

FEDERAL COMMUNICATIONS COMMISSION

WASHINGTON, D.C.

In the Matter of
ALLOCATION OF FREQUENCIES TO THE VARIOUS
CLASSES OF NON-GOVERNMENTAL SERVICES Docket No. 6651
IN THE RADIO SPECTRUM FROM 10 KILO-
CYCLES TO 30,000,000 KILOCYCLES

REPORT OF THE COMMISSION

(March 5, 1946)

In its reports, dated May 25 and June 27, 1945, the Commission announced its final allocation of 90 channels in the band from 88 to 106 megacycles for FM broadcasting; and on August 24, 1945, this assignment was further expanded to provide 10 additional channels in Area I, the northeastern portion of the United States, between 106 and 108 megacycles. The history of the proceeding, the evidence upon which this allocation was based, and the Commission's reasoning, have been fully set forth in reports, dated January 15, 1945, May 25, 1945, June 27, 1945, and August 24, 1945, and need not here be reviewed.

On January 2, 1946, the Zenith Radio Corporation petitioned the Commission to make an additional allocation for FM broadcasting of 40 channels between 42 and 50 megacycles (subsequently amended to specify 30 channels between 44 and 50 mc.). The Zenith petition was joined in by the General Electric Company, and had the support of Major Edwin H. Armstrong, the inventor who pioneered in FM broadcasting. On January 3, 1946, the petition was designated for hearing and was heard on January 18 and 19, 1946, before the Commission *en banc*. The notice of hearing specified the following issues:

1. Whether the band 42 megacycles to 50 megacycles, or any part of it, should be made available for FM broadcasting in addition to the assignment already made to FM in the 88 to 108 megacycle band.
2. If any portion of such band is made available for FM broadcasting, whether such frequencies should be available for Non-Commercial Educational, Community, Metropolitan and Rural FM stations or only for Rural FM stations, and whether such frequencies should be available for FM stations in the entire United States or only in Area II.
3. To obtain information concerning the additional cost of FM receivers if the band 42 megacycles to 50 megacycles, or any part of it, is made available for FM broadcasting in addition to the band 88 to 108 megacycles.

In its Report, dated May 25, 1945, the Commission stated (p. 81):

In making an allocation for FM, it is the Commission's purpose to make provision for a service which will not be simply a new and improved broadcast service but which will be the finest aural broadcast service which is

attainable under the present state of the radio art. The Commission confidently expects that in the years to come this new service will develop to a point where there may be between 1,000 and 3,000 FM transmitters and between 50 million and 100 million FM receivers in the hands of the public. In planning for such a service it is obviously of the utmost importance that the allocation be made in the portion of the spectrum which is best suited for that purpose. With respect to allocations for other broadcast services it has sometimes been necessary to make compromises between various services competing for particular parts of the spectrum. However, with respect to FM the Commission is prepared to assign to it that portion of the spectrum which is shown to be best suited to its requirements. The Commission feels that it must proceed on this basis because it seems clear that this important new broadcast service will remain permanently in the portion of the spectrum to which it is assigned as a result of this hearing.

This statement still represents the Commission's basic policy with respect to FM broadcasting.

The Zenith petition, in essence, proposes that FM broadcasting shall proceed simultaneously in two bands, one from 44 to 50 megacycles, and the other from 88 to 108 megacycles. The objections to this dual-band allocation appear decisive. It was the general consensus of those who testified at the hearing that adding a second band decreases the overall efficiency of set performance. It is necessary to sacrifice some sensitivity and stability if two FM bands are incorporated in one receiver, and other complications arise such as antenna dimensions.

Furthermore, if two FM bands are approved, one or the other but not both will be licensed in many areas. However, all sets would have two bands thereby imposing a "dead" band on millions of set owners. The added cost to a purchaser of such a two-band set would be from \$1.50 to \$6.00 or more and on an annual basis for all users this added cost would run into millions of dollars.

Moreover, a two-band FM system will have an unpredictable effect upon the listening habits of the public in that it would require that the listener switch to select one band or the other unless this operation were done by automatic means. Habits of listening on one band to the exclusion of the other might well develop, which would complicate further the problems of assigning frequencies to FM stations.

Another factor which should merit consideration—but which is by no means conclusive—is that a few manufacturers have proceeded with plans to build two-band sets. This would give them a competitive advantage over other manufacturers who have proceeded with a view of producing one-band sets in accordance with the Commission's June 1945 allocation. The delay in producing two-band sets would range from four weeks to five months. As is pointed out later, there are no advantages to a two-band receiver which would warrant the Commission in requiring this delay.

Accordingly, the Commission concludes that FM broadcasting can proceed on a sounder basis in one band rather than in two bands.

In the course of the hearing, it was alleged that, at least in some parts of the country, the demand for FM channels exceeded

the number of channels available from 88 to 108 megacycles and that, therefore, a second band should be added. On the basis of the record now before us and the needs of other radio services, the Commission is not able to determine that the public interest requires additional channels for FM broadcasting. The Commission has considered the requests and needs of the various services for channels in this portion of the spectrum and has concluded that the existing allocation provides a fair and equitable distribution of channels among these services. The evidence does indicate, moreover, that in the event additional channels prove necessary, they can later be added to the present band. The feasibility of expanding an existing broadcast band by the addition of contiguous channels is shown by the fact that the boundaries of the standard broadcast band have been expanded from time to time without undue difficulty.

There remains only the question whether new evidence has been introduced in the course of the January 18-19 hearing which can cause the Commission to determine that its previous decision to allocate the region from 88 to 108 megacycles to FM broadcasting was mistaken and that the propagation characteristics of a lower band are so superior to the propagation characteristics of the 88-108 megacycle band as to cause the Commission to reconsider and alter its basic allocation. The Commission has given the fullest possible consideration to this proposal, and has determined to maintain FM in the 88-108 megacycle band only after a careful reconsideration of all the evidence.

Perhaps the most significant feature of the January 18-19 hearings was the unanimity with which all parties agreed that FM broadcasting in the region presently assigned, from 88 to 108 megacycles, will provide an excellent, interference-free and static-free service over substantial areas. Further, the evidence was conclusive that receivers in the medium-price range will shortly be available for the reception of signals in this band, and that transmitting equipment for the band will also shortly be available.

The three major factors which the Commission considered in its previous decision to place FM in the 88-108 megacycle band were (1) sporadic E interference, (2) F2 layer interference, and (3) extent of coverage. These may be considered in order.

(1) *Sporadic E Interference.*—With respect to sporadic E, which the Commission predicted would cause serious interference in the lower band, new evidence submitted consisted of measurements made during the past year by the Commission at several locations throughout the United States and measurements made by the Zenith Radio Corporation monitoring station at Deerfield, Illinois, during a period of approximately two months. Whereas the Zenith observations showed only a limited amount of sporadic E reception, the Commission's recordings show that during the past year the occurrences of sporadic E transmission were in substantial agreement with the recordings made previously and given in the Commission's report of May 25, 1945. All parties agreed that sporadic E would not be a disadvantage in the upper band. The only new point raised with

respect to sporadic E was the statement of Major Armstrong that in his opinion tropospheric enhancement of the signals of FM stations operating in the lower band would occur towards the periphery of their service areas at approximately the times when sporadic E interference would be at its height. Major Armstrong stated that this tropospheric enhancement would serve to reduce the amount of sporadic E interference to be anticipated in the lower band. No quantitative data concerning the extent of this offsetting factor were introduced. It would occur only toward the periphery of the service area, and would not affect the predictions concerning sporadic E nearer to the transmitter. Mr. Norton agreed that this would have some compensating effect, but that no quantitative determination could be made since the extent of the simultaneous occurrence of the two phenomena either with respect to time or degree is not known. Finally, it should be noted that the tropospheric enhancement theory is not a ground for moving the FM allocation. At best, it merely reduces one of the handicaps of the lower band as compared with the upper band.

(2) *F2 Layer Interference.*—With respect to F2 layer interference, no new evidence or testimony was introduced, except the testimony of Mr. Norton that the sunspot cycle now on the rise has continued to show marked similarities to the sunspot cycle which reached a maximum in 1778, and that hence we may anticipate during the coming decade F2 interference even in excess of predictions heretofore made. Recent Bureau of Standards reports indicate that in April 1946 the ionosphere will be capable of supporting F2 transmission of frequencies between 44 and 56 megacycles for 50 percent of the time during mid-day hours, in certain areas which must be considered in allocating frequencies in the United States. The disastrous effects anticipated from F2 interference have been set forth in the May 25, 1945 report at page 63.

(3) *Extent of coverage.*—With respect to extent of coverage, it should first be noted that all witnesses agree, and all the evidence shows, that in the present state of the art service to farmers situated at a great distance from metropolitan areas must continue to come primarily from standard broadcast stations. At the best, assuming an FM station with an antenna height of 1,000 feet and with 300,000 watts effective radiated power, the most optimistic prediction of anticipated range in the lower band is 100 miles. Secondary service rendered many hundreds of miles from the transmitters of standard broadcast stations is not to be expected from FM stations either in the upper or lower band.

Measurements made by the Zenith Radio Corporation at Deerfield, Illinois, and by the Federal Communications Commission at Andalusia, Pennsylvania, on transmitters operating in the upper and lower bands were introduced in evidence. Witnesses for the Zenith Radio Corporation and others testified that in their opinion these measurements supported the assertion that, in general, stations in the lower band would serve a much larger range than stations in the 88-108 megacycle band. They stated that in general the area served by an FM station in the higher band would be 60% less than

for a comparable station on the lower band but admitted that this opinion was more or less of an estimate. The Commission is unable to accept this opinion.

In the first place, the measurements were limited to one receiver location in the Deerfield instance and one receiver location in the Andalusia instance. Predictions for the entire service areas of a station or for the country as a whole cannot properly be based upon two receiver locations.

Second, the Deerfield measurements at a fixed receiver location on the lower band were in striking contrast to the "proof of performance" measurements made pursuant to Commission Standards of Good Engineering Practice and filed by the licensee of the station in question in 1943, before this proceeding was instituted. The Deerfield measurements on the lower band were similarly in disagreement with other "proof of performance" measurements and data accumulated with respect to propagation in the lower band. Where a single series of measurements thus conflicts with the volume of data available, it obviously cannot be considered as conclusive by the Commission.

Third, the analysis made of the Deerfield measurements defined "satisfactory service" in the upper band as 10 microvolts per meter, but accepted a signal only one-half as strong as satisfactory in the lower band. While it is true that with specially designed antennas it is theoretically possible to produce as strong a signal at the receiver terminals with 5 microvolts per meter in the lower band as with 10 microvolts per meter in the upper band, for two-band operation with signals of such low intensity a separate antenna will be required for each band, with the consequent complication in antenna structure and the inconvenience of switching antennas with changes from one band to the other. It is believed that such an arrangement would be the exception rather than the rule and that the theoretical advantages would not be achieved in practice. This claimed advantage of the lower band further assumes the same receiver sensitivity in each band. As a witness for petitioner conceded, this is not true with respect to its own two-band receiver exhibited in the course of the hearing, which requires 20-25 microvolts in the lower band and only 10 microvolts in the upper band. It should also be pointed out that where noise or station interference exists, the low frequency antenna will pick up twice as much interference as on the higher band and consequently there is no effective gain so long as the internal receiver noise is not the limiting condition.

Fourth, the Deerfield measurements were made at a point considerably beyond the service areas of the stations measured. The standard of 10 microvolts per meter for the higher band and 5 microvolts per meter for the lower band were considerably too low to supply satisfactory service on either band. The Commission's Standards specify a median field of at least 50 microvolts per meter, and no evidence was introduced that the lower band would show superiority on the basis of a 50 microvolt per meter signal strength standard. In addition, no evidence was presented to show that at or within the recognized service contours the drop-outs would be

greater on one frequency or the other, since the measurements were made at a point beyond these contours. These measurements were made during the summer and early fall, a period during which tropospheric transmission is above average; it should be borne in mind that year-round service cannot be predicted upon the basis of summer measurements where the troposphere is concerned. Accordingly, the Deerfield measurements can at best be considered as indicating that, in a region so far from the transmitter that satisfactory FM service is doubtful in either band, the service in the lower band is somewhat less unsatisfactory than the service in the upper band for the period of observations.

The Andalusia measurements were similarly inconclusive due in part to the fact that they were made in one place only, in part to the fact that the Empire State Building may have interfered with the transmission paths of the signals in question, and in part to the fact that there is some doubt concerning the interpretation of the results during a period of several hours. As in the case of the Deerfield measurements, the Andalusia measurements were made beyond the service area of the stations measured on any of the bands, and accordingly serve only to indicate that at a point where all bands are unsatisfactory, some bands are less satisfactory than others. Finally, the Andalusia tests were not consistent with the Deerfield tests in that the median value of the 46.7 megacycle frequency was less than the median value at 83.75 megacycles, whereas at Deerfield the lower frequency provided the higher median field.

Accordingly, the Commission is unable to find that the Deerfield and the Andalusia measurements constitute a sufficient basis for service area predictions.

Summarizing, the Commission concludes that whether or not sporadic E in the lower band will be as intense as was predicted in earlier reports, there will still be a substantial problem of sporadic E interference in the lower band, and no similar problem in the upper band. The Commission further concludes that F2 interference may be a serious problem in the lower band and will not affect service in the upper band. With respect to extent of coverage, the Commission is unable to find that the lower band shows any substantial advantage over the upper band, within the expected service areas of FM broadcast stations. With respect to service to rural areas, the Commission concludes that in the present state of the art and considering the present economics of broadcasting, service to farmers situated at a great distance from cities must continue to come for the greater part from standard broadcast stations.

There is nothing whatever in the present proceeding which casts any doubt upon the ability of the FM stations in the 88-108 megacycle band to render a superior, interference-free and static-free service over ranges of 60 miles, and perhaps in excess thereof. Despite earlier warnings and predictions, the salient fact is that the band assigned to FM broadcasting by the Commission will furnish an excellent service, and the industry has proceeded with notable dispatch to design and produce FM transmitting and receiving equipment which will render excellent service to the American people in the band assigned.