Chapter II

MEASUREMENT OF ATMOSPHERIC NOISE INTERFERENCE TO BROADCASTING
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1. INTRODUCTION

The principal object of the investigations which form the subject matter of this thesis, is to measure atmospheric noise interference to one specific service, viz. broadcasting, in the bands 3 and 5 Mc/s. A method for the measurement of atmospheric noise interference to broadcasting has been described (AIYA). This method has been adopted for carrying out the measurements. It is an objective method developed on the basis of subjective considerations and the procedure given for the collection and assessment of data has a statistical basis, which, as has been pointed out earlier, is very necessary as atmospheric noise is a statistical phenomenon. It is proposed to describe this method in detail in this chapter as it is the method adopted for carrying out the noise measurements.

2. SUBJECTIVE BASIS OF THE METHOD

The method is based mainly on the results of listening experiments. Such experiments cannot be always considered very satisfactory. But, since the ultimate judge of the quality of a broadcast programme
programme is the ear, the most practical and the most realistic approach to the problem is to rely as far as possible on the average ear as the final instrument for assessment of annoyance.

Subjective experiments revealed that the median value of the duration of the impulse was 0.2 seconds. Further, it was found that the majority of the listeners feel the annoyance of atmospheric noise when there are at least ten impulses per minute. Therefore, it appears that noise which exists for 3% of the time \((0.2 \times 10 = 2\text{ seconds per minute})\) has an annoyance value. This criterion is for speech, in which the annoyance of noise is more felt than in music.

Impulses of the highest magnitude obviously cause the maximum annoyance. Therefore, when a large number of impulses are received, the average of the ten highest impulses per minute would be an adequate measure of noise having an annoyance value. Hence, the average of the ten highest impulses per minute is taken as the noise value. In the large majority of cases it has been found that arithmetical averaging of the ten highest impulses is adequate. Therefore, arithmetical averaging is adopted. In the next chapter a typical set of readings as recorded and the arithmetical averaging of ten
ten highest peaks per minute is given for a typical case as an illustration.

3. CLASSIFICATION OF NOISE.

Several attempts have been made to classify noise. But, in the paper referred to (AIYA) a new classification has been adopted and this again is based on the results of long period listening experiments. When the atmospheric noise is heard through the loudspeaker of a receiver, it is possible to distinguish individual impulses from each other and so long as this is possible, the type of noise received is called type B noise. When this type of noise is due to local thunderstorms, the magnitude of the impulses shows wide variations from impulse to impulse. This special form of type B noise is called type C noise. As the number of impulses per minute goes on increasing, the ear finds it difficult to distinguish each impulse separately. The resolving power of the average ear is crossed when the number of impulses per minute exceeds fifty. When impulses are received at this rate or higher, the ear gets the impression of continuous noise similar to fluctuation noise. This type of noise is called type A noise. It is necessary to point out that even type
type A noise arises from impulses and therefore, it must be measured by the same standards as other types of noise.

Since the classification of noise has importance with reference to standards of satisfactory service, it is useful to listen to noise while measurements are carried out.

4. THE NOISE METER

The investigations of Stuedel (STUEDEL) justify the construction of noise meter of the rapid charge slow recovery type. For the noise meter which thus measures the quasi-peak value, the following time constants are chosen:

- Charging time constant: 10 milliseconds.
- Discharge time constant: 500 milliseconds.

Subjective tests were taken by listening to noise and observing the noise meter kicks, and it was found that the meter does relate satisfactorily the readings to the annoyance for at least 50% of the impulses.

For engineering evaluations, it is necessary to work with equipment which conforms to the normal types.
Therefore, a communication receiver having a bandwidth of 6 Kc/s at 6 dbs. down is used. This choice of bandwidth is more in conformity with those met with in commercially mass produced receivers than the higher bandwidth recommended and used in some of the previous investigations. The equipment as used for noise measurements in the 2.5 to 20 Mc/s band is described in chapters III and IV.

The use of automatic recording is unsuitable. There are frequent changes of noise intensity which require changes of sensitivity ranges, if accuracy is to be maintained. Otherwise, observations get recorded when the receiver or the amplifier is working under overload conditions and this leads to inaccuracy in measurements. Further, the problem of interference is most serious. Therefore, observations are recorded manually.

5. CALIBRATION

"Atmospheric noise is a form of interference. The noise source should be considered a form of radiator and its field strength should be measured in microvolts per metre. The noise meter thus becomes a noise field strength meter. A standard signal generator
generator should be used for calibration purposes. Since measurements are made on the audio frequency side, the question of a suitable audio frequency and a suitable percentage modulation arises. 30 per cent modulation by a 400 c/s note is usually used for receiver testing, etc. The same should also be used in this case. All the results can be given on this basis. In addition, it is useful to provide conversion data for converting these results to what would be obtained with 15 per cent and 50 per cent modulation. While carrying out the calibrations, it is necessary to feed the output of the signal generator through the equivalent impedance of the aerial at the point at which the aerial is connected. For maintaining calibration accuracy, the power to the receiver must be supplied through a constant voltage transformer and the calibration periodically checked.

For theoretical purposes, it is necessary to appreciate the significance of this calibration. The noise field strength is due to the noise source operating as a radiator at a particular frequency within the limits of the defined band-width of the receiver. This radiator is considered as equivalent to a radiator at the same frequency carrying a 30 per cent modulation by a 400 c/s note."
6. RECORDING AND ANALYSIS OF OBSERVATIONS

"Observations are taken continuously for ten minute periods, three times an hour. All impulses are generally recorded, but when the number of impulses exceeds twenty per minute, about twenty of the highest during the minute are recorded. The general practice is to record about 600 impulses per hour. The continuous background noise, here called type A noise, is recorded by reading the meter twice in each ten minute interval. This is done very carefully when the number of impulses per minute, due to type B noise, is less than ten. Higher values will be recorded for type A noise, in the noise meter described in this paper, when a large number of impulses due to type B or type C noise is also present. But this is of no significance, as the type A noise which appears as a background is never stated when the number of impulses due to type B or type C noise exceeds ten per minute.

Type A noise which is read twice in each ten minute interval gives six readings for the hour. They are arithmetically averaged to give the average for the hour. A similar procedure is adopted for averaging type B or type C noise. The 300 highest values recorded during the 30 minutes in any hour of observation
observation are arithmetically averaged to obtain the average value of the ten highest peaks per minute. This is stated as the quasi-peak value of type B or type C noise for the hour.

The hourly values so obtained are tabulated for the whole month. The twenty four hours of the day are divided into four divisions:–

- 06.00 to 12.00,
- 12.00 to 18.00,
- 18.00 to 24.00,
- 00.00 to 06.00.

This division has been made having regard to broadcasting as a utility service and the use of the Indian Standard Time is found convenient in India. Separate tables of hourly values for the whole month are prepared for the four divisions. The monthly table of one division is examined at a time. During some months, the number of impulses per minute due to type B or type C noise is less than five throughout. In such cases, analysis of only type A noise is resorted to and observations of type B or type C noise, if any, are ignored. During some months, the number of impulses due to type B or type C noise always exceeds the rate of ten per minute. In such cases, type A noise is ignored. During a few
few other months, however, the number of impulses per minute due to type B noise varies and has values below ten also. For such months, the median value of the number of impulses per minute is computed for the whole month. If this is less than five, type B noise is ignored. If it is more than five and less than ten, values of both type A and type B noises are computed and given. If it is more than ten, only type B noise is computed.

The following procedure is adopted in all cases for obtaining the magnitude of noise in one division of the day for the whole month. The hourly averaged readings for the month are sorted into groups and a graph is drawn - percentage of readings exceeding a value against the value. From this graph, the median value for the month and the value that is exceeded during only 10 per cent of the hours of observation, the higher decile value, are both obtained. In giving noise figures for the month, it should be adequate to state the median value of the hourly averages for each of the four divisions of the day but, if a higher figure is desired, it is best to state the higher decile value also for each division of the day.

Sometimes, when the hourly values are sorted into groups, it is found that they fall into more than one
one set. In such cases, the median value, etc. are obtained for each set separately as each may have a different source of origin. Monthly values are obtained by weighting the value of each set in proportion to the frequency of its occurrence. Under no circumstances are the results of type A, type B and type C noises mixed up.

Before proceeding to compute the results, the following general principles are observed. To compute the hourly average, there must be at least two ten minute periods of continuous observations, the two ten minute periods to lie in the two halves of the hour. For any six hour division of the day, there must be at least three hourly averages and these hours must be alternate. For computing monthly averages, there must be readings for at least ten days of the month and the days must be spread over the whole month. In actual practice, observations should be obtained far in excess of these minima.

REFERENCES
