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CIVIL AERONAUTICS AUTHORITY
BUREAU OF FEDERAL AIRWAYS
TECHNICAL DEVELOPMENT DIVISION

Washington

NOTE NO. 20

METHODS DEVELOPED FOR THE ELIMINATION OF
VOICE INTERFERENCE ON SIMULTANEOUS RADIO RANGES

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Air Transport Section

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SUMMARY

Inasmuch as the success of the Simultaneous Radio Range depends upon the clear reception of voice or range, at the discretion of the user, the question of over modulation or voice spill-over disrupting the range signal through the range filter assumes major importance. This report contains the results of flight tests conducted at major terminals throughout the 1st, 4th, 5th and 7th regions and instructions issued for the elimination of this interference.

INTRODUCTION

The simultaneous radio range was designed primarily to permit the simultaneous transmission and reception of voice and range signals with provision also for selecting either at the pilot's discretion. This is desirable since it eliminates any necessity for pilots on instruments and preparing for a landing, to request continuous range. To do so deprives all other airmen of weather information normally scheduled to be broadcast during the periods of the continuous range signals.

The simultaneous radio range should make it possible to receive voice or range with the use of a filter or by returning the receiver to the level of whichever signal is desired. This is accomplished by means of a slight difference in voice and range frequency.

Voice spill-over on the range signal, when employing a filter was noticed and occurs when the sum of the range and voice modulation levels exceed 100 percent. This condition resulted in many requests

for temporary discontinuance of voice broadcasts. As in the case of the old type BRA range, this caused other airmen not particularly concerned with the range signal but interested in weather broadcast, traffic, field conditions, and other pertinent information, to be deprived of this service. The purpose of the simultaneous range was thus, to a large extent, defeated.

PURPOSE

The problem of eliminating the adverse spill-over effect was made a joint project of the Air Transport Section of the Technical Development Division, and the Airways Engineering Division. Various tests were conducted to determine the proper ratios between the side-band and carrier currents when employing the range filter. No attempt will be made to describe these tests. However, sufficient flight tests were made on different types of equipment to indicate the need for the readjustment of the percentage of voice modulation at all simultaneous stations.

ADJUSTMENT PROCEDURES

Copies of the following letter of instructions were issued by the Chief, Airways Engineering Division to all Regions:

"It has come to the attention of this office that the adjustments for proper percentage of voice modulation in the simultaneous radio ranges are not being made uniformly at all stations. In order to minimize difficulties that result from improper adjustments, and to make the adjustments at all stations

uniform, it is requested that the following procedure be adopted:

- "(1) With an audio-frequency signal of 400 cycles fed into the input of the speech amplifier at the control station, set the gain control of the speech amplifier so that the output of the amplifier is 0 db. In those cases where this output is maintained at a higher level (provided the telephone company does not object) in order to override excessive line noises, this higher level should be maintained.
- "(2) After the above adjustment has been made, adjust the gain control of the constant output amplifier at the transmitting station so that its output is 0 db.
- "(3) Check the regulating feature of the constant-output amplifier to see that the limiter tube just begins to act when the output reaches 0 db. This will be indicated by the fact that the reading of the limiter tube current meter just begins to decrease. Any necessary adjustment of the regulating feature can be made by means of the controls provided for this purpose and described in the proper instruction books.
- "(4) Remove the limiter tube from the constant-output amplifier and adjust the gain of this amplifier so that its output is plus $1\frac{1}{2}$ db.
- "(5) Adjust the gain control of the transmitter so that the percentage of modulation of the carrier is 65%. The modulation measurement is to be made in the standard manner using a cathode ray oscillograph and a pickup wire placed in the vicinity of the center tower. Extreme care should be used in this measurement to avoid errors due to improper use of the cathode ray tube, such as improper focusing, insufficient deflection, unstable pattern, etc. It will always be possible to get a sufficient amount of r.f. pickup so that the use of the amplifier in the oscilloscope will not be required. The deflection of the cathode beam should not be less than $1/2$ " on either side of the horizontal axis when there is no modulation.
- "(6) Replace the limiter in the constant-output amplifier, but do not change the settings of the gain control of the constant-output amplifier of the transmitter.

"The settings of the gain controls of the constant-output amplifier and transmitters found by the above method are not to be changed under any condition. In actual use of the equipment for voice broadcasts, it is imperative that the operator maintain his voice level as constant as practicable and in addition that he maintain the peaks in the output of the speech amplifier at the control station at 0 db. (or at the level determined in accordance with instructions under (1)). The operator may employ the gain control on the speech amplifier to assist him in maintaining this limit. It is very important that under no condition shall the output of the speech amplifier at the control station exceed 0 db. It must be remembered that whenever the output of the speech amplifier is permitted to exceed 0 db, there will be a momentary "spill-over" of the voice into the range signal and this is very objectionable to pilots using the range courses.

"After the gain controls of the equipment have been set in the manner described above, the ratio of corner to center tower currents must be checked in the manner described in the course alignment data supplied with it for each station. At the time that this ratio is properly set, readings should be taken of the r.f. line currents for the side-band and carrier channels of the transmitter and a daily check should be made to see that the ratio of these two currents does not change.

"The C.A.A. has committed itself to adjust all SBRA stations to prevent voice interference in the range signals before the winter weather sets in. For this reason it is requested that all simultaneous radio range stations be promptly readjusted in accordance with the procedure outlined above, beginning with the more important terminal stations. In any case, all stations should be so readjusted with a minimum of delay.

"The above instructions supersede and replace any other instructions that may have been previously issued concerning these adjustments."

It was believed advisable, subsequent to this, to make flight checks, and to assist field personnel in becoming familiar with the method of procedure. Accordingly, on November 7, 1939, the Chief, Airways Engineering Division wrote to the 4th, 5th, 6th and 7th Regions, as follows:

"Mr. D. M. Rainey of the Technical Development Division is planning a visit to your Region in the near future to offer his assistance in connection with the problem of voice interference with range signals. Mr. Rainey has run flight tests on several of the ranges in the eastern part of the country as part of a Technical Development project to eliminate the above-mentioned type of interference, and it is believed that the information thus gained may be helpful to you.

"It is suggested that arrangements be made for Mr. Rainey to accompany the patrol pilot and radio engineer during readjustment of one or more ranges in accordance with instructions contained in letter to All Regions of November 6."

STATIONS ADJUSTED AND FLIGHT CHECKED

The Charleston and Elkins, W. Va., and the new Philadelphia simultaneous radio range stations were used for tests and proving grounds prior to the issuance of the instructions of November 6. At these points the percentage of voice modulation was set at the prescribed 65 percent and found to be completely free of all voice interference. It was also noted that without employing the use of the filter, adequate voice reception was obtainable, and the usable distance was not materially reduced. It is necessary, however, to retune the receiver to the desired resonance of voice or range on each occasion to obtain the best results. This apparently is a limitation of the simultaneous range.

During the time allotted to the 4th Region the following facilities were adjusted and flight checked with the assistance of the Regional Radio Engineer and Patrol Pilot: Ft. Worth, Dallas, Amarillo and Wichita Falls, Texas. Upon the completion of adjustments at these stations, the regional personnel were enabled to correct the other ranges within the Region.

The 5th Region was next visited, where the writer was joined by a Radio Engineer from the Washington office of the Airways Engineering Division. The Kansas City simultaneous radio range was the first adjusted because of its proximity to the regional office. The station was adjusted by the Regional Radio Engineer according to the instructions issued by the Bureau of Federal Airways, and it was subsequently flight checked by the Patrol Pilot and writer. During the check it

was found that the voice interference still persisted. Considerable time was spent in tracing the source of trouble. This involved the checking of the constant speech amplifier, the transmitter filter, and all other sources within the transmitter for maladjustments. During this time, the aircraft filter of the patrol ship used was suspected of being too broad since it was of a different type and make from those of other Regions. This was replaced to conform to the standard type uniformly used. Further testing, after replacing the filter, proved that interference still existed. It had been assumed up to this point, that the station was operating normally. However, after exhausting all other possibilities, it was found that the towers were detuned and that the ratio of the corner and center tower currents of the station was incorrect. This made it impossible to obtain the desired results without retuning all towers. After retuning the towers, the voice modulation was properly adjusted, and upon flight checking the range was found to be free from spill-over interference.

The St. Louis and Wichita simultaneous ranges were then visited and the knowledge gained at Kansas City was applied. The regional personnel felt they had sufficient information to adjust the other simultaneous ranges within the region. However, upon the request of the Regional Manager, it was agreed that the writer upon his return from the West Coast would arrange to meet the Regional Patrol Pilot and Radio Engineer at Cheyenne, Wyoming, and recheck several of the stations which they had adjusted.

A visit was then made to the 7th Region at Seattle, Washington, at which point it was found that although the regional personnel had adjusted the voice modulation to 65 percent, the interference or discontinuity of range signal still prevailed. Upon rechecking with the Regional Radio Engineer on this adjustment, it was noted that the range modulation was actually less than 30 percent. Proper adjustments were made with the result that subsequent flight checking showed no trace of interference. The condition of the Spokane simultaneous range was similar to that of Seattle, with the exception that the voice modulation instead of being under, was well over 100 percent. Corrective measures restored this to normal.

The 5th Regional Engineer and Patrol Pilot were contacted by prior arrangement. The stations at Cheyenne, North Platte and Omaha were then rechecked and found to be free from voice interference.

CONCLUSIONS

1. The resetting of voice modulation at all simultaneous radio range stations, according to instructions, has definitely increased the efficiency of these facilities and will permit the station operation and maintenance personnel to retain this adjustment.
2. The diminishing number of requests received by the Civil Aeronautics Authority Communications Stations for continuous range attests that the simultaneous feature may be utilized without the former objectionable voice interference.

C O P Y

TRANSCONTINENTAL & WESTERN AIR, INC.

10 Richards Road
Kansas City, Mo.

Mr. Tom Bourne
Chief Engineer
Airways Engineering Division
Civil Aeronautics Authority
Washington, D. C.

Dear Mr. Bourne:

We wish to compliment you on the improved operation of the simultaneous range stations at Kansas City, St. Louis and Wichita since the recent adjustment of modulation percentages of these stations. Recent reports from pilots state that there is little or no voice spill-over on these stations when the filter is used during voice broadcasts. Provided the adjustments do not change, the ranges will give improved service.

Apparently, Indianapolis has not yet been readjusted, as reports from pilots indicate considerable voice interference to the range signal when using the filter during voice broadcasts.

Very truly yours,

(Signed) Howard K. Morgan
Supt. of Communications

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C O P Y

AMERICAN AIRLINES, INC.
NEW YORK, N.Y.

December 18, 1939

Mr. Richard C. Gazley
Chief, Technical Development Division
Civil Aeronautics Authority
Washington, D. C.

Dear Mr. Gazley:

Reference is made to your letter of November 7 to Mr. Damon, and our reply of November 15 in regard to the adjustment of the range and voice ratios at Charleston and Elkins, W. Va.

The following is a summary of our observations on the operation of these stations:

1. The range and voice ratios of the two subject stations is apparently satisfactory, as the writer in a flight over Charleston and Elkins on November 29 observed that no spill-over was noticeable on range frequencies. Our AM-25 pilots were questioned on this matter and no unsatisfactory reports were received.

2. No interference was observed on the Washington Control Tower operation from the Elkins Station and no unsatisfactory reports have been received from our AM-25 pilots.

3. There are numerous multiple courses in the east leg of the Charleston range, accompanied by rapid fading and surges in the signal strength. Such condition is often experienced on ranges in terrain similar to that around Charleston, altho we are of the opinion that it may be somewhat relieved if the frequency of Charleston could be lowered. As you know, it is now 400 kc., and it is believed that a frequency in the lower end of the band would improve operation of the range if such a channel could be obtained.

Very truly yours,

AMERICAN AIRLINES, INC.

J. G. Flynn, Jr.
Sup't. of Communications.