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SUGGESTED SHORT TERM IMPROVEMENTS
FOR A TACTICAL AIR CONTROL SYSTEM (U)

Report No. R-23

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SUGGESTED SHORT TERM IMPROVEMENTS FOR A TACTICAL AIR CONTROL SYSTEM

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I. INTRODUCTION

The present study is an outgrowth of observations of TAC operations in the Longhorn Exercise by R. I. Hulsizer and L. S. Lavatelli of this laboratory. These observers reported very serious limitations in the ability of the overall air control system to process and utilize the information received from the radar net. They suggested that a study of short-term remedies be undertaken by this laboratory.

This report represents the results of a five week study to determine the possible application of existing techniques in improvement of the operation of the Tactical Air Force Aircraft Control and Warning network. The purpose of the study program has been restricted to a consideration of those short term improvements which could be achieved with available equipment and within the scope of the present doctrine of the Tactical Air Command.

The major sources of pertinent information which have been used are: (1) Observations of the Longhorn Exercise. (2) Discussions with Colonel I. F. Stinson, Communications and Electronics officer of the 9th TAF, and members of his staff. (3) Observations of the tactical MEW systems in Europe in 1944. (4) Discussion with H. Sherman and J. Freedman concerning the general study of tactical control systems underway at the Rome Air Development Center.

(5) Observations of the Lincoln Air Defense Laboratory and their field installations. (6) Discussions with M. Chaffee and others at Air Force Cambridge Research Center, of the Korean problems and present thinking. (7) Discussions with personnel of Rand Corporation and Gilfillan Brothers on their proposed demonstration of a narrow-band radar relay network. (8) Reports of PROJECT CHARLES, the VISTA Committee, etc. (9) Reports and recommendations of the British T.R.E. on the Royal Observer Corps and the proposal which led to the CDS as set up by NRL.

This study indicates that the major limitation on the present usefulness of the Tactical Air control system derives from the inefficient methods presently used in forming a clear picture of the air situation from the available radar data. The time required for the present voice telling and hand plotting techniques employed at various parts of the system causes the available communication and filtering facilities to saturate at an unrealistically low traffic level. The important information sources for TAC at present are located at the Tactical Air Direction Centers (TADC). It is felt that any effective short term improvement of the present system must come by increasing the efficiency of information handling at the TADC.

II. RECOMMENDATIONS

A. Concentrate Detailed Control at TADC

In the present system the most current radar information is available at the long range search set at the TADC. Since precise information is required for control of aircraft, the active control functions of the network should be concentrated at TADC where this information is most readily available.

Facilities must be provided at TADC for additional air controllers. Under reasonable traffic conditions, a single controller should not be expected to assume responsibility for vectoring of more than 1 or 2 simultaneous missions. The facilities of TADC must be adequate to permit proper control, within these limitations, of the number of controlled missions which may be required under active battle conditions.

Provisions should also be made to enable aircraft to be scrambled directly on orders from TADC. This can best be effected by including at TADC some personnel who now perform these functions at TACC.

B. Provide High-Capacity Clear Picture at TADC

The efficiency of the tracking, identification and control functions at TADC derive in a large measure from the freshness and completeness of the "clear picture" on on the plotting board. The air situation map provided by the TADC plotting board of the Longhorn exercise appeared to be insufficient to cope with realistic traffic levels. It is essential to provide facilities for an up-to-date and virtually complete plot at TADC if satisfactory control is to be achieved. To this end three possibilities have been examined. All three methods display numbered track arrows, the ancillary information being carried by track numbers on a tote board:

1. Revival of M.E.W. System

This system as used in Europe in 1944 is well known; it calls primarily for considerably larger numbers of scope-tell-plot teams and careful organization. It has demonstrated its track handling capacity under heavy traffic conditions in combat with propeller-driven aircraft.

2. Photographic Techniques

These techniques are being studied by the Lincoln Laboratory and are described in the report of Project Charles. An advantage of this technique is the elimination of the plot-tell bottleneck. Each tracker should be able to track 15 or 20 planes, since he is only required to align numbered plastic arrows against signals on a large horizontal projection of the PPI picture. A further advantage results from the filtering operation which is performed by rephotographing the plot from below. The time delays should average between forty and sixty seconds.

3. Direct Optical Technique

Direct optical means for constructing a plot similar to that obtained by photographic techniques have the logistic advantage of not requiring any photographic process.

The recently developed P-19 phosphor is now available for the standard twelve inch PPI. This phosphor has no initial flash and has a long after-glow, visible for as long as two minutes after excitation. Because of this property, a P-19 display has practically all of the advantages of multiple-projection photography.

In the optical system one projects a small scale plotting board directly onto the operations room screen. An image of this screen is optically superimposed on a portion of the P-19 PPI display. The tracker watches this combined display, keeping small track-arrows aligned with the PPI tracks and the result appears on the OPS room screen. Several trackers work on different areas - or even on PPI's of different radars if remoted information is available. Their separately projected pictures are optically combined by positioning into a mosaic of proper relation and register.

C. Provide Protection for TADC

In the first phases of a war in the near future, our Air Forces in the theater of operations will probably be faced with an enemy possessing considerable numerical air superiority. Therefore, steps should be taken at once to improve the security of the TADC.

The search radar, VHF transmitters, and height finding equipment which constitute prominent and inviting targets, should be removed from the operation center by about five miles. A properly radomed microwave relay link should be provided between the radars and the operations room. The present AEW equipment appears to be suitable for this purpose with small modification. Alternatively, a coaxial cable link could be provided for this purpose. Only a small crew should be required at the actual radar site for security and maintenance, and for operation of the height finding equipment. This precaution would assure that in the event of destruction of the radar site, the bulk of the skilled personnel associated with the operations of the TADC would not be exposed to direct attack.

To insure continuity of operation in the face of heavy enemy air activity, stand-by radar equipment should be provided for TADC at another location. If such an arrangement is precluded by logistic considerations, provisions should be made in the assembly of the radar units, to permit rapid air transport of critical parts, such as antennas, transmitters, etc.

The radar site and operation center should be heavily protected by machine gun turrets, ground AA, and missile equipment. While complete security of the zone is impractical, the cost to the enemy for destruction of a radar site should if possible be made higher than the cost of replacement.

D. Transmit Data from Gap-Filler Radars to TADC Automatically

In the present control system, delays and lost reports result from the hand-plotting and voice-telling operations required to furnish information to TADC from its associated gap-filler radars. By substituting automatic devices, a marked improvement in the speed and reliability of the data transmission from the light-weight gap-filler to TADC can be expected. The following three methods appear to be in a sufficient state of development to merit serious consideration for this purpose:

1. The equipment presently used by the Lincoln Laboratory in its radar relay network may be adaptable to this purpose. This particular apparatus suffers most severly from inadequate facilities for azimuthal integration of signals from noise.

2. The Haller-Raymond-Brown Rafax equipment offers a possibly less complex basis for a radar relay than the Lincoln system. A cathode ray tube phosphor is used for integration, and even with presently tested phosphors, appears to give better integration than the Lincoln relay equipment. The possible use of other phosphors may materially improve the integrating characteristics of the Rafax equipment.

3. A Vidicon television camera scanning a remote indicator tube at an extremely low rate may also be used for

radar relay purposes. In its present state this apparatus is the best of the three for integration of signals from noise.

All of the foregoing techniques would permit compression of radar information from the gap filler set into a single audio bandwidth of perhaps three kilocycles. The information is delayed only by a fraction of a second in time, and degraded in accuracy to about one-half to one mile in range and one beamwidth in azimuth. The slowed-down video received at TADC can be reconverted to a PPI presentation and plotted simultaneously with the information from the search radar at TADC by the plotting techniques outlined above in B.

E. Improved Communication to TACC-JOC

Pending successful culmination of either the facsimile reproduction or conducting glass plotting board techniques now being developed at Lincoln Laboratory, it is suggested that the completely inadequate voice-tell link between TADC and TACC be converted to a voice link between a pair of experienced controllers (or higher level personnel) at the two sites. The digestion and comprehension of the situation by these experienced persons assures that the limited amount of information which can be transmitted will be in the most useful and pertinent form.

III. PROPOSED DEMONSTRATION

It is proposed that a demonstration incorporating the essential features of some of the above recommendations be set up as soon as possible at Pope Air Force Base. The demonstration should be evaluated by a suitable group of Air Force and civilian personnel.

IV. CONCLUSION

Since World War II, the smaller cross sections, higher speeds, and higher ceilings of jet aircraft have appreciably decreased the effectiveness of radar for skin-tracking of single planes. Therefore, the longer-term aim for improving TAC coverage apparently must be to use larger numbers of smaller radars tied together into a correlated network. The development of bandwidth compression techniques for communication and of computing techniques for processing and utilization of data from such a network is a major interest of this Laboratory. It is hoped that the suggested short-term improvements will enable both operational and research personnel to determine more realistically the requirements of a future integrated system.

The recommendations of this report do nothing to improve the basic coverage or portability of radar equipment proper, or to increase the capacity of close-control facilities for blind attack on ground installations. They do not reduce personnel requirements.

The recommendations are designed to improve the communication, processing, and utilization of data from presently available TAC radar, and to improve the security of the system against air attack. Future improvements of coverage, portability and close control capacity will augment the advantages of the present recommendations.