APPLICATION BULLETIN NO. 9

RF RADIATION REGULATION COMPLIANCE

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The regulations for human exposure to radio frequency (RF) radiation require special measures to control general public and occupational exposure.[1] The occupational exposure requirements present a unique problem to the AM broadcast engineer who is required to make periodic base current measurements.[2] Proximity to radiating components while performing the current measurements may expose the engineer to RF radiation for a time interval in excess of the guidelines.[3]

Since Delta Electronics, Inc. introduced the Model TCA RF Ammeter series in 1975, over 6200 ammeter systems have been installed in AM broadcast stations on a world-wide basis. In support of TCA users, Delta has been investigating a number of approaches to enable the broadcast engineer to accurately measure the base current without exposing the engineer to time-averaged field strengths exceeding the permissible levels, and thereby meet license renewal requirements with respect to ANSI exposure compliance.[4]

INTRODUCTION

Every AM radio station in the United States must address the question of occupational exposure to nonionizing RF radiation during tower base current readings. For station license renewal, broadcasters at facilities licensed under Part 73 of the Federal Communications Commission (FCC) rules, which include commercial AM broadcast stations, are required to determine public and occupational exposure to RF radiation.[5] This, of course, includes exposure during tower base current readings.

Since health effects of exposure to nonionizing RF radiation are unclear[6], minimizing such exposure is a reasonable safety precaution and is, therefore, good engineering practice. Research on the biological effects of nonionizing RF radiation is continuing[7] and may lead to exposure standards that are tighter than the existing American National Standards Institute (ANSI) guidelines. Furthermore, the establishment of a standard for exposure implies a health risk for which the broadcaster may be held legally accountable. This risk is equivalent to any other business risk. For these reasons, the broadcast engineer should consider taking steps to *minimize RF exposure, where feasible, to well within the ANSI guidelines.*

THE PROBLEM DEFINED

The first step in addressing the potential RF exposure problem is to determine whether an exposure problem exists. Thus, the question to be answered is: will the engineer taking base current readings be exposed to electric and/or magnetic fields from all sources which, when averaged over any six minute period[8], result in exposure beyond ANSI guidelines? If, in the case of an AM only site, the electric field is less than 632 volts per meter and the magnetic field is less than 1.58 amperes per meter, the answer to this question is no and no RF exposure problem exists. That is, the radiation energy absorbed by the engineer would not exceed the ANSI guidelines. However, a prudent engineer might elect to take steps to minimize RF exposure for the reasons given above.

For multiple RF radiation sources, such as an FM station colocated with an AM station, the RF exposure is determined by adding the fractions of the ANSI exposure limit from each source.[9] This method of calculation is necessary because the human body absorbs RF energy more readily at FM frequencies than at AM frequencies.[10] Fortunately, the radiation source for FM is at the top of the tower and should, therefore, contribute little to the total RF exposure when measuring base currents. The engineer must not, however, overlook multiple sources when evaluating RF exposure during base current readings.

Unfortunately, the determination of the electric and magnetic field strengths in the vicinity of the tuning elements at the base of a tower is not a simple matter. Use of the tables, charts and antenna field equations contained in the FCC technical bulletin is not sufficient to guarantee exposure below ANSI limits because tuning elements produce locally intense fields[11] which cannot be taken into account in the tables, charts or equations. The best that the use of tables, charts or equations can do is to indicate a probability of exceeding the exposure limits. (Note that when using the tables and charts you must conservatively assume that all of the station's power goes to each antenna.)[12] Thus, the only acceptable method for determining the field strengths of interest is field measurements made with suitable instruments.[13]

Assuming that such measurements have been made and that the fields exceed the ANSI limits, base current readings may still be taken as usual if exposure times are limited so that the six minute time average exposure is less than exposure at the ANSI limits for six minutes.[14] As an example, assume that the measured fields are 2.45 times the ANSI limit: 1548 volts per meter or 3.87 amperes per meter. Remembering that power and, thus, energy absorption increases as the square of the voltage or current, the energy absorption rate is six times the rate at the ANSI limit. Therefore, to keep the same six minute averaged RF exposure, the engineer may make readings for up to one minute of exposure without exceeding the guidelines provided that for the previous five minutes and for the succeeding five minutes the engineer is not exposed to RF radiation. This time restriction is necessary to guarantee an acceptable exposure averaged over any six minute period. In such cases, the answer to the above question is, again, no. No RF exposure problem exists. Care should be exercised that anyone potentially exposed, especially new employees, be made aware of these exposure time limitations. This would ideally be implemented as part of the station's overall safety program.

In the above example, the one minute exposure limit would be plenty of time to make a base current reading. This appears an adequate solution but consider a four tower array. The time required to make a complete set of base current readings would be nineteen minutes. On bitter cold days, however, the person taking readings might decide to accept the unknown health hazard, excessive RF exposure, over the known health hazard. Clearly, the better policy is to find some ammeter technology that will allow base current reading away from fields that exceed ANSI limits.

APPLICATION OF EXISTING TECHNOLOGY

Assuming that the engineer has an RF exposure problem or wishes to minimize RF exposure, his first step would be to try to adapt his existing system so as to avoid excessive RF exposure. For thermocouple ammeters, the answer would probably fall into the category of exotic solutions. For instance, the engineer might use a telescope or a television camera to view the ammeter from a distance.

With Delta Model TCA series ammeters, several opportunities exist to reduce RF exposure. Since the meter enclosure of a TCA system is separated from the toroidal current transformer by a coaxial cable, the meter enclosure may be moved to a location of minimum exposure.

Utilizing the remote metering provisions of the TCA series ammeters is another method to reduce long term exposure to RF radiation. The engineer need only enter the high field area at the base of a tower often enough to ensure accurate remote readings.[15]

FURTHER DEVELOPMENTS

What does an engineer do, however, if the RF fields are so high that his base readings can never be taken without violating the ANSI guidelines? Legal releases are deemed unacceptable[16], so a technical solution must be found. Again, exotic solutions could solve this problem, but Delta believes that cleaner, simpler solutions exist. To this end, Delta engineers are investigating several possible answers. Preliminary field trials show promising results.

REFERENCES

[1]Federal Communications Commission, Rules and Regulations, Part 73, Subpart I, §1.1305

[2]Federal Communications Commission, Rules and Regulations, Part 73, §73.51

[3]American National Standards Institute, American National Standard Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 300 kHz to 100 GHz, (New York, 1982)

[4]op. cit. FCC §1.1305(d)

[5]Ibid

[6]National Association of Broadcasters, A Broadcaster's Guide to FCC RF Radiation Regulation Compliance, (Washington 1987) p. 1

[7]Ibid

[8]Robert F. Cleveland, FCC Technical Bulletin on "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation, Federal Communications Commission, Office of Science and Technology Bulletin No. 65 pp. 5 and 7

[9]Ibid

[10]Ibid

[11]Ibid p. 29

[12]Ibid p. 15

[13]op. cit. NAB p. 7

[14]Ibid p. 10

[15]Federal Communications Commission, Rules and Regulations, Part 73, §73.57(d)

[16]Federal Communications Commission, Further Guidance for Broadcasters Regarding Radiofrequency Radiation and the Environment, (January 1986) p. 3