U S DEPARTMENT OF COMMERCE
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Technical Development Report No 28

NATIONAL ALLOCATION PLAN FOR ASSIGNING RADIO-RANGE FREQUENCIES IN THE BAND 119–126 MEGACYCLES

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National Allocation Plan for Assigning Radio Range Frequencies in the Band 119–126 Megacycles

SUMMARY

The plan outlined herein was developed as a guide in assigning operating frequencies to all ultra-high-frequency radio range stations now planned or which in the future may be built as a part of the national system of air navigation radio aids. The plan is based upon a standard channeling system in the band of radio frequencies between 119 and 126 megacycles, which is devoted exclusively to radio range service. Frequency intervals between assignable operating channels are uniformly established at 200 kilocycles, thus providing a total of 36 channels inclusive of the terminal frequencies of the band.

INTRODUCTION

For the first time in the history of aeronautical communications it has become possible to apply advance technical planning in the allocation of radio frequencies to the end that there shall be an orderly expansion of service on a national scale. This can be assured only through systematic adherence to a comprehensive long-range plan. Costly, dangerous, and sometimes makeshift readjustments, which are necessary in the case of the 200–400 kilocycle range service in order to accommodate each new station, can thus be avoided on ultra-high frequencies. The ultimate radio-frequency requirements of the aeronautical services and the course of future development were not so well known when the original service allocations were made in the low and medium-high frequencies upon which aeronautical radio communications have heretofore been dependent. As a result, in order to find operating frequencies for vitally needed safety aids, it was necessary to reduce to the extreme limit, both the frequency separation between contiguous range channels and the geographical separation between stations sharing the same frequency. The number of additional stations which could be accommodated thereby was increased several fold, but at the cost of continual revision of frequency assignments with attendant great expense, not to mention the resulting confusion and difficulty for the users of such facilities. The actual cost of changing the frequency of only one simultaneous range station averages at least $800, exclusive of the salaries of the force of technicians required. The indirect expense to the users and others who must keep their operating manuals and records up to date is difficult to estimate, but it is considerable when it is remembered that to add one new station or change the frequency of an existing one in such a vast interlocking national network usually involves a rearrangement at several other stations in the same area in order to avoid interference.

These frequency allocation problems are usually capable of technical solutions when only airway radio facilities are considered, but when stations of other services are involved the question becomes one for negotiation. The compromise demanded frequently cannot be tolerated and minimum safety standards still maintained. The only alternative in such cases is to limit flight operations.

Fortunately, however, it is now possible to take advantage of the foresight wisely applied by the Interdepartmental Radio Advisory Committee when the frequencies above 30,000 kilocycles were allocated finally to specific services. The aeronautical services eventually were given an exclusive band of frequencies instead of being forced to suffer interference from other services as they now do in the 200–400 kilocycle band It was possible to obtain an exclusive frequency band in competition with conflicting demands from other services only because those responsible for the allocation were desirous of avoiding past mistakes and were able to appreciate both the importance and manifold advantages of the economical use of a small exclusive band, instead of a dangerous and inefficient sharing of a large number of scattered frequencies

DISCUSSION

On the basis of service and interference radii as determined by propagation characteristics, earth curvature, flight altitudes, and average station spacing, it was determined that a given frequency assignment might be repeated safely at distances of approximately 500 miles Aircraft midway between two such stations transmitting on the same frequency would not expect to hear a signal from either until reaching altitudes of 29,000 feet or more, even taking into account wave refraction, since line of sight would be somewhere above 41,000 feet Considering the natural geographical spacing between airports on a representative airway, a maximum of four intermediate stations was estimated as desirable to provide a range at bends in the airway or at points where stations are necessary because of large and abrupt changes in ground contour Thus, a total of five frequencies was established as the minimum number required throughout a distance of 500 miles, the same frequencies being usable by repetition indefinitely in the same sequence in any given direction With stations spaced at approximately 100-mile intervals the aircraft would naturally tune to the frequency of the nearest ground station so the possibility of interference from any other stations operating on the same frequency would be extremely remote If an aircraft were at very great altitudes under such circumstances and should for that reason hear unwanted signals, these signals would of course be overridden by the local desired signal because of the much greater intensity of the latter as compared with the interference which would be greatly attenuated with distance

BASIS OF ALLOCATION PLAN

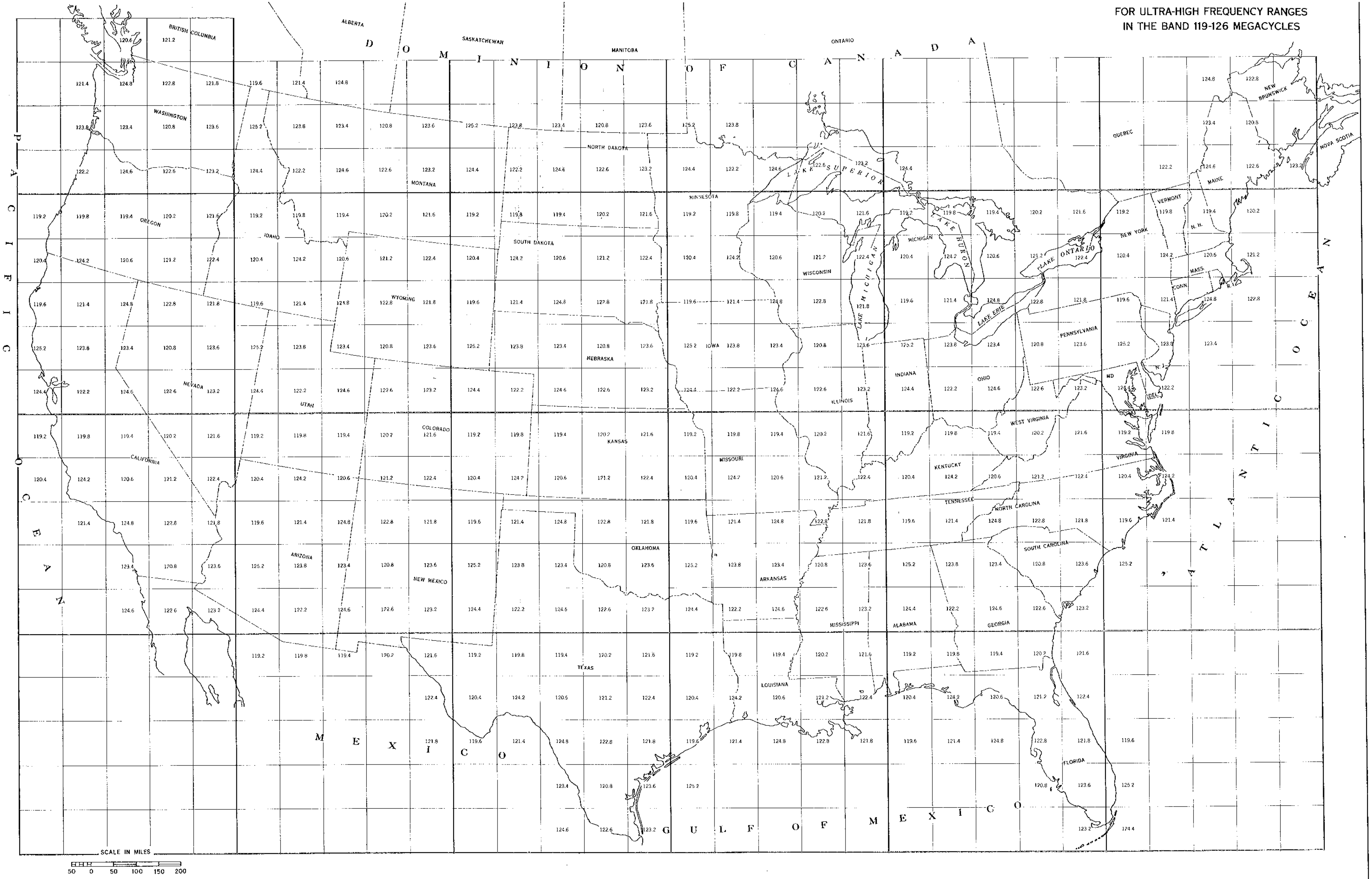
From this premise was developed a standard geographical unit area for radio-frequency assignment purposes This unit area is a 500-mile square subdivided into 25 equal 100-mile square areas, to each of which is assigned an individual radio frequency from the following list of 25 primary channels

119 2 megacycles
119 4
119 6
119 8
120 2
120 4
120 6
120 8
121 2
121 4
121 6
121 8
122 2
122 4 megacycles
122 6
122 8
123 2
123 4
123 6
123 8
124 2
124 4
124 6
124 8
125 2

These units, when superimposed upon the map of the continental United States, provide a definite geographical subdivision of the entire country with a predetermined frequency for any location which may be selected now or in the future Figure 1 illustrates the recommended subdivision of the continental United States into 500-mile square units for frequency assignment purposes

In order to achieve the maximum possible frequency separation between a station located in any particular 100-mile square area and any station in one of the eight areas contiguous thereto, it is desirable to depart from a normal consecutive numerical assignment of the 25 available primary channels A consecutive system of assignment would give a minimum frequency separation of only 200 kilocycles between some of the adjoining areas It is possible, however, to arrive at an arbitrary disposition of frequencies which would give as much as 400 kilocycles minimum separation between stations in adjoining areas One such arrangement is indicated in figure 2 where the minimum separation has been increased to 400 kilocycles and the average is nearly 2 5 megacycles

FOR ULTRA-HIGH FREQUENCY RANGES IN THE BAND 119-126 MEGACYCLES



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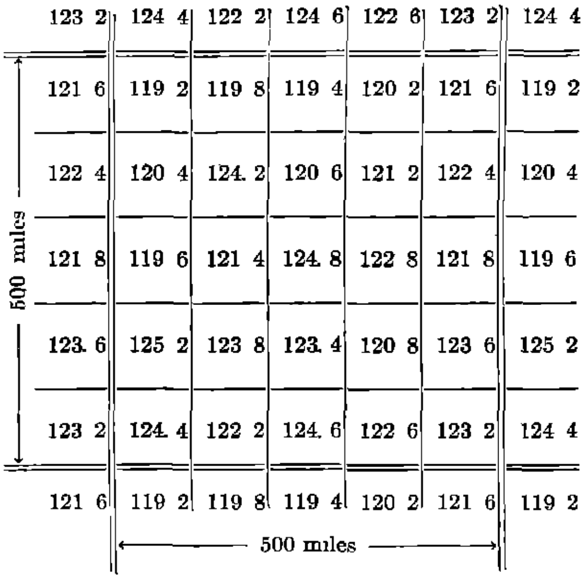

123 2	124 4	122 2	124 6	122 6	123 2	124 4
121 6	119 2	119 8	119 4	120 2	121 6	119 2
122 4	120 4	124. 2	120 6	121 2	122 4	120 4
121 8	119 6	121 4	124. 8	122 8	121 8	119 6
123. 6	125 2	123 8	123. 4	120 8	123 6	125 2
123 2	124. 4	122 2	124. 6	122 6	123 2	124 4
121 6	119 2	119 8	119 4	120 2	121 6	119 2

Figure 2

APPLICATION OF ALLOCATION PLAN TO FOUR-COURSE AURAL RANGE SYSTEM

If we assume a standard four-course aural range and essentially the same disposition of designated airways of the United States as of the date of this report, ultra-high-frequency replacements for the existing 250 low-frequency airway ranges of all classes can be accommodated plus sufficient additional stations to provide complete national service coverage

As air traffic becomes heavier, especially at points where airways converge, there is also a growing need for auxiliary ranges at certain terminals to provide additional approaches over which the highly concentrated flow of incoming and outgoing air traffic from several directions can be segregated and safely directed To provide for this supplemental type of range, eight additional frequencies are designated from which may be selected frequencies with adequate geographical separation from other channels in use in that particular area The entire eight supplemental channels may be duplicated a sufficient number of times to care for all local situations which can be reasonably anticipated The frequencies proposed for this purpose are

119 0 megacycles
120 0
121 0
122 0

123 0 megacycles
124 0
125 0
126 0

Three auxiliary primary channels also are provided for use as substitutes in case any of the 25 regular channels are found for any reason to be unusable—for example, on account of local or harmonic interference from stations of other services which may happen to be situated in close geographical proximity The frequencies are

125 4 megacycles
125 6
125 8

APPLICATION OF ALLOCATION PLAN TO TWO-COURSE VISUAL RANGE SYSTEMS

Many pilots who have had experience with ultra-high-frequency localizers of the Civil Aeronautics Administration's instrument landing system strongly advocate the adoption of two-course ranges There is no fundamental difference between the present instrument landing localizer and the proposed two-course range The service radius of the range is, of course, greater It has numerous advantages over the four-course range important among which is the simplification of the pilots' navigational problems

The same allocation plan would be equally applicable to ranges of the two-course type

EFFECT ON RECEIVER DESIGN

The allocation plan as outlined lends itself to the use of aircraft receivers designed for push-button tuning This form of simplified tuning is considered desirable, particularly from the standpoint of scheduled air carrier operations The plan permits an allocation of the minimum number of push-buttons for range service on aircraft regularly assigned to any particular route, and allows for the reservation of other pretuned frequencies for instrument landing localizer and airport traffic control service without involving an unreasonable number of push-buttons

CONCLUSIONS

An experimental application of this allocation plan on a Nation-wide scope based upon existing and anticipated future requirements for radio range service leads to the conclusion that the adoption of such a plan will—

- *a* Contribute to the most economical and efficient utilization of the frequencies now available for range service
- *b* Avoid the necessity for costly and confusing frequency changes which would otherwise be necessary in order to accommodate additional stations as they are added from time to time to serve new routes or to fill gaps on existing airways
- *c* Reduce inter-station radio interference to a minimum by providing the maximum possible frequency separation between geographically contiguous stations
- *d* Accommodate the maximum possible number of stations
- *e* Facilitate the solution of tuning problems in the design and operation of aircraft receivers

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