 sections of monitoring readings.
5.7 Data process	The maximum Emax, minimum Emin, field strength E (50%), E (80%) and E (95%) which do not exceed in 50%, 80% and 95% of the time can be counted separately according to the requirement.	➢Complement 5.7.1 unit conversion formula. , the conversion formula of electric field intensity and power density in far field is supplemented. ➢The data processing of 5.7.2 is modified and perfected according to the three situations: using non-selective broadband electromagnetic radiation monitor, using selective broadband electromagnetic radiation monitor and continuous monitoring, the data calculation formulas are given respectively, and the relevant expressions and measurement units are verified and perfected.
5. 6 Monitoring method		➢Add selection of electromagnetic radiation monitoring methods for non selective frequency selection and frequency selection in the compilation instructions ➢In the basic method, it is stipulated that "monitoring with non-selective broadband electromagnetic radiation monitor" should be used first. If the monitoring results exceed the evaluation criteria for a single project stipulated in HJ/T 10.3, then "frequency-selective electromagnetic radiation monitor should be used to measure this point.

GB 21288-2007 《Limits for human local exposure to electromagnetic fields emitted by mobile phones》

ICS 13.280
C 71

中华人民共和国国家标准

GB 21288—2007

移动电话电磁辐射局部暴露限值

Limits for human local exposure to electromagnetic fields emitted by mobile phones

2007-11-14 发布　　2008-08-01 实施

中华人民共和国国家质量监督检验检疫总局
中国国家标准化管理委员会　发布

The standard sets a public head exposure limit for electromagnetic radiation from mobile phones that emit electromagnetic waves near the human head.

Applicable to all mobile phones that provide public access to the human head at frequency of 30MHz~6GHz.

Exposure Limit: Average specific absorption (SAR) of any 10 g biological tissue and 6 min continuous exposure should not exceed 2.0 W/kg.

YD/T 1644《Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices Human models, instrumentation, and procedure》

YD/T 1644.1-2007 is basically equivalent to IEC 62209-1-2005, which specifies the specific absorption rate evaluation procedures for handheld wireless communication devices using a transmitter near the ear. It is suitable for any electromagnetic field transmitting equipment with a frequency range from 300MHz to 3GHz. This standard is only a standard for measuring electromagnetic radiation, not a standard for safety limits.

YD / T 1644.2-2011 is basically equivalent to IEC 62209-2-2010, which stipulates testing method of mobile phone for body. It is applicable for any electromagnetic field emission equipment with operating frequency ranging from 30 MHz to 6 GHz. YD/T 1644.1-2018 has been drafted and is expected to be issued by the end of 2018.

Conclusion

China applies environmental EMF limits different to the international recommendations due to the succession of the previous standards, national study results and the risk evaluation (with the future technology).

Exposure limits for mobile products complies with the international standards.

Measurement method generally complies with the international standards.

The trend is to adopt the international limits.

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Thanks!