The National Association of Broadcasters
NATIONAL PRESS BUILDING ★ ★ ★ ★ ★ WASHINGTON, D. C.
JAMES W. BALDWIN, Managing Director

NAB REPORTS ★ ★ ★ ★ ★ Vol. 4 - - No. 59
OCT. 15, 1936

Further Testimony at FCC Allocation Hearing

A number of witnesses appeared today before the Federal Communications Commission at the allocation hearing and at adjournment Judge Sykes, chairman, announced that tomorrow morning engineers for the Columbia Broadcasting System would begin their testimony. He stated that at the conclusion of Friday's hearing adjournment would be taken until next Monday. There is no definite indication as to how long the hearings will continue but it is not expected that they will run for more than two or three days next week.

Among witnesses heard today were: William B. Way, Vice President and General Manager of KVOO, Tulsa, Okla.; D. A. Read, Station WTIC, Hartford, Conn.; Charles W. Horn and Dr. C. B. Jolliffe, engineers, appearing on behalf of the National Broadcasting Company.

William B. Way

Mr. Way during the course of his testimony told the Commission that his station believes that it is inadvisable for clear channels to be forced into sharing time arrangements and requested that stations of that type be allowed to utilize "their equipment, justify their investments, and above all, to protect the consumer in his right to uninterrupted reception."

Mr. Way said:

Our principals own and operate radio station KVOO in Tulsa, Okla., which is a cleared channel sharing time with station WAPI of Birmingham, Ala. In our testimony before this Honorable Commission, in keeping with the informal hearing docket No. 4063, we desire to present our contentions with respect to certain phases of the present allocation and future allocation of radio frequencies.

We are of the opinion that the present allocation of radio frequencies, as now maintained and supervised under and by virtue of the authority of the Federal Communications Commission, with respect to radio broadcasting, in an effort to serve the public interest, convenience and necessity, is inadequate to keep pace with the developments which have been brought about by the recent past, but which must eventually evolutionize radio broadcasting.

As brought out in the statement of Honorable John W. Kendall, associate counsel of certain licensees on shared time cleared channel assignments, KVOO-WAPI, WOWO-WWVA and KEX-KOB, have been permitted to operate simultaneously during daytime hours. KVOO, however, did not appear with the group above mentioned because we felt that our station stands in a unique position as compared with the other four sharing time stations operating simultaneously during daytime hours. The importance of this peculiar and difficult situation was in effect recognized by the Clear Channel Group when Mr. Edwin W. Craig, chairman of the group, stated, "Such, for example, is the case where two clear channel stations are dividing time and are located at substantial distances from each other. We can readily appreciate and sympathize with the economic hardship imposed on them."

Experiments

Many years of experiment have been consumed by all phases of the radio broadcasting industry, in an effort to determine the reaction of the public to the utility of radio. To a great degree, natural and man-made interferences have been conquered as a result of surveys and technical improvements in reception and transmission. While we have not made a comprehensive survey of certain economic problems which might indirectly bear upon the ultimate solution, nevertheless, our research has disclosed that very little attention has generally been given by the industry as a whole to the consumer or "listener-in" as an indispensable factor in the equation which proves to us that radio broadcasting must have clear channels in the true sense of the term. We are of the opinion that the consumer's place in the industry is of equal importance with that of the advertiser. A careful study of the periodicals devoted to radio broadcasting convinces us that the attention given to the commercial picture far outweighs the consideration due to the consumer. The consumer's annual investment in new receiving equipment in order to obtain the maximum reception, together with the consumer's cost of operation of his receiving set, is of major importance, since without the consumer, radio broadcasting would have no outlet. The consumer, then, must be considered in connection with the retention of clear channel stations. This consideration would yield to the consumer the greatest utility of his receiving set prior to the obsolescence period which is bound to come with respect to his receiving equipment; especially is this true when we consider the future developments which are certain in radio broadcasting. When television is added, the situation will again be different, but for the moment radio broadcasting is in effect a vocal art and as such is undergoing rapid development. I think that in principle, the use of radio should increase public enlightenment, encourage responsible citizenship, and enhance interest, intelligence and tolerance in our world of today.

Proposition No. 1

> The retention of "Clear Channel Stations" as defined in Section 72 of the Federal Communications Commission Rules and Regulations, with certain exceptions as may be necessary to provide the millions of consumers in America with a maximum of service.

In this connection we recommend reallocation of a sufficient number of stations in such a manner that east-west duplication will be secured. This we believe is necessary in order to relieve the allocation congestion in the center of the country.

Proposition No. 2

> Power increases on Regional and Local stations, but with less protection to their secondary coverage; by Regional stations we mean "regional station" as defined under Rules and Regulations of the Commission, section 73, to-wit: A station licensed to operate simultaneously with one or more stations assigned to the same frequency designated for such use, and with an authorized power of not less than 250 watts nor more than 1,000 watts at night, and not more than 2,500 watts during daytime. By "local station" we mean, as defined in section 74 of said rules, to-wit: A station licensed to operate with other stations assigned to the same frequency designated for such use, and with an authorized power of 100 watts at night and not more than 250 watts during the daytime.

It is our opinion that, by giving less protection to secondary coverage, the result would be considerable further duplication in the stations of each of the classifications listed, namely, regional and local.

Proposition No. 3

The utmost of service, efficiency, utility and convenience should be maintained on all radio stations, with the proper preservation of clear channels in order to meet national emergencies.

It is our belief that in the event of a national emergency, such as war, all radio facilities, broadcasting, point to point, amateur, police, etc., might be subjected to governmental service. This should make it imperative that the United States take advantage of all technical advances to have available the most efficient mass communications system possible. This is especially important in view of the fact that neighboring countries may not be, in fact have not been, limited to a maximum of 50 kilowatts power. We have no assurance that nearby high-power stations will not be built and operated in such manner as to deliver a comparatively usable signal to a large portion of the United States, blanketing or making useless some of our most consistently serviceable channels. These usable signals from foreign stations would create a grave potential propaganda hazard. We should therefore take every reasonable advantage of technical progress, through private initiative, to build for our national physical and morale protection the most efficient broadcasting transmission system of which our nation is capable; a system on a par with the technical advances we have made in all branches of science and industry.

Proposition No. 4

Immediate steps should be taken to eliminate the necessity of stations sharing time on clear channels.

We are of the opinion that there should be a change in the present policy of allowing clear channels to be operated as sharing time channels. According to section 79 of the Rules and Regulations of the Federal Communications Commission, Part III, the term "sharing time station" means "a station, the operating hours of which are so restricted by the station license as to require a division of time with one or more other stations using the same frequency in the same geographical area."

It has been our uniform experience that the consumer is constantly complaining because of his inability to have what we choose to call *constancy of radio* convenience.

To illustrate our proposition, we must necessarily be governed by our own experience, which, in our opinion, is largely true where "sharing time" situations exist; for example:

KVOO at Tulsa, Oklahoma, divides time with WAPI, in that on Monday, Tuesday and Wednesday KVOO goes off the air after 9:00 P.M.; Thursday, Friday and Saturday in October, KVOO goes off the air from 5:45 P.M. to 9:00 P.M. and on Sunday off at 8:15 P.M. KVOO is a station with operating power of 25,000 watts, on 1140 kilocycles, whereas WAPI at Birmingham, Alabama, has an operating power of 5000 watts, on 1140 kilocycles, which divides night time with KVOO as heretofore pointed out.

They both are designated as operating on a nationally *cleared* channel. The consumer or "tuner-in" does not take time to become fully informed as to why this condition exists, nor as a layman would he understand the situation. Most consumers are not able to grasp the times of operation and silence of stations. They are interested in tuning in on their favorite station and they expect an *uninterrupted reception.* We have found, by our contact with our listeners, and by reason of numerous surveys which have been made, that there is a tendency for the consumer to tune his receiving set to his favorite radio station for his evening radio broadcasting reception.

Case of KVOO

In the case of KVOO, a specific example of what we term interrupted reception is illustrated by the broadcast of the Fleishman Yeast Hour, which features Rudy Vallee. The consumer in the coverage area of KVOO turns his dial to 1140 kilocycles at 6:00 P.M., to enjoy an hour of one of the oustanding programs on the air. At exactly 6:30, he hears a station announcement, advising him that KVOO is signing off until 9:00 P.M. At the time of this announcement, the Fleishman hour is only one-half completed. The listener's clear, uninterrupted reception is immediately blocked, and he is forced to go prospecting across the band, in an effort to retrieve the program to which he was listening. He then endeavors to pick up the program over some other station with less favorable reception as a result of either man-made or natural interferences. This illustration does not have a hypothetical origin, since we receive complaint after complaint, wanting to know why reception is interrupted over KVOO, but nevertheless KVOO, as well as WAPI, is designated as a high powered clear channel station, which, of course, is in name only.

We also direct your attention to the fact that, where a sharing time station is forced off the air, as illustrated above, the consumer rarely returns to the station which has signed off, for the remainder of his radio reception for the evening; however, if he should do so, in radio broadcasting parlance, the renewed transmission is "cold" to the listener.

It can be seen, therefore, that where clear channel stations operate on what is known as sharing time as defined above, that there will naturally be created, from the evils of the system, an antagonized and dissatisfied consumer. There are many other matters which naturally affect the public service, necessity, and convenience by reason of the present sharing time arrangement of allocation on clear channels.

Economic Questions

One of the major economic questions deserving careful consideration in connection with sharing time stations on clear channels is the operating cost to the effectual station. The original investment and the actual operation of the station are substantially the same when that station is located in a sparsely settled area or when a similar station is located in a heavily populated area, and this would hold true to a great extent where the station located in a heavily populated area operates on full time and the other station located in a sparsely populated area operates on a sharing time basis.

We have found that on account of being on the air only part of the time, our program expense is substantially as great, even greater than a station in continuous operation, as we need just as many announcers and just as much paid talent available, but can only utilize a part of their services. Of course, our power bill will be somewhat less, although we must have just the same connected load as a transmitter operating on full time, and furthermore, being on a clear channel we must maintain the same high standard of program service as any full time station on a clear channel. Our depreciation item, our engineering costs, and other costs are substantially the same.

Speaking entirely of our own situation, records on file with the Commission will show that since 1930 this sharing time clear channel station has operated at a loss and has endeavored to render high class service, and has in fact done so strictly as a communication company and not as a subsidiary of any other enterprise. Through all of the period we have continuously improved our program service and equipment so that even with all of the losses sustained we have still been willing and financially able to improve our service to the listeners. Considering the enormous investment of our company we believe that KVOO, or any other sharing time station similarly situated, should be given an opportunity to at least recover its investment and off-set depreciation charges by being permitted to operate as a full time station in the true sense of the term. In this connection KVOO has a 50 kilowatt Western Electric transmitter, and the total investment is in excess of $300,000.

Summary

Summarizing, we direct this Honorable Commission's attention to the fact that our section of the country has been referred to in the past, by certain spokesmen in radio circles, as the hinterland of the United States, and said statement has doubtless been prompted by ignorance of existing conditions in what we choose to term the area with the most prolific opportunities in radio broadcasting. The Midwest, from Ohio to Colorado, is the radio center of the United States, Tulsa being almost in the geographical center.

Without the uniform rules and regulations heretofore adopted by the Federal Communications Commission, detrimental policies and harmful practices would result; therefore, we feel that the propositions we have herein submitted will be of assistance to this Honorable Commission in determining that it is inadvisable for clear channels to be forced into sharing time arrangements. We hope that our suggestions will assist this Honorable Commission in its policy of serving the public interest, convenience and necessity, and therefore give to the affected stations an opportunity for them to utilize their equipment, justify their investments, and above all, to protect the consumer in his right to uninterrupted reception.

Cross Examination of Mr. Way

Mr. Way was subjected to a short cross examination by T. A. M. Craven, chief engineer of the Commission, during the course of which he told of the difficulties of sharing time on a clear channel

as experienced by his station. He said that undoubtedly, while he had no special knowledge of the facts, regional stations sharing time had similar difficulties.

He spoke especially of the difficulty of reception for listeners when KVOO goes off the air and the fact that there is no continuity of service. At that time, namely when KVOO is silent, there is practically no radio reception in the rural area for from 85 to 90 miles around Tulsa. He stated that his station did make a little money last year and made a profit in 1930 but generally has been unprofitable.

D. A. Read

Mr. Read on behalf of WTIC gave an early history of that station, spoke of its operation as a part-time clear channel station and of the difficulties which it had experienced, and then told of experimental simultaneous operation. He took up also the benefits of duplicate operation.

Mr. Read said:

Early History

Station WTIC, located in Hartford, Connecticut, licensed originally in the name of Travelers Insurance Company, and more recently in the name of the Travelers Broadcasting Service Company, a wholly owned subsidiary of the first-named company, was originally constructed December 13, 1924. The station began regular broadcasting on February 10, 1925, the original plant consisting of a 500 watt transmitter and the necessary appurtenances thereto. The station operated on several frequencies at a power of 500 watts until at or about the time of the general reallocation of 1928, at which time the station was granted an authorized power of 50,000 watts on the frequency of 1060 kc., sharing time equally with Station WBAL of Baltimore, Maryland.

During the first year of the station's operation it did not enjoy any chain affiliation and did not broadcast any commercial programs. It was conducted purely on an institutional basis by our company with a view that the good will to be derived from such operation would enure to the benefit of our company. This method of operation continued until the commencement of the year 1926. The total expenses of operation from the date of the station's establishment until the end of the year after it acquired a clear channel status (February 10, 1925, to January 1, 1930) were $359,782.39.

Operation as a Part-Time Clear Channel Station

The expansion of our broadcast activities and the increase in authorized power and change in assignment which gave Station WTIC a part-time clear channel status was preceded by numerous conferences between representatives of our company and members of the Federal Radio Commission and its staff. At that time the Commission was engaged in a general reallocation and the question of allotting clear channel assignments is largely a matter of finding persons or organizations who were willing to assume the financial and other responsibility necessarily incident to such an undertaking. From our conferences with the Commission and its personnel, we were led to believe that if our company undertook a program of expansion and accepted a clear channel status with the financial outlay necessarily incident to the erection of what was then known as a "super-power" station, we would receive the exclusive use of a clear channel frequency. It was upon this understanding that our company decided to undertake this step.

After this decision was arrived at, and subsequent to the ordering of equipment and a large part of the actual construction work, we were advised that legislative and other developments at the Commission had brought about a situation where WTIC could not have exclusive use of the clear channel frequency, but would be required to divide time with Station WBAL at Baltimore. We mention these facts, not as a criticism of the Commission or of its personnel, but merely as an explanation of why our company, comprised we believe of ordinarily prudent and conservative business men, undertook an expansion program of this magnitude at this time, particularly in view of developments which I shall hereinafter relate.

With the commencement of the year 1926, Station WTIC began operating as an outlet on the Red Network of the National Broadcasting Company, and at this time began broadcasting other programs of a commercial nature, which, we believe, not inconsistent with our institutional policies and practices. From the outset we believed that an institution such as ours had much to lose and little to gain by putting on programs of an inferior class or advertising of a nature which seemed to conflict with other policies and practices of our organization. Moreover, we thought it necessary to equip ourselves from a technical and a programming standpoint in line with our general company policies and in line with what we believe to be the best current practices of the period employed by other high-power clear channel stations.

Under Handicap

It goes without saying that from the very outset we operated under a very severe handicap. Under our time-sharing agreement with WBAL, it was necessary for us to broadcast only on alternate days, coming on the air one afternoon at 4:00 o'clock p. m., and signing off the next afternoon at the same hour, except on Sundays, at which time a slightly different arrangement was followed. Under the circumstances it was practically impossible to retain our listening audience or to build up an audience of regular listeners. Radio listening is more or less a habit, and persons will necessarily become accustomed to tuning to particular stations and listening to particular programs, namely, those stations and those programs which they regularly received at the hours of the day during which they are accustomed to listen. Moreover, we found that our station was not attractive to national advertisers and that the National Broadcasting Company sold it with great difficulty, not only because of our inability to build and retain a listening audience for the reasons heretofore stated, but also because broadcast advertisers frequently desired to book programs such as "Amos and Andy" and other popular features "straight across the board" or for a given period on each broadcast day. Being able to broadcast only on alternate days, our station was necessarily eliminated from such business, and also from such other regular business as was offered for broadcasting on the days when we were scheduled to remain silent. It is interesting, as well as painful, to note that the results of our operation under this arrangement through the years 1930 to 1934, inclusive, resulted in a net aggregate loss of $1,509,191.99, or a loss in 1930 of $305,888.74; in 1931 of $306,256.97; in 1932 of $325,997.53; in 1933 of $361,009.71, and in 1934 of $294,041.04.

Experimental Simultaneous Operation

Being faced year by year with these tremendous operating losses and with the fact that even if these losses could or should be disregarded, the station was not really performing adequate public service due to the interruptions in its operating schedule, we made consistent and repeated efforts to secure some relief from the handicaps under which our operating schedule placed us. Our first step along this line consisted of extensive research in the possibilities of synchronous operation, conducted not only by the regular employees of our technical staff, but also with the assistance and guidance of Professor W. J. Williams of Rensselaer Polytechnic Institute. With the cooperation of the National Broadcasting Company, and its technical staff under the direction of Charles W. Horne, we finally made application for and received authority to undertake such operation with Station WEAF, a clear channel station located in New York, New York, licensed in the name of NBC, and which also carried the Red Network program of that company. After considerable expenditure of time, effort and money, we were doomed to disappointment in this venture, because we found that the complaints from listeners in the area between New York and Hartford were such that the Commission felt compelled to cancel this authorization. This authorization was granted on the 1st day of October, 1931, and cancelled on the 14th day of June, 1932.

Possibility of Duplication

As our situation was in no sense improving, we then began a study of the possibility of duplicate operation with some station located at such a distance from Hartford as would permit both stations to render an acceptable program service. In this matter our choice of stations was necessarily limited, since stations of comparable power which were enjoying full time clear channel assignments were not desirous of duplicate operation, and WBAL, the station with which we were sharing time, was so located as to make such a type of operation unattractive either to it or to us. It so happened that stations KTHS, at Hot Springs, Arkansas, and KRLD, at Dallas, Texas, were confronted with a problem somewhat similar to that which confronted WTIC and WBAL. In other words, the Hot Springs station and the Dallas station, although both classed as clear channel stations, were each enjoying only part-time operation, being forced to share time upon a common frequency, namely, the frequency 1040 kc. In this state of affairs, and after extensive negotiations between representatives of these stations, a plan was evolved whereby Station WTIC and

KTHS were to switch frequencies, thus permitting the simultaneous full-time operation of KRLD and WTIC on the frequency 1040 kc. and duplicate day and divided night-time operation between KTHS and WBAL. This plan was presented to the Commission in the form of appropriate applications. After extensive study and hearings before the Commission en banc, the Commission on May 8, 1934, granted experimental authority for such operation, which authorizations have been successively renewed down to date.

Benefits of Duplicate Operation

As heretofore stated, the Commission authorization for simultaneous operation became effective May 8, 1934, and by such operation during the balance of that year we were able to reduce our losses rather substantially. The loss for the year 1933 amounted to $361,009.71, whereas, in the year 1934, it amounted to $294,-041.04, or a difference of $66,968.67. In the year 1935 we were able still further to reduce our losses, a loss for that period amounting to $203,897.44. For the year 1936, we show, up to October 1, an operating profit of $17,577.93, the first profit which we have derived from the operation of our station throughout the approximate twelve years since its inception. We anticipate that our profit for the entire year, taking into account our existing contracts and anticipated business, will amount to approximately $35,000.00.

Benefits to the Listening Public

Inasmuch as we had once been required to discontinue our experimental synchronous operation because of the dissatisfaction of the listeners we were somewhat apprehensive of the listeners' reaction to our experimental duplicate operation. Although we had conducted certain extra hour tests which convinced us that the simultaneous operation of KRLD and WTIC under this plan would be acceptable to a degree, we were not sure that these conditions would be obtained throughout the hours before midnight or throughout an entire year's operation. We were, therefore, very much pleased to find that operation during regular broadcast hours throughout the summer months of 1934 resulted in no objections from our listeners and were extremely gratified to find that such operation during our first winter resulted in no objection. As heretofore stated, we have continued to operate on this basis since May 8, 1934, and to my personal knowledge only two complaints of interference have been received at WTIC. One complaint came from a listener located at a little town in the Province of Saskatchewan, Canada, and the other complaint from a listener located at Detroit, Michigan.

Some indication of the increase in the popularity of the station since our full-time operation can be gathered from the fact that in the year 1933 before our simultaneous operation the National Broadcasting Company received 4,676 letters from listeners concerning programs broadcast over Station WTIC; in the year 1934, during the latter part of which we enjoyed simultaneous operation, this letter response increased to 9,605; for the year 1935, during all of which time we enjoyed full-time operation, this letter response has increased to 32,112; and for the portion of this year for which we have records, namely, January through August, this letter response has increased to the figure of 56,114. It must be remembered that these are letters sent either directly or indirectly to the National Broadcasting Company and concerning network programs. They do not include letters sent to the station concerning non-network programs.

I do know from my own personal observations and from reports made to me by my engineering staff, that we are now serving, and have throughout the duration of this experiment served an area which would approximate the primary service area of a clear channel station operating on a frequency such as ours without duplicate operation. I also know that we furnish some degree of secondary service throughout a relatively wide area. Mr. McNary, who will follow me on the stand, will give you the details concerning the nature and extent of the present service, the technical steps which have been taken and are now being taken to make this type of operation possible, and the technical conclusions to be drawn from our experience.

Conclusions

For my own part, I desire to conclude my remarks by saying that the beneficial results of this operation have, to my personal knowledge, been two-fold. It has permitted WTIC to give a well-rounded uninterrupted program service to a rather large and heavily populated area which heretofore had been served in only a very unsatisfactory manner; and, secondly, it has permitted our company to reduce our already tremendous operating losses to the vanishing point, and now, after twelve years of uninterrupted operation, we realize for the first time a slight benefit.

Statement on Behalf of KRLD

It is hardly necessary for me to state that WTIC and KRLD have been closely associated in connection with the experiment whereby they are operating simultaneously on 1040 kilocycles. I have been authorized by Station KRLD to make the following statement:

Simultaneous operation with WTIC has proved most satisfactory. KRLD is regularly licensed (and has been since April 30, 1929) to operate simultaneously with Station KTHS during the day, and to share time with that station at night. Although the relationship between KRLD and KTHS has always been very harmonious, the time-sharing arrangement inevitably resulted on many occasions in preventing KRLD from carrying programs of national importance which were features of the Columbia Broadcasting System or, oftentimes, of carrying important programs in their entirety. It also seriously handicapped the purely local activities of the station. Furthermore, it was found that many advertisers objected to the use of a station which was not on the air continuously during its broadcast day and, therefore, did not have the advantage of a continued and sustained audience.

Since the inauguration of simultaneous operation with WTIC on an experimental basis, KRLD has enjoyed an increase in the number of its listeners and a resulting increase in revenue, all due to the regular use of its assigned frequency. During the entire period of experimentation KRLD has received no complaint of any interference from its listeners, and has received much satisfactory comment from a radius of approximately 100 miles. This would indicate that the listeners who depend upon KRLD for their radio service have no objection to the presence of WTIC on the same channel, and probably know nothing whatsoever of the simultaneous operation. It would therefore appear that such operation is an advantage both from the standpoint of the station and of the listeners, and that its continuation on a permanent basis should be encouraged both from an engineering and a commercial standpoint, and in the furtherance of an economic use of a desirable frequency.

Cross Examination of Read

Mr. Read was subjected to a short cross examination during the course of which he said that his station gives secondary service in Vermont, New Hampshire and Maine. In connection with the losses which his station has sustained over a period of years Mr. Read explained that there had been included in those losses a write-off for experimentation.

Charles W. Horn

Mr. Horn, on behalf of the National Broadcasting Company, advocated (1) an additional classification calling for 50 millivolts for metropolitan areas as a minimum signal necessary for good service, (2) that the power measurements of a station be made by the so-called direct method of antenna measurement and (3) that field strength measurements be made of all stations.

Mr. Horn said:

One of the most difficult problems facing the broadcasting industry and the Federal Communications Commission is that of determining accurately the service areas of individual stations. Because of the varying conditions which exist, such as fading, changes in Heaviside Layer, different ground conductivities, adjacent channel interference, and made-made static, no one has yet been able to devise a yardstick which will permit us to answer this question with any degree of mathematical certainty.

I propose to discuss today the efforts which the National Broadcasting Company has made toward finding an answer. With the variables that exist there may never be a fixed and final formula applicable to all stations everywhere and I want to make it clear that we do not go so far as to recommend our method as a standard to be adopted by the Commission. However, we do believe that the efforts we are making along these lines will be of interest both to the Commission and to other broadcasters.

First, I want to discuss some of the varying influences which effect radio wave propagation. This discussion will also constitute National Broadcasting Company's comments on items listed in the Notice of Hearing.

Propagation Characteristics of the Various Frequencies in the Range 550-1600 KC.

The Engineering division of the Federal Communications Commission has available in existing literature a considerable quantity·

of material concerning wave propagation. The curves and data prepared for the coming meeting of the C. C. I. R. next year is of this type. The data obtained from the recent Clear Channel Survey is also of value. The only additional material I might offer is a paper by Mr. William A. Fitch of the National Broadcasting Company explaining a simplified method of using the Sommerfeld formula. This article is complete with curves and is herewith offered.

The curves and technical information referred to above are the result of many measurements made over a considerable period of years. The industry now has available suitable instruments as well as competent and experienced engineering services to carry on such measurements with the result that we have removed a great deal of guess work and are depending more upon measured data. The Engineering Division of the Commission has likewise been alert and taken advantage of additional information whenever it became available and is to be commended for its share in developing higher standards and thus helping to improve radio conditions.

Prevailing Attenuation

I am presenting herewith a map prepared by our engineers on which are shown the ground conductivities in areas in which we have made measurements of stations. This map shows the conductivity calculated from surveys of sixty stations in different cities. Lines are drawn in several directions from each location and the figure on each line indicates average conductivity in that particular direction and out to the distances to which measurements were carried. In some cases where there was a decided difference in conductivity the attenuation factor is shown for different portions of the line. It is hoped that the information on this map will be helpful to the Commission engineers and that it may be added to data which they already possess. Accumulation of data of this type will make possible the preparation of maps so that we shall know in the future what the radio conditions are in all localities and with considerable accuracy.

Proper Ratio of Desired to Undesired Signal

The proper ratio of desired to undesired signal is something which is dependent to a great extent upon the general receiver characteristics. As Mr. Van Dyke has analyzed this subject and presented some tables, it is not necessary that it be repeated here. In the large experience that we have had, and including the experience of an innumerable number of listeners as expressed in their mail, I can substantiate the results obtained by Mr. Van Dyke in his measurements and studies of receiver characteristics.

Interference due to natural static varies with the seasons and is more prevalent in the southren part of the United States, especially in the summer. A paper on this subject by Mr. R. K. Potter appeared in the Proceedings of the Institute of Radio Engineers foi September 1932. The effect of interference from natural static is now much less than it was during the earlier days of broadcasting because of the use of higher transmitter powers, and a continued improvement may be expected by still further increasing the ratio of signal to static by the use of higher powers. Those of us who are old timers in this industry will remember the difficulties we encountered due to natural static because of the extremely low powers then employed by the transmitting stations. Here again, we are dealing with engineering factors which are well known and which are expressed in our signal-to-noise ratios so definitely a part of radio engineering.

Static

In the more built-up sections and particularly the larger cities we experience a considerable amount of so-called man-made static which is due to electrical devices. Most man-made static is due to either defective electrical equipment or such apparatus as the older style X-Ray machines which are inherently noise-producing and which must be installed with proper shielding. New devices such as diathermy machines are emitting radio frequency waves that have been found to travel great distances. Apparatus of that ype should be filtered or shielded and we must look to the manufacturers of these devices for help and cooperation. It is pleasing to note that railways in many localities have made efforts to reduce interference caused by their apparatus. Trackless trolleys, using the two-wire overhead system and equipped with pneumatic tires, present a problem that needs serious attention. A recent report by manufacturers indicates that something like two thousand such trolleys will be put in service in the United States during 1936. There are quite a number of such trolleys in use in London and the combined efforts of the transportation people and the broadcasting interests in England have resulted in a reduction, but not complete elimination, of the interference.

Interference due to electrical apparatus has engaged the attention of such organizations as the National Electrical Manufacturing Association and others responsible for electric design standards. Both in Europe and America there has been cooperation between manufacturing companies and radio engineering committees in an effort to reduce interference from this source. Credit is due the power and electrical companies for their efforts and it is safe to say that interference by man-made static is much less in the United States than in other countries which are comparable to us in electrification.

Satisfactory Service

In radio reception the governing factor is always the ratio of the strength of the desired signal as against the intensity of the interfering signal or static. The required ratios for satisfactory service are given in Mr. Van Dyke's presentation. For some years engineers have been using the standard published by the Engineering Division of the Federal Communications Commission which shows that for good reception receivers in cities require 10 millivolts, in residential sections 2 millivolts and rural localities .5 millivolts per meter of signal intensity. These figures are based on the fact that electrical noises are greater in cities than in residential and rural parts of the country. These have proven quite satisfactory except in the case of metropolitan areas where a great deal of electrical disturbance and other factors are present. Our experience indicates that we must add another classification to this table to take care of conditions in metropolitan areas.

Because antennas in metropolitan districts pick up a greater amount of electrical noise, it is necessary that the desired signal strength be greater in order to maintain the proper signal-to-noise ratio. However, in these areas, an additional obstacle is encountered because of the shielding effect of steel structures which causes a reduction in the amount of radio signal energy which arrives at the average antenna. While there may be 10 millivolts of signal intensity in the atmosphere above such a city the antenna may receive but a fraction of this energy because of such shielding. Therefore, the average antenna in a metropolitan district not only suffers from increased electrical noise but generally receives less than its share of radio energy with consequent poor results. The only solution possible is a higher signal strength over such territories and our observations and measurements indicate that in metropolitan areas the signal intensity must not be less than 50 millivolts in order to render acceptable service. Even with this signal strength there will be spots that will not obtain adequate service due to exceptionally deep shadows cast by steel structures, but these may be classed as extreme cases.

Heaviside Layer and Sun Spot Cycle

The Heaviside Layer is usually considered as being a conducting, and therefore a reflecting, layer in the upper atmosphere approximately 100 kilometers or so above the surface of the earth. There are a number of layers having varying effects on different frequencies. Considerable investigating work has been done by such organizations as the United States Bureau of Standards, the Carnegie Institution and others and reports of this work have been published.

Long distance transmission is obtainable because of the so-called sky wave which is reflected back from the Heaviside Layer. That wave which leaves the antenna and travels along the surface of the earth is known as the ground wave and is eventually absorbed and falls to such a low value as to be useless for service. Between the ground wave area and the secondary area we have the so-called fading band which is a point where the sky wave returns to earth and has sufficient strength to seriously interfere with the ground wave. We generally term the area within the fading band as the primary service area although where unusually strong interference exists from other stations, either on the same channel or on neighboring channels, the primary area is in this case much more restricted. In other words, the primary service area of a broadcasting station is that territory in which it places a sufficiently strong signal and free from interference in order to render good service. We refer to the territory beyond the fading band as a secondary area in which some service is rendered but of a much less reliable type. In this territory slow fading takes place and there are variations in the strength and steadiness of the signal. Also on shared channels this area experiences a great deal of interference due to the low ratio between the desired signal and one or more interfering signals.

Seasonal Variations

Seasonal variations have a marked effect upon the sky wave, which furnishes this secondary service, but has little effect upon

the ground wave. During certain periods of sun spot cycles certain reactions are noted. The sky wave may come back to earth with greater intensity nearer the station and cause the fading band to move inward. This was noted at two particular stations during the past few years. Also the service rendered the secondary area has been found better during periods when the sun spots are less prominent. The secondary area receives less service in summer due to the longer daylight periods as compared with the winter as these Heaviside reflections take place after dark. The secondary area is also influenced in the summertime by a higher static level especially in the southern half of the United States.

From the above it will be noted that the best service rendered the public is, of course, in the primary service areas which are less affected by atmospheric and cosmic changes. The Federal Radio Commission prepared a map, together with some statistics, under date of December 14th, 1933, on which was shown "Calculated Night Primary Coverage of All Broadcast Stations Based Upon Interference, Propagation and Frequency Characteristics." A glance at this map will show that the greater portion of the area of the United States is in the secondary service area and not in the primary area of broadcasting stations. The statistics which came with the map indicate that of a total of 119,636,708 United States population, the number of people that resided within the primary coverage of the broadcasting stations was 76,662,000 or 64.2 per cent. There were approximately 43,000,000 people living within the secondary coverage area or 35.8 per cent of the total population. Receivers in this secondary area, which by the way happens to be 70.6 per cent of the total area of the country, are solely dependent upon the sky wave or secondary area signals of stations which have sufficient power and are free from interference.

Little Change

While this map is dated December 1933, we will find that there has been relatively little change in the number of stations since that time and while some of these stations may have increased their power they have not materially increased their primary service area because of the fading limitations. It is safe to estimate that the percentage of population in the secondary area is still as great as it was at the time the map was prepared. (I offer this map for your consideration.)

Long distance transmission or service to the secondary area is possible only on channels which are free from interference. The system we have adopted, that of using high power on clear channels and lower power on shared channels, is universally recognized and is in use in Europe as well as other parts of the world.

Synchronization

In order that there may be no misunderstanding I would like to give my definition of this term. I consider two or more stations to be operating in synchronism when the carrier waves are not only of the same frequency but their phase relationship is maintained to within a few degrees. Such precise frequency control plus the necessity of transmitting the same program are absolute requirements if two stations are to operate in synchronism with their ground wave service areas adjoining or near to each other but not overlapping. To maintain this precise frequency control requires some common frequency standard or source—I have found that a connecting wire line supplying the stations in question with a standard frequency is best, plus equipment at each station to prevent line changes from causing variations in the phase of the radio wave. This equipment is in the nature of a flywheel which prevents any rapid line fluctuations from affecting the output frequency.

Using such specifications a reasonably good signal may be expected in areas where the signal strength of the desired station does not drop to less than five or possibly four times the intensity of the station with which it is synchronized, providing the identical program is broadcast simultaneously. In areas where the signals are nearly of the same intensity, say less than 4 to 1 in ratio, difficulties are encountered due to the carrier frequency being partially, and frequently even greatly, suppressed which results in distortion.

Signal Ratio

There is a belief in some quarters that stations can be synchronized and different programs broadcast. This does not hold true until the separation between the station is great enough to provide a signal ratio of 20 to 1, desired to undesired. This is because the factor which then causes the greatest interference is not the carrier wave conflict but the modulated portion of the wave, or cross talk. Even with all conditions under control in the case of synchronized operation, care must be taken to see that the telephone line connecting the stations is not of such a length or characteristic to introduce lag in the audio signal, which can cause serious loss of quality. Synchronizing a whole chain of stations is at present impractical, both technically and economically. One reason is that the networks do not furnish programs regularly from only one fixed location but switch to different cities for various programs and sometimes even insert selections originating at a point distant from where the main program takes place. Another reason is that while I know of some time delay circuits I do not know of any which covers the whole music range. Even if they could be built it would be impractical to readjust and change such devices even between programs.

We have the benefit of the experimental work being done on the several installations of this type which has given us a clearer understanding of the problem together with some quantitative results. In other words, we know what can or cannot be done at the present state of the development.

I would like to state that synchronization of radio stations is still in an experimental stage. I have kept myself informed of what is going on in Europe by personal contact, and find that they have the same views I have expressed.

Standards and Methods of Measurement

In the earlier days of broadcasting it was somewhat difficult to measure the power radiated from a transmitter. The best we could do was to estimate the efficiency of the apparatus and arrive at some approximate values. This led to a number of methods of determining the power radiated. With the information which we now have available, the only logical engineering method is a direct measurement of the antenna resistance and the amount of current flowing in that antenna. With complicated antenna design, in order to obtain directional effects, it is possible to make the measurements in the main transmission line feeding the antenna array. It is urged that the direct method of measuring power be adopted as the standard. With the measuring instruments available today accuracy within ten percent is easily obtained.

Field intensity measuring sets are now readily available as well as engineering organizations equipped to do this work. Field intensity measurements should be made at one mile from the antenna plus a sufficient number of measurements on radials out to the limit of the good service area. From these data, curves can be drawn to show the efficiency of the radiator, ground system, conductivity of soil and the signal intensity in the area surrounding the station. With the equipment available today, an accuracy within ten percent is possible.

Determination of Service

The satisfaction a listener can obtain from his receiving set is dependent upon a number of factors, the principal ones being:

(a) The field strength of the desired signal.
(b) The strength of interfering signals from undesired stations.
(c) The noise level in his particular locality.
(d) Fading and distortion due to fading.

Early in 1933 the engineering department of the National Broadcasting Company undertook the work of making field strength measurements of over one hundred stations throughout the United States as well as a couple in Canada. This was the largest undertaking of its kind ever attempted and while the cost was very large it was considered necessary as we wanted to know how well we were serving the country. On this one survey alone we made 21,316 measurements which entailed 232,218 miles of traveling by the measuring units. Eighteen crews of engineers were engaged in this work. In addition to our own Company engineers we engaged the services of recognized consulting engineers and their methods and measurements were compared with those made by our own men. In all cases the latest types of measuring equipment was used.

Accurate Measurements

With more accurate measurements of power radiated and resultant field contour maps, we begin to have some evidence of coverage. However, as field strength measurements are necessarily made in the daytime and do not show the night phenomena, such as fading and interference from distant stations on the same or adjacent channels or the noise levels existing in a territory, and since it is not possible to determine the effect of these except over a very long period of time and at an exorbitant cost, the National Broadcasting Company turned to its audience for a more immediate

answer. The method we adopted has been to analyze more than 15,000,000 pieces of mail received by our stations from their listeners. Part of the information we thus obtained has already been made available to the industry through the publication known as "NBC Network Areas", copies of which I will be glad to submit for the record.

Every letter received from listeners is carefully checked as to point of origin and the station to which it is addressed. The point of origin is noted in order to determine the county from which it came. We use counties as the smallest sub-division of territory because that system coincides with U. S. census information which includes the number of homes having radio receivers. Our method depends upon percent of mail received from counties as compared with the number of homes having receiving sets in those counties. Please note it is not based upon population but upon the number of homes having receiving sets and for that reason gives more accurate information. In this survey work we are not so much concerned with the contents of these letters as we are concerned with their points of origin. Because of the tremendous volume of mail, in the first seven months of 1936 we have already received 4,237,000 such letters, any small discrepancies are averaged up. Also as you will note, this in no way can be confused with so-called popularity contests as we obtain our information from postmark and address and as we have been continuing this survey over the last several years it is also not subject to territorial or local errors because stations retain the letters referring to their own local programs and only forward those concerning network programs. The information thus obtained is tabulated and the number of letters from each county, per unit of time and per thousand radio homes gives us an index figure for that county. Taking those counties as par which are within the good service area of the station under survey, as determined by field strength measurements, and noting their mail response per 1000 radio homes, we have a basis of comparison with which to judge the response from all counties.

Survey Individually

Each station is surveyed individually and in each case its own par rating is determined. It is possible that people in different sections of the country may have different habits when it comes to writing letters. Also it would be unfair to use an index figure per 1000 radio homes of one station, or even an average figure, to rate another station.

This survey we are conducting is a continuous process. We have a staff which varies between 30 and 35 people to take care of this work which is handled in New York, Chicago and San Francisco.

These measurements took many months and after all the information had been assembled we compared the signal field strength contour maps with our letter surveys. There was general agreement between the two results and in those cases where there were any marked differences we found we could determine the reasons for the deviations. In some cases it was traceable to interference from some other station on the same channel, or from an adjacent channel and sometimes even to man-made static.

As we have been conducting this method of surveying the service areas of the stations on the National Broadcasting Company network continuously for over three years and as we are constantly checking results, we feel we have demonstrated the reliability of the system. Its great advantage over other systems is that it shows the response of millions of listeners living in every State and County of the United States and over a long period of time. It truly is the expression of the American public although they do not know that they are participating in a survey, which, in our opinion, is also desirable.

Summary

Gentlemen, in summarizing I wish to repeat the three recommendations I have made—they are:

1. An additional classification calling for 50 millivolts for metropolitan areas as a minimum signal necessary for good service.
2. That the power measurements of a station be made by the so-called direct method of antenna measurement.
3. That field strength measurements be made of all stations.

Horn Cross Examination

Signal intensity of 50 millivolts in cities was advocated by Mr. Horn under cross examination. He said that in his opinion this is needed because of steel buildings and noises over such territory. He indicated that of course 50 millivolts would not be needed over every place. He stated that his company had made surveys indicating that New York City showed decided shadows.

Mr. Horn testified that there are certain variables in modern antennas. NBC, red network, he said, covers the entire country but this does not necessarily mean that it gives good service. At least, he said, the listeners can understand the station to which they are listening.

Dr. C. B. Jolliffe

Dr. Jolliffe said that the standards of allocation must of necessity be kept abreast of modern engineering practice. Interference from unwanted radio stations, said Dr. Jolliffe, is a problem of allocation and "your Commission has a primary responsibility for the solution of this problem."

Dr. Jolliffe said:

Allocation of Frequencies to Broadcast Stations

The basis of an engineering determination of a proper allocation of frequencies and classification of broadcast stations can be reduced to three factors:

(1) Standard of service,
(2) Characteristics of receiving sets,
(3) Relation between field intensity and distance.

Theoretically, given these three factors any problem of broadcast allocation can be worked out. Unfortunately none of the three factors is capable of exact definition and the proper ones to use in a given case are either matters of technical judgment or protracted studies in particular locations. We have presented in this hearing data obtained from studies made over a period of several years upon which engineers can base technical judgment.

The re-allocation of broadcast facilities made in 1928 was developed without definite standards or quantitative measurements. Primarily it was the combined experience of a group of engineers who had been closely identified with the early development of radio broadcasting. Since that time quantitative studies have been made by various engineers and engineering groups which confirm this early experience. In the Fifth Annual Report of the Federal Radio Commission, published in 1931, there appeared for the first time definitions of standards of service for various classifications of stations and their application to allocation problems. It was then stated, "Since many of the standards are also based on the present-day average receiving sets, average standards of listeners, present design of antennas, and so forth, they will, of course, be changed as the art progresses." Revisions and extensions of these standards appeared in the Sixth and Seventh Annual Reports of the Federal Radio Commission and the First Annual Report of the Federal Communications Commission.

Survey

The clear channel survey conducted by your Commission and this hearing are logical continuations of the study of these standards in order to obtain the most accurate and most modern data available at this time. As stated in the hearing on June 15 before the full Commission, the research and engineering staffs of RCA and its affiliated companies are available to your Commission for the study of technical problems which will assist your staff in solving the allocation problems.

The standards of allocation must of necessity be kept abreast of modern engineering practice. They must, however, be sufficiently stable and changes made gradually so that the public, which has many millions of dollars invested in receiving sets and the largest stake in broadcasting, may adjust itself to the new standards.

The receiving set industry is built around the set of standards which is reflected in the allocation to broadcast stations. Since changes in allocation will have their repercussions in the factories of the receiving set manufacturers, the service organizations of these manufacturers and the homes of persons using present day receiving sets, it is of the utmost importance that changes in allocation or re-allocation of frequencies to broadcast stations proceed on the basis of evolution and experimentation rather than by radical and sensational changes.

The basic standard from which to study all allocation problems is the technical standard of the program which is delivered by the loud speaker of the radio set installed in the listener's home. You have been told that there will be at the end of this year approximately 30,000,000 receiving sets in use by the public of the United States. I submit that the technical excellence of the programs which come out of the loud speakers of these sets is the engineering measure of public interest, convenience and necessity.

Program Marred

The program delivered by a receiving set can be marred by receiving set noises, man-made electrical noises, and interference from radio stations. The receiving set manufacturers take every precaution to reduce receiving set noise well below an objectionable value. The Commission, receiving set manufacturers and electrical manufacturers can cooperate to reduce the interference caused by electrical machinery, flashing signs, diathermy machines and other sources of man-made electrical interference. The existence of this interference can also be recognized and proper allocation of power to transmitting stations can submerge it by producing sufficient signal strength at the receiving set so that the interference is below an objectionable value.

Interference from unwanted radio stations is a problem of allocation. Your Commission has the primary responsibility for the solution of this problem. There have been numerous observations, measurements and studies made to determine the maximum amount of interference which can be tolerated in the output of the receiving set, all of which agree very closely with the present standards of your Commission.

The good service area of a station has been defined by your Commission as "that area in which reception free of interference is obtained at least 90 per cent of the time." This is reasonable and the first definition of standard of service. To make this quantitative a second definition is necessary and must relate to the OUTPUT of the receiver. Our data have shown that a signal at the OUTPUT of a receiver can be defined as "free of interference" when the power ratio of the signal to interference is greater than 30 db for crosstalk or 37 db for 10 kc heterodyne. These two definitions define the MINIMUM standard of service.

Allocation Problems

To obtain the relationship of this standard of service to allocation problems it is necessary to reflect the standard back through the receiving set to the receiving antenna and determine the maximum field intensity produced by interfering stations operating on the same and adjacent frequencies which can be tolerated without exceeding the maximum of interference at the output of the receiving set. To do this a typical receiving set is necessary.

Data have been presented to you which represent the composite performance of modern broadcast receiving sets from which a typical receiving set can be evolved. The proper typical receiving set to use is one of engineering judgment and we have suggested what our engineers believe is the proper interpretation representative of receiving sets in use today. This gives a reasonable basis for this phase of allocation.

The third factor, relation between field intensity and distance, has been one concerning which your Engineering Department has done much work. The intensity of the field produced by a radio station at any point distant from the station can be determined from the propagation curves which engineers have developed. The propagation of radio waves along the ground has been a subject of much study, both by theory and measurement. If the attenuation factor is known in a particular area it is not difficult to calculate the field of intensity which will be produced in the vicinity of a station. Data available are not conflicting when properly interpreted and a full and complete answer as to the ground wave propagation of radio waves in the broadcast spectrum is available in the radio literature and in the studies which have been made by engineers of the Commission. Further studies will undoubtedly change these curves in some minor particulars, but for the purpose of allocation the data now available are sufficiently accurate.

Field Intensity Records

The analysis of the field intensity records in the clear channel survey, which have been published in your report, correlated with the work of others such as the International Broadcasting Union and the Bureau of Standards, gives an excellent basis for determining the proper propagation curve to use to determine the field intensity produced by a station beyond the limit of the ground wave. The field intensity at a distance from a radio transmitter varies from minute to minute, hour to hour, day to day, season to season and position in the sunspot cycle. It is not proper to use the maximum value to which a signal might rise, and the prevailing practice of using a "quasi maximum" above which the signal does not rise more than a given percentage of the time is reasonable and consistent with the definition of good service area of a station. The standard which has been used for the "quasi maximum" by the Commission as that signal above which the value does not rise more than 10 per cent of the time appears to be satisfactory and consistent with the definition of standard of service. Whether this value should be 10 per cent, or 5 per cent as is used in international documents, is immaterial since at the present time under the conditions of application the tolerance is greater than the difference between the 5 per cent "quasi maximum" and the 10 per cent "quasi maximum" curves. The experience and opinions of engineers all over the world certainly indicate that the value of 10 per cent interference time is the MAXIMUM that should be considered as satisfactory.

Sunspot Cycle

The position in the season or sunspot cycle which can be considered as proper to use is, again, a matter of engineering judgment. The same tolerance, namely, a standard transmission curve above which the signal does not rise throughout the entire transmission cycle more than 10 per cent of the time, would appear reasonable. To determine this curve accurately would require that measurements be made through a period of eleven or more years. The time of the clear channel survey was not at the peak of good transmission with respect to the sunspot cycle or with respect to the maximum for the seasons but somewhat after the peak had been reached. The curves which were developed as a result of this series of recordings could be used as the standard of transmission for a period of years until it is possible to accumulate a greater amount of transmission data.

There are available, therefore, data which permit setting up definitions of the three factors which form the fundamental basis for the determination of allocation. From these data numerical values or curves can be set up as a part of your Regulations which will determine, under a given set of conditions, whether or not the listeners who are entitled to obtain reception "free of interference" from a given station will receive that to which they are entitled.

In order to apply these standards of allocation it is necessary to set up definitions of classes of stations based on the limit to which each station is entitled to give service "free of interference."

Two Classifications

There are only two general classifications of broadcast stations: (1) stations operating on frequencies on which a single station is permitted to operate at night (clear channels), and (2) stations operating on frequencies on which more than one station is permitted to operate at night (duplicated channels). Other classifications are sub-classifications of those two.

Consider first the classification of frequencies on which more than one station is permitted to operate at night. This general classification contains what has been called in the past "regional," "high power regional," "local" and, for lack of a better name, "duplicated clear channel" stations. It is well known that the range of interference of a station extends far beyond the range at which it is capable of giving satisfactory service. When two stations are operating on the same frequency there is surrounding each station an area in which the receiving stations receive signals from the nearer station at a sufficient field intensity so that the output of the loud speaker reproduces the program on that signal "free of interference" from the distant station based on the definition of the standards of service given above. The extent of this area depends on the relative power and geographical separation of the stations on the same and adjacent channels. Under a given set of conditions the standards of service will define this area.

Engineering Judgment

It is a matter of engineering judgment and allocation policy to determine how far from the station receiving sets are entitled to receive signals "free of interference" on the basis of the standards of service. In the standards at present used by the Commission averages are used over widely variable conditions.

In the final analysis the standard of protection should be set up for each frequency based on interference caused by stations operating on the same and adjacent frequencies, natural and man-made interference in the localities where the frequency is used, propagation characteristics of the frequency and distribution of population in the areas served. This composite picture is the one which determines the area which is to be given reception "free of interference" for any station. Conditions vary throughout the spectrum and the present allocation of frequencies to different types of stations is so widely different that it appears to be essential to apply the standards of service to each frequency and set up its protection separately and definitely in each case. General names and general specifications are no longer sufficient and are, in fact, misleading.

There is no difference between the fundamentals for determining the service of a 100 watt station operating on the same channel with other 100 watt stations and the service of a 5 kw. station operating on the same channel with other stations of the same or different power. The principles of calculation remain the same, and the standards of allocation apply.

Turning now to the consideration of frequencies on which only one station is permitted to operate at night, this subject was discussed very ably in "The Clear Channel in American Broadcasting", a report of the Institute of Radio Engineers which was submitted to the Federal Radio Commission. The results of the clear channel survey conducted by your Commission, the data which have been prepared by the Commission and submitted in hearings and data presented by engineers show the value of clear channel stations to the listeners of the United States.

Primary Service Area

Without clear channels some 40,000,000 people of the United States who live outside the primary service area of broadcast stations would be without any type of radio reception. The inauguration of service to these people in 1928 when the Federal Radio Commission adopted the principle of clear channels was in response to a very insistent demand for service by non-urban listeners. For more than two years prior to the re-allocation in 1928 there was no clear channel service as we know it today. The experience, observations and measurements which have been made since that time show that this type of station is the only type of station capable of giving a reasonably satisfactory service to rural communities. Your clear channel survey is an additional piece of evidence to bear out this statement. No technical development has been made since 1928 to reduce the necessity for clear channels to serve rural listeners and there are no such developments in the laboratory.

The allocation problem with respect to the primary area "free of interference" of clear channel stations is the same as with respect to stations operating on duplicated channels. The PRIMARY SERVICE area which it is designed to protect "free of interference" can be calculated on the same principles as the primary service of a so-called "regional station." The only difference in the calculation is that one source of interference has disappeared, namely, interference on the same channel. Adjacent channel interference presents the same problem as far as the definition of primary service is concerned.

Secondary Service

In addition to protecting the primary service area the principle of assigning a single station to a frequency and permitting it to operate at a higher power, is to give SECONDARY SERVICE to those people who have no primary service or whose primary service is severely limited. This service is not ideal but it is the only type of service which it is possible to give to a scattered population. Fortunately, the electrical noise level in rural districts and small communities is quite low and signals of low field intensity can be used for service. These low field intensities are susceptible to all types of interference, the signals vary in intensity and the intensity of signals on adjoining channels likewise change. Consequently a listener may have freedom of interference for a short time and then experience inter-channel interference for a period of time due to changes in relative values of signals which are received at that point. The modern receiving set with automatic volume control acts both to help and to complicate the problem. It keeps the wanted signal at a constant level but may, in doing so, accentuate side channel interference.

Selectivity of Sets

The possibility of changing the selectivity of receiving sets by means of variable selectivity controls makes it possible to receive service through much inter-channel interference. Such high selectivity may reduce the quality of the reproduced signal, but it does produce an interference-free signal. Signals in the secondary area of clear channel stations are usually not free of interference as defined by the standard of service. They do provide a service, however, which provides a large amount of enjoyment for those people who are not close to entertainment centers. Higher power on such stations will increase the average level of the received signal and reduce the number of times that the signal becomes entirely unusable and increase the amount of time it is "free of interference" not only from other stations but also from man-made and natural interference (static). In those cases where clear channel stations are serving large centers of population increased power on the stations will improve the service in the primaary service area, and in all cases will extend and improve the secondary service signal to outlying rural communities. Consequently it is logical and desirable to permit the use of adequate power by all stations holding clear channel assignments. What the upper limit of this power is we do not know; certainly not 50 kw. and probably not 500 kw. Developments will demonstrate what is engineeringly practicable and feasible. Duplicate assignments should not be made on these channels even though they may now appear technically possible. Certainly such assignments will impede progress and limit future use of all developments to provide better service to the rural population. It is a sure method of stopping progress.

Technical Problem

The number of clear channels which should be provided is a combined technical and policy problem. From the technical standpoint it must be recognized that there are daily and seasonal differences in the long distance transmission of radio waves. Stations which are satisfactory one day may not be useful at all at other times and consequently a number of stations must be available to provide continuity of service. To maintain continuity of a given program day in and day out, season by season, it is highly desirable that the listener have available the same program on several widely distributed stations. If a listener could provide himself with an elaborate antenna arrangement and widely separated receiving systems to provide diversity reception such as is done in commercial receiving stations, then a single transmitting station of sufficient power would be adequate to provide a given program. This is not possible. It is possible, however, through the multiple transmission of the same program from several stations to give each listener a multiplicity of possibilities of reception, thus reversing the process and giving diversity of transmission rather than diversity of reception, and thus assuring a greater percentage of time for the reception of a particular program.

The number of clear channels now actually clear and used as clear channels is the minimum number which can give adequate service to rural communities scattered over the vast area of the United States.

With respect to the suitability of various bands of frequencies for the various services, it is possible to submit data to show that practically any frequency in the broadcast band is most suitable for a particular classification of station. The difference between the propagation characteristics of the ground waves of stations on different frequencies in the broadcast band is well known and the technical radio literature is freely used by the engineers of your Commission. This hearing has brought forward further data which I do not believe are in conflict with any data which were previously available. All the stations in the country cannot use the low frequencies and consequently certain stations will, under certain classifications, have a larger service area than other stations in the same classification. These differences are well known and if every case is studied carefully the best solution for the area can be determined.

Maximum Power

The question of the maxium power to be permitted to be used by stations on duplicated channels is one which can usually be determined by the amount of electrical interference from non-radio sources which are encountered in the outer edge of the area which is entitled to be "free of interference." If, for example, the outer limit of this area is 1 mv/m and it includes urban communities where noise level can be expected to be high, the output of the receiver may not be "free of interference" due to non-radio interference. If the power of the station is raised from 1 kw. to 5 kw. the signal strength at the outer area would be raised from 1 mv/m to 2.2 mv/m. This might be sufficient to submerge the level of non-radio interference to less than an objectionable value or at least approach more nearly to this condition. In other cases the limit of the area "free of interference" may be, for example, 5 mv/m. Increasing the power of such station five times would increase this signal strength from 5 mv to 11 mv/m. It is probable that 5 mv/m is sufficient to override local electrical interference at all points within the protected area and consequently the increase to 11 mv would not result in any better service, but would simply increase the strength of the interference in the area outside the good service area and make it more objectionable. Since each frequency must be considered with reference not only to stations operating on that frequency but also on adjacent frequencies, the power to be permitted must be determined by all the conditions. These are known in any case and so the problem can be solved in each case if referred back to the one criterion, output of the receiving set.

Overcome Interference

The power necessary to overcome interference in the protected service area of the station must be permitted or it is useless to protect this area. The power on adjacent channels must be balanced in such a way as to provide the maximum of service. Arbitrary limitation may be restrictive, intelligent analysis based on maximum service to listeners is necessary and in the public interest.

The number of stations on a duplicated channel must be based on the type of service which the station is intended to render to the public. Regional and local stations play an important part in American broadcasting. Their service areas and established audiences have been built up on the basis of service and should not be destroyed or reduced. If a station is permitted on a regional or local channel with less geographical separation from the existing stations than is at present maintained it will reduce the service of the existing stations. In such cases it can usually be shown that public interest will be better served by the improvement in the service of existing stations rather than the establishment of a new station.

New Re-allocation

It might be possible to have a complete new re-allocation such as was done in 1928 and change stations from one frequency to another and classifications of stations from one group of frequencies to another. But you will still have, when this is done, a status which is similar to the present except that the picture will be changed with respect to individual stations. Some will gain; others will lose, but the net gain to the listeners of the United States as a whole would be zero. Such a disturbing upset of the listening habits of the United States might be in the private interest of some stations but would not be in the public interest of the listeners. The present allocation over a period of years has given a large measure of satisfaction. It is not perfect, but it does provide service of some kind to all the people of the United States.

Directional antennas have been applied in many installations and under various conditions. The use of directional antennas has a place in the allocation structure. They are not, however, the solution to all allocation problems. A directional antenna can be built with practically any type of characteristic and to meet practically any condition of protection to other stations on the same channel. It provides no protection for its own service area. How far directional antennas can enter into the allocation problem is a question of policy and economics. From an engineering standpoint it is not a wise policy to permit the installation of a station using a directional antenna to protect other stations on the same channel and at the same time receive interference from these other stations inside the area which it is primarily designed to serve. For example, if a station is to serve a particular city and the interference received from other stations on the same or adjacent channels is so severe that a section of the city which is densely populated receives severe interference, it will result inevitably in severe criticism of a regulatory body which permits such installations and it is not good engineering practice.

Standards of Service

Here again the standards of service can be applied. Calculations on the basis of logical engineering assumptions which give the distribution of service can be made and information can be obtained to show the distribution of population. There are some distributions which would permit very severe directivity with satisfactory service. There are others which will not. Whether or not a station will be permitted to operate or to be installed with the use of a directional antenna must be answered in each individual case. There can be no generalization on this subject. In every case of use of a directional antenna the conditions of use and area of protection of service should be specified by the Commission at the time of authorization.

The same situation exists with respect to synchronization of broadcast stations. It is possible to operate two or more stations exactly on the same frequency. The problem of application is both an engineering and economic one. It is not a "cure-all" solution. Each application must be studied and the best solution arrived at in the public interest. Technical data to apply are known and each case must be given individual attention.

Adherence to sound engineering principles must result in distribution of broadcast facilities to geographical areas. Proper decisions in individual cases can provide fair and equitable distribution to communities within a geographical area. A mathematical system for evaluating facilities is not necessary to comply with Section 307 (b) of the Act and experience has shown that the application of such a system results in an inefficient use of the broadcast spectrum. Radio waves do not respect artificial boundaries and a wise and intelligent allocation of the frequencies available for broadcasting will make use of the known factors to give the best service possible to all the population of the United States.

Ultra High Frequencies

There have been some suggestions that the development of high and ultra-high frequency broadcasting would reduce the congestion in the standard broadcast bands. The broadcast frequencies between 6000 kc. and 20,000 kc. give long distance service but cannot replace the service of clear channels. They are subject to international interference and wide variations in propagation characteristics. If all the frequencies between 6000 and 20,000 kc. available to broadcasting were used in the United States there still would not be enough frequency space to provide a full and complete competitive service to rural communities.

With respect to frequencies for broadcasting above 30,000 kc. there was much discussion at the time of the hearing in June. These frequencies are capable of giving a better and more satisfactory service to a local area than are the standard broadcast frequencies. Signals from stations operating on these frequencies are steady, substantially free of interference and capable of giving high fidelity service. If your Commission will authorize the commercial use by broadcasters of an adequate band of frequencies above 30,000 kc. you will take a step toward the eventual reduction in the congestion in the standard broadcast band. Receiving sets for these frequencies will come into use when frequency allocations are stabilized and local service will be greatly improved.

In conclusion, all topics under Item I can be answered by the application of existing data which are available and the answers to the questions may be summarized as follows:

Summary

(1) Specify by regulation standard of service "free of interference" on basis of OUTPUT of receiving set.

(2) Specify by regulation a "typical receiving set," including all factors which influence the output of this receiver.

(3) Specify propagation curves to be used in allocation problems to relate field intensities to output of transmitting stations.

(4) Classify by regulation each frequency on which duplicated operation is permitted on the basis of a protected primary service area in which a station is entitled to reception "free of interference" permitting use of sufficient power to provide field intensity sufficient to overcome man-made interference to the limit of this area.

(5) Provide clear channels without limit of power in order to give the best possible secondary service to persons outside primary service area of stations specifying standards of protection for primary service area.

(6) Set up mileage-frequency separation tables which relate all factors of standards of service, receiving sets and propagation for each classification of stations and for all frequencies capable of producing interference.

(7) Specify basis on which standards can be replaced by field observations of existing conditions.

(8) Make application of devices such as directional antennas, synchronization, etc., only if such application results in improved service in areas without adequate service and where it is possible to give complete service to the population of the area, specifying standards of service and all conditions at time of such grant.

Data have been submitted which can be used to set up and measure all those factors. If these data are not sufficient to meet your need and you believe that more data are required, the problem is so important to the American public that the data necessary must be obtained before you make decisions that will change the fundamentals of allocation. Technical facts are known now or can be measured; they should be applied accurately and at all times.

Jolliffe Cross Examined

Under cross-examination by Mr. Craven, Dr. Jolliffe said that it is absolutely essential to have flexibility of the Commission's regulations. He agreed he said with the announced policy of the Commission in this regard. Dr. Jolliffe discussed the international situation and explained that he had attended all of the international radio conferences with the exception of one. He admitted that there are international interference complications in North America including Central America but he expressed the opinion that they

are not very serious. At the Madrid Conference he stated that the engineers did not expect any serious interference from 500 kilowatt stations.

South American Situation

In connection with the South American situation he called attention to the fact that the population there is very sparse. He said that in South America they could obtain good radio service from their own stations without any interference from a limited number of 500 kilowatt stations in the United States. The situation there he said has not become acute. Detailed data relative to interference in South America from the United States is being collected by the UIR and will be available at the meeting next year of the C. C. I. R. at Bucharest.

Answering a specific question Dr. Jolliffe said that in his opinion 500 kilowatts stations can not serve the whole country. He called attention to the fact that high power stations might deliver a better signal 1,000 miles away from their location than they would 250 miles away because of fading. In his opinion he stated that a high powered New York station could not give a good service to the West Coast under present development of radio. If a station were placed on the same frequency on the West Coast and the dominant station on the East Coast had its power increased the West Coast station would have its service very materially reduced, he stated. In limiting the power of stations Dr. Jolliffe said that it would tend to impede progress in radio. Questioned about the duplication of 790 kilocycles by WGY with 50 kilowatts and KGO with 7½ kilowatts, Dr. Joliffe said that each station renders a good service in their primary area.