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## Solutions to non-radio equipment radiating radio waves interference in the regular radio communication services

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### ABSTRACT

As Chinese economy and society developed, radio communication technologies have also developed. Various kinds of radio equipments have increasingly more functions and changed from items for special use to common equipments that have integrated into people's daily life. But everything has two sides. The great boost of radio technologies has brought a series of problems. The issue of non-radio equipment radiating radio waves' interference in regular radio communication services is getting more severe. In order to maximize the conveniences the radio communication brought to us, it's urgent to find the solution to non-radio equipment radiating radio waves' interference in regular radio communication services, which is also the key of this thesis. Starting from the definition of non-radio equipment radiating radio waves, this thesis presented a detailed research of how the interference was produced, such as co-channel interference, adjacent channel interference, intermodulation interference and radiated radio interference from non-radio equipment itself. Then this thesis provided effective solutions, such as all radio regulatory organs can work with departments of quality supervision, inspection and quarantine, departments of industry and commerce and the customs departments; radio regulatory organs can also participate in setting the standards, bring in more talents, work harder on research and development and provide support on theories for the researchers.

### KEYWORDS

Radiated radio waves; Interference caused by non-radio equipment; Radio communication; Solutions.

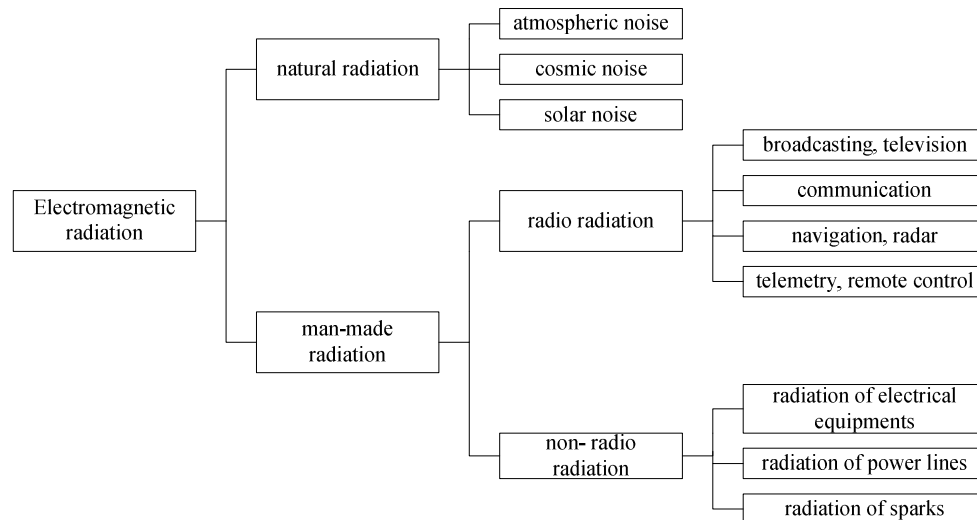


## INTRODUCTION

*Regulations of the People's Republic of China on the Management of Radio Operation* has given specific instructions about the management of non-radio equipment radiating radio waves. However, some relative facts and the radio regulatory organs' long experience showed that there are many urgent problems in the management of non-radio equipment radiating radio waves' interference in regular radio communication services. Non-radio equipments generate electromagnetic radiation when they're in use, which influence the surrounding electronic devices. Since radiated radio waves are invisible to human eyes, they have always been neglected by people. Non-radio equipments bring conveniences to our life and work in a sense. But they also have the characteristics of high output, strong radiation, concentrated energy and highly destructive and these characteristics cause interference in radio communication services and even make them out of order<sup>[1]</sup>. Non-radio equipments can also cause malfunction or automatic explosion of military devices, spontaneous combustion or explosion of volatile matters, unclear images on TV or interrupted broadcast. As modernization drive develops, the use of radio communication gets more common. It's necessary to eliminate non-radio equipment radiating radio waves' interference in regular radio communication services to ensure the good function of radio communication.

## THE DEFINITION OF AND CHARACTERISTICS OF NON-RADIO EQUIPMENT RADIATING RADIO WAVES

*Regulations of the People's Republic of China on the Management of Radio Operation* and other documents concerning radio equipment just gave vague descriptions on non-radio equipment radiating radio waves and radio equipment, not specific definitions and characteristics. To clearly demonstrate the differences of them, Figure 1 presents a general diagram of non-radio equipment radiating radio waves.



**Figure 1 : The diagram of electromagnetic radiation**

It's easy to conclude the characteristics of non-radio equipment radiating radio waves from chart 1. First, it includes various kinds and has been put into use in many fields, covering all aspects of people's life. Second, the range of radio radiation is small than that of non-radio radiation. And their radiation fields are also different. Third, despite other factors, non-radio equipment's interference in radio communication is closely linked to its installation and use. In a deep sense, radio waves are the bridge in radio communication system. To put it in simple words, non-radio equipment's interference in radio communication system is the radio channel got influenced. Radio frequency spectrum is the total of all radio waves and is renewable shared resources. Different from nonrenewable resources like water or minerals, radio frequency spectrum can be repeatedly used and is inexhaustible. Since radio waves' transmission cannot be controlled by people or regions and they are common resources, it's an urgent task to management them systematically and scientifically. Radio frequency spectrum has the characteristics of exclusiveness. It means one radio frequency can only be used by one radio communication system at one time in one place. If other things happen, radio communication will be influenced<sup>[2]</sup>. Chart 1 also suggests electromagnetic radiation sometimes can be influenced by natural radiation. Therefore it should be taken into consideration when tackling non-radio equipment's interference in radio communication to arrange protective management to radio communication.

## THE PROCESS OF NON-RADIO EQUIPMENT RADIATING RADIO WAVES' INTERFERENCE IN REGULAR RADIO COMMUNICATION SERVICES

### Co-channel interference

As Figure 2 indicates, co-channel interference refers to the fact that when a carrier frequency is identical to the desired signals' carrier frequency and comes into the undesired signals within the pass band of the receiver in the same way,

causes interference and makes radio communication out of order<sup>[3]</sup>. Sometimes the resources of radio frequency spectrum are repeatedly used to improve the utilizing rate of radio communication's frequencies. If the distance wasn't properly handled, interference would occur. More powerful the interference is, more influences it causes to radio communication. It even can cause blocking interference to the receiver. Co-channel interference is not caused by equipment damage or malfunction but is closely linked to the region it is in or artificial factors. For example, illegal high-power mobile phones can have access to communication frequency without any means, whose interference in radio communication is direct and the most powerful. And wireless video surveillance system sometimes causes interference to radio communication and produce noises and even make it out of order.

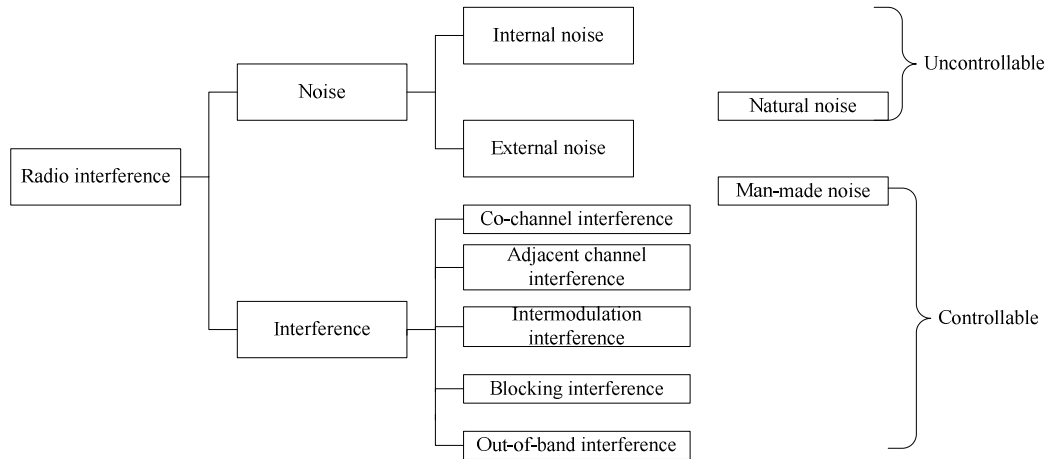


Figure 2 : The categories of radio interference

**Adjacent channel interference**

As Figure 2 suggests, adjacent channel interference refers to the mutual interference of adjacent channels and is mostly caused by the poor selection of the receiver or the excessive frequencies of the sender and broad channels. The former one is easy to tackle, which is to improve the selection of the receiver. The latter is more difficult and can only be dealt with by limiting the channels and frequencies. Mostly, adjacent channel interference is caused by aged receiver and some damaged parts. In general, such cases are rare but possible. There are regulations specifying the standard distance of adjacent channels, which is the foundation of proper use of radio communication.

**Intermodulation interference**

As Figure 2 suggests, intermodulation interference refers to the fact when two or more frequency signals simultaneously enter into the sender or the receiver and since circuit is not linear, a third frequency is generated (which is the intermodulation frequency) and the intermodulation frequency happens to match the frequency of a certain receiver and thus causes interference to this frequency<sup>[4]</sup>. It's difficult to fundamentally tackle this problem but the influences can be reduced through some means. First, the distance between antennas needs to be properly arranged to increase the coupler loss between digital channels. Second, the radio signals from the sender need to be handled; the receiver's selection needs to be improved and means such as improving the linearity of the equipment to make intermodulation proportion of the two channels reach the balance.

**The radiation interference of non-radio equipment itself**

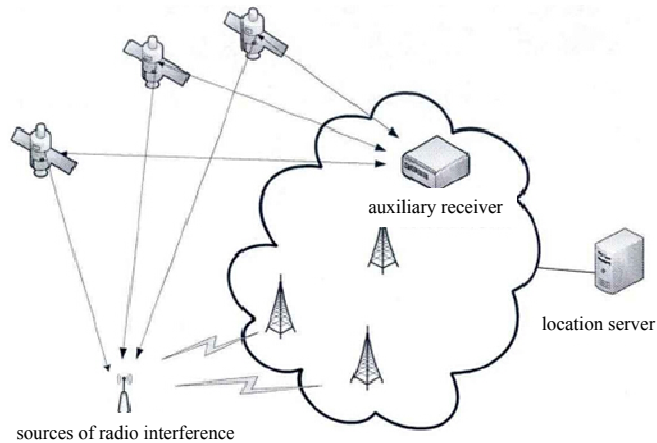
TABLE 1 shows the interference caused by all kinds of equipments to radio communication. Radio equipments generate radio waves when they are in use and therefore influence radio stations. Situations like this are called radiated interference caused by non-radio equipment. There are various kinds of non-radio equipments: high frequency furnaces, heat sealing machines, high-voltage lines, which are used in industrial production; motorbikes and electric bicycles; high frequency equipments and X-ray machines, which are medical apparatus<sup>[5]</sup>. Amongst all these equipments, illuminating appliances and similar equipments account for the largest proportion and industrial, scientific and medical apparatus or installations account for the smallest.

TABLE 1 : All kinds of apparatus or equipments' interference in radio communication services

Information technology apparatus	26%
Illuminating appliances and other similar apparatus	27%
Industrial, scientific and medical apparatus or installations	27%
Control devices of audio, video, audio and video clips and lighting in recreation places	13%
Other kinds of non-radio equipment radiating radio waves	7%

## IDENTIFYING SOURCES OF RADIO INTERFERENCE FROM NON-RADIO EQUIPMENT RADIATING RADIO WAVES

### Analyzing the characteristics of the sources of radio interference and identifying the sources



**Figure 4 : Diagram of indentifying sources of radio interference from non-radio equipments**

Figure 4 is the diagram of indentifying sources of radio interference from non-radio equipments. The primary task is to collect sources of radio interference and know about their characteristics. Then through observing or measuring the parameters of the sources or demodulating contents of monitoring signals, to identify sources of radio interference and create conditions for accurate location. Measuring the parameters of the signals should start from signal frequencies, ranges and time and find out which types or services they belong to in order to tackle the problem based on the realities. Besides, regular signals have their own characteristics and clear regulations on frequency offset and occupied bandwidth. Comparing out-of-band radiation to regular signals, the signal intensity of the former weakens as frequency offset increases and bandwidth would be obviously excessive<sup>[6]</sup>. For example, the characteristics of spurious emission signals can be deduced, with unstable bandwidth and unclear service characteristics. Although due to the intermittent emissions of mobile equipments and unstable location of sources of radio interference, the exact location cannot be discovered. But by monitoring analog signals, useful information can be obtained to trace the user of the equipment and eventually identify sources of radio interference, which lay the foundation for the proper use of radio communication.

### Differentiating the types of antennas and analyzing signal transmission path

Generally, sources of high-power radiation set antennas in high or obvious places to enlarge the radiation range. During identifying sources of radio interference, if it reaches the territory of the sources, it's helpful to search for the transmitting antenna of the service in order to speed up the research. For example, omni-directional high-gain antenna is usually used in cluster service and paging service and plate-like antenna and coaxial collinear antenna are usually used in mobile communication system like mobile phones and Personal Handphone System<sup>[7]</sup>. If the situation is complicated, signal transmission path should be clearly identified and differentiated signal and direct signal should be compared to avoid influencing the whole process.

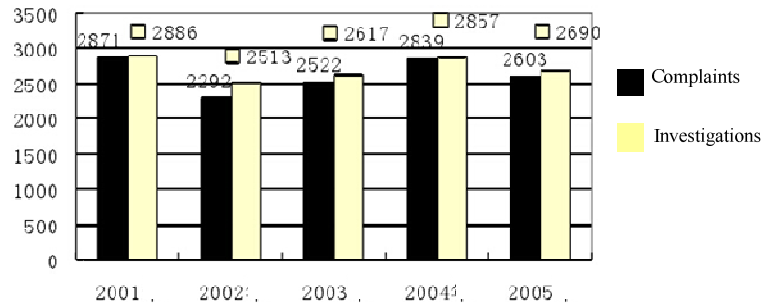
## SOLUTIONS TO NON-RADIO EQUIPMENT RADIATING RADIO WAVES' INTERFERENCE IN THE REGULAR RADIO COMMUNICATION SERVICES

Currently, as information technology develops, radio services has been closely linked to people's life and work and it's playing an increasingly important role. With more and more non-radio equipments being put into use in various fields and non-radio equipment radiating radio waves being the primary sources of radio communication services, the management of radio communication services is both a challenge and a new development opportunity. The interference mentioned above is of various kinds and caused by various reasons, but it's all directly linked to frequency, sites and equipment properties. Besides, it needs joint efforts of various departments like design departments and manufacturing departments to prevent such issues. Therefore, the solutions to non-radio equipment radiating radio waves' interference in the regular radio communication services are:

### All radio regulatory organs should work with departments of quality supervision, inspection and quarantine, departments of industry and commerce and the customs departments

Figure 5 shows the complaints and investigations of non-radio equipment radiating radio waves' interference in the regular radio communication services in 2001-2005. It's necessary for radio regulatory organs to collect statistics of non-radio equipment radiating radio waves within their own territory and make relative development plans. They also can

establish database of equipment manufacturing, quality supervision and inspection to ensure all the information can be dealt with in a systematic and scientific way, so as to create favorable conditions for tackling non-radio equipment radiating radio waves' interference in the regular radio communication services. What's more, the punishment for shoddy non-radio equipments should become more severe and relative regulations should be made to let the public realize the damages of non-radio equipment radiating radio waves' interference in the regular radio communication services. Whoever, individual or groups, uses radio frequency or channel without any permission will take the responsibilities for doing so.



**Figure 5 : Complaints and investigations of non-radio equipment radiating radio waves' interference in the regular radio communication services in 2001-2005**

### **Radio regulatory organs should make more engagement in making standards for the manufacturing of non-radio equipments**

When the central radio regulatory organ makes the standards of non-radio equipment radiating radio waves' interference in the regular radio communication services, local radio regulatory organs should hand in the statistics they collected or obtained through scientific research or experiments to provide facts for improving regulations concerning such field. Besides, radio regulatory organs should make announcements to the public that any purchase of such equipments that do not meet the national quality standards can make complaints to the manufacturer for reimbursement. Such activities can reduce the use of shoddy non-radio equipments and eventually eliminate them. Meanwhile, the interference in radio communication service is reduced, which is good for proper, efficient operation.

### **More talents should be employed and more scientific research should be conducted**

Radio regulatory organs should draw from advanced international practice and make plan to tackle non-radio equipment radiating radio waves' interference in the regular radio communication services based on realities. The first step would be to employ more talents. Then it's necessary to tackle the problem with advanced technology to reduce the interference and ensure proper operation. Various departments should set up a joint EMC testing laboratory, which is economical and able to share good resources among the departments and therefore can provide "one-stop" services to the users<sup>[8]</sup>. Objectively, it's impossible to completely eliminate the interference but it's practical to measure the interference from laboratory or with relative apparatus and therefore to adopt effective measures to ensure proper operation under safe circumstances.

## **CONCLUSION**

This thesis starts with the definition of non-radio equipment radiating radio waves and further explores how non-radio equipment radiating radio waves causes interference in regular radio communication services. This problem can be tackled with joint work with departments of quality supervision, inspection and quarantine, departments of industry and commerce and the customs departments, more engagement in making standards for the manufacturing of non-radio equipments, hiring more talents and conducting more scientific research. In a deep sense, if such problem cannot be properly handled, the regular communication system would be influenced or paralyzed and people's life may even be threatened. To attach great importance to such problem will guarantee the proper operation of radio communication and provide favorable conditions for a clean electromagnetic environment.

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