

DISCUSSION OF THE SECRET FM HEARING

An Examination of the Testimony, Now Declassified, of the FCC Hearing on March 12th and 13th, 1945

BY PAUL A. DE MARS*

IN ORDER that the issues under consideration at the secret hearing before the Federal Communications Commission on March 12th and 13th, 1945, may be presented with proper perspective and orientation, there is first presented a brief historical background.

Background ★ Frequency Modulation was disclosed to the radio art in October, 1935. The occasion was a demonstration before the Institute of Radio Engineers in New York City. Hardly a ripple of interest was aroused by this disclosure and it is interesting to note that the revolutionary implications in the field of communications and broadcasting were missed by the attending engineers.

In June, 1936 the FCC held an informal engineering conference at Washington, D. C., in the matter of "the allocation of frequencies above 30,000 kc. and the review of present frequency allocations." At this conference, Major Armstrong presented a sound-on-film recording of a comparison of FM and AM reception. The comparison was between reception of FM signals from a transmitter radiating about 2 kw. on a frequency of 41 mc. from an antenna located on top of the Empire State Building in New York City, and the 50-kw. standard broadcast station WEAJ. The receiving point was at Haddonfield, N. J., a distance of 85 miles. The recordings strikingly presented the marked superiority of FM at 41 mc. over the standard band in quality of service and reduction of noise. Nevertheless only Major Armstrong and the writer spoke for the inclusion of a band of frequencies above 40 mc. for the development of FM, and predicted the revolutionary implications of the demonstration. It is worth noting that the reception recorded at Haddonfield was at a distance of 85 miles from the transmitter, which is beyond the primary service range of the 50-kw. clear-channel AM standard broadcast stations in this area. The Commission did allocate the band 42.5 to 43.5 mc. for FM experimentation.

The pioneering in FM by Major Armstrong, the Yankee Network, F. M. Doolittle, and others directed the attention of the broadcasters to this new development.

Of special significance was the fine reception demonstrated at distances of 75 miles and more from the high-power stations at Alpine and Paxton.

FOLLOWING the Secret FM Hearing on March 12 and 13, 1945, there were intimations that serious errors in certain conclusions by the FCC's engineering department were suppressed by impounding the records under the cloak of military restrictions.

One of those conclusions was that F2-layer transmission would go twice as high in frequency as had been considered possible by others. Much publicity was given to this finding as a reason for shifting FM broadcasting to 88 to 108 mc. At the Secret Hearing, it was determined that the frequency increase was not 100%, but only 7%. Nevertheless, the Commission suppressed this information, and continued to offer the erroneous conclusion as a reason for shifting the FM band.

Although the records were declassified after V-J Day, nothing has been published on this subject, probably because few radio engineers have the background of knowledge and personal experience to analyze and discuss this testimony.

One of the engineers so qualified is Paul A. de Mars. For military reasons, he was not permitted to take part in the Allocations Hearings, as he was then commissioned as a Lieutenant Commander in the U. S. Navy. However, he did attend as an observer. His discussion of the Secret FM Hearing, therefore, is written from his own observation of the proceedings.

Recognizing that broadcasting in the VHF band was inevitable, the FCC ordered a hearing in March, 1940. At that time, there were some who favored AM for this band, but the advantages of FM

were so conclusively demonstrated that FM was selected for VHF broadcasting, and the band of 42 to 50 mc. was assigned.

Testimony at this hearing covered very thoroughly the propagation characteristics of frequencies above and below 40 mc. This testimony was in accord with the engineering facts, and recognized that a band from about 40 mc. up would provide the best service.

Then came the war, and the Radio Technical Planning Board was created at the request of the FCC. The RTPB reported that the consensus of its members favored the 42- to 50-mc. band for FM. However, upon the insistence of some network engineers who raised the question of the importance of the sky wave phenomena which might be expected to exist at certain positions of the sunspot cycle, the matter was referred to Dr. Dellinger, who resolved it in favor of the present band.

Dr. Dellinger's comment on the RTPB Panel 5 recommendation,

"Be it hereby resolved that it is the consensus of this Committee that the present position of FM Broadcasting in the spectrum should not be changed,"

is worthy of being fully quoted:

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D. C.

May 1, 1944

Mr. C. M. Jansky, Jr.,
970 National Press Bldg.,
Washington 4, D. C.

Dear Mr. Jansky:

I have your letter of April 20 requesting any information I can give on item 2 of the agenda for the April 11 meeting of RTPB Panel 5. I read pages 13 to 60 of the proceedings of the meeting as you suggested, and noted in particular that the motion on page 44 read: "I move you that subject to any information to the contrary from Dr. Dellinger, that this Panel adopt the recommendations of the Committee with respect to item 2 of this agenda." The Committee recommendation referred to was: "Be it hereby resolved that it is the consensus of this Committee that the present position of FM Broadcasting in the spectrum should not be changed."

The point in question is that the fre-

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quencies concerned are sometimes affected by long-distance interference, contrary to an expectation that was widely held at one time, and there is a fear that this interference may be so great as to seriously impair the usefulness of those frequencies for broadcasting. Essentially the Panel appears to request that I inform it whether that fear is well founded. *I believe I may with propriety respond to this request, and the answer is that the fear is not well founded.* (Author's italics.)

During certain years of the sunspot

FCC Hearings ★ The work of the RTPB finally came to hearing before the FCC in October 1944 and, barring some desultory observations, no one undertook to challenge its findings until a few days before the ending of the hearing. Then came a bombshell. The FCC authority on propagation, K. A. Norton, on the basis of some recently declassified information, predicted world-wide interference from the F₂ ionosphere layer at frequencies 100% higher than would be expected from any previous data.

group of men who have had long experience in propagation matters:

Dr. H. H. Beverage
 Dr. G. W. Pickard
 Dr. H. T. Stetson
 Dr. C. R. Burrows
 Mr. Stuart Bailey
 Dr. Edwin H. Armstrong.

They were in agreement as to the existence of basic error in Mr. Norton's prediction concerning F₂ layer interference. The conclusions reached are covered in a memorandum prepared by Doctors Beverage, Burrows, and Armstrong.

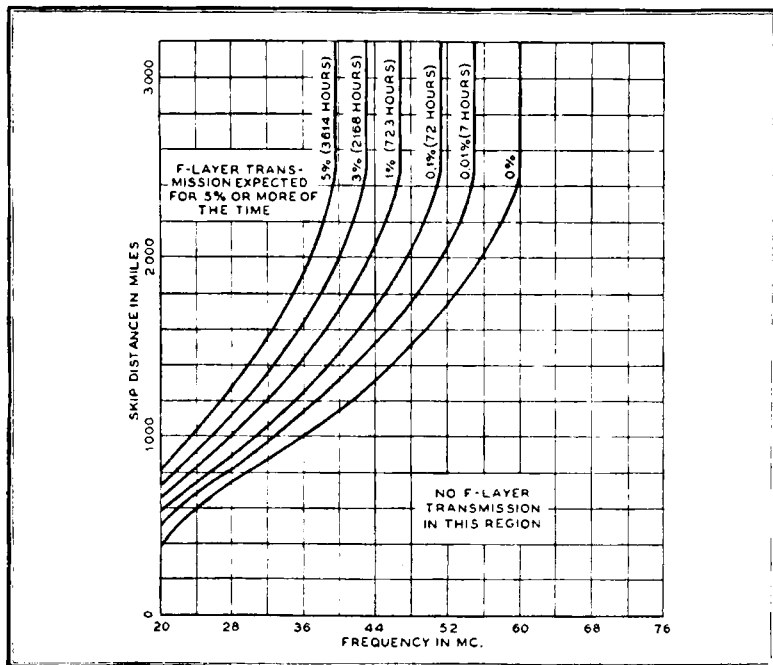
A separate Armstrong brief was presented with that memorandum at the oral argument. His brief and the memorandum were published in full in the March, 1945, issue of *FM AND TELEVISION*.

Summarized, this brief states in part that the difference of opinion between the Commission's proposals and the recommendations of the RTPB revolved about the evaluation of the amount of interference which may result from the reflection of radio waves from the various ionized strata above the earth. The problem was more involved by reason of the fact that the type of interference which had been emphasized as the most serious type, namely, F₂-layer transmission, is not now being experienced in any of the channels of the present FM band, and so cannot be positively evaluated by direct measurement.

The Norton testimony at the October hearing, dealing with the skywave interference, centered about Exhibit 380, which undertook to predict by a series of curves the intensities of these interferences and the percentage of time over which they might be expected to occur within the boundaries of the United States. These curves, Figs. 1, 2 and 3 of Exhibit 380, are reproduced here for reference purposes.

The Secret Hearing ★ At the oral argument, the Armstrong brief and the memorandum prepared by Doctors Burrows, Beverage and Armstrong, which was also presented on behalf of Panel 5 of the RTPB, were not challenged. Mr. Norton, however, declined cross-examination on the subject of his conclusions with respect to F₂-layer interference, stating that he was prevented from defending his position because of the military classification of the data, and suggesting that a closed hearing be held under the supervision of the military. Questioned by Mr. Denny if he would be able to substantiate the conclusions set forth in Exhibit 380, Mr. Norton replied: "Yes, I will certainly be able to substantiate those conclusions at such a session."

There followed the secret hearing on
 (CONTINUED ON PAGE 53)



NORTON FIG. 1 — EXHIBIT 380

PERCENTAGE of the listening hours and (in parentheses) the number of listening hours (6 A.M. to Midnight) during the last sunspot cycle (1933-1944) for which the F-layer skip distance was less than the values shown for particular frequencies. Estimated from the National Bureau of Standards Ionosphere measurements at Washington, D. C.

cycle F₂-layer transmission at those frequencies occurs over long distances for short parts of the day, and sporadic-E transmission occurs at irregular times in all years. The phenomenon of very short bursts of long distance interference appears to be closely associated with, and possibly a manifestation of, sporadic E transmission. The extent of these effects, however, is not such as to seriously impair the value of these frequencies. *It may also be stated that no radio frequencies are free from transmission vagaries.* (Author's italics.)

I surmise that a general statement of this kind is all that the Panel wishes. If it desires specific propagation data so as to go into the subject quantitatively, I shall be glad to take up the request with the military committee which controls the work of my laboratory.

Very truly yours,
 (signed) J. H. DELLINGER,
 Chief, Radio Section.

Time did not permit thorough examination of the Norton figures, both with respect to the extrapolations and the assumptions from which they were derived. Furthermore, Mr. Norton's definite predictions of F₂ skywave interference from without the country were based upon ionosphere measurements at a then unidentified part of the world. Declassification of this material permits the disclosure that the site of these measurements was the island of Maui, Territory of Hawaii.

Subsequently, Dr. Beverage pointed out in a supplemental statement certain errors in the Norton testimony.

Nevertheless, on January 15, 1945, the FCC issued its proposed allocations, with FM moved up in frequency, and on February 26, 1945, began its hearings of oral argument on its findings regarding FM.

The Norton's testimony and Exhibit 380 were reviewed carefully by the following

(CONTINUED FROM PAGE 48)

March 12th and 13th, 1945. Testimony covering all aspects of FM broadcasting with respect to the frequency bands under consideration was presented. Nothing appreciably modifying previous testimony developed, except in connection with the F2-layer interference controversy. The high spot of this hearing was the change in Mr. Norton's testimony, in which he reduced his prediction of F2-layer interference from 100% to 7% over the accepted Bureau of Standards measurements made at Washington. Cross examination forced

and concise account of this complex and confusing subject, it follows in full, with Major Armstrong's permission:

Docket No. 6651

April 18, 1945

This brief is prepared at the instance of Commissioner Denny, who made the suggestion while still General Counsel of the Commission.

Its purpose is to point out to the members of the Commission the conflicts between the record of the open hearing and that of the secret hearing and the impor-

mission into the United States up to frequencies 100 per cent higher than that indicated by the Washington data.

The testimony given on behalf of the Commission in the secret hearing shows that both these propositions have now been withdrawn. It is now admitted that the Washington data applies throughout the United States. The highest increase which is now predicted above the Washington data, for F2 interference from foreign stations, for the same conditions under which 100 per cent was predicted in the October testimony, is less than 7 per cent.

The important parts of the testimony in the open and in the closed hearings are quoted hereinafter. Where the testimony quoted from the closed hearing modifies the public record, its importance is pointed out and references are made to the memorandum filed at the oral argument by Panel 5 and to my brief presented at that time. (Page references to my brief refer to the printed copy.)

History of This Controversy ★ Since the questions of fact revolve entirely about the testimony with respect to Exhibit 380, it is essential to review its history insofar as its figures relate to the F2 type of interference.¹ This Exhibit was first presented by Dr. L. P. Wheeler on October 26th, who described briefly its four figures. On October 28th Mr. K. A. Norton, formerly employed by the Commission but now employed in the Operations Analysis Division of the Army Air Force, testified about Exhibit 380 in detail.

On the basis of recently declassified ionospheric measurements made in other parts of the world, Mr. Norton predicted with great definiteness skywave interference (F2) from without the country at frequencies far higher than had ever been experienced in past sunspot maximums.

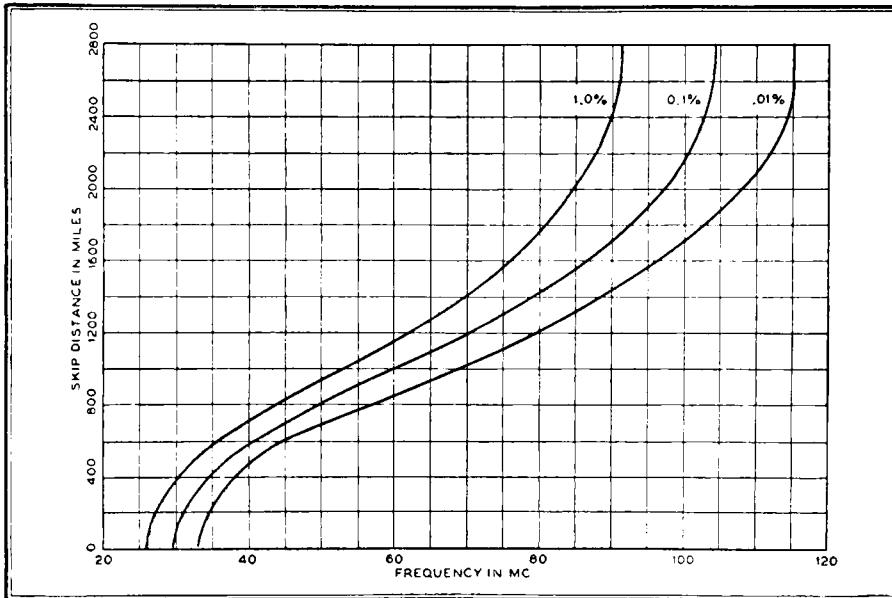
Fig. 2, based on an unnamed point without the country, shows F2-layer transmission at frequencies approximately twice as high (120 megacycles) as Fig. 1 based on the Washington measurements of the Bureau of Standards, where 60 megacycles is the absolute cutoff.

Referring to the measurements at other points throughout the world Mr. Norton testified:

"When this world-wide picture of the ionosphere becomes available the inadequacy of the Bureau of Standards Washington data, made at a single geographical location, becomes apparent" (pp. 3763-3764).

On the basis of this figure Mr. Norton recommended placing FM and television

¹ No mention will be made of Sporadic E, as an agreement on a set of facts has been arrived at with the Engineering Department of the Commission.



NORTON FIG. 2 — EXHIBIT 380

ESTIMATED percentage of the listening hours during the last sunspot cycle (1933-1944) for which the F-layer skip distance would have been expected to be less than the values shown for particular frequencies. (The conditions shown here are based on ionosphere measurements at the station having the highest presently-known critical frequencies and thus correspond to the worst anticipated conditions of potential F-layer interference to United States VHF stations from VHF stations in any part of the world. The measurements at this ionosphere station were available only from March through August 1944 and were estimated for sunspot cycle maximum conditions.)

him to admit that F2-layer reflections from the ionosphere over the equator had no bearing on interference in the U. S. unless the ionosphere within 1,250 miles of the border would support transmission. This was the point of the Beverage-Burrows-Armstrong memorandum which charged the basic error. Attempts to make public this change in the Norton testimony were unsuccessful. However, Mr. Denny, then General Counsel, suggested that Major Armstrong prepare a classified brief for the Commission for the purpose of pointing out the conflicts of the Norton testimony in the public and the secret record. Formerly classified as Restricted, this brief has never been published. It presents the comparison of the record of the open hearing and the secret hearing where conflicts exist, and where the public record has been repudiated.

Since it does not appear possible to present a more thorough, understandable,

tant aspects wherein the testimony in the public record has been repudiated, not only by Mr. Norton himself but also by members of the engineering staff of the Commission.

The brief is long because the mistakes made in the public hearing were not freely admitted but were developed only after prolonged cross-examination in the secret hearing.

The conflicts arise entirely by reason of testimony given on October 28th by Mr. K. A. Norton a few days before the ending of the hearing. In his testimony at that time Mr. Norton characterized the Washington data of the Bureau of Standards, or which the art has relied for guidance for years, as inadequate both as a guide for F2 layer skywave interference between stations within the United States and for interference from foreign stations. As a second proposition, Mr. Norton and Dr. Wheeler then predicted F2 skywave trans-

above 120 megacycles (public record pp. 3771-3772).

While Dr. Wheeler made no allocation recommendations, he made the following statement about Fig. 2 after having described the curves of Fig. 1 based on the Washington measurements:

"The second figure shows a similar state, but the measurements used are taken at a station having the highest presently known critical frequencies, which will thus give us the worst conditions which may be anticipated for potential F-layer interference to United States VHF stations from VHF stations in any part of the world."

On cross-examination of Mr. Norton, the question of the applicability of the curves of Fig. 2 to interference conditions within the United States was raised. The cross-examination was handicapped by the fact that the location of the point for which the curves of Fig. 2 were predicted was unknown.

Mr. Norton repeatedly stated during his cross-examination that the Washington data did not govern interference within the United States. On pages 3794-3795, as part of an answer he volunteered this statement:

"... But it does not follow that this Fig. 1 is applicable to the United States, interference in the United States, whereas Fig. 2 is applicable to interference only from points outside the United States. These two figures give extreme conditions between which I think the interference problem lies, and that is true both within the United States and outside of the United States. Unfortunately, because of the restricted character of this material we can't be more specific, but we can go that far."

On page 3799 he was asked the following question about interference between stations within the United States and made the following answer:

"Q. I just wanted to get the first point clear, that so far as we are concerned if we moved up to 60 megacycles — and I take 60 megacycles because it comes right on one of the curves and it is easier to read — we would accomplish two things in our interference between our own high powered stations within the United States. We would eliminate F2 layer interference practically entirely, I will say, because nothing is perfect in this world, and at the same time we would reduce the sporadic E from 1/10th of 1 percent of the time to 1/100th of 1 percent of the time."

"A. Well of course, as I mentioned before, this figure is not — Fig. 1 — is not applicable to the whole United States and we do know that there are

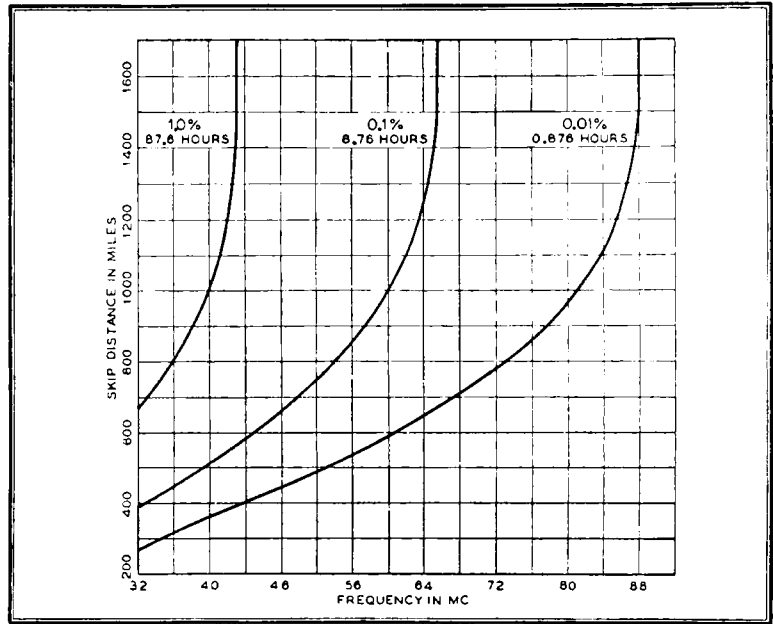
other places in the United States where the situation is more like Fig. 2, although not as high. So I am afraid that relative to the F layer problem, 60 megacycles isn't high enough."

On page 3800 he was asked the following question:

"Q. What would be the curve which would determine the percentage of interference and the value of it within the United States among our own high power stations? You said it is not Fig. 1 and it is not Fig. 2. Is there any curve which you could draw based on any data which you have which would en-

this I understand cannot be discussed at the hearing."

Dr. Beverage then pointed out that the condition of the ionosphere within approximately 1,000 miles of the border of the United States would determine the question of whether interference entered the United States from stations in other parts of the world, and not the condition of the ionosphere at some unknown location if this location were beyond this boundary. (At the secret hearing this unknown location was revealed as being more than twice this distance from the United States.)



NORTON FIG. 3 — EXHIBIT 380

PERCENTAGE of the time and (parentheses) the number of hours during the period September 1943 through August 1944 for which the Sporadic E-layer skip distance was less than the values shown for particular frequencies. Estimated from the National Bureau of Standards Ionosphere measurements at Washington, D. C.

able us to estimate how much interference there would be?"

"A. Well, no I am afraid that it would not be desirable at this time to settle that question in a public hearing; that is, as far as I am concerned. It may be that you can find other witnesses who would be able to do that."²

Under date of November 1 in a supplemental statement filed with the Commission at its request, pp. 4485-4495, Dr. H. H. Beverage took issue with Mr. Norton's conclusions with respect to interference coming from without the United States as predicted from the curves of Fig. 2. He pointed out that:

"In order for Fig. 2 to serve a useful purpose one should know the location at which the measurements were made;

² As will appear hereinafter from the testimony in the closed hearing, Fig. 1 does apply to interference within the United States between our own stations.

During the latter part of November, an informal conference was held in the office of Mr. Adair and attended by members of the Armed Forces, the Commission's staff, the Bureau of Standards, and industry.

On January 24th a new position on the subject of F2-layer interference was taken in a paper presented by Messrs. Norton and Allen at the annual convention of the Institute of Radio Engineers.

This paper in its final form was recently published by the Commission under the title "Very-High-Frequency and Ultra-High-Frequency Signal Ranges as Limited by Noise and Co-Channel Interference" by E. W. Allen, Jr., Mr. Norton having withdrawn his name as co-author in the meantime.

The paper contains much of the material of Exhibit 380, except that controversial Fig. 2 of that Exhibit, which

showed F2 transmission at frequencies 100% higher than Washington, is missing, On page 6, referring to Fig. 4 of the paper, identical with Fig. 1 (derived from the Washington data) of Exhibit 380, appears the statement that "The best estimate which we are able to make is that the frequencies shown in Fig. 4 should be increased by 15% when considering conditions applicable to interference throughout the United States."

This represented a repudiation as of a date of January 24th of the "facts" testified to by Mr. Norton in the October hearing about Fig. 2 (Exhibit 380) as regards interference coming from without the United States.³

The importance of this does not seem to have been recognized because of the continual reference to Mr. Norton's testimony as "factual data."

On January 15, 1945, the Commission issued its proposed allocations and on February 28th began its hearings of oral argument on its findings regarding FM.

At the oral argument there was presented on behalf of Panel Five a memorandum concerning F2 transmission prepared by Doctors Burrows, Beverage and Armstrong, and concurred in by Doctors Stetson and Pickard and Mr. Stuart L. Bailey. The memorandum pointed out certain fundamental errors in Mr. Norton's conclusions. This memorandum was also presented by me as a part of my brief as filed and testified to without cross-examination or any attempt to overthrow any of its findings.

At the oral argument Mr. Norton declined cross-examination on the subject of his conclusions with respect to F2 layer interference, testifying (public record, p. 4870) as follows:

"Unfortunately due to security considerations I will not be able to discuss in much more detail at this time the basis for the conclusions which I reached relative to the problem of F-layer interference. If the Commission feels that the facts in this regard are necessary before it can make a decision as to the proper place for FM in the radio spectrum, then I suggest that a closed session be held under the supervision of the military."

On page 4872 the following question was asked and answered:

"Mr. Denny. I would like to ask one question. I do not know whether you would want to go this far on the record.

³ During the oral argument Mr. Allen's paper was offered in evidence as Exhibit 593 (p. 4851). Cross-examination about the change was refused on the ground of classified information at the oral argument as will also appear hereinafter (public record pp. 4875-4878). However, as will also appear hereinafter, even this 15% increase was withdrawn (secret record pp. 45 and 226).

I want to ask a question, but if there is any doubt about it, do not answer it.

"It has been suggested in the course of these hearings when you presented your Exhibit 380 that the curves contained in that Exhibit indicated much greater F-2 layer reception than had heretofore been anticipated and the briefs and oral presentations that have been made have suggested you made certain fundamental errors in the computation of those exhibits. I would like to know whether, if such a closed session as has been suggested is held, you would expect to be in a position to substantiate the conclusions set forth in Exhibit 380.

"Mr. Norton: Yes, I will certainly be able to substantiate those conclusions at such a session."

The Closed Hearing ★ The statements which have been quoted from Mr. Norton's testimony in this brief are those whose accuracy has been questioned in the memorandum filed on behalf of Panel Five and in my brief.

They are the principal "facts" on which the Commission proposed to move FM.

They are the "facts" which were repudiated at the secret hearing.

At this point it is in order to restate the questions in which we are interested:

(1) That Fig. 1 represents the conditions for F2 transmission between stations located within the United States for conditions of the last sunspot maximum.

(2) That what we are interested in with respect to interference entering the United States (or leaving it) is the condition of the ionosphere at a point approximately 1250 miles beyond our borders and not the condition of the ionosphere at the Equator or any similar distant part of the world.

(3) That Fig. 2 does not represent interference conditions which may be expected for the United States from foreign stations anywhere.

Point (1) will be treated first. No attempt whatever was made in Mr. Norton's testimony to substantiate the statements abstracted and reproduced on page 4 of this brief that the interference between stations located within the United States lay between the limits of Fig. 1 and Fig. 2, that is, occurred at frequencies higher than indicated by the Washington data. It was admitted by both Mr. Adair and Mr. Allen that Fig. 1 represents the condition within the United States. During the testimony of Dr. Newbern Smith, who is associated with Dr. Dellinger in the propagation studies carried out by the Bureau of Standards, he was questioned as follows (secret record p. 45):

"Mr. Adair: If my memory is correct, I believe, referring to Mr. Norton's

Fig. 1 (Exhibit 380), in that conference we held in my office some months back, you indicated that you felt that maybe those frequencies should be increased by about 15%. Would you correct me if I am wrong? How does that agree with Mr. Norton's Classified Exhibit No. 7 here?"

"Dr. Smith: I have not seen that Exhibit. I am afraid I can't answer that off-hand. I would have to study this.

"Mr. Adair: Maybe you can tell us after lunch. I believe you did say they should be increased about 15%.

"Dr. Smith: That is for transmissions coming into the continental United States from outside.

"Mr. Adair: Yes; that is right."

During Dr. Wells' examination Mr. Allen corrected the view expressed in Exhibit 593 in a statement as follows (secret record p. 226):

"Mr. Denny: I think Mr. Allen has a question.

"Mr. Allen: I have discussed it with Dr. Smith. It was my understanding that the 15% increase in frequency was due to the stations in the southern part of the United States interfering with each other. Dr. Smith said I was not correct on that. It was for interference coming into the United States from outside."

On page 23 of my brief, commenting on the statement in Mr. Allen's paper Exhibit 593, appears the following statement:

"If by 'throughout the United States' is meant interference between our own stations it is believed to be still incorrect.

"If it is understood that the critical frequencies as determined by the Washington measurements should be increased by 15% for certain parts of the United States for interference coming from without the country, then I think we shall have arrived at the facts with respect to Fig. 2 (Exhibit 380)."

The accuracy of this statement is now admitted.

With respect to point (2), Dr. Wells, who made the measurements on which Mr. Norton based the predictions of Fig. 2 of Exhibit 380, testified as follows (secret record p. 225):

"Major Armstrong: Dr. Wells, do you agree that insofar as interference entering the United States from without the country is concerned, the thing that we are concerned with is a line roughly 1250 miles around the borders of the United States, and in the condition of the ionosphere at that point?"

"Dr. Wells: Yes, insofar as F2-layer interference is concerned."

Mr. Norton, on the same point, testified as follows (secret record p. 238):

"Major Armstrong: Everybody is already agreed, I take it, that for interference to enter the United States a line roughly 1,250 miles beyond our borders will determine whether or not interference gets into the country.

"Mr. Norton: Yes, that is correct.

"Major Armstrong: And unless the ionosphere 1,250 miles away supports transmission, then we need not worry about F2-layer interference.

"Mr. Norton: That is right."

This confirms the statement in the memorandum (my brief, p. 37):

"What we are concerned with respecting transmissions entering the United States is the condition of the ionosphere at points lying within a line approximately 1200 miles beyond our borders."

A condition of the ionosphere having some high reflecting value over the Equator, or some other distant point, is not the controlling factor for interference entering the United States.

With respect to point (3), the difference between the testimony in the open and closed hearings is the most striking of all the conflicts.

Whereas Fig. 2 shows transmission up to a cutoff value of 120 megacycles, or 100% higher than the Washington data, the cutoff frequency now predicted by Mr. Norton for transmission over this path for the same conditions of sunspot maximum is 64 megacycles (Classified Exhibit 7) for the San Francisco-Honolulu path. This is less than 7% higher than the cutoff frequency shown in Fig. 1 of Exhibit 380 (Washington). The Miami-Lima, Peru, cutoff frequency is given as 62 megacycles, or approximately 3½% higher than Washington. These figures are for the highest hours of the highest month of a sunspot maximum having the intensity of the last cycle.

This confirms the statement of the memorandum (my brief p. 37):

"Experience gained by operation during past sunspot cycles indicates that the Washington data gives an accurate guide for transmission characteristics throughout the greater part of the United States. . . .

"There is some experimental evidence gained from amateur experience that transmission as it affects the south and southwest portion of the United States, may be expected to run 10 to 15 per cent higher than that indicated by the Washington data. The experimental results of the transmission appear to be highly sporadic and to have been observed on relatively few days."

Analysis of the Norton Testimony in the Closed Hearing ★ While under any ordinary circumstances the matter might be dropped at this point with the statement that Dr. Dellinger's appraisal of the situation as stated to Panel Five has now been confirmed, the repeated references to Mr. Norton's testimony as "factual data" warrants further examination of the record.

In his direct examination in the closed hearing Mr. Norton presented the "control point" theory of ionospheric propagation from a classified document known as the IRPL Radio Propagation Handbook (Classified Exhibit No. 1).

This Handbook contains the most modern theory of propagation as worked out by Dr. Dellinger's laboratory in cooperation with the corresponding British laboratory. Dr. Smith, who is largely responsible for it, testified as follows:

"Major Armstrong: Dr. Smith, as I understand it the theory which was presented here⁴ was worked out by your Laboratory and the corresponding British Laboratory.

"Dr. Smith: That is right.

"Major Armstrong: I would like to agree with it also, Mr. Chairman. Our disagreement is not with what was said here today but what was said in the record last October."

To clear up on the record the difference between the predictions made by Mr. Norton about interference coming into the country on last October and his predictions during the closed hearing and the reason for it, I quoted from his previous testimony, where the reflection from only one point of the ionosphere was considered, and asked the following question (secret record pp. 30-31):

"Major Armstrong: There should have been two points taken into consideration there in accordance with the theory you have expressed today. Is that right?"

The following incomprehensible answer was given:

"Mr. Norton: No. The present theory I have expressed today would involve only one, namely, the point which would support the highest frequency transmission, and that point might be the one near the transmitter or the one near the receiver. I think that is shown quite well on Classified Exhibit No. 3. For example, if we take the path from Buenos Aires to Washington we find one control point 1,250 miles from New York that is marked Number One on this Exhibit, and we find another control point not at the Equator, to be sure, but about 1,250 miles from Buenos Aires. Now I have looked into the

⁴ By Mr. Norton.

matter and I have found certain paths between South America and the Eastern part of the United States where the control point would be on the Equator, and it is quite obvious if you rearrange the geometry here a little you can find such a point.

"And in addition it turns out that the point in the ionosphere which controls these transmissions is this more southerly point around the Equator at certain seasons of the year and certain times of the day. So that the method is briefly this. You select on a long distance circuit two control points, each 1250 miles from transmitter and receiver. Then you investigate the ionosphere for these two points and you find the maximum usable frequency for each of these points in the ionosphere and the one which will support the —, that is, the one at which the maximum usable frequencies are closest is the one to use in deciding the maximum usable frequency for that circuit."

The IRPL Handbook (Classified Exhibit No. 1) specifically states that it is the lower of the two control point frequencies which determines the maximum usable frequency between two places on the earth's surface.

As Step 9 in the process of making the determination of the frequency to use in communicating between two places the Handbook states (p. 52):

"9. Read the value of the m.u.f. (maximum usable frequency) at each control point. The lower of the two values is the m.u.f. for the path. . . ."

The first sentence in Mr. Norton's answer states the opposite. The final sentence does not make sense.

It is my understanding that Mr. Norton did not correct his testimony after it was transcribed. The question of whether there was a typographical error was taken up with the Engineering Department on April 7th which advised me that Mr. Norton was on the West Coast. On April 16th the Engineering Department advised me that it had not been able to get in touch with Mr. Norton but that the word *closest* was probably *lowest* as that was the only logical conclusion from the context of the sentence.

However, the first sentence of the answer states the *highest* frequency should be taken and is in conflict with the last sentence of the answer if it states that the *lowest* should be taken.

If Mr. Norton used only the highest frequency in his predictions of last October with respect to the effect of the Fig. 2 conditions on interference in the United States, then the error pointed out in the memorandum is admitted.

(CONCLUDED ON PAGE 64)

DISCUSSION OF THE SECRET FM HEARING

(CONTINUED FROM PAGE 56)

However, a different explanation of the difference between the October predictions and the closed hearing testimony is given by Mr. Norton in subsequent cross-examination.

On page 238 (secret record) the subject was pursued further and the following questions asked and answers given:

"Major Armstrong: Now I refer to Exhibit 7, and I note you have modified your predictions of interference from South America and Australia of 80 megacycles for several hours a day, given on page 3767 (public record).

"Mr. Norton: Yes, that is correct.

"Major Armstrong: And I assume that that is because you have taken into account the condition of the ionosphere at the 1,250 mile points.

"Mr. Norton: No; that is not the case. I think perhaps you misunderstood my testimony.

"Major Armstrong: You state it then.

"Mr. Norton: Surely. The reason I changed my estimate was that I used a new method of correcting sunspot minimum to sunspot maximum conditions, taking into account the geomagnetic and geographic latitudes of the ionospheric reflecting points."

Now taking this answer at its face value, compare it with the testimony given in the October hearing on the subject of correcting sunspot minimum to sunspot maximum conditions (public record p. 3766):

"Upon considering all of the data from these other stations, it was found that the ionosphere over one of them supported higher frequency transmissions than the ionosphere over any of the others and this station was chosen for further analysis. Unfortunately, data are not available at this station prior to March of this year so that it has been necessary to estimate sunspot cycle maximum conditions.

"Two independent methods were used for making these estimates and the resulting values obtained by these two methods agreed within a few per cent.

"Fig. 2. shows the skip distances as a function of frequency for various percentages of the listening hours during the last sunspot cycle that the transmissions would have been expected over paths passing near this particular ionosphere station."

The attention of the Commission is now specifically directed to Mr. Norton's statement that Fig. 2 (Ex. 380) which showed F2 transmission up to a cutoff value of 120 megacycles and which was based on two independent methods for making these estimates whose resulting values are supposed to have agreed within a few per cent, has

now been superseded by a new method of correcting sunspot minimum to sunspot maximum conditions which gives a cutoff value of the transmission of 64 megacycles, or 7% higher than the Washington data instead of 100% higher.

Hence it is now admitted in the secret hearing that the high F2-layer interference predicted last October, on the basis of the then newly declassified military information, has now by reason of the adoption of a new method of "estimates" been reduced to a frequency practically coincident with the long-known Washington measurements (7% higher).

Mr. Norton, whose F2-layer predictions have been withdrawn, now seeks to substitute as a basis for moving FM up a prediction with respect to maximum sunspot activity over the next 30 years which is not only at variance with the history of sunspot cycles during the past 200 years but was specifically challenged at the secret hearing by Dr. Harlan T. Stetson, an acknowledged expert in the field, a position which Mr. Norton does not claim for himself.

While the subject has now approached close to fantasy, if the Commission wishes to undertake a further study I understand Dr. Stetson will be glad to prepare a memorandum.

In closing, the attention of the Commission is called to the fact that evidence of long distance tropospheric transmission (500 to 1,000 miles) at frequencies in the vicinity of the proposed new FM band is accumulating. These transmissions are being observed from very low powered transmitters.

Respectfully submitted,
EDWIN H. ARMSTRONG

The foregoing facts have been assembled to assist the reader in drawing his own conclusions, taking into consideration all other factors that have been presented in the public record.

It is the writer's opinion that the reliability of the testimony of many witnesses concerning the advantages of the higher frequencies is seriously open to question.

However, the matter of the wisdom of the Commission's action in moving FM from its former band to 88 to 108 mc. will not be discussed in this memorandum, since its sole purpose is to present facts developed in the Secret Hearing insofar as they relate to F2 transmission.

In succeeding issues, these propagation questions will be examined further.

ENGINEERING SALES

(CONTINUED FROM PAGE 8)

graph sales in the middle western area. He will make his headquarters in Chicago, where he has been previously associated with both Lyon & Healy and Bissell-Weisert.

Dallas: Fred Cross, recently released from the AAF, is staff assistant at J. Y. Schoonmaker Company, manufacturers' representatives at 2320 Griffin Street.

Motorola: Mid-western regional manager is Murray Yeomans. He has been in the Motorola service and engineering products departments for 11 years. Now he will make his headquarters in St. Louis.

Jackson, Miss.: S. D. Camper, who resigned recently from the Crosley sales organization, has become president of Southern Wholesalers, Inc. This company will distribute the Crosley line in the Jackson area.

Espey: Has appointed Morham Exporting Company, 458 Broadway, New York City, as representatives for South and Central America and the West Indies.

Raytheon: Has launched an extensive promotion program behind the Raytheon Bonded Electronic Technician Program, under the direction of Arthur E. Akeroyd, distributor sales manager. Purpose is to help legitimate service men by assuring their customers of bonded protection against gyp practices such as were disclosed by the Reader's Digest of August 1941.

Gates Radio: Has opened a sales office at 40 Exchange Place, New York City. B. W. Lacher is in charge.

Snyder: About January 1st, Snyder Manufacturing Company, of Philadelphia, will open a Chicago sales office in the 333 Building, with Dwight Nelson and Leo Gibrich in charge as midwest representatives.

Kaar: Will expand emergency and marine radio telephone sales in New England through representative Irving I. Kahn & Company, 3324 Main Street, Hartford; in the middle Atlantic states through Jack Weber, 114 Liberty Street, New York; and in Kansas, western Iowa, Missouri, Nebraska, and Colorado through C. E. Moore, 3118 Linwood Boulevard, Kansas City, Mo.

Stromberg-Carlson: Callander-Lane Company, Columbus, Ohio, will distribute Stromberg radios in the central Ohio area. Partners in this concern are D. G. Callander and R. H. Lane.

Crosley: Newcomer is S. D. Mahan, appointed vice-president and general sales manager in charge of domestic and export sales, advertising, and service. For nearly three years he has been director of War Bond advertising and promotion for the U. S. Treasury, and previously served as general advertising manager for Westinghouse.