SERBIAN JOURNAL OF ELECTRICAL ENGINEERING
Vol. 2, No. 1, May 2005, 1 - 4

Draft Amendments to CCIR Report 943 and Question 48/10 (CCIR Study Groups, Doc. YUG 10/1)

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Abstract: This paper presents text of the document of the CCIR Study Groups, for period 1982-1986, and draft amendments to the CCIR Report 943 and question 48/10, prepared by the author prof. dr Jovan Surutka, regular member of Serbian Academy of Sciences and Arts. The amendments are accepted by the CCIR Study Groups as Doc. YUG 10/1.

The author developed a new method of elimination of the static atmospheric electricity from the guys of LF and MF broadcast antennas.

Keywords: Static atmospheric electricity, Antenna masts, Guy rope insulators.

1 Introduction

The safety of LF/MF broadcast antenna masts immediately before and during thunderstorms as a problem was espied and described very early. By the time it has become of growing importance, especially nowadays with the steady increase of powers of LF and MF broadcast transmitters. Report 943 deals with the protection of sound-broadcasting stations against lightning and describes an LF antenna specially designed for protection against lightning. As indicated, such type of design does not seem to be practical for antennas higher than $\lambda/4$.

This document deals with a new method of elimination of the static atmospheric electricity from the guys of LF and MF broadcast antennas, which has been applied to the MF broadcasting antenna of Belgrade station (684 kHz, 2000kW), having a height of 235m. An amendment to Report 943 is proposed accordingly.

2 General

The static atmospheric electricity and the atmospheric discharges very often cause serious difficulties in the operation of LF and MF high power broadcast transmitters immediately before and during thunderstorms. These difficulties and even incidents, have been noticed since the very beginning of use of the most

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common type of antennas for this purpose, i.e., the vertical steel mast, insulated and driven in its base, and guyed with steel ropes divided by insulators into sections shorter than resonant length.

The guy rope insulators are subjected to two kinds of voltages: (1) induced RF voltages due to the RF current in the antenna mast, and (2) electrostatic voltages, due to atmospheric electrostatic field in the vicinity of the antenna.

While the RF voltages are practically constant in time and depend on the radiating power, the electrostatic voltages are variable and can reach very high values. Immediately before and during thunderstorms, electrostatic voltages as high as 200 and 300, and even 400kV are often encountered across an insulator. They are consequence of very strong atmospheric electrostatic field between the clouds and the earth. There were quoted maximal field strengths of 5kV/m (Surutka and Veličković, 1973).

Very high static voltages and flash-overs they produce across the guy rope insulators are particularly dangerous in the case of high power transmitters. Once the static voltage has broken the spark gap of the insulator, the RF voltage can originate and maintain the electric arc, even if it were much less than the voltage required to start the arc.

When the arc occurs at the insulator which connects the guy rope to the antenna mast, the antenna impedance varies appreciably and the transmitters reflectrometric protection extinguishes the arc momentarily. The only trouble in this case is very short interruption in transmitting.

However, the arc on the other guy rope insulators, which are not in contact with the antenna mast, does not activate the main protection system and, therefore, the arc continues to exist on account of the RF energy. In the cases of high-power transmitters the RF power of the arc can be considerable and it can damage the insulator. In absence of special precautionary measures for extinguishing the arc, the safety of the mast can be jeopardized. Particularly, the existence of the arc of long duration can have fatal outcome in the cases of strain-insulators, the armatures of which do not hook up. In any case, an exchange of the broken insulator is laborious and costly.

It can seem peculiar, but a direct or near stroke of lightning to the mast or guys represents an incomparably smaller risk against the antenna safety than the arc caused by the static atmospheric electricity. The lightning stroke ignites sparks on all insulators along a guy, and consequently it activates reflectrometric protection.

3 Method of Protection Applied to the Belgrade MF Antenna (684 kHz, 2000kW power transmitter, 235m antenna height)

Since its putting into operation, in 1948, with a power of 150kW, and especially after the putting into operation, in 1975, the new MF transmitter of Radio Belgrade (684kHz), having a power 2000kW, its antenna (235m high) has steadily been annoyed with the static electricity and its consequences. Several technical solutions, representing state-of-the-art in this field, have been applied, including the implementation of the so-called "dissipation array" at the top of the antenna. However, no appreciable results have been obtained, and in storm periods the usual way to avoid incidents due to atmospheric electricity has been that of reducing the transmission power.

In 1977 an efficient and simple solution was proposed and realized by (Surutka, 1978; 1979). The solution is based on the use of static-drain coils which are connected in parallel to all guy insulators except those which are closest to the mast. The inductances of the coils are chosen so as to form antiresonant circuits with the sectionalizing insulators at the operating frequency of 684kHz. In this way the guy ropes are set to zero static potential and, consequently, the static electricity is eliminated from them. As usual, the mast is also set to zero static potential by static-drain coil at the base of the mast. The system was put in operation in April 1977 and since then no one flash-over or arc had been noticed.

4 Proposed Amendments to Report 943

4.1 Change the title to read:

"PROTECTION OF LF-MF SOUND BROADCASTING STATIONS AGAINST STATIC ATMOSPHERIC ELECTRICITY AND LIGHTNING."

4.2 Add a new paragraph to read:

6. The Belgrade MF antenna (684 kHz): An efficient and simple solution for eliminating static electricity has been applied to the Belgrade MF antenna (684 kHz, 2000kW transmitter power, 235m height). It is based on the use of static drain-coils, which are connected in parallel to the guy insulators, forming antiresonant circuits with them at the operating frequency. See (Surutka, 1978; 1979).

4.3 Add to references

SURUTKA, J. V. [1]: New experiences in eliminating static electricity from the guys of high power MF/LF antennas (in Serbian), Proceedings of 22nd

Yugoslav Conference on Electronics, Telecommunications, Automatization and Nuclear Sciences, June 1978, Zadar (Yugoslavia).

SURUTKA, J. V. [2]: New experiences in eliminating static electricity from guys of high power MF antennas (in Serbian); Tehnika-elektrotehnika, XXVIII, No. 10, pp. 1-5, Belgrade, 1979.

4.4 Add to Bibliography section the following reference

SURUTKA, J. V. and VELIČKOVIĆ, D. M. [3]: Static voltages on the guy insulators of MF and LF broadcast tower antennas (in Serbian), The Radio and Electronic Engineer, Vol. 43, No. 12, pp. 744-750, London, Dec. 1973.

5 Proposed Amendment to Question 48/10

5.1 Change the title to read

"PROTECTION OF LF-MF SOUND BROADCASTING STATIONS AGAINST STATIC ATMOSPHERIC ELECTRICITY AND LIGHTNING."

6 Conclusion

This paper presents the original text prepared by the author and accepted by the CCIR Study Groups as Document YUG 10/1 and draft amendments to report 943 and question 48/10. It presents the contribution of the author to the work of CCIR Study Groups and the confirmation of the results achieved by the author who developed a new method of elimination of the static atmospheric electricity from the guys of LF/MF broadcast antennas.

7 References

[1] J. V. Surutka: New experiences in eliminating static electricity from the guys of high power MF/LF antennas, (in Serbian), Proceeding of Papers of the 22nd Yugoslav Conference on Electronics, Telecommunications, Automatization and Nuclear Sciences, Zadar, June 1978.

[2] J. V. Surutka: New experineces in eliminating static electricity from the guys of high power antennas, (in Serbian), Tehnika-Elektrotehnika, Vol. XXVIII, No. 10, pp. 1-5, Belgrade, 1979.

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