Research on Controlling Limits for Electromagnetic Environment in China

Anqi Tu1*, Zhiyong Zhang2, Runa A3, Han Zhang4

1Inner Mongolia Electric Power Research Institute, Hohhot 010020, China
2Tu Anqi: 979440511@qq.com

Abstract. With the remarkable growth of power demand, power transmission and transformation facilities are gradually developing towards the direction of large capacity and ultra high voltage. In China, 500kV EHV AC power grid is mainly used for long-distance power transmission. However, people have panic and psychological pressure for the electromagnetic environment problems caused by high-voltage transmission lines. This paper concentrates on electromagnetic environment control limits around 500kV EHV AC electric power transmission lines in China. The power frequency electric field and power frequency magnetic field of two buildings under the transmission lines are monitored. With the support of objective scientific data, reducing or even eliminating public excessive panic about the electromagnetic environment caused by 500kV EHV AC transmission system.

1. Introduction

In China, transmission lines are divided into high voltage (HV), extra high voltage (EHV) and ultra high voltage (UHV) according to the operating voltage. In general, high voltage power grids refer to 110kV and 220kV power grids; extra high voltage power grids refer to 330kV, 500kV, and 750kV power grids. Ultra high voltage transmission includes the 1000kV alternating current (AC) voltage and ±800kV direct current (DC) voltage transmission projects and technologies. When an AC transmission line works, the electric charge on the wire will generate a power frequency electric field in the space, and the current on the wire will generate a power frequency magnetic field in the space[1].

With the increasing public awareness of environmental protection, people are extremely concerned about the possible health risks caused by exposure to electromagnetic fields. The research focuses on the electromagnetic environment monitoring for two buildings in China under two 500kV EHV AC electric power transmission lines. And according to the Chinese standard GB 8702—2014, determine whether the monitoring value is within the controlling limits for electromagnetic environment.

2. Electromagnetic fields

Electromagnetic fields (EMF) are everywhere in our environment. Electric fields that are generated by natural resources, such as the accumulation of local charges in the atmosphere is related to thunderstorms while the Earth's magnetic field is used as navigation by birds and fish.

Human-made sources of electric fields include medical equipment using static fields, such as magnetic resonance imaging (MRI), appliances using low-frequency electric and magnetic fields, frequencies are around 40-60Hz, and various wireless, telecommunications, and broadcasting equipment using high frequency electromagnetic fields with frequencies around 100kHz-300GHz.
When used properly, electromagnetic fields can greatly improve the quality of life and health. However, when electromagnetic fields are higher than a certain level, they are also harmful to health and the degree of impact varies with the frequency of the magnetic field. Therefore, many countries in the world have established standards to limit exposure to electromagnetic fields to limit specific frequencies, applications, and the whole electromagnetic field spectrum[2]. In China, since January 1, 2015, the standard GB 8702—2014 Controlling limits for electromagnetic environment has been implemented.

3. Experimental
The experiment focuses on the electromagnetic environment test around 500kV EHV AC electric power transmission line. The two buildings selected for the test are located under two nearly parallel 500kV EHV AC electric power transmission lines in China. In this experiment, the power frequency electric field and power frequency magnetic field that produced by AC transmission and transformation project are monitored by calibrated Narda EFA300 power frequency electromagnetic instrument.

3.1 Test method
This experiment based on the Chinese standard HJ 681—2013 Electromagnetic environmental monitoring method for AC electric power transmission and distribution project. And it needs to be carried out under the normal operation conditions of the corresponding equipment of 500kV EHV AC electric power transmission lines.

Each monitoring point should be tested 5 times continuously and each testing time should be not less than 15s. The maximum value in stable state can be read and recorded. If the fluctuate of monitoring readings is great, the testing time should be extended appropriately.

3.2 Monitoring point
The monitoring points should be located in the open ground with flat terrain, far away from trees without other power lines, communication lines and broadcasting lines. The monitoring probe is set up at a height of 1.5m above the ground level (or based plane). When monitoring power frequency electric field, the distance between monitoring personnel and monitoring probe should not be less than 2.5m. The distance between the monitoring probe and the fixed object should not be less than 1m.

For the monitoring of the electromagnetic environment outside the building, the monitoring points should be arranged at the side of the building that close to the power transmission and transformation project and at least 1m away from the building. When monitoring in the building, points should be arranged at the area 1.5m away from the wall or other fixed objects. If the above distance requirements cannot be met, the center position of the building base plane should be taken as the monitoring point, but the distance between the monitoring point and the surrounding fixed objects (such as walls) should not be less than 1m. For monitoring on the balcony or platform of the building, points should be arranged 1.5m away from the wall or other fixed objects (such as guard rails). If the above distance requirements cannot be met, the balcony or platform based on the plane center should be taken as the monitoring point[3].
Figure 1 shows the schematic diagram of measuring points arrangement. In this experiment, 9 monitoring points were selected around two buildings. Figure 2 takes monitoring point 8 as an example and shows the distance between the instrument and the building during the monitoring. The distance between instrument and building of every monitoring points keeps 1m.

3.3 Environmental Conditions
First, the environmental conditions should meet the requirements of the instrument operating manual. Secondly, the monitoring work should be carried out in the absence of rain, fog and snow. Meanwhile, the ambient humidity should be below 80% during monitoring to avoid the effects of leakage current from the instrument holder. This experiment is conducted on a sunny day. The ambient temperature is 4 degrees and the ambient humidity is 49% during monitoring.
4. Results and Discussion
This experiment monitored the power frequency electric field strength and power frequency magnetic field strength. The monitoring values are shown on Table 1 and Table 2.

The table 1: controlling limits for public exposure on chapter 4.1 of GB 8702—2014 specifies the standard controlling limits of power frequency electromagnetic fields.

4.1 Power frequency electric field strength
According to GB 8702—2014, for 500kV EHV AC with frequency of 50Hz, the controlling limits for public exposure of electric field strength is required to be \( \leq 4000\text{V/m} \). Therefore, it can be seen from table 1 that the electric field strength around the monitoring points are all less than the controlling limits 4000V/m.

4.2 Power frequency magnetic field strength
According to GB 8702—2014, for 500kV EHV AC with frequency of 50Hz, the controlling limits for public exposure of magnetic field strength is required to be \( \leq 100000\text{nT} \). Therefore, it can be seen from table 2 that the magnetic field strength around the monitoring points are all less than the controlling limits 100000nT.

| Monitoring points | Distance from building | Power frequency electric field strength (V/M) | Arithmetic mean |
|-------------------|------------------------|---------------------------------------------|----------------|
| 1                 | 1m                     | 2013 2025 2022 2025 2017                   | 2020.4         |
| 2                 | 1m                     | 1045 1044 1040 1043 1051                   | 1044.6         |
| 3                 | 1m                     | 552.6 563.5 549.5 557.5 556.1             | 555.84         |
| 4                 | 1m                     | 995.5 992.5 988.9 989.9 993.7             | 992.1          |
| 5                 | 1m                     | 1217 1218 1216 1220 1215                   | 1217.2         |
| 6                 | 1m                     | 1448 1442 1442 1442 1443                   | 1443.4         |
| 7                 | 1m                     | 1224 1223 1220 1216 1218                   | 1220.2         |
| 8                 | 1m                     | 1369 1373 1363 1344 1361                   | 1362           |
| 9                 | 1m                     | 1682 1689 1690 1688 1689                   | 1687.6         |

| Monitoring points | Distance from building | Power frequency magnetic field strength (nT) | Arithmetic mean |
|-------------------|------------------------|---------------------------------------------|----------------|
| 1                 | 1m                     | 762.2 779.5 754.2 750.9 762.8               | 761.92         |
| 2                 | 1m                     | 549.5 555.1 538.3 546.2 535.2               | 544.86         |
| 3                 | 1m                     | 455.1 455.9 466.9 474.3 469.3               | 464.3          |
| 4                 | 1m                     | 481.2 507.5 470.3 512.3 490.1               | 492.28         |
| 5                 | 1m                     | 547.1 550.5 531.7 557.6 548.5               | 547.08         |
| 6                 | 1m                     | 636.9 653.3 603.9 627.6 596.9               | 623.72         |
| 7                 | 1m                     | 592.1 593.1 586.5 588.3 593.6               | 590.72         |
5. Conclusion

It can be seen that the power frequency electric field strength and power frequency magnetic field strength at the monitoring points are all within the controlling limits for public exposure. With the urban construction and economic development, the power demand continues to increase. Meanwhile, the construction of power transmission and transformation facilities is developing towards the direction of large capacity and ultra high voltage. Whether the electromagnetic field produced by high voltage transmission will have adverse effects on the ecological environment, animals and plants has gradually attracted public attention. In addition, some members of the public have negative emotions of excessive panic. The electromagnetic field produced by high voltage transmission lines should be treated more scientifically and rationally, and excessive panic should be avoided based on objective scientific data.

References

[1] Y. Gao, (2015) The research on high voltage transmission line electromagnetic environment and the biological effects of human. Master Thesis North China Electric Power University: 1–68.

[2] World Health Organization, (2006) Electromagnetic fields and public health. https://www.who.int/gho/phe/emf/en/.

[3] Ministry of Environmental Pretention of Peoples’s Republic of China. (2004) Radiation Environment Monitoring Technology Center, Electromagnetic environmental monitoring method for AC electric power transmission and distribution project, 1-3.

[4] Ministry of Environmental Pretention of Peoples’s Republic of China and General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (2015) Radiation Environment Monitoring Technology Center, Controlling limits for electromagnetic environment, 1-6.