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FM BROADCAST CHANNEL FREQUENCY SPACING

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SUMMARY

This report studies the effect of reducing the adjacent channel frequency offset from the presently used 200 kHz to 150 kHz and to 100 kHz. The analysis shows quite conclusively that both the 100 kHz offset, with a receiver filter, and the 150 kHz offset (no filter) are more efficient in population and area coverage efficiency than the 200 kHz offset for both stereophonic and monaural operation. The 100 kHz offset, with filter, gives about twice the improvement that the 150 kHz offset offers. However, the 100 kHz offset advantage is contingent upon the use of a low pass filter following the demodulator in the stereophonic receiver, without which the 100 kHz offset is somewhat worse than the 200 kHz offset. For lack of protection criteria the effect of reducing the frequency offset upon SCA and quadraphonic operation could not be evaluated.
Introduction

The total spectrum bandwidth available for assignment to FM broadcast stations is limited and in some areas quite congested. It is therefore desirable that station assignments be made in the most efficient manner. The present study was undertaken to determine the relative efficiency of adjacent channel FM assignments at 100 kHz or 150 kHz separations as contrasted with the present assignment plan which uses 200 kHz separations. The area coverage efficiencies, service ranges and available number of station assignments are compared for both monaural and stereophonic operation. The technical station operating parameters, such as emission bandwidth, frequency deviation, etc., are assumed to be unchanged. The study does not include the effects of Subsidiary Communications Authorizations (SCA) and quadraphonic operations.

A simplified equilateral triangular cochannel lattice assignment plan has been assumed for this study as the most efficient station assignment configuration. Admittedly, such a regular configuration is not representative of the true physical distribution of the distances between population centers, nor are the transmitting antenna heights uniform nor the radiated powers all the same. In effect, all the station parameters, as well as the physical and propagation parameters, are statistically variable. The net effect is to increase substantially the overall standard deviations in the results, which means that because of this variability, the actual performance could differ greatly from what these idealized computations predict. Nevertheless, the comparisons and trends indicated in this study should be sufficient for the determination of station assignment policy. Thus, the Ad Hoc Committee used substantially the same techniques for its TV studies and noted (P 5 of Vol. II), "Even though the present data may be inadequate for making an accurate prediction of the eventual total service, it should be noted that comparisons of national services which differ because of different allocation policies can, nevertheless, be made with a high degree of accuracy. For example, useful comparisons can be made between the results to be expected with different antenna heights, powers, station separations, etc."

Service Concepts and Criteria

Since the wanted and interfering signals in the FM frequency range (88-108 MHz) vary both in time and from location to location, it is useful to describe the service in statistical terminology, using the same concepts of service that have been developed for TV broadcasting. Thus, the service at any location is considered to be
Should the 100 kHz adjacent channel offset operation be adopted in the U.S., there would then be the economic incentive to mass-produce such filters at a reasonable cost especially in view of the increasing use of integrated circuits. Therefore, the emphasis in this report has been upon the use of such low pass filters in the stereophonic receivers for the 100 kHz offset. The problem of retrofitting existing stereo receivers which do not have filters, is beyond the scope of this report.

For this study the following values of minimum usable field strength levels were assumed to compute service in the presence of noise only:

\[
\begin{align*}
\text{Monaural} & : \quad 24 \text{ dBu} \\
\text{Stereophonic} & : \quad 36 \text{ dBu}
\end{align*}
\]

The monophonic value was derived by applying a 10 dB fading factor to the 50 \(\mu\text{V/m}\) median field strength which has often been used by the F.C.C. for rural service. And, the stereophonic value was then obtained by adding 12 dB to the monophonic value, as suggested by CCIR. Other numbers may be substituted for the above but the computed trends will not be changed, except perhaps at the greater cochannel spacings. Because of the multiple interference for a full lattice, the noise is relatively unimportant except for a combination of wide spacings and low radiated power.

The receiving antenna discrimination pattern of Fig. 2 was used for service computations. It is similar to that of CCIR Recommendation 419 except that the discrimination increases with the square of the secant of the angle from the main beam rather than the logarithmic trend of CCIR. The secant squared variation is believed to be more typical for receiving antennas.

A triangular lattice network of cochannel stations with stations located at the vertices of the equilateral triangles provides the most efficient area coverage for a channel, as outlined in Reference 4. Consequently, equilateral triangle cochannel networks were employed in this study. The adjacent channel stations were located as efficiently as possible within the equilateral cochannel triangles, using the assignment techniques developed in References 5 and 6. The assignment method is described in more detail in Annex A.

Figs. 3, 4 and 5 illustrate the most efficient regular assignment plans for FM broadcast stations with minimum adjacent channel carrier offsets of 200, 150 and 100 kHz, respectively. Only the basic parallelograms, consisting of two adjacent equilateral cochannel triangles, are shown. The numbers at the various station locations denote the multiples of the minimum permissible adjacent channel frequency offset. The negative numbers indicate that the station carrier frequency is lower than the reference carrier frequency. Thus, in Fig. 4 the station at
The number of station assignments available, compared to that at a
200 kHz offset, is computed from

\[ \frac{N_{\Delta f}}{N_{200}} = \left( \frac{S_{200}}{S_{\Delta f}} \right)^2 \left( \frac{200}{\Delta f} \right) \]

where

\[ \Delta f = \text{the minimum frequency offset, in kHz} \]
\[ N_{\Delta f} = \text{the number of frequency offsets before a channel}
\text{may be repeated at a given location, for a frequency}
\text{offset of } \Delta f \]
\[ S_{\Delta f} = \text{the cochannel spacing for a frequency offset of } \Delta f, \]
\text{in km}

The service ranges and lattice efficiencies were computed under the
assumed lattice configurations of Figs. 3, 4 and 5, using the multiple
interference computation techniques of Annex 2 for the combinations
of transmitting antenna height and radiated power given below in Table 1.

<table>
<thead>
<tr>
<th>Curve</th>
<th>Power, kw</th>
<th>Transmitting Antenna Height, ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>50</td>
<td>2000</td>
</tr>
<tr>
<td>B</td>
<td>50</td>
<td>1000</td>
</tr>
<tr>
<td>C</td>
<td>50</td>
<td>500</td>
</tr>
<tr>
<td>D</td>
<td>10</td>
<td>500</td>
</tr>
<tr>
<td>E</td>
<td>3</td>
<td>300</td>
</tr>
</tbody>
</table>

Discussion

Using the parameters listed in Table 1, service contours and efficiencies
were computed for 200 kHz, 150 kHz, and 100 kHz, without filter, offsets
for both monaural and stereophonic operations. In addition, the
service contours and efficiencies were also computed for the 100 kHz
stereophonic operation, with filter. These are plotted versus
a single criterion but rather on a joint weighted comparison of
the several criteria. So long as the service radius per station
is great enough to cover the required area and to provide for
economic viability, it becomes a relatively unimportant parameter
to the allocation engineer. Thus, the main attention should be
focused upon the overall area efficiency and the relative number
of station assignments - i.e. the area and the population coverage.
No attempt will be made here to assess the relative importance of
the overall area efficiency and the relative number of available
station assignments, other than to note that they are both quite
important. Further, it is believed that stereophonic coverage for
FM is much more important than monaural coverage.

For purposes of comparison, Table 2 was derived from Fig. 6 through
19. At the cochannel spacings for which the maximum area efficiencies,
the cochannel spacings at which they occur, the station service radii
for these spacings, and the relative number of station assignments
available both for monaural and stereophonic operation. It is
noted that both the relative number of assignments and the relative
efficiency of operation increase as the frequency offset is decreased,
except that the 100 kHz operation, without filter, is the least
efficient mode of operation. On the other hand, the station service
range decreases somewhat as the offset is reduced. Thus, for a full
lattice of Class B FM stations - 50kw at 500 ft the stereo area
efficiency at 100 kHz offset, with filter, is 23% greater than with
the 200 kHz offset and the available number of station assignments
is 51% greater. The improvement for 150 kHz offset as compared to
the 200 kHz offset runs about half that for the 100 kHz offset,
with filter. A comparable improvement is available for all height-
power combinations used in the study. Unquestionably, the improvement
available in reducing the offset below 200 kHz is substantial. For
monaural operation the trends are similar but the improvements in
"overall area" efficiency and available number of assignments, as
the frequency offset is reduced, are even greater than for stereo
operation.

The comparisons between the different offsets are made from a some-
what different point of view in Table 3, which was also compiled
from Figs. 6 through 19. In this table, the stereophonic service
radius is kept constant, the cochannel spacings being varied to
provide the desired service radius. Thus, if the service radius is
set to provide a given service area per station on the basis that such
a service radius is required to provide station economic viability,
the comparison still shows that the 100 kHz offset, with receiver
filter, is the most efficient operation and that the 100 kHz offset,
without filter, is the least efficient. Again, the 150 kHz offset
It should also be emphasized that our cities and towns are not
arranged geographically in nice regular lattices, so that the
full efficiencies of the reduced offsets could not be realized
in practise. However, the relative trends and comparative
advantages would be realizable, so that the results of this
report should be useful in assessing the costs for continuing
with the present 200 kHz offset.

Conclusions

The analysis shows conclusively that from a technical point of
view both the 100 kHz offset, with a low pass receiver filter
after the second demodulator, and the 150 kHz offset are more
efficient than the presently used 200 kHz offset, both in overall
area coverage efficiency and in the available number of station
assignments - i.e. in area and population coverage. The 100
kHz offset, with filter, shows about twice the improvement that
the 150 kHz offset offers. However, the 100 kHz offset advantage
would be contingent upon the use of receiver filters, without which
the efficiency would be a little worse than that for the 200 kHz
plan. Also, since there already exists a viable FM system with
a 200 kHz offset, any reassessment would have to consider other
factors, such as the costs of changing station frequencies, the
costs for incorporating the receiver filters for 100 kHz offset,
reduced SCA service range, and reduced quadraphonic service range.
Annex A

REGULAR EFFICIENT ASSIGNMENT PLANS

The assignment plans were designed along the concepts developed in References 5 and 6 for the efficient distribution of adjacent channel stations within the cochannel lattice. The technique not only provides an efficient assignment plan but also gives a systematic method of locating the stations in a regular order, with each station receiving equal cochannel and adjacent channel interference protection. The practical application of the technique for locating the adjacent channel stations within the basic cochannel parallelogram of two adjacent equilateral cochannel triangles is relatively simple. The basic cochannel parallelogram is subdivided into $N^2$ equal smaller parallelograms, as shown in Figs. 3, 4 and 5, by dividing the sides of the basic parallelogram into $N$ equal parts and drawing a grid of parallel lines through the dividing points. $N-1$ is the number of adjacent channel stations. And, $N$ is also the number of frequency offsets before a channel may be repeated at a given location. The stations are ordered in multiples of the minimum offset frequency $\Delta f$, so that $m \Delta f$ represents the carrier frequency offset. Using the lower left corner of the basic cochannel parallelogram as the zero of a graph plot, the adjacent channel stations are located in regular order at points

\[(A1) \quad (X, Y) = (mA, mB) \quad ; \quad m = 1, 2, \ldots, N\]

\[m \Delta f \quad = \quad \text{carrier frequency offset, in kHz}\]

\[\Delta f \quad = \quad \text{minimum frequency offset, in kHz}\]

When $mA$ or $mB$ exceeds $N$ or a multiple of $N$, the remainder is used for plotting the stations within the basic parallelogram. Thus, for plotting purposes

\[(A2) \quad mA - aN = mA - bN \quad \quad a; b = 0, 1, 2 \ldots \]

\[m = 1, 2, \ldots, N\]

In the above, $a$ may be different from $b$.

Various values of $A$ and $B$ are tried and the best combination with respect to interference is selected by observation. The choice is not difficult and can usually be made quite readily, since those adjacent channel combinations are known, which are the most susceptible to interference. Further, a number of combinations of parameters $A$ and $B$ give essentially the same lattice, rotated about the center axis.
ANNEX B

COMPUTATION OF SERVICE AND INTERFERENCE

The method used for the computation of station service in the presence of both single and multiple sources of interference will be developed in this Annex. It is a combination of two methods described in Volume II of the Ad Hoc Report. 1/

The field strength from a station may be described, approximately as a two dimensional lognormal (in μV/m) or normal (in dBu) distribution, in order to account for the variability with time and from location to location. Thus, the field strength may be described by:

\[(B1) \quad F(L,T) = F(50,50) + X(T)\sigma_T + Y(L)\sigma_L \quad \text{dBu}\]

where

\[\begin{align*}
F(L,T) &= \text{the level of field strength exceeded for} \\
& \quad \text{T percent of the time in at least L percent} \\
& \quad \text{of the locations, in dBu} \\
F(50,50) &= \text{field strength median in both time and} \\
& \quad \text{location, in dBu} \\
\sigma_T &= \text{standard deviation for time variability, in dB} \\
\sigma_L &= \text{standard deviation for location variability,} \\
& \quad \text{in dB} \\
X(T), Y(L) &= \text{standard variates for the normal distribution}
\end{align*}\]

In (B1), \(F(50,50)\) and \(\sigma_T\) may be obtained from FCC Report R6602, 2/

where

\[(B3) \quad \sigma_T = \frac{F(50,10) - F(50,50)}{1.282} \quad \text{dB}\]

From Volume I of the Ad Hoc Report 1/ is obtained the value of

\[(B4) \quad \sigma_L = 8.3 \quad \text{dB}\]

And the standard Gaussian variate, \(X(T)\) or \(Y(L)\), is tabulated in many statistical textbooks. It is also plotted in Figure 30 of Reference 8.
are added powerwise statistically to give a resultant required wanted field which is also constant with time and has a variability with location which is assumed to be lognormal. This technique for combining multiple interferences is good so long as the \( F_{\text{dri}} \) have about the same standard deviations for their location distributions. It is therefore used to combine all the interferences except noise which is assumed not to vary from location to location. To compute the resultant lognormal distribution from the various interference sources (except noise), the first two central moments for the individual location distributions \( F_{\text{dri}} \) are added.

\[
\begin{align*}
\alpha &= \exp(\sigma_i^2/2) \sum_i P_i \text{ watts} \\
\mu &= \left[ \exp(\sigma_i^2) - 1 \right] \exp(\sigma_i^2) \sum_i P_i^2 \text{ watts}^2 \\
\sigma_i &= 0.23026 \text{ \sigma}_L = 1.90655 \text{ nepers} \\
P_i &= 10 \frac{F_{\text{dri}}}{10} \text{ watts} \\
\sigma_L &= 8.3 \text{ dB}
\end{align*}
\]

(B8)

The resultant median and normal standard deviation are then computed from:

\[
\begin{align*}
\sigma_{\text{dr}}^2 &= \ln \left[ 1 + \mu k/\alpha^2 \right] \text{ nepers}^2 \\
P_{\text{dr}} &= \alpha \exp(-\sigma_{\text{dr}}^2/2) \text{ watts} \\
k &= 0.468 \quad \text{(for zero correlation)}
\end{align*}
\]

(B9)

The factor \( k \) was found empirically to improve the lognormal approximation for the resultant. More details on this lognormal approximation for the resultant distribution of the required wanted signal may be found in Volume II of Reference 1. The values of (B9) may be converted to the more useful units:

\[
\begin{align*}
\sigma_{L\text{dr}} &= 4.3429 \sigma_{\text{dr}} \text{ dB} \\
F_{\text{dr}}(50,50) &= 10 \log P_{\text{dr}} \text{ dBu}
\end{align*}
\]

(B10)
BIBLIOGRAPHY


2. International Radio Consultative Committee (CCIR), XII th Plenary Assembly, New Delhi, 1970, Volume V, Part I, "Broadcasting Service (Sound)"

3. International Radio Consultative Committee (CCIR), XII th Plenary Assembly, New Delhi, 1970, Volume V, Part 2, "Broadcasting Service (TV)"


8. H. Fine "A Further Analysis of TASO Panel 6 Data on Signal to Inter-Radios and Their Application to Description of TV Service" FCC TFR Report No. 5.1.2 (April, 1960)
Table 2

Comparison Under Conditions of Maximum Efficiency

<table>
<thead>
<tr>
<th>Monaural</th>
<th>2000 ft.</th>
<th>1000 ft.</th>
<th>500 ft.</th>
<th>500 ft.</th>
<th>300 ft.</th>
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</thead>
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<tr>
<td></td>
<td>50 kw</td>
<td>50 kw</td>
<td>50 kw</td>
<td>10 kw</td>
<td>3 kw</td>
</tr>
<tr>
<td>S100 (mi)</td>
<td>230</td>
<td>200</td>
<td>205</td>
<td>200</td>
<td>195</td>
</tr>
<tr>
<td>E100 (%)</td>
<td>22.8</td>
<td>21.5</td>
<td>19.6</td>
<td>19.5</td>
<td>16.7</td>
</tr>
<tr>
<td>R100 (mi)</td>
<td>41.0</td>
<td>34.5</td>
<td>33.3</td>
<td>32.7</td>
<td>29.3</td>
</tr>
<tr>
<td>N100/N200</td>
<td>1.91</td>
<td>2.00</td>
<td>2.10</td>
<td>1.90</td>
<td>1.70</td>
</tr>
<tr>
<td>E100/E200</td>
<td>1.25</td>
<td>1.28</td>
<td>1.32</td>
<td>1.32</td>
<td>1.37</td>
</tr>
</tbody>
</table>

|                | 200      | 200      | 205     | 200     | 185     |
| S150 (mi)      | 190      | 200      | 205     | 200     | 15.2    |
| E150 (%)       | 20.8     | 20.0     | 18.2    | 18.2    | 32.7    |
| R250 (mi)      | 39.5     | 39.7     | 39.6    | 38.7    | 1.26    |
| N150/N200      | 1.87     | 1.33     | 1.40    | 1.27    | 12.2    |
| E150/E200      | 1.14     | 1.19     | 1.22    | 1.23    | 1.25    |

|                | 225      | 200      | 210     | 195     | 180     |
| S200 (mi)      |          |          |         |         |         |
| E200 (%)       | 18.2     | 16.8     | 14.9    | 14.8    | 12.2    |
| R200 (mi)      | 50.5     | 43.0     | 42.5    | 39.5    | 33.0    |

| Stereophonic   | 285      | 265      | 265     | 245     | 245     |
|                |          |          |         |         |         |
| S100f (mi)     | 18.9     | 16.7     | 14.5    | 13.5    | 10.2    |
| E100f (%)      | 46.0     | 40.1     | 37.3    | 33.5    | 25.4    |
| R100f (mi)     | 1.42     | 1.51     | 1.51    | 1.40    | 1.33    |
| N100f/N200     | 1.19     | 1.33     | 1.23    | 1.24    | 1.34    |

|                | 350      | 345      | 345     | 305     | 280     |
| S100u (mi)     |          |          |         |         |         |
| E100u (%)      | 14.7     | 12.6     | 10.6    | 9.5     | 6.9     |
| R100u (mi)     | 50.0     | 45.0     | 41.0    | 35.0    | 27.2    |
| N100u/N200     | 0.94     | 0.89     | 0.89    | 0.90    | 1.02    |
| E100u/E200     | 0.92     | 0.91     | 0.90    | 0.87    | 0.91    |

|                | 250      | 240      | 245     | 215     | 205     |
| S150 (mi)      |          |          |         |         |         |
| E150 (%)       | 16.9     | 15.3     | 13.0    | 12.1    | 8.9     |
| R150 (mi)      | 47.0     | 42.8     | 40.0    | 34.0    | 27.2    |
| N150/N200      | 1.23     | 1.22     | 1.18    | 1.21    | 1.27    |
| E150/E200      | 1.06     | 1.10     | 1.10    | 1.11    | 1.17    |

|                | 240      | 230      | 230     | 205     | 200     |
| S200 (mi)      |          |          |         |         |         |
| E200 (%)       | 15.9     | 13.9     | 11.8    | 10.9    | 7.6     |
| R200 (mi)      | 50.5     | 45.0     | 41.3    | 35.5    | 29.0    |
### Table 3 (Continued)

Comparison Under Conditions of Constant Service Radius

<table>
<thead>
<tr>
<th>Stereo (mi)</th>
<th>Δf (kHz)</th>
<th>Sst (mi)</th>
<th>Est (ft)</th>
<th>Na₂f N200</th>
<th>EΔ₂f E200</th>
<th>Emono Rmono</th>
<th>EΔ₂f F200</th>
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<td>50</td>
<td>100f</td>
<td>390</td>
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<td>1.12</td>
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<td>1.01</td>
<td>1.06</td>
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<td></td>
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Figure 1
REQUIRED SIGNAL TO INTERFERENCE RATIOS vs. CARRIER FREQUENCY DIFFERENCE

- STEREOPHONIC (FILTERED RECEIVER)
- STEREOPHONIC (UNFILTERED RECEIVER)
- MONAURAL
Figure 2
RECEIVING FM ANTENNA GAIN PATTERN

\[ G = \begin{cases} 
-20 \log \sec \theta \text{ dB} ; & 0^\circ \leq \theta \leq 59.9^\circ \\
-6 & ; \theta > 59.9^\circ 
\end{cases} \]
NUMBERS 0-5 REFER TO FREQUENCY DIFFERENCE IN 150 KHz MULTIPLES, POSITIVE BEING ABOVE THE DESIRED CHANNEL AND NEGATIVE BEING BELOW THE DESIRED CHANNEL. EQUILATERAL TRIANGLES ARE FORMED BY ANY 3 CO-CHANNEL STATIONS.

<table>
<thead>
<tr>
<th>Carrier Difference m</th>
<th>S/I Protection Ratio in dB</th>
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<td>28</td>
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<tr>
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<td>8</td>
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<td>-7</td>
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<td>-40</td>
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**Figure 4**
Figure 6

DISTANCE TO THE SERVICE CONTOUR vs.
CO-CHANNEL STATION SPACING

$H_t = 30$ ft
$P_t$ and $H_t$ as specified
200 kHz Offset Plan Monaural Broadcasting

$P_t$ and $H_t$
A - 50 kW, 2000 ft
B - 50 kW, 1000 ft
C - 50 kW, 500 ft
D - 10 kW, 500 ft
E - 3 kW, 300 ft
Figure 8

DISTANCE TO THE SERVICE CONTOUR vs.
CO-CHANNEL STATION SPACING

H_r = 30 ft
P_t and H_t as specified
100 kHz Offset Plan
Monaural Broadcasting

Pt and Ht

A - 50 kW, 2000 ft
B - 50 kW, 1000 ft
C - 50 kW, 500 ft
D - 10 kW, 500 ft
E - 3 kW, 300 ft
Figure 10

**DISTANCE TO THE SERVICE CONTOUR**

**vs.**

**CO-CHANNEL STATION SPACING**

$H_r = 30 \text{ ft}$  \quad $P_t$ and $H_t$ as specified

150 kHz Offset Plan  \quad Stereophonic Broadcasting

- **A** - 50 kW, 2000 ft
- **B** - 50 kW, 1000 ft
- **C** - 50 kW, 500 ft
- **D** - 10 kW, 500 ft
- **E** - 3 kW, 300 ft

**CO-CHANNEL STATION SPACING - MILES**

**DISTANCE TO SERVICE CONTOUR - KILOMETERS**

**CO-CHANNEL STATION SPACING - KILOMETERS**

**DISTANCE TO SERVICE CONTOUR - MILES**
Figure 12

**DISTANCE TO THE SERVICE CONTOUR vs. CO-CHANNEL STATION SPACING**

- **H_r = 30 ft**
- **P_t and H_t as specified**
- **100 kHz Offset Plan**
- **Stereophonic Broadcasting (with Receiver Filter)**

**Legend:**

- **A** - 50 kW, 2000 ft
- **B** - 50 kW, 1000 ft
- **C** - 50 kW, 500 ft
- **D** - 10 kW, 500 ft
- **E** - 3 kW, 300 ft

**Axes:**

- **Y-axis:** Distance to service contour - Kilometers
- **X-axis:** Co-channel station spacing - Kilometers

**Graph Details:**

- The graph illustrates the relationship between co-channel station spacing and distance to the service contour under different power and height conditions.
- Curves A, B, C, D, and E represent different power levels and heights as specified in the legend.
- The graph is used to determine the required spacing between stations to avoid interference.
Figure 14

FM STATION ALLOCATION EFFICIENCY vs.
CO-CHANNEL STATION SPACING

$P_t$ and $H_t$

A - 50 kW, 2000 ft
B - 50 kW, 1000 ft
C - 50 kW, 500 ft
D - 10 kW, 500 ft
E - 3 kW, 300 ft

$H_p = 30$ ft

$P_t$ and $H_t$ as specified

150 kHz Offset Plan
Monaural Broadcasting

CO-LIGHT STATION SPACING - KILOMETERS
Figure 16
FM STATION ALLOCATION EFFICIENCY VS.
CO-CHANNEL STATION SPACING

Finite Power
Infinite Power

$H_T = 30 \text{ ft}$
$P_t$ and $H_t$ as specified
200 kHz Offset Plan
Stereophonic Broadcasting

$P_t$ and $H_t$
A - 50 kW, 2000 ft
B - 50 kW, 1000 ft
C - 50 kW, 500 ft
D - 10 kW, 500 ft
E - 3 kW, 300 ft
Figure 18
FM STATION ALLOCATION EFFICIENCY
vs.
CO-CHANNEL STATION SPACING

Finite Power
Infinite Power

$H_r = 30$ ft
100 kHz Offset Plan
$P_t$ and $H_t$ as specified
Stereophonic Broadcasting
(no Receiver Filter)

$P_t$ and $H_t$
A - 50 kW, 2000 ft
B - 50 kW, 1000 ft
C - 50 kW, 500 ft
D - 10 kW, 500 ft
E - 3 kW, 300 ft
Figure 20

STEREOPHONIC SERVICE RANGE vs. MONOAURAL SERVICE RANGE

$H_r = 30 \text{ ft} \quad P_t$ and $H_t$ as specified

$P_t$ and $H_t$

A - 50 kW, 2000 ft
B - 50 kW, 1000 ft
C - 50 kW, 500 ft
D - 10 kW, 500 ft
E - 3 kW, 300 ft

Offset Plans

- 100 kHz Plan, Filtered Receiver
- 150 kHz Plan, Unfiltered Receiver
- 200 kHz Plan, Unfiltered Receiver
- 100 kHz Plan, Unfiltered Receiver