5G Mobile Communication Base Station Electromagnetic Radiation Management Policies, Standards in China and Work Suggestions

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Abstract. The current national policies and technical requirements related to electromagnetic radiation administration of mobile communication base stations in China are described, including laws and regulations on electromagnetic radiation management, electromagnetic environmental impact assessment system for mobile communication base stations, technical standards, etc.. Based on the analysis on these laws, regulations and standards, some issues are analyzed and the work suggestions are proposed.

Keywords: Mobile Communication; Base Station; Electromagnetic Radiation; Environment Protection; Environment Impact Assessment; Technical Standard; Exposure; Limit.

1 Introduction

On June 6, 2019, China officially issued the 5G commercial licenses and began the construction of 5G commercial base stations (acronym for BS). As of the end of September 2023, the total number of 5G BS had reached 3.189 million, with an annual average of nearly 800,000 new 5G BS and 22.6 5G BS per 10000 people. Over 90% of 5G BS have achieved co- construction and sharing, and 5G networks are accelerating their development towards intensive, efficient, green, and low-carbon [1]. At the same time, this period is also an important stage when the Chinese government and people increasingly pay more attention to ecological environmental protection and green development. The scientific and effective management of the impact of electromagnetic radiation (acronym for EMR) from BS on the environment has become one of the important tasks of government regulatory departments. In addition, the people's attention to EMR from BS is also increasing, and there is an urgent need for legal, scientific and reasonable response measures [2,3]. Moreover, the rapid development of mobile communication industry and the rapid increase of various wireless service applications have also led to more and more complex for the management of radio spectrum resources, especially for the increasingly management of radio interference, which has also promoted the systematic development of EMR management of BS [4,5].

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Based on the above background, in order to solve the contradiction between the rapid construction of communication BS and the management of EMR environmental impact assessment (acronym for EIA) of BS, the country has introduced a series of corresponding laws and regulations in recent years. The basic idea is to simplify the procedures and replace the pre-accident supervision to strengthen the post accident supervision, support the acceleration of BS construction from the top-level planning level, and achieve comprehensive and effective management of electromagnetic EIA work of BS. Thus, the mutual promotion and development between the mobile communication industry and the ecological environment protection industry can be achieved. However, monitoring and management, standard formulation, and technical research in this area are still in the developing stage, and further research and investigation are needed. This article also provides work suggestions in this regard.

2 Laws

2.1 Environmental Protection Law of China

The new version of the Environmental Protection Law of China (hereinafter referred to the "Environmental Protection Law"), which was implemented on January 1, 2015, is the top level important law for the management of EMR in China [6].

The Environmental Protection Law regulates that construction of projects that have an impact on the environment should be subject to EIA in accordance with the law, otherwise construction cannot be started; Companies that discharging pollutants shall take measures to prevent and control environmental pollution and hazards, including EMR, generated in production, construction, or other activities.

Citizens, companies, and other organizations have the right to obtain environmental information, participate in monitoring, and supervise environmental protection according to the law.

If a construction corporation fails to submit the EIA documents of a construction project according to the law or starts construction without approval, the environmental protection supervision and management department shall order it to stop construction, impose a fine, and may also order it to restore to its original state.

2.2 Environmental Impact Assessment Law of China

The Environmental Impact Assessment Law of China (hereinafter referred to as the "EIA Law") was revised and implemented on December 29, 2018 [7].

The term "EIA" as used in the EIA Law refers to a method and system for analyzing, predicting, and evaluating the environmental impacts that may occur after the implementation of planning and construction projects, proposing countermeasures and measures to prevent or mitigate adverse environmental impacts, and conducting follow-up monitoring. EIA is divided into planning EIA and construction project EIA.

According to the EIA Law of China, the state implements classified management for the EIA of construction projects based on their impact extent on the environment.

The construction corporation shall, in accordance with the following provisions, organize the preparation of an environmental impact statement book, environmental impact statement form, or fill in and submit an environmental impact registration form (acronym for EIRF). The 3 modes are collectively referred to as the EIA documents:

1) Where significant environmental impacts may be caused, an environmental impact statement shall be prepared to comprehensively evaluate the environmental impacts generated;

2) If it may cause slight environmental impact, an environmental impact statement form shall be prepared to analyze or specially evaluate the environmental impact generated;

3) If the environmental impact is small and there is no need to conduct an EIA, an EIRF should be filled in and submitted.

The classified management directory for EIA of construction projects shall be formulated and published by the competent ecology and environment department of the State Council, i.e., Ministry of Ecology and Environment of China (abbreviated as MEE).

The content and format of the environmental impact statement form and the EIRF shall be formulated by the MEE. The state implements filing management for EIRF.

The EIA Law also regulates that the construction corporation shall not commence construction if the EIA documents of a construction project have not been reviewed by the approval department according to the law or have not been approved after review.

In the event of non-compliance with the approved EIA documents during project construction and operation, the construction corporation shall organize a post assessment of the environmental impact, take improvement measures, and report to the original EIA document approval department and the construction project approval department for filing.

The original EIA document approval department may also instruct the construction corporation to conduct a post assessment of the environmental impact and take improvement measures.

The competent ecology and environment department shall track and inspect the environmental impact of a construction project after it is put into production or use. If serious environmental pollution or ecological damage is caused, it shall identify the causes and responsibilities.

If the construction corporation fails to file the EIRF for the construction project according to the law, the competent ecology and environment department at or above the county level shall order the filing and impose a fine.

3 Regulations of the State Administrative Department

3.1 Environmental Monitoring Management Measures

The "Environmental Monitoring Management Measures" is the Decree No. 39 of the State Environmental Protection Administration 2007, which came into effect on September 1, 2007, mainly regulates the general management system for environmental protection departments to carry out environmental monitoring activities such as environmental quality monitoring and pollution source monitoring [8].

3.2 Regulations on Radio Administration of China

The Regulations on Radio Administration of China, were revised and implemented in December 2016 [9].

The article 35 of the Regulations stipulates that "for the establishment of large-scale wireless radio stations (stations) and ground public mobile communication BS, their station layout planning shall comply with the requirements of resource sharing and electromagnetic environmental (acronym for EME) protection".

The article 40 of the Regulations stipulates that "units or individuals using radio stations shall obey the national environmental protection regulations and take necessary measures to prevent EMR pollution caused by radio wave emissions.

3.3 Environmental Protection Memorandum for Communication Base Stations

The Environmental Protection Office radiation Memorandum, i.e., Environmental Protection Office radiation document [2017] No. 1990 (hereinafter referred to as the “Memorandum”), had been jointly signed by the formerly Ministry of Ecological Protection (Now MEE), the Ministry of Industry and Information Technology (abbreviated as MIIT), the four telecommunication operators (China Telecom, China Unicom, China Mobile, and China Broadcast Network) and the China Tower on October 26, 2017, stipulating that the construction of communication BS in China should be carried out in accordance with the Memorandum [10].

The Memorandum specifies the responsibilities of every parties, i.e., the 4 operators and the China Tower, monitoring labs, supervision organizations and the public, in different stages, e.g., before put on record, monitoring and information disclosure, as well as the requirements of popular science propaganda and complaints management. See Figure 1 for the program and the division of labour.

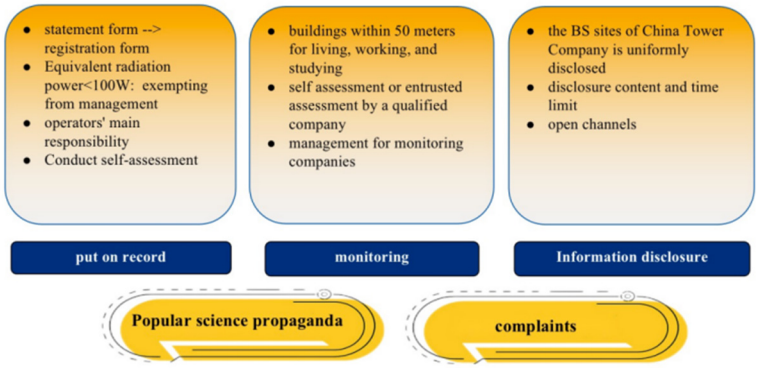

Figure 1 the responsibilities specified by the Memorandum

According to the Memorandum, the EIA of the construction of mobile communication BS should be conducted in the form of an EIRF, in accordance with GB8702-2014.

As soon as possible after putting into operation, monitoring should be carried out by themselves or entrusted organizations which have certified by China Inspection Body and Laboratory Mandatory Approval (abbreviated as CMA) according to law in accordance with the "HJ 1151-

2020 Mobile Communication Base Station Electromagnetic Radiation Environmental Monitoring Method (Trial)".

The Memorandum also reached consensus on information disclosure, popular science promotion, complaints, and cooperation mechanisms.

The four operators must compile internal management documents based on the actual situation of the company and the Memorandum to further implement the EMR environmental monitoring measures for communication BS.

The China Tower company is required to build a BS EMR environmental monitoring information disclosure platform.

3.4 Classified Management Directory for Environmental Impact Assessment of Construction Projects

The new version of the "Classified Management Directory for Environmental Impact Assessment of Construction Projects (2021 Edition)" came into effect on January 1, 2021 [11].

This management directory adjusts the classification of EIA of communication BS into EIRF, and implements record management in accordance with the "Administrative Measures for the Filing of EIRF of Construction Projects" as next chapter.

3.5 Administrative Measures for the Filing of Environmental Impact Registration Forms for Construction Projects

The filing management measures came into effect on January 1, 2017, stipulating that the EIRF of construction projects should be filed online, and the MEE should uniformly establish an online filing system for the EIRF of construction projects [12].

Before the construction project is completed and put into production and operation, the construction corporation should log into the online filing system, register real information in the online filing system, fill in and submit the EIRF of the construction project online.

After the construction corporation submits the EIRF online, the online filing system automatically generates a filing number and receipt. The filing of the EIRF for the construction project is complete.

The construction corporation can print and retain the completed EIRF for the construction project and the filing receipt of the EIRF for the construction project.

The filing receipt of the EIRF of a construction project is a proof that the competent environmental protection department has confirmed the receipt of the EIRF of the construction corporation.

After the completion of the filing of the EIRF for the construction project, the county environmental protection department shall synchronously disclose the filing information to the public through the online filing system on its website and accept public supervision. The competent environmental protection department or other departments responsible for environmental protection supervision and management may conduct supervision and inspection on the compliance of the construction corporation with the provisions of these

measures by means of spot checks, inspections based on reports, etc. A template of the EIRF for the construction project is provided.

4 Technical Standards

4.1 National Standards

1) GB8702-2014 Controlling limits for electromagnetic environment

GB8702 specifies the control limits for the EME, and the limits for public exposure to the mobile communication frequency bands are shown on table 1 and Figure 2 [13].

Table1 Public exposure limits for EMR from Mobile Communications in China

Frequency Range (MHz)	Electric Intensity *E* (V/m)	Magnetic Field Intensity *H* (A/m)	Magnetic Induction *B* (μT)	Plane Wave Equivalent Power Density *S* (W/m^2)
30-3000	12	0.032	0.04	0.4
3000-15000	$0.22f^{1/2}$	$0.00059f^{1/2}$	$0.00074f^{1/2}$	f/7500
15 000-300 000	27	0.073	0.092	2

The plane wave equivalent power density limit for the 900 MHz/1800 MHz mobile communication frequency bands is 40 μW/cm^2.

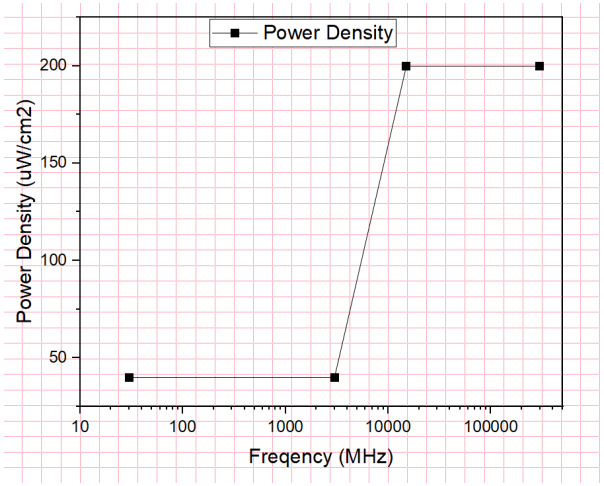

Figure 2 GB8702 limits diagrammatic presentation

The table 2 is the comparison between the Chinese national standard GB8702-2014 and other typical EMR limit standards in the world, i.e., ICNIRP-2020 and IEEE C95.1™-2019. The ICNIRP limit standards are adopted by many countries and regions in the world, followed by the standard limits of the IEEE system. By comparison, China's limits are very strict.

Table 2 Comparison of Typical EMR Limit Standards between China and the World

Countries and organizations, conditions	900MHz mobile telecom ($\mu W/cm^2$)	1800MHz mobile telecom ($\mu W/cm^2$)	2600 MHz	3500 MHz	4900 MHz
China GB8702-2014	40	40	40	46.7	65.3
International Committee on Non-Ionizing Radiation ICNIRP-2020, 30 minutes RMS average, whole	450	900	1000	1000	1000
America, Canada, IEEE C95.1™-2019, 30minutes RMS average, whole	450	900	1000	1000	1000

2) GB21288-2022 Limits for human local exposure to electromagnetic fields emitted by mobile phones

GB21288 stipulates that the average specific absorption rate (SAR) of a mobile phone to any 10 g of biological tissue for any continuous 6 minutes shall not exceed 2.0 W/kg [14].

4.2 Industry Standards

Currently, various industry standards that have been issued and effective are mainly formulated by MEE and MIIT. The typical list is as following. These standards specifically describe the technical management requirements and methods for various aspects of EMR from mobile communication BS.

1) HJ1151-2020 Monitoring method for electromagnetic radiation environment of 5G mobile communication base station (Trial).

2) HJ 972-2018 Monitoring method for electromagnetic radiation environment of mobile communication base station (Formerly Document No. 114).

3) HJ/T 10.2-1996 Guideline on Management of Radioactive Environmental Protection - Electromagnetic Radiation Monitoring Instruments and Methods.

4) HJ/T 10.3-1996 Guideline on Management of Radioactive Environmental Protection - Environmental Impact Assessment Methods and standards on Electromagnetic Radiation.

5) YD/T 3137-2016 Evaluation Method for Compliance with Basic Limits of Electromagnetic Fields (10MHz to 300GHz) Exposure to Human Beings for Low Power Electronic and Electrical Equipment.

6) YD/T 2830-2015 Technical Requirements for Electromagnetic Radiation Online Monitoring System.

7) YD/T 3026-2016 Technical Requirements for Electromagnetic Radiation Management of Communication Base Stations.

8) YD/T 2196-2010 General Requirements for Electromagnetic Protection Safety Management of Communication Systems.

9) YD/T 2192-2010 Electromagnetic Radiation Mitigation Technology around Communication Base Stations.

10) YD/T 3731-2020 Radio Frequency Electromagnetic Field Measurement and Compliance Determination of Human Exposure Limits for Operating Base Stations.

The HJ series standards are mainly released by MEE, and the YD series ones are mainly released by MIIT. From the view of technical details, the HJ series have the emphases on the general requirements, i.e., have relatively small distinguish treatments on different communication technologies features and the differences of each others. For an example, 5G with MIMO smart antennas have the beam-forming technology and the power density at specific points always alters with the terminal users location distribution and transmission services types, which is obvious different from the other generation communication technologies without smart antennas. In contrast, the YD series have some more focuses on measurement and computation technologies details considerations and so are more suitable for the accurate and comprehensive measurements. But now commonly, the legal regular tests are according to the HJ series standards, and the YD ones are only as reference methods and mainly used in research.

5 Work Suggestions

China has established a relatively complete legal and regulatory system, as well as corresponding specific management measures. The main contents include: firstly, require the current EIA of communication BS to implement filing management in accordance with the "Filing Management Measures"; Secondly, according to GB8702-2014, as soon as the BS are put into operation, it shall be monitored by itself or by a legally accredited monitoring institution in accordance with the HJ1151-2020; The third is that the Memorandum stipulates requirements for the information disclosure related to BS radiation, science popularization and publicity, letters and complaints, cooperation mechanisms, and internal management documents of each company. These systems and standards have played a decisive guiding role on the management of BS EMR, and will promote the coordinated development of mobile communication industry and the EMR ecological environment of BS in China.

However, during the research, it was found that there are still some urgent issues that need to be addressed in the specific management of EMR EIA for BS, such as monitoring management, standard formulation, and technical research, etc..

One is the issue of limits, which are many times stricter than general international limits. It causes China to have to build a large number of low-power stations to reduce the radiation of a single station when building BS. However, this requires the construction of more stations to ensure coverage. This has greatly increased the cost of 5G construction in China. It is suggested to urgently strengthen research and investigation, and establish more scientific and reasonable limits that are more in line with the common development of the every parties' undertakings.

The second is a technical issue, as the monitoring method is not conducive to the test of smart antennas. 5G BS widely use Massive MIMO technology, one of the characteristics of which is intelligent beam forming. Compared to non intelligent antennas with uniform coverage, the radiation power of smart antennas will intelligently increase the radiation power of the user's

area and reduce the power of other areas based on the distribution of users, resulting in higher short-term and local power in the user's area, but lower overall average power actually. For this reason, it is recommended to use a specialized radiation evaluation method for smart antennas, which is based on the statistical conservative approach, e.g., binomial cumulative distribution algorithm, to evaluate the EMR of 5G BS [15].

The third issue is monitoring implementation management issue. Due to factors such as heavy workload, tight time, and high costs, a small number of monitoring institutions have been found to have violated laboratory quality management requirements and specific management regulations during monitoring. It is recommended to balance various factors, make a good work plan and strengthen supervision.

The fourth issue is public supervision. There is still a knowledge and information gap between the administrative departments, professional departments, and the general public, which brings difficulties in dispute resolution. Suggest strengthening communication between departments, especially practical experience exchange; Strengthen publicity, education, and science popularization for the public, and call for more public participation in regulatory authorities and third-party random inspections.

6 Conclusions

In recent years, the communication industry and the ecological and environmental protection industry have closely cooperated, planning a comprehensive top-level design mode to accelerate the coordinated development between the construction of mobile communication BS and the EMR EIA of BS, providing strong support for the harmonious progress of the two sides. At the same time, there are still some issues in specific management implementation, technology, and standards that require joint efforts and active cooperation within and between industries, as well as broad public participation, to gradually solve various problems and strive for further scientific, balanced, and effective development.

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References

[1]The State Council Information Office of China (SCIO). (20-10-2023) SCIO briefing on development of industry and information technology in first three quarters of 2023. http://english.scio.gov.cn/pressroom/2023-10/31/content_116785805.htm.

[2]Anqiong Zou. Evolutionary game and analysis of stakeholder stragegy in 5G base station construction conflict. Southwest Jiaotong University Master Degree Thesis. 2021.7.

[3]Haizhu Zhang. Risk construction, opportunity structures, and the logic of NIMBY protest caused by technological risk: taking the anti-base station incident of H community in Qingdao as a case. Public Administration and Policy Review. 2021.10. pp.31-44.

[4]Guoqing Li, Yan Zhang, Denian Shi, Bo Liu. The current states and development trends of base stations electromagnetic radiation environment impact assessment in China. Telecommunications World. 2016, vol.1, pp.56-62.
[5]Guoqing Li, Denian Shi, Bo Liu. The current states of base station electromagnetic radiation envrionment impact assessment in China and the work suggestions. Modern Science & Technology of telecommunications. 2015.8. pp.34-40.
[6]Environmental Protection Law of China.China Human Resources & Social Security Publishing Group Co.,Ltd. 2015.
[7]Environmental Impact Assessment Law of China. China Democracy and Rule of Law Publishing House. 2022.6.
[8]Ministry of Ecology and Environment of China. (2007.7.25) Environmental Monitoring Management Measures. https://www.mee.gov.cn/gkml/zj/jl/200910/t20091022_171846.htm.
[9]The State Radio Monitoring center Testing Center. (2016.11.28) Regulations of China on Radio Administration. http://www.srrc.org.cn/2017/tiaoli/tiaoli.aspx.
[10]Ministry of Ecology and Environment of China. Environmental Protection Memorandum for Communication Base Stations. 2017.12.20. unpublised.
[11]Ministry of Ecology and Environment of China. (2020-11-30) Classified Management Directory for Environmental Impact Assessment of Construction Projects. https://www.mee.gov.cn/xxgk2018/xxgk/xxgk02/202012/t20201202_811053.html.
[12]Ministry of Ecology and Environment of China. (2016-11-16) Administrative Measures for the Filing of Environmental Impact Registration Forms for Construction Projects. https://www.mee.gov.cn/gzk/gz/202112/t20211211_963797.shtml.
[13]GB8702-2014 Controlling limits for electromagnetic environment. 2014.9.23.
[14]GB21288-2022 Limits for human local exposure to electromagnetic fields emitted by mobile phones. 2022.12.29.
[15]IEC 62232-2022. Determination of RF field strength, power density and SAR in the vicinity of base stations for the purpose of evaluating human exposure.2022.10.