THE DEVELOPMENT OF A PROCEDURE FOR EVALUATING THE PROFICIENCY OF AIR ROUTE TRAFFIC CONTROLLERS

prepared by

JOHN A. HAGAY

Report of a survey conducted at the American Institute for Research, Incorporated, Pittsburgh, Pennsylvania, under the auspices of the National Research Council Committee on Aviation Psychology, with funds provided by the Civil Aeronautics Administration.

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Committee on Aviation Psychology

Executive Subcommittee

M. S. Viteles, Chairman

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National Research Council

1949

LETTER OF TRANSMITTAL

NATIONAL RESEARCH COUNCIL

2101 Constitution Avenue, Washington, D. C.
Division of Anthropology and Psychology

Committee on Aviation Psychology

February 14, 1949

Dr. Dean R. Brimhall
Civil Aeronautics Administration
Room 5217, Commerce Building
Washington 25, D. C.

Dear Dr. Brimhall:

The attached report, entitled The Development of a Procedure for Evaluating the Proficiency of Air Route Traffic Controllers, by John A. Nagay, is submitted by the Committee on Aviation Psychology with the recommendation that it be included in the series of Technical Reports of the Division of Research, Civil Aeronautics Administration.

It is generally recognized that the air traffic control system is a major factor in determining the effectiveness of commercial aviation. The efficiency with which the current air traffic control system is operated is largely dependent upon the ability, skill and attitudes of air traffic control personnel. It seems likely that this will continue to be the case for some time to come. For this reason, it seems highly appropriate to center attention upon research designed to eliminate factors which may interfere with optimal day-to-day performance of such personnel.

The investigation described in the attached report, referring to the work of the controller, represents a step in this direction. While the results seem promising, more is needed in the way of research on the job of controller, and the investigation should be extended to include personnel engaged on other air traffic control jobs. Plans have been made to do so, and work in this area will be extended as rapidly as additional funds become available for this purpose.

Cordially yours,

MSV:maf

Morris S. Viteles, Chairman
Committee on Aviation Psychology
National Research Council

EDITORIAL FOREWORD

As the number and speed of transport and other aircraft flying the airways of this country increase the demands on traffic control personnel mount rapidly. While developments in the field of engineering and electronics may eventually decrease the importance of the human element in air traffic control, the ability, skill and attitudes of controllers and associated personnel still represent important factors in the maintenance of flight schedules and in the prevention of aviation accidents.

At the request of the Civil Aeronautics Administration research has been undertaken on the development of procedures for evaluating the proficiency of air traffic control personnel. Such procedures can be put to practical use in ensuring optimal performance of personnel in the operation of the current air traffic control system.

The present report describes the preliminary steps taken in the development of improved procedures for the evaluation of proficiency in one job in the air traffic control system; viz., air traffic controller. An extensive job analysis has led to the formulation of experimental procedures for the evaluation of proficiency which are now ready for field test and validation. Arrangements have been made for such a field test which should yield a final instrument suitable for day-to-day use in air traffic control centers. In addition, consideration is being given to the extension of research to cover other jobs in the air traffic control system.

The investigation described in this report was conducted under the auspices of the Committee on Aviation Psychology by the American Institute for Research. It grew, in part, out of work done previously under the direction of Dr. L. Dewey Anderson, Consultant to the Civil Aeronautics Administration, who also cooperated in this investigation. The project was carried out under the general direction of Dr. John C. Flanagan, and under the immediate supervision of Mr. John A. Nagay, in cooperation with Dr. Thomas Gordon, and involved the close cooperation of Civil Aeronautics Administration personnel as listed in the Acknowledgments of the author on page vii of this report.

Morris S. Viteles, Chairman
Committee on Aviation Psychology

February 9, 1949

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Morris S. Viteles, Chairman
Committee on Aviation Psychology

February 9, 1949

ACKNOWLEDGMENTS

The original planning of the survey described in this report was done by Dr. John C. Flanagan, in cooperation with Dr. Morris S. Viteles, Dr. Dean R. Brimhall, Dr. L. Dewey Anderson, and Mr. Thomas Gordon. The entire project was conducted under the guidance of Dr. Flanagan and Mr. Gordon, both of whom gave generously of their time in assisting the writer. Practically all the members of the Aviation Branch of the American Institute for Research, professional and clerical, contributed in some way to the completion of the project. Specific mention should be made of the efforts of Dorothy L. Berger, whose assistance in the later stages of the study was invaluable, and to John D. Myers, who devoted considerable time to the data collecting phases.

The investigators were particularly impressed throughout the course of the research by the splendid spirit of cooperation evidenced by Civil Aeronautics Administration personnel at all the installations visited. Special mention is also made of the interest and patience displayed by Mr. George S. Porter, Chief Controller at the Pittsburgh center, and the members of his organization, who were the recipients of frequently repeated visits by research personnel because of their convenient proximity.

Finally, acknowledgments are due to the following aeronautical specialists who collected the basic data of the study and again to Dr. Dean R. Brimhall and to Mr. L. L. Kullenburg, and the others of their staffs, through whose efforts the services of the specialists were obtained.

R. H. Bell	3rd Region
J. H. Firebaugh	7th Region
W. V. Fox	4th Region
A. C. Leathers	5th Region
J. T. Ragsdale	2nd Region
J. A. Toomey	1st Region
D. R. Whitney	6th Region

John A. Nagay
Project Director
American Institute for Research

5 January 1949

SUMMARY

The purpose of this study was to develop a procedure for evaluating the proficiency of air route traffic controllers. As a logical first step, the existing measures of proficiency available in Civil Aeronautics Administration files were examined. This examination revealed that Civil Service ratings fail to discriminate adequately among employees; there were also indications of halo effect. Other records were too incomplete or insufficiently uniform to provide data upon which to produce conclusive findings with respect to currently used proficiency measures.

It was then necessary to select a method for the analysis of the job under study. Three general approaches to job analysis were considered:

(1) Analyses of the worker on the job
(2) Analyses of the job requirements
(3) Analyses of the worker requirements

An activity analysis of the controller's job was undertaken as an exploratory first step to determine the usefulness of such a technique as an indicator of the relative importance of the various job components in terms of the time devoted to them. Observations were made of the activity of controllers during three watches at two centers. A total of 7397 such observations was made at 15-second intervals. Watch 2, (0800-1600) was the busiest period and controllers had less time for scanning the board and talking with their associates in IFR than in VFR weather. The amount of time spent on the interphone (the task which occupies most of the controller's time regardless of watch or weather) also increased in Watch 2 and in IFR weather. Indications of the operation of fatigue were also present in the data. It was concluded that although the activity analysis gave the observable job components and a better understanding of the job to the investigators, other job analysis methods would better serve the primary purpose of the present project.

The job analysis method chosen for the main study was the critical requirement approach. It was felt that this method would provide data most readily adaptable to the construction of an evaluation procedure, because: (1) its end product is the statement of the abilities, characteristics, and skills that are critical to success in the activity; (2) these requirements are stated in behavioral terms.

The critical requirements of the job were determined by applying the critical incident technique. Aeronautical specialists of the Civil Aeronautics Administration were assigned to the American Institute for Research to act as interviewers and covered a substantial portion of the control towers, centers, and communications stations throughout the continental United States during the collection of incidents. These incidents were reports of the specific behaviors of controllers that were responsible for their having been considered especially effective or ineffective at the job. Each individual behavior was then classified under the job area in which it had occurred. Critical requirements were then formulated to cover the combined groups of behaviors. The critical requirements were the behavioral statements of what controllers had been observed to do on the job that made for excellent or failing performance.

During the collection of incidents, data were obtained in addition to the description of the behavior. Reported critical behaviors occurred most frequently during the winter months and during IFR weather. There were some

indications that the frequency of incidents in the "Aiding Aircraft in Trouble" area may be out of proportion to the true importance of that area due to a tendency of interviewees to recall spectacular events more readily. Corroborating the activity analysis, the watch showing the highest frequency was Watch 2, and the hours showing the highest frequencies were the first and last hours of the three watches (except the first hour of the second watch).

A procedure for evaluating the proficiency of air route traffic controllers was developed. The same framework of 10 main and 47 subcategories that had been used in the analyses of the incidents was utilized in assembling 313 specific check items. The items consist of statements of critical behaviors, effective and ineffective, stated with a degree of specificity that would enable the observer to easily recognize them and yet stated generally enough to encompass all the behaviors classified under their respective headings. Effective and ineffective behaviors are listed side by side. A tentative form of "The Check List of Critical Requirements for the Evaluation of Air Route Traffic Controllers" is included in the report.

It is planned that observations of controllers by rating officials will be made throughout the rating period and when critical behaviors are noted, they will be recorded by a symbol in the appropriate item of the check list. An additional form will be provided during a supplementary phase of this research. This will be a one-page form upon which the observations of the check list can be summarized and an over-all proficiency score calculated. It is also planned, in this second phase of the project, to determine, with the help of controllers and supervisory personnel, which effective statements indicate outstanding performance and which indicate satisfactory performance on the job. These degrees of effectiveness will be taken into account by assigning additional weight to the statements of outstanding job behavior.

I. INTRODUCTION

The present system of controlling air traffic in the United States is undergoing constant change. New electronic devices have been developed or are in the process of development that will ultimately insure the safe flight of the rapidly-increasing fleets of private, commercial, and military aircraft regardless of weather conditions or crowded airlanes. In the interim, however, before the nearly complete mechanization of air traffic control is realized, there is a pressing need for job information on the individuals who carry out these responsible duties. As new methods of control and new personnel practices are introduced during the "transition period" between the present system and automatic control, what will their effect be upon the proficiency of air traffic personnel? This report is an account of an attempt to provide a measure of the proficiency of control personnel, a means of determining the degree to which they meet the requirements for safe and effective control of air traffic.

In May of 1948, the American Institute for Research, at the request of the Assistant for Research to the Administrator of the Civil Aeronautics Administration and the Chairman of the Committee on Aviation Psychology, submitted a proposal to the National Research Council Committee on Aviation Psychology to conduct research in the field of Air Traffic Control. The purpose of the research as stated in the proposal was to develop "... criterion measures of proficient air traffic control and communication through job analysis techniques ...", and was intended as a starting point for further research in the area of selection, training, equipment design, or fatigue.

Aims and Scope of the Present Project

Early in the course of the research, it was decided to limit the present study to a consideration of one specific job in air traffic control, that of air route traffic controller. It was believed that an intensive survey of the requirements of one important activity would better serve the needs of the Civil Aeronautics Administration than a more general study of several.

The first objective of the study was the choice of a method of job analysis that would be best suited for providing data for the construction of a criterion measure of proficiency. An examination of the records of the proficiency of air route controllers already available in Civil Aeronautics Administration files was undertaken to determine the adequacy of the present methods. A survey of the literature on job analysis methods was completed and an exploratory study which was designed to test the applicability of one of the reported methods to the problem under study was done.

The next objective of the study, after the consideration of the already existing measures was a direct examination of the job aimed at the development of new procedures. A technique for determining

the critical requirements of the job similar to that used in other research projects conducted by the American Institute for Research was applied to the job of air route traffic controller.[1] This process was designed to determine those requirements of the job that are critical in the sense that the possession or lack of them makes the difference between safe, effective controllers and those whose job behavior results in hazards to safe flight.

The final objective of the study was the construction of an evaluation procedure based upon the critical requirements for effective controllers. It is believed that the procedure developed will provide a more objective means for determining the effectiveness of controllers than does the rating device used at present and will provide a tool for determining the effect of the introduction of new personnel practices or equipment upon controller proficiency. A later report will include the results of a supplementary study to be conducted early in 1949, in which the procedure developed in the present project will be subjected to field tryouts, subsequent revision, and its reliability determined.

II. FINDINGS IN THE LITERATURE

Aims

Before the start of the study of the air route traffic controller's job, it was necessary to consider the available job analysis methods and to choose the one which seemed most suitable. The work of the air route traffic controller makes unusual demands upon the analyst since much of the important activity of the controller is non-observable and must be inferred from the results of his actions. The fact that no clear-cut sequence of operations exists in the controller's job raised additional difficulties. Although the controller directs the course and altitude flown by the aircraft from departure point to destination, he may be called upon to perform any function of his job at any time. Before deciding upon any one method for studying a job of this nature, a survey of pertinent job analysis methods was made.

Analysis of the Worker on the Job

There are three approaches commonly used in the analysis of jobs. The analysis may be approached by studying the worker on the job, by analyzing the demands of the task apart from the worker, and by analyzing the worker in terms of the traits required to perform the task successfully. The most commonly used method necessitates actual participation by the analyst in the activity under study or actual observation of the workers employed on the task. An analysis of the operations

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[1] Flanagan, John C., Army Air Forces Aviation Psychology Program Research Reports, Report No. 1, U. S. Government Printing Office, Washington, D.C., 1948.

performed, a list of the machines used, and the conditions under which the task must be performed are included. The time taken by a worker to perform a single activity and analyses of the motions he uses in performing that activity are also included in an analysis of the worker at the task. Studies of the type done by Barnes and Mundel[2] in which various manual tasks were analyzed in terms of performance time and motions used exemplify two of the methods which study the worker on the job. A third method which studies the worker on the job, analyzes the job as a whole instead of breaking it down into elements based on the theory that the pattern of the job and its unique quality are destroyed by analyzing its elements. Studies in which an actual work situation is simulated, exemplify this method.

Job Requirement Analyses

It is also possible to analyze a job apart from the worker at the task. Charters and Whitley[3] illustrated this method by analyzing jobs in terms of the different activities performed. Their study, like that of Strong and Uhrbrock[4], involved the use of an analysis of activities performed to study jobs of a non-manual nature. These investigations collected comprehensive lists of the duties performed by workers on the job but made no attempt to determine the relative importance of the various activities in terms of their contribution to job success or failure. Viteles'[5] "Job Psychograph", another method of analyzing the job apart from the worker at the task, involves getting the "mental ability" requirements of the job from trained observers.

A variation of this is the questionnaire method also described by Viteles[6] which involves questioning workers on the job concerning traits or behaviors required by the task. Viteles does not consider the statements of workers concerning the traits and ability requirements of a job to be accurate enough for use, however. Thorndike[7] discussed a study utilizing an interview technique in which persons

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[2]Barnes, R.M. and Mundel, M.E. "Studies of Hand Motion and Rhythm Appearing in Factory Work." University of Iowa Studies in Engineering. No. 12, 1938.

[3]Charters, W.W. and Whitley, I.B. Analysis of Secretarial Duties and Traits. Baltimore: Williams and Wilkins Co., 1924.

[4]Strong, E.K. and Uhrbrock, R.S. Job Analysis and the Curriculum. Baltimore: Williams and Wilkins Co., 1923.

[5]Viteles, M.S. Industrial Psychology. New York: W.W. Norton & Co., 1932.

[6]Viteles, M.S., ibid.

[7]Thorndike, R.L. Army Air Forces Aviation Psychology Program Research Reports, Report No. 3., U.S. Government Printing Office, Washington, D.C., 1947.

proficient in the job, those in training, and persons having difficulty at the job were requested to comment on the job requirements.

Worker Requirement Analyses

Another job analysis procedure involves the detailed study of individuals outstandingly successful in the activity. The history, abilities, and scores of these individuals on various tests may be considered in making the analysis. Why the individuals are more successful than others is not determined, however, and Viteles[8] therefore questions the usefulness of this method.

Both Shartle[9] and Ghiselli and Brown[10] indicate the possibility of analyzing the worker in terms of the necessary or desired characteristics of the man who is successful at the job. Shartle[11] points out the value of using either the questionnaire or interview for obtaining the information desired. Neither the interview or the questionnaire is designed to produce detailed job analyses but rather to obtain specialized information about a job. Mosher and Kingsley[12] quote Hull's method of analyzing the job by studying a large number of individuals to discover in which activities the superior individuals differ most from the less efficient.

Applicability to the Present Study

Ghiselli and Brown[13] indicate that in studying primarily non-manual jobs such as the controllers', the analyst's interest is centered "primarily on the types of situations with which the employee is confronted and the procedures he uses in adapting to them." The analyst has a much more difficult job when he is studying a non-manual task because he must discover all the situations with which any individual in the job may be

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[8] Viteles, M.S., op. cit.

[9] Shartle, C.L. Occupational Information. New York: Prentice-Hall, Inc., 1946.

[10] Ghiselli, E.E. and Brown, C.W. Personnel and Industrial Psychology. New York: McGraw-Hill Book Co., Inc., 1948.

[11] Shartle, C.L., op. cit.

[12] Mosher, W.E. and Kingsley, J.D. Public Personnel Administration. New York: Harper & Bros., 1941.

[13] Ghiselli, E.E. and Brown, C.W., op. cit.

called upon to deal. Several ways of discovering what these situations are have been reported. Charters and Whitley[14] report a study in which the workers themselves were questioned. The techniques used by Special Studies and Standards Section of the Personnel Classification Division of the Civil Service Commission involve questionnaire studies in which experts are requested to define the job and to discuss the factors making for differences in levels of difficulty or responsibility. From these data, job evaluations are drawn up which describe each of the grade levels of the job and their requirements. Hogan and Wallace[15] suggest a combination of activity analysis by the worker himself and observation of the worker on the job for obtaining job descriptions in detail.

Since the controller's job is not predominately manual in nature, a study of the motions used to perform the various tasks would not yield the most meaningful results. Studying the job as a whole would probably not be useful in spite of the realistic quality of such a study because much of the controller's activity is not of the type which can be organized into any sequence or order. An analysis of the worker in terms of trait requirements shown by successful or unsuccessful individuals is unable to explain why the successful worker is more efficient than the less successful.

Several of the methods discussed appear to have value for the present study. In general, analyses of the job in which workers are asked to report their own tasks, and the type in which experts and those with a thorough knowledge of the job are requested to report the nature of the tasks and the factors involved in satisfactory performance of the task are both applicable. The controller's job is a complex one and only those well-acquainted with it would be able to provide information concerning the situations which the controller meets and the methods he uses to solve the problems which arise. Observations of the worker on the job provide partial answers to the question of what distinguishes good from poor control and are a necessary first step in the execution of the more discerning methods which must be used in the study of complex activities.

The method chosen to study the job of air route traffic controllers had to be, for the purposes of this project, such that the data obtained would readily lend themselves to the construction of a procedure for measuring proficiency. Hence, the prime requisite was that the method reveal the job activities that are important and in which gradations of controller effectiveness occur.

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[14] Charters, W.W. and Whitley, I.B., op. cit.

[15] Hogan, R.L. and Wallace, M.C. "Finding Training Material for the Hard-to-Fill Job." Personnel Administration, March 1943.

An activity analysis of the controller's job based on the method of a study reported by Christensen[16] was undertaken as an exploratory first step to determine the usefulness of such a technique in indicating the relative importance of the various components of the job in terms of the amount of time devoted to them. At the time this phase of the study was started, it was believed that the job was sufficiently "manual" to justify such an approach.

The Critical Requirement Approach

The data from which the measure of proficiency for air route traffic controllers was ultimately constructed were the critical requirements of his job. First described by Flanagan[17], this approach to job analysis arrives at the job requirements which are critical for success in the activity. The determination of those job requirements which are really critical, which have repeatedly been observed to make the difference between success and failure at the job, has tremendous advantages for the investigator whose aim is to evaluate the worker's proficiency, particularly regarding more complex activities where clear-cut criterion measures, such as units of production, are not available.

Even in relatively simple tasks, however, hundreds of specific job requirements may be discovered. These may vary from unimportant characteristics, the presence or absence of which would make little difference in the effectiveness of the worker on the job, to those so crucial to effective performance that their absence results in the worker's dismissal, or, as in the controller's job, in actual danger to human life. Job requirements of the latter sort are the type that the critical requirement approach reveals, and proficiency measures based on such requirements will have the advantage of covering only important aspects of the job to the exclusion of irrelevant detail. It is, therefore, an economical method.

A common failing of many job analysis techniques is that they produce statements of job requirements in terms of traits. When it is said that a man must be "dependable" to perform certain work, the problem of defining "dependability" becomes a separate task for each individual concerned with the results and there may be as many definitions as there are individuals. The same list of traits may also be equally applicable to several jobs. The need for stating required abilities in explicit and unambiguous terms is more generally recognized than it has been in the past although the use of trait descriptions is still widespread. The critical requirement approach has the further

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[16] Christensen, J.M., Aerial Analysis of Navigator Duties with Special Reference to Equipment Design and Workplace. Memorandum Report WCREXD-694-15A, Hq., AAC, Eng. Div., 2 February 1948.

[17] Flanagan, J.C., op. cit.

advantage of stating requirements in behavioral terms, in statements of exactly what individuals do that results in effective performance on the job. The implications of the use of behavioral descriptions for proficiency measures are obvious, for two supervisors evaluating a worker are much more likely to agree when asked if he "reports for work on time" than they are if asked if the worker is "dependable".

As previously stated, the job analyst, in studying a job that is primarily non-manual, must discover all the situations with which any individual engaged in the activity may be called upon to deal. Whether or not the critical requirements provide adequate coverage of all such situations is a function of the adequacy of the sampling techniques used to obtain the data from which they are derived, and the proper use of the method requires the use of a wide and representative sample.

A description of the specific techniques by which the critical requirements of air route traffic controllers were determined follows later in the report.

III. METHODS AND PROCEDURES

The General Plan of the Project

The approach to the objectives of the project was divided into two broad phases: (1) an examination of the existing measures of controller proficiency; and (2) a direct examination of the job aimed at the development of new criteria.

Examination of the Existing Measures of Proficiency

Letter of Authorization

As a necessary first step in the execution of the first phase of the study, a means of introducing the project to the traffic control installations which were to be visited by research personnel was obtained from the Civil Aeronautics Administration. It consisted of a mimeographed letter signed by the Assistant Administrator for Federal Airways in which the project was described briefly and the cooperation of the center, tower, and communications stations was solicited. The letter also provided identification for American Institute for Research personnel and authorization for them to visit the control installations throughout the regions in the course of the research. The letter is reproduced in Appendix A.

Civil Service Ratings

During a field trip to the personnel offices of the First Region

of the Civil Aeronautics Administration, the Civil Service efficiency ratings of 1529 employees of all grades were obtained from the files. These were examined to obtain an impression regarding their adequacy as measures of efficiency. Individuals are rated on groups of items selected from a list of 31 and an over-all rating of "Excellent", "Very Good", "Good", "Fair", or "Unsatisfactory" is determined. The items are in terms of traits, ("Dependability" for example) and carry no guarantee of consistent interpretation among rating officials. That the present rating device apparently fails to do a thorough job of discriminating among employees is evidenced by the following distribution:

Number rated "Excellent"	26
Number rated "Very Good"	861
Number rated "Good"	640
Number rated "Fair"	0
Number rated "Unsatisfactory"	2
	1529

An examination of the item-by-item ratings of 214 CAF-6's, 8's and 9's employed in the air route traffic control division of the First Region points to another inadequacy of the presently-used rating method - that of "halo effect". The percent of the individuals of these grades rated on Form 51 with the same symbols on all items or with all the symbols the same except one is shown on Table 1. The tendency for raters to rate all items similarly appears to be particularly prevalent when assistant controllers (CAF-6's) are being evaluated and there is a noticeable drop in this practice as the higher grades come under the rater's considerations.

TABLE 1.

PERCENT OF CONTROLLERS IN 4 CENTERS OF GRADES CAF-6, 8, AND 9 RATED WITH THE SAME SYMBOL ON ALL ITEMS OF FORM 51 OR ON ALL ITEMS EXCEPT ONE

	PERCENT				
Grade	Center 1	Center 2	Center 3	Center 4	Total
CAF-6	33.1	33.3	35.2	77.4	45.9
CAF-8	13.8	0	0	65.0	22.5
CAF-9	0	0	0	0	0

Other Measures of Proficiency

Other available measures were considered in the preliminary phase of the study as possible components of a composite criterion of controller proficiency. These data were also obtained at the First Region and are listed by type of measure and number of scores as follows:

Type of Measure	Number of Scores
Performance Ratings	244
Certification Examination Grades	52
Hours of Flying Time	244
Years of Controller Experience	241

The "Performance Ratings" obtained were ratings of "High", "Middle", and "Low" made by senior controllers. The correlations among various combinations of the measures obtained are reported in Table 2.

TABLE 2.

CORRELATIONS BETWEEN PROFICIENCY MEASURES

Variables	r	N
Civil Service Ratings and Performance Ratings	.26	155
Civil Service Ratings and Certification Examination	.44	52
Performance Ratings and Certification Examination	.49	52
Hours of Flying Time and Performance Ratings	-.06	244
Years of Controller Experience and Performance Rating	.19	241

In general the correlations found between the variables suggest a lack of relationship among the measures, particularly in view of the fact that the effect of extraneous factors may well have inflated these coefficients. Although it is not definitely known, it is quite possible that the same individuals who made the Performance Rating also made the Civil Service Rating. A similar possibility exists with respect to ratings and certification examination scores, or at least there is a likelihood that the rater knew something of the examination results and may have been influenced by them. The lack of relationship between flying experience and performance is a rather surprising finding and is contrary to popularly-held belief. Some degree of correlation between years of experience in the job and performance ratings is typical of many jobs and this coefficient may be somewhat increased by the possible operation of bias in ratings favoring the "old men" on the job. In view of the findings described above, it was felt that these data did not offer a very promising source for the construction of a composite criterion.

Training examination grades were also examined. Although steps are being taken to standardize training procedures throughout the Civil Aeronautics Administration, at the time that this investigation was conducted there was not sufficient uniformity among the procedures at various centers to provide usable information.

"File Thirteen"

Records of investigations of accidents, near accidents, irregularities, conflictions, and other errors are kept at the Control Center and called "File Thirteen". This practice, like the standardization of training procedures, is comparatively new and has just begun to be followed systematically in regions other than the first. It was felt that these reports might be valuable in that they would provide job information in the form of descriptions of controller errors. However, these data were too fragmentary at the time to provide anything other than supplementary information. In the New York Center, for example, when the practice of keeping such files originated, the controllers estimated that only a small number, approximately 1/12, of the reports concerned situations where the responsibility for the error lay with air route traffic controllers.

Direct Examination of the Job Aimed at Development of New Procedures

Time Analysis of Air Route Traffic Controllers

1. Aims

This phase of the research consisted of a time analysis of the duties of an air route traffic controller and its method was based on a study of navigators' activities conducted by personnel of the Aero Medical Laboratory[15] although the method differs from the navigator study in several respects. It represented an investigation of the usefulness of the method as a job analysis procedure and particularly its value in providing a measure of the relative importance of the various job components in terms of the frequency with which they appeared throughout the work period.

2. Procedure

As a first step in constructing a format which to record observations

[15] Christensen, J.M., op. cit.

of the controllers' activities, detailed observations were made of two controllers at the Pittsburgh center at approximately one-minute intervals. This was kept up for several hours until a point was reached where no new activity became apparent. This list of controller activities was then checked for completeness of coverage by several controllers, chiefs, and seniors, and revised accordingly. (Appendix B). The actual observations of the controllers for this study were recorded on a form based upon the resulting detailed task list. Activities were classified into four general headings: Manual, Interphone, Visual and Verbal with several activity breakdowns under each. (Appendix C). Observations were made at 15-second intervals, the observer being prompted by the flashing of a red light attached to a clip-board.[19]

Observations were made over a period of three watches at the Cleveland and Washington center. New equipment was in use at each of these centers. The observer sat at the side of the controller being observed and plugged his headset into the controller's interphone connection. The nature of the study was explained to the controller; he was assured that his work was not being evaluated; and he was asked to continue at his job as though the observer were not there. It was the belief of the observers that the controllers in general understood and complied with the latter request and that the pattern of activities recorded was not significantly altered by the presence of the observer. In addition, at the start of each hour, the controller was asked whether the weather conditions prevailing in his sector were VFR, IFR or Marginal. Each time the red signal light came on, the observer recorded the controller's activity at the appropriate place on the form. A total of 7397 observations was made at 15-second intervals at the two centers.

Tallies were made of the total number of observations for each of the listed tasks. First, all the observations for the first hour of each watch observed, the second, third and remaining hours through the eighth were totalled and averaged giving a composite eight-hour period based on the total number of observations. Next, the percent of time spent by controllers at various tasks during three watches at two centers was calculated. This breakdown was obtained to determine how time spent at the various activities varied among watches and whether or not controllers at different centers tended to spend similar amounts of time at the same activities. It was necessary to restrict the calculations to include only observations made under one type of weather conditions to eliminate the effect of fluctuations in weather upon

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[19]The interval timing device was constructed from an electric clock. The sweep second hand was utilized as a contact arm which made contact with four points set at equal intervals around the face, completing a circuit at each contact through a bell transformer and lighting the six-volt lamp attached to the observer's clip-board The possibility was considered of using auditory stimuli, such as having the observer prompted by a signal transmitted through headphones or by means of a buzzer to be located nearby. However, inasmuch as it was necessary for the observer to wear a headset to monitor and interpret the controller's interphone activities, and inasmuch as incoming calls to the center were preceded by a buzzer signal, it was decided that the visual signal to the observer was the only practical method

the time devoted to the various tasks. VFR conditions were chosen for this analysis. Observations made under all three weather conditions, VFR, IFR, and Marginal, were totalled, averaged, and the percent distribution of time among the various activities calculated for each type. Here, 4544 (61.43%) observations were made under VFR weather conditions, 1123 (15.18%) under Marginal, and 1730 (23.39%) under IFR. A similar breakdown was completed on the observations made during each of the three watches without regard to center or weather. Finally, the observations made during the total of 6 watches were broken down to 2 half-day periods for comparison of the percent of time spent by controllers at various activities during the first and second half of an average watch. The data for the first half included 51.5% of the total 7397 observations and the second half, 48.51%.

3. Results

For purposes of simplicity, the activities observed were grouped into four major categories which adequately described their components. These major categories were Manual activities, Interphone activities, Visual activities and Verbal activities. In addition to these categories, Miscellaneous and Inactivity were also used. The analysis of the composite eight-hour period (Figure 1) shows that approximately 12 percent of the controller's time was spent on manual activities, 29 percent on interphone activities, 18 on visual, 18 on verbal communication with associates, 8 percent on miscellaneous activities and 15 percent on inactivity. The issuance of clearances occupies most of the controller's time under the largest general category, interphone activities.*

An examination of Figure 2 reveals practically no consistency between the amounts of time that controllers at two centers spend at various activities. The only activity which varies in the same direction at both centers is visual activity which increases slightly from Watch 1 through Watch 3. The lack of consistent relationships between the centers in time devoted to other activities suggests that the job of controlling air traffic is quite different at these two centers despite the fact that similar equipment is used at both and that observations were made during the same general weather conditions at each. It further suggests that before any conclusive statement can be made regarding the distribution of an "average" controller's time over the work period, a much larger population must be sampled.

Figure 3 pictures a breakdown of all the observations grouped under the watches during which they were made. These data include the observations made at both centers during all weather conditions. When the percent of time spent during each watch on each activity was calculated, small differences appeared. Twelve percent of the time was spent on manual activity during Watch 1, 9 percent during 2 and 13 during 3. Interphone activity increased from 12 percent on Watch 1 to 38 and 37 percent on Watches 2 and 3, respectively. Visual activity increased

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*Editor's note: Broad generalizations, particularly with specific reference to percentage of time spent in various activities, should not, of course, be made due to the variability of such percentages in different centers, during different watches, and under various weather conditions, as indicated in Figures 2-5.

FIGURE 1.

TIME ANALYSIS OF CONTROLLER ACTIVITIES

Average Percent of Time Spent on Job Components by 6 Controllers During 6 Watches at 2 Centers Combined into an 8 Hour Period Based on 7397 Observations at 15 Second Intervals by 2 Observers

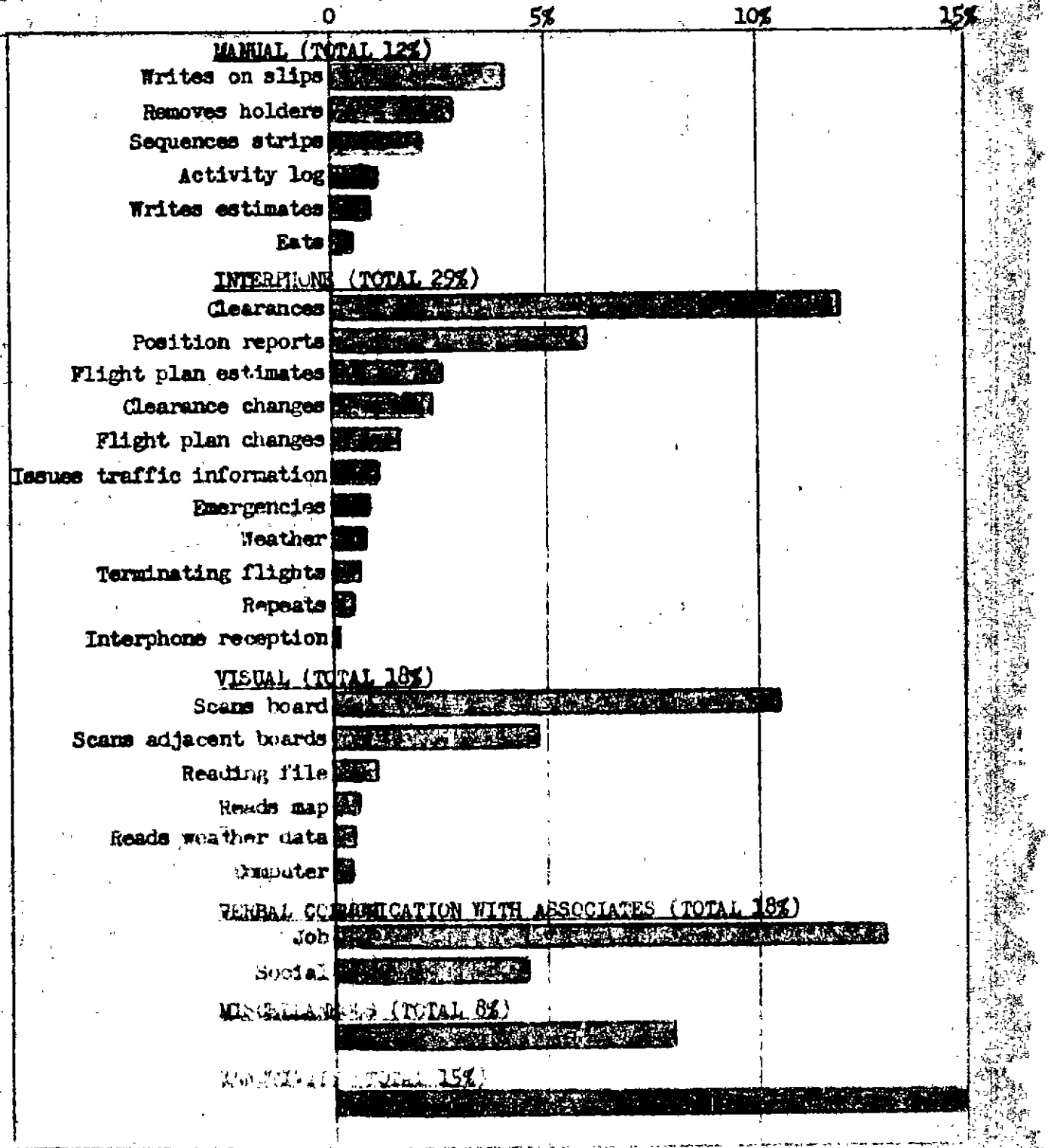


FIGURE 2.

TIME ANALYSIS OF CONTROLLER ACTIVITIES

Percent of Time Spent by Controllers on Job Components During 3 Watches at Two Centers under VFR Weather Conditions Only

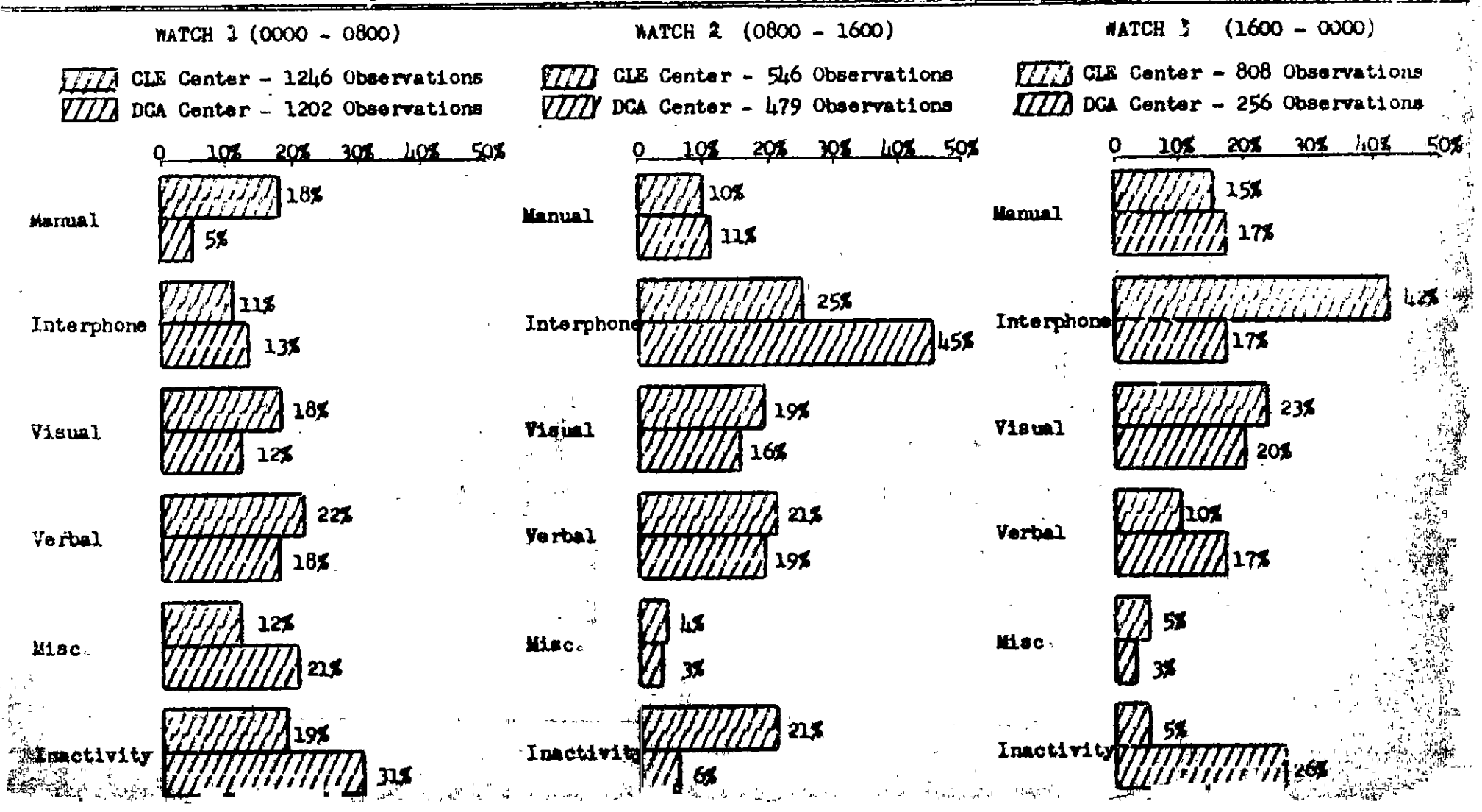


FIGURE 3.

TIME ANALYSIS OF CONTROLLER ACTIVITIES

Average Percent of Time Spent on Job Components by 6 Controllers
During 6 Watches at 2 Centers Combined into 3 Watches
Based on 7397 Observations at 15 Second Intervals by 2 Observers

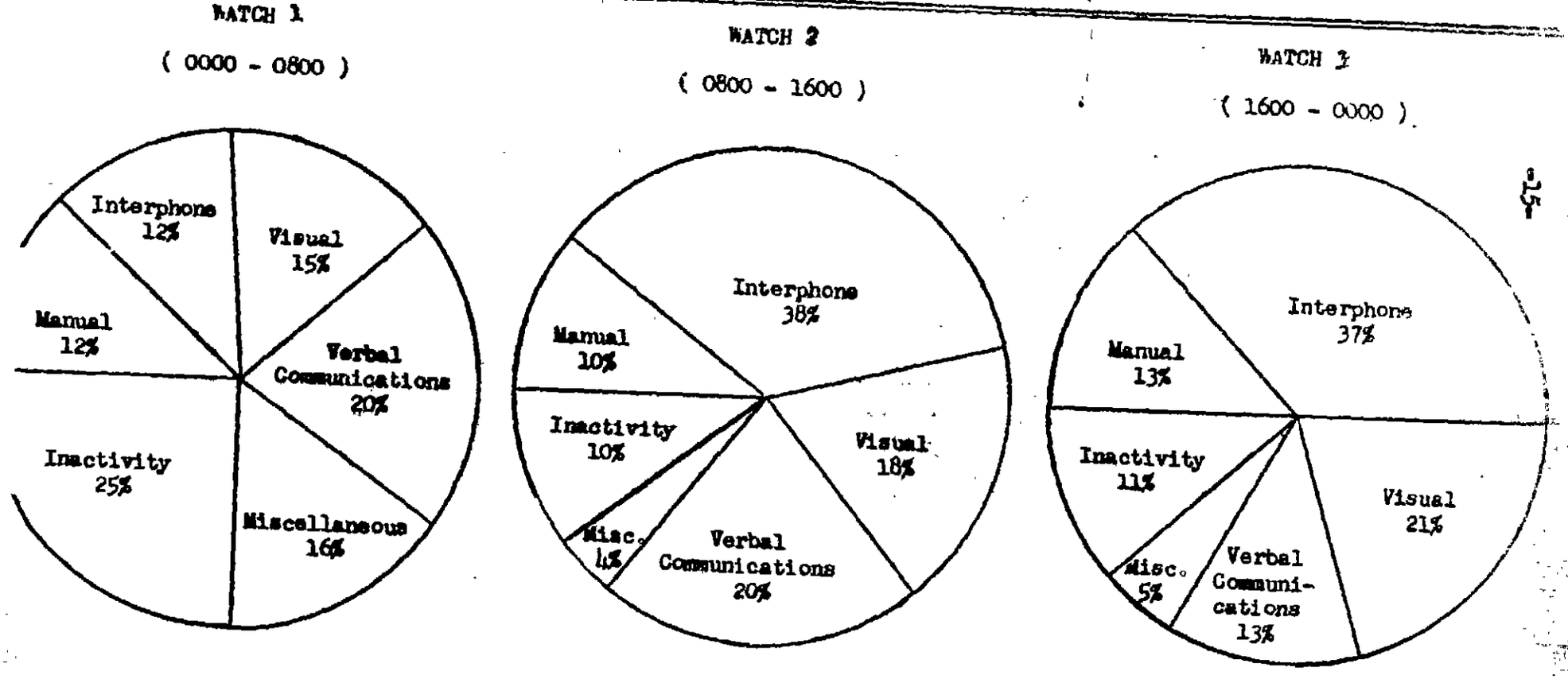
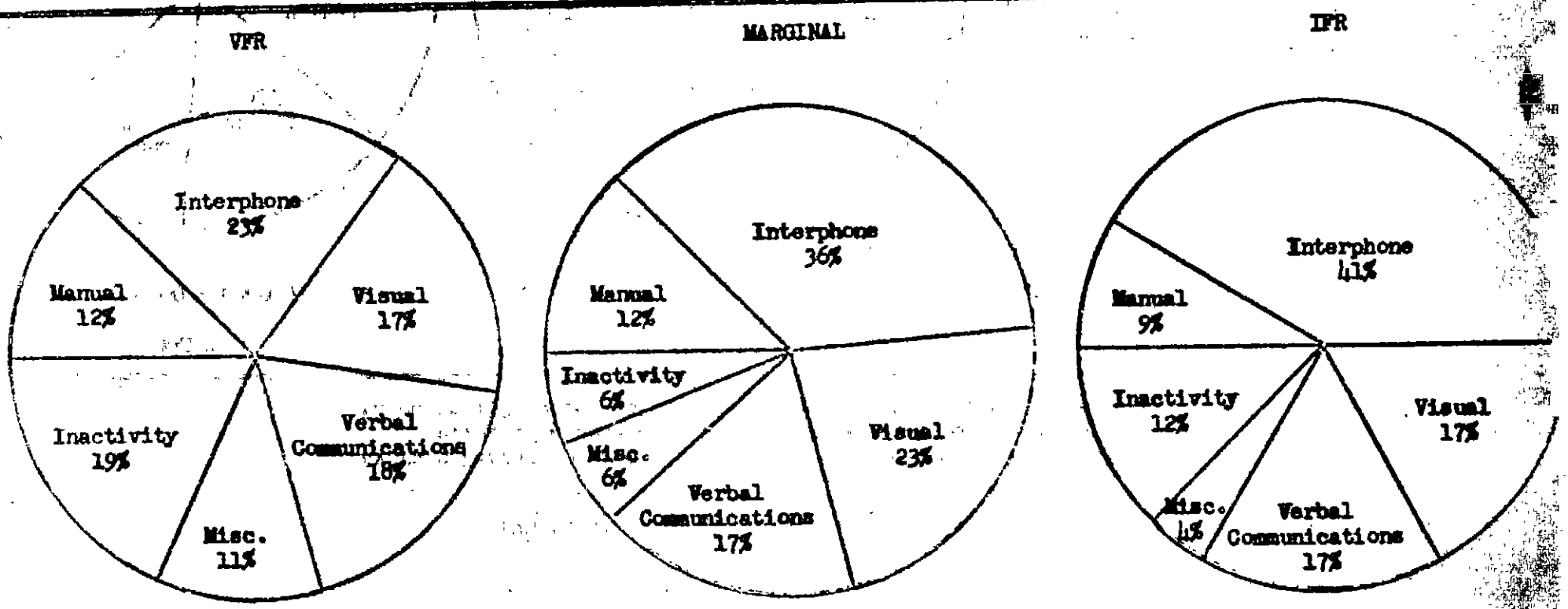


FIGURE 4.

TIME ANALYSIS OF CONTROLLER ACTIVITIES

Average Percent of Time Spent on Job Components by 6 Controllers
Over 6 Watches at 2 Centers During VFR, Marginal, and IFR Weather Conditions*
Based on 7397 Observations of Which 61.43% were Made During VFR Weather, 15.18% Marginal and 23.39% IFR

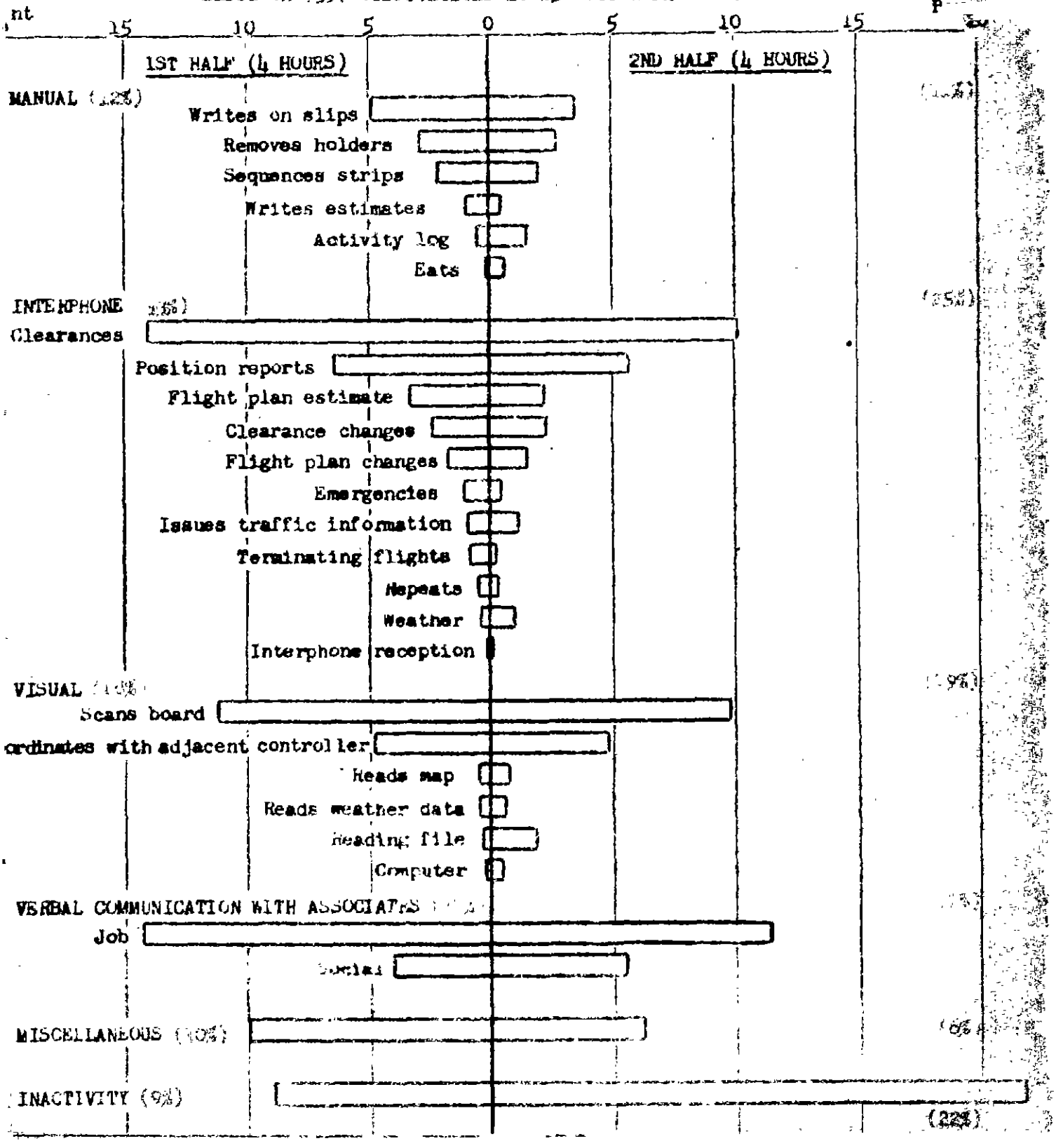


* Controllers' Estimates

FIGURE 5.

TIME ANALYSIS OF CONTROLLER ACTIVITIES

ge Percent of Time Spent on Job Components by 6 Controllers During 6 Watches at 2 C
ombined into 2 Four Hour Periods Representing the 1st and 2nd Half of a Composite Watch
Based on 7397 Observations at 15 Second Intervals



from 15 percent on Watch 1 to 18 and 21 percent on Watches 2 and 3. Verbal communication decreased from approximately 20 percent on Watches 1 and 2 to 13 percent on Watch 3. Miscellaneous activities, which included several minor activities with very low frequencies, decreased from 16 percent on Watch 1 to 4 and 5 percent on Watches 2 and 3. Inactivity decreased from 25 percent on Watch 1 to 10 and 11 percent on Watches 2 and 3.

In the analysis of activities in terms of VFR,* Marginal and IFR* weather, it was found that manual activities decreased from 12 percent of the total in VFR and Marginal to 9 percent in IFR weather. Interphone activity increased from 23 to 36 to 41 percent of activity under the three weather conditions. Visual activities occupied approximately 17 percent of the controller's time in IFR and VFR weather and 23 percent during Marginal weather. Verbal communication remained approximately the same in all kinds of weather although a breakdown showed that social communication[20] appeared 7 percent of the time in VFR weather and only 1 and 2 percent in Marginal and poor weather. Job-associated communications increased from 11 to 17 and 15 percent; miscellaneous activities decreased from 11 to 6 and 4 percent; and inactivity decreased from 19 to 6 to 12 percent under the conditions of VFR, Marginal, and IFR weather.

The fifth breakdown (Figure 5) in terms of time spent on each activity during the first and second halves of a composite watch indicated that approximately 12 percent of the time in the first half and 11 percent in the second half were spent in manual activity. During the first half of the composite watch 33 percent of the controller's time was spent on interphone activity as opposed to 25 percent of the time during the second half of the watch. Approximately 18 percent of the time was spent on visual activities during both halves of the eight-hour watch. Verbal communication was approximately the same for both halves of the watch. Miscellaneous activities occupied 10 percent of the first half of the watch and 6 percent of the second. Inactivity increased from 9 percent of the time during the first half to 22 percent during the second half of the watch.

4. Conclusions

From the first analysis of the time spent on each component regardless of center, weather or watch, it becomes apparent that the largest percentage of time is spent on interphone activity on this job. Visual activity and verbal communication occupy second place in importance according to time spent. Manual activity is third and miscellaneous fourth. Inactivity comprises 15 percent of the time spent. It would, therefore, appear that, in terms of time spent, interphone activity would prove most profitable for studying the job. Any proficiency

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[20] A breakdown of Verbal Communication with Associates.

*Editor's Note: VFR denotes "Visual Flight Rules"; IFR denotes "Instrument Flight Rules."

measure devised needs to take into consideration the tasks included under interphone activity as a major topic. The relative importance of the other activities might be considered to follow the order stated above.

It might appear from the analysis of the results that as the time of day changes the need for certain types of activity changes. For instance, the workers spend on interphone activities about 1/3 as much time during Watch 1 as they spend on these activities in either of the other watches. This may be attributed, however, to the fact that Watch 1 had only VFR weather and that Watches 2 and 3 had all of the Marginal and IFR weather with some VFR. The variation among centers previously pointed out undoubtedly affects this situation also. This significant difference between time spent on interphone activity in Watch 1 and in Watch 3 is a necessary consequence of the differing weather conditions in the two watches.

Increases in visual activity from 15 percent in Watch 1 to 21 percent in Watch 2 may also be indicative of the weather changes or other factors. The worker was inactive 25 percent of the time on Watch 1 in which the weather was good and only 10 percent of the time in Watches 2 and 3 when the weather was varied. Because there were times when it became difficult for the observer to differentiate between "inactivity" and "scanning the board", and necessary for him to make judgments, the accuracy of the number of recordings in these categories may occasionally be questionable.

In an analysis of time spent at each activity during various types of weather, it is apparent from the data that interphone activity almost doubles when the weather changes from VFR to IFR. Visual activity changes slightly from VFR to Marginal and from Marginal to IFR but not at all from VFR to IFR. Verbal communication changes very little with the weather except that, as is to be expected, the time spent in social conversation with associates drops considerably when instrument conditions prevail. Inactivity changes greatly between Marginal and VFR weather—there is 3 times as much inactivity in good weather as in Marginal and in IFR weather about 2/3 as much as in VFR. This would indicate, logically enough, less activity in good weather than in poor weather. This is a possible indication that some changes should be made in the length of the working day. The difference between the percents of time spent on interphone activity in the first and second halves of the composite watch is sufficiently large that it cannot reasonably be attributed to chance. Similarly, a statistical test of the difference between the percent of inactivity on the first and second halves of the watch indicates that the difference is also larger than could be expected if no real difference existed. The great difference between the inactivity categories during the halves of the watches is, of course, partly dependent on the variations in interphone activity. Whether the difference is also partly the result of fatigue, of errors due to sampling or some other factor not readily discernible is not known. Generalizations should be made cautiously as the composite eight-hour period included observations of only two samples of each watch.

Very few of the job components are manual in nature; the job consists more of such non-observable activity as thinking, making judgments, visualizing, etc., and it was principally for this reason that the activity analysis was not carried out at more centers. Variations in the frequency of activities between centers also suggested that a much more extensive sampling will be necessary to produce really conclusive findings. Although the activity analysis provided a picture of observable job components and provided the investigators with a better understanding of the job, it gave no indications of effectiveness or ineffectiveness and it was decided that other job analysis methods would better serve the immediate purposes of the present project. Because of the importance for planning and policy purposes of this type of information derived from such an activity analysis, it is recommended that this study be extended to include an adequate sample of stations and weather conditions.

The Critical Incident Technique

The "Critical Incident Technique" is a method for determining the critical requirements of an activity. Like the critical requirement approach, it was first described by Flanagan[21] in reports of the research conducted in the Aviation Psychology Program but was first formally named "The Critical Incident Technique" in earlier American Institute for Research reports [22,23].

The method consists of the collection and analysis of a sufficient number of behavioral incidents describing effective and ineffective job performance to cover adequately all the critical situations with which the worker comes in contact. Individuals who are in the best position to observe; i.e., those individuals who actually work at the activity or who are intimately associated with it, are asked to report on the behavior of their associates in critical situations. They are asked to describe what the individual did in a specific situation at a specific time that led to his being considered either outstandingly effective or ineffective at the activity. Large numbers of these incidents are collected and analyzed, and from this analysis, those patterns of behavior that make for success or failure on the job emerge.

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[21] Flanagan, J.C., op. cit.

[22] Gordon, Thomas, The Airline Pilot: A Survey of the Critical Requirements of His Job and of Pilot Evaluation and Selection Procedures. Civil Aeronautics Administration, Division of Research, Report No. 73, Washington, 1947.

[23] Preston, Harley O., The Development of a Procedure for Evaluating Officers in the United States Air Force, Pittsburgh: The American Institute for Research, 1948.

Critical incidents may be obtained by the individual interview, the group interview, the examination of records, or the written questionnaire. Of these, the individual interview seemed to be the most appropriate device for use in this study.

Certain precautions must be taken to insure that the incidents obtained will be usable and will provide sound basic data from which to determine the critical requirements. The tendency of interviewees to interpret or evaluate performance, to make sweeping indictments or broad generalizations must be overcome by tactful insistence on the part of the interviewer that they confine themselves to descriptions at the behavioral level. The tendency of interviewees to report an excess of very dramatic incidents may impair the representativeness of the sample. This danger can be held to a minimum if care is taken to request the most recent incident that the interviewee can recall or to restrict his report to incidents which have occurred within a specified time limit. This has the additional advantage that such descriptions will no doubt be recalled more accurately and in greater detail. Other less common trends in incident reporting which the interviewer must guard against are the tendency of the interviewee to report incidents which he has not observed at firsthand; to report incidents which are innocuous, or "luke warm", about which he has no definite conviction as to their effectiveness or ineffectiveness; or to include a series of separate behaviors in a single incident without indicating which is most significant in making the performance critical.

Collection of Critical Incidents

The collection of critical incidents for this study was accomplished by the use of an intensive interviewing program covering all seven Civil Aeronautics Administration regions in the continental United States. The American Institute for Research was particularly fortunate in being able to secure the services of one aeronautical specialist from each region to travel among the centers, towers, and communications stations of his region conducting critical incident interviews. The services of these men were secured through the efforts of the Assistant to the Administrator for Research of the Civil Aeronautics Administration. All the aeronautical specialists participating in the program had had control experience at one time or another and since their job calls for travel among the installations of their regions as "inspectors", they were in an excellent position to act as interviewers. It should be emphasized here, however, that during the interviewing phase, these men were acting as representatives of a private research organization and not in their official capacities. They were assigned to the American Institute for Research on a sort of "detached service" basis with their salaries and travel expenses paid by the Civil Aeronautics Administration. Interviewees were assured that the motives of the interviewer were not concerned with the evaluation of the individual reporting the incidents or of those upon whom he reported, but that the information collected would be used to develop more effective means of evaluating the proficiency of controllers in general.

The program opened with a conference with the interviewers on interviewing methods, held in Pittsburgh on September 21-22, and the deadline for the return of the completed interviews was set at October 13. The circular letter requesting the assignment of the specialists to the program is reproduced in Appendix D.

Conference on Interviewing Methods

Aims

The purposes of the conference on interviewing methods were: (1) to acquaint the aeronautical specialists with the objectives of the research; (2) to enlist their cooperation and interest in the problem; (3) to obtain their help in formulating plans on the selection of interviewees and the formulation of interview questions; and (4) to familiarize them with the interviewing procedures which have been found most satisfactory for use in connection with the critical incident technique.

Procedures

The first part of the program was spent in a period of orientation for the specialists and included an explanation of the function of the American Institute for Research, the history of the project, the objectives of the study, the inadequacy of the present measures of proficiency, and an explanation of the critical incident technique and its use in the present study. The participation of the specialists in the discussion was encouraged at all times during the conference. It is believed that their interest was enhanced by their participation in formulating the questions to be asked and their recommendations as to who should be approached as interviewees. The criteria of a good incident[24] were discussed and practice interviews recorded, played-back, and criticized.

Selection of Interviewees

The selection of those individuals who were to be approached as interviewees for the collection of critical incidents on controllers was made in line with the suggestions of the specialists. The bases upon which the specialists' choices rested were that the interviewers selected must be individuals who were familiar with the air route traffic controller's job and whose

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[24] See Appendix E, "Interviewers' Materials."

contacts with the controller were such that frequent opportunities to observe his behavior in critical situations were available. The various types of personnel selected were all engaged in work closely allied to air route traffic control. The individuals whom they believed to be in positions to best observe incidents illustrative of effective and ineffective control are listed below together with the tentative quotas of interviews to be conducted with each:

Individuals to be Interviewed	Interview Quota
1. Senior Air Route Traffic Controllers	8
2. Air Route Traffic Controllers	7
3. Assistant Air Route Traffic Controllers	5
4. CAA Aircraft Communicators - CAF 7, 8, 9	5
5. Airline Operations Personnel	5
6. Airport Traffic Controllers - CAF 7, 8, 9	5
7. Chief and Assistant Chief Air Route Traffic Controllers	5
	40

Later in the course of the interviewing program it became advisable to eliminate airline operations personnel from the list of interviewees but the specialists were asked to make up the deficit in additional interviews from among the other groups.

Interview Questions

Tentative lists of questions designed to elicit reports of both effective and ineffective controller behavior from the interviewees were offered to the specialists for review and comment. It was felt that these men could aid in making the questions more meaningful to Air Traffic Control personnel by suggesting changes in phrasing, suggesting better criteria of effectiveness or ineffectiveness, etc.

Different questions were developed for each of four types of interviewee. Senior, assistant chief, and chief controllers were asked 2 questions designed to elicit reports of effective controller behavior and 4 for ineffective incidents. The "effective questions" were:

1. If promotions were entirely dependent upon your judgment of a controller's effectiveness, think of the man you would recommend first for promotion and describe something he did in a specific situation at a specific time that illustrates his effectiveness.

In addition three "probing" questions were asked to obtain reports in greater detail and to have the effectiveness or ineffectiveness of the behavior clearly identified by the interviewee.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What made the way he handled the situation outstanding?

2. Now will you describe the last time you observed a controller on your watch do something that you felt was a particularly effective piece of work. Describe the situation in detail.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What made the way he handled the situation outstanding?

Examples of the kinds of incidents obtained in response to the above questions follow:[25]

1. This controller was unable to get the attention of the controller on the adjacent sector for coordination purposes. After several attempts this controller left his sector and went over to the adjacent sector and noticed that the other controller was very busy. Instead of demanding the attention of this adjacent controller he looked over the traffic situation on this sector and figured out a safe and efficient altitude to clear the flight in question. He then got the attention of the other controller long enough to point out coordination solution and received the other controller's approval. This incident demonstrated this man's ability to improve the efficiency of the entire control center by his cooperativeness.

2. At _____ during IFR weather three aircraft were holding on the range station awaiting their turn to land. Each aircraft reporting to a different communication agency. Severe icing existed at at the levels these aircraft were holding and one after the other requested emergency approach account icing. The controller after receiving these requests advised each aircraft to use same frequency and by doing this simultaneous instructions were given and aircraft directed to maintain 1000 foot separation in descent. All three aircraft descended on the same course of the range with adequate separation and two were again given holding instructions after reaching a level where no icing was reported and awaited their turn to land. Alertness and ability to utilize existing communication channels provided a rapid answer to an emergency situation.

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[25] It is believed that the inclusion in this report of sample incidents, from which all materials which might identify individual controllers or installa- has been removed, is not a violation of the confidential nature of the data.

The questions designed to obtain reports of ineffective controller behavior from chiefs, assistant chiefs, and seniors were:

1. Think of the last time that you felt it was imperative to assist a controller because you felt that the situation was critical. I would like you to give me all the details about that situation.

(a) What were the circumstances surrounding the situation?
(b) Exactly what did the controller do, or what were you afraid he might do?
(c) What did you do that was different from what he did or might have done?

2. Think of the last controller whom you recommended or would have liked to recommend for a "Minus" rating on any item of the Civil Service Efficiency Rating Form. No doubt your judgment is based on many observations of this individual in a number of situations but we would like you to describe in detail one specific situation you observed in which he particularly warranted a "Minus" rating.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What would have been the best way of acting in that situation?

3. Think of the last controller whom you recommended for demotion, dismissal, or warning rating, or would have liked to recommend for demotion, dismissal, or warning rating. Now will you think back and describe the situation you observed that was the "last straw" in making you decide he should be demoted, dismissed, or issued a warning rating?

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What would have been the best way of acting in that situation?

4. Recall the last instance that you observed a controller do something or start to do something that was responsible, at least in part, for a confliction or near-accident. Describe the situation in detail.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What would have been the best way of acting in that situation?

Sample Incidents Illustrative of Responses

1. A northbound aircraft was approaching _____ at 11,000 enroute to _____. The pilot requested change in altitude to 7,000. The controller immediately approved 7,000 with no restrictions on descent. A glance at the board showed a southbound at 10,000 approaching _____ through which the aircraft at 11,000 wanted descent on instruments. I had to grab the controller's phone, told the communicator not to deliver the clearance just issued. Instructions were issued to descend on a shuttle on the west course of the _____ range to avoid the southbound at 10,000. This controller resigned shortly after this, realizing his inability to do the work safely.

2. The controller received a flight plan from an adjacent center pertaining to an aircraft operating through the _____ area. The flight plan received contained the correct route information and was posted correctly on all the flight progress boards and indicated the correct route. In transmitting this information to the next adjacent center the controller gave the adjacent center incorrect enroute information, even though all the flight progress strips on his board stated the route correctly. The result was a traffic confliction within the adjacent center's area.

3. (a) This controller had issued a clearance allowing an aircraft to climb through the altitude of an opposite direction aircraft on a course where lateral separation was not provided. This situation was recognized by me at once and clearances were immediately issued to avoid the potential confliction. The problem was explained carefully to the controller and two practice problems were given immediately to demonstrate the time needed for an altitude change. It was demonstrated by a computer and mathematically how a controller could determine his time and latitude to permit altitude changes.

(b) The controller advised that he understood this particular problem. Within 15 minutes after the first situation which was subsequently explained as outlined above, the controller issued a second clearance for an aircraft to climb through the altitude of another aircraft without adequate separation.

(c) The controller should have been able to determine whether or not the aircraft were or were not within the required latitude of time separation required for aircraft to climb through another aircraft's altitude.

4. This incident concerns an over flight and a departure. The controller in issuing instructions to the departing aircraft advised him to climb on the south leg of the _____ range to a specified altitude, but neglected to advise what procedure to follow after reaching that altitude. This omission of instructions resulted in the pilot following a procedure different from that the controller had anticipated and as a result the two departing aircraft and the southbound aircraft crossed the range station two minutes apart at the same altitude. The controller did not issue specific instructions in this case and took too much for granted. In order to adequately handle the situation the clearance to the outbound should have contained all necessary instructions to climb and cross the range which would have provided either altitude or time separation between the two aircraft.

The second grouping of interviewees for whom questions were developed included CAA Aircraft Communicators, Airline Operations Personnel, and Airport Traffic Controllers. Five questions comprised the interview for this group, 2 for effective incidents and 3 for ineffective.

1. No doubt there have been circumstances in which an air route controller has done something which you felt represented good control. Describe the situation in detail.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What made it may be handled the situation outstanding?

2. Think of a specific incident while you were on the interphone, when an air route controller really expedited the flow of control information due to the effectiveness of his interphone work.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What was outstanding about the way he acted in this incident?

Sample Incidents

1. This controller received a position report on an aircraft at 5,000 feet over terminal A and upon checking his board he found that he had no advance information on this aircraft but that he had an air carrier approaching the same fix also at 5,000. The controller immediately conferenced the tower, CAA Radio, and the air carrier radio and told air carrier radio to call their flight tower and CAA radio to call other aircraft and told all agencies that he would stand by. The CAA Radio worked the itinerant aircraft and the Controller instructed the pilot to reverse course immediately. By that time the air carrier radio was in contact with their flight and the controller instructed him to descend to 4000 feet immediately. I think this controller really expedited the flow of control information by the effectiveness of his interphone technique.

2. This controller was working a landing sequence under IFR conditions and I gave him a position report that army so and so was on the southeast course of this particular range at 9,000 feet. The controller issued a standard holding clearance for the aircraft. Upon delivering the clearance the pilot advised me that he was not at 7,000 feet. I reported this information to the controller and he immediately advised me to broadcast an emergency message for all aircraft below 7,000 feet to vacate the southeast course of this range and he also advised me to ascertain from the pilot of this army aircraft why he was not maintaining his altitude. The army aircraft reported that he had engine trouble, had heard the emergency message and was requesting an immediate clearance to land from 7,000 feet. Since the traffic had already been advised to vacate the approach course, this aircraft was cleared without delay.

Questions used to obtain ineffective incidents from tower, communications, and airline operations personnel with examples of incidents received from each:

1. No doubt there have been occasions during your work with air route traffic controllers in which a controller has done something which in your opinion indicated poor control. Will you describe in detail the most recent situation of this sort?

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What would have been the best way of acting in that situation?

2. Now think of the last time an air route controller did something ineffective that irritated you. Describe the situation in detail.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) How would you have preferred that he acted in this situation?

3. Think of a specific incident while you were on the interphone, when an air route controller actually hindered the flow of control information due to the ineffectiveness of his interphone work.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What would have been the best way of acting in this situation?

1. I was working approach control under IFR conditions with heavy traffic. This controller cleared an inbound to the tower to cruise at the minimum altitude. This clearance was issued while the aircraft was approximately forty miles out from the airport. By clearing the aircraft in at the minimum altitude other aircraft were delayed over the range station until this aircraft landed and departing aircraft were also delayed.

The controller could have cleared this aircraft in at the proper altitude for the sequence and prevented all of the unnecessary delays.

2. This controller told me to attempt to contact army so and so at 11:55. I started calling this aircraft at 11:55 and after several calls I heard this aircraft working another station one hundred miles from my station. I reported this information to the controller but he did not tell me to discontinue calling the aircraft. Not knowing all of the particulars of why he wanted me to call the aircraft, I continued to call until 12:15 at which time I reported to the controller that I was still unable to contact the aircraft. The controller advised me to discontinue calling because he had obtained the information he needed from the other station that had worked the aircraft. This irritated me because he could have relieved me of unnecessary work by telling me to discontinue calling as soon as he knew the aircraft was in contact with the other station.

3. This controller was working under stress of heavy traffic in IFR weather conditions. At one time during this day the controller, apparently rattled, started giving me clearances so rapidly that it was impossible to copy. I was forced to ask for so many repeats that it required more time than if he had given me the clearance slow enough in the first place. This condition lasted about two hours before the controller realized that he was actually hindering the flow of traffic information through the ineffectiveness of his interphone technique.

Six questions were prepared for controllers, three for effective incidents and three for ineffective.

1. If promotions were entirely dependant upon your judgment of a controller's effectiveness, think of the man you would recommend first for promotion and describe something he did in a specific situation

at a time that illustrates his effectiveness.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What made the way he handled the situation outstanding?

2. Now will you describe the last time you observed a controller on your watch do something that you felt was a particularly effective piece of work. Describe the situation in detail

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What made the way he handled the situation outstanding?

3. Think of the controller whom you would most like to have assigned the sector next to yours. No doubt your judgment is based on many observations of this individual in a number of situations but we would like you to describe in detail a recent specific situation you observed that illustrates your reason for choosing him to work next to you.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What was outstanding about the way he handled the situation?

Sample Incidents

1. Ten B-29 aircraft eastbound on a cross country trip were flying 500 on top. In the vicinity of _____, they began to encounter instrument conditions and requested separation Since they were not on the Federal airways, the controller was not responsible for providing separation; however, he suggested to the leader of the flight who was at 16,000 feet that the leader assign the next aircraft climb to 16,500 and the following aircraft descend to 15,500, the next B-29 climb to 17,000 and the next B-29 descend to 15,000 etc. In this manner the aircraft would be provided separation and weather reports indicated a solid top in the vicinity of _____ about 90 air miles east. Here was a situation in which the controller had no direct responsibility at the time but was willing to assist the squadron leader in providing safe flight for a group of aircraft flying off airways The information was offered as a suggestion and the flight leader gave the necessary instructions In approximately 20 minutes the flight leader advised they were in the clear again flying 500 on top.

2 At _____, two north bound aircraft were converging at 7,000 foot altitude with insufficient separation due to the revised estimate on the second aircraft, noticing the controller on sector 3 was tied up with instrument approach at _____, this controller immediately took the initiative and effected separation himself by clearing one aircraft to climb immediately 500 feet until standard separation could be provided.

Prompt and correct analysation of adjacent problem and remedial action immediately made this an outstanding example.

3. This controller was working _____ - _____ sector and I was on the sector to the East, _____, etc. He had a departure he wanted to clear through my sector at 13,000. There was no indication that 13,000 was not clear in my sector but I was tied up with departures at _____. This controller knew I was clearing westbound aircraft from _____. I was so busy that he couldn't get a word to me to ask for approval. As a result he cleared his departure to climb westbound and to recross _____ range only at 13,000 -- no delay expected. In the meantime I became free and approved his use of 13,000 through my sector. Some controllers would not have taken the precaution he did and would have used 13,000 without coordination. Had I already assigned 13,000 confliction would have resulted. This confidence in the coordination this man always effects make him desirable to have in the next sector.

Ineffective

1. If it were within your authority to recommend a man for demotion, dismissal, or a warning rating, think of a controller whom you feel should be transferred or dismissed or issued a warning rating and describe the situation you observed that provided the "last straw" in the making of your decision.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What would have been the best way of acting in that situation?

2. Think of the last time when the controller who preceded you at the board left you with a traffic situation that was confused and difficult to straighten out.

(a) What were the circumstances surrounding the situation?
(b) What had the previous controller done that made the situation difficult to straighten out?
(c) What did you do to remedy the situation?

3. Think of the controller whom you would least like to have assigned the sector next to yours because of your lack of confidence in his control ability. No doubt your judgment is based on many observations of this individual in a number of situations, but we would like you to describe in detail one recent specific situation you observed that illustrates your reason for not wanting him to work next to you.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What would have been the best way of acting in this situation?

Sample Incidents

1. This particular controller was working his sector with stacked up traffic at two major terminals. The controller received a report that the number one aircraft was contact at terminal A. Through his negligence he marked the information down on the number one aircraft at terminal B and cleared

the number two aircraft at terminal B to land. This negligence of the controller created a serious traffic confliction which provided the "last straw" in making me decide that he should be demoted

2. The airport involved was a very busy _____ terminal. Traffic was heavy with a large backlog of aircraft waiting for departing clearances.

The previous controller had cleared three outbound aircraft. His instructions had not set up the request for specific information requiring reports of when turns were made, when on course and when vacating specific altitude. Naturally traffic was moving slowly under this type of control.

Upon coming on duty it was necessary for the controller to attempt to acquire the necessary information before releasing further aircraft. This information could have been obtained automatically had the initial clearance requested definite reports.

3. I relieved this controller and noted that among several flights posted over the very congested terminal A, an inbound strip posted on a round robin flight from terminal A to a point in the adjacent center's area and return. The strip indicated the altitude and original pilot's estimate but did not indicate clearance information issued by the adjacent center. I questioned the controller I was relieving and he said that he had received no coordination from the adjacent area on this flight and that he assumed the flight was returning VFR. To be on the safe side I checked with the adjacent center and was advised that the aircraft was returning IFR and that the information had been coordinated. I arranged my traffic at terminal A just in time to prevent a hazardous traffic confliction. A subsequent investigation revealed that this controller had received this coordination but neglected to post the flight progress strip accordingly.

The final type of interviewee for whom a special set of questions was constructed were the assistant controllers. As in the case of the tower and communications personnel, 5 questions were provided, 2 for effective incidents, and 1 for ineffective.

1. Think of the air route controller that you would most like to work with. No doubt this individual has done many things that convince you of his effectiveness, but we would like you to describe in detail one specific situation in which he did something that made you think him particularly effective.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What was outstanding about the way he handled the situation?

2. Now will you describe the last time you observed a controller on your watch do something that you felt was a particularly effective piece of work. Describe the situation in detail.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What made the way he handled the situation outstanding?

Sample Incidents

1. A military field called the center at approximately 2200 and advised the expected operation of 12 trips to a terminal in an adjacent control area. Weather required instrument flight the entire route. The controller receiving this information realized that the aircraft would start operation during the midnight to morning trick when only one assistant and one controller were on duty.

This controller then prepared all the information normally required. Furthermore, he coordinated the information with the adjacent center relaying flight plan information and coordinating the required altitudes. It was only necessary for the short handed crew to forward the time off and estimate when the aircraft departed. Had it been necessary for the people on the midnight to 8 trick to handle the entire coordination they would have been swamped since other traffic was fairly heavy at the time.

2. This controller was controlling one army aircraft enroute to _____. On approaching _____ the aircraft reported heavy icing conditions. The controller cleared this aircraft to the lower and held other aircraft at outlying fixes or at altitudes with no ice. This controller could have cleared this aircraft down one or two thousand feet and gotten by with less work in changing the traffic picture. However, he remained calm and handled the situation very effectively. All during this incident the controller had time to calmly and effectively help me in my job. His method of controlling under stress of peak traffic conditions demands the respect and confidence of all center personnel.

Ineffective

1. Think of the controller that you would least like to work with. No doubt this individual has done many things to convince you of his ineffectiveness but we would like you to describe in detail one recent specific situation in which he did something to convince you of his ineffectiveness.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What would have been the best way of acting in the situation?

2. Now will you describe in detail the last time you observed a controller do something that you felt was a particularly ineffective piece of work.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What made the way he handled the situation outstanding?

3. Think of a controller with whom you have worked whom you would not recommend for a promotion to a senior controller. Describe in detail a specific thing which you observed this controller do which convinced you he would not make a satisfactory senior controller.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What would have been the best way of acting in that situation?

Sample Incidents

1. IFR conditions prevailed. A southbound aircraft was ready for take-off and a northbound aircraft approximately 15 minutes south had been given clearance to descend to the tower from 7,000 feet. The take-off aircraft was issued a clearance to the destination airport with instructions to climb well to the right and was given his traffic as a landing aircraft descending from 7,000 feet to the tower. After this clearance was issued the controller then gave the descending aircraft traffic climbing southbound well to the right-- however, he also gave instructions to the landing aircraft to descend well to the right. This being accomplished while the landing aircraft was close into the station, which is very difficult for a pilot to do.

The controller could have had the aircraft maintain an altitude until past a certain fix, or rerouted the flight.

2. Three Navy aircraft were cleared from one field to a terminal approximately 150 miles distant. They were all cleared at 2000 feet with time separation on take off. The destination had weather indicated instrument flight at that altitude. All had been cleared to the tower with restrictions. Enroute the time separation was lost due to fact aircraft used different power settings. The assistant controller called the attention of the controller to this fact and requested advice as to the type of clearance he desired to be issued.

The controller advised to clear all three aircraft to the tower VFR approach from 2,000 if not possible maintain VFR and advise. The assistant questioned this clearance and all three pilots questioned the clearance. The controller took no further action. Apparently the pilots in direct communication with each other worked out their own separation.

The controller issued an impossible and absurd clearance and was unable to see his mistake. The aircraft obviously could not maintain VFR if on instruments.

3. A controller was responsible for a portion of a training program for assistant controllers. His portion dealt with the procedures for traffic control specifically, separation by time, altitude and lateral means.

When approached by an assistant controller for an interpretation of various technicalities of separation problems this controller would avoid a direct answer thus giving the impression he was not sure he knew the answer or was hesitant in making a decision.

He should have given outright answers or if he could not answer the question he should have conferred with other controllers to derive a satisfactory answer for the assistant's inquiry.

Booklets were issued to each interviewer for the recording of incidents with provision for several data questions at the bottom of each page (Appendix E) involving the month, time, weather, and watch in which the incident occurred. In addition, the interviewers were equipped with a standardized introductory statement and a list of "Rules for a Good Incident". (Appendix E.)

Description of Sample

The aeronautical specialists collected a total of 1249 usable incidents from among the seven regions. The distribution of these incidents among the regions is shown in Table 3.

TABLE 3.

DISTRIBUTION OF CRITICAL INCIDENT INTERVIEWS AMONG THE SEVEN REGIONS

Region	No. Interviews	No. Critical Behaviors	Effective	Ineffective
1	37	214	93	121
2	40	199	91	108
3	23	98	60	38
4	39	194	100	94
5	29	177	78	99
6	54	171	67	104
7	36	196	92	104
TOTALS	258	1249	581	668

Interviews were conducted at Civil Aeronautics Administration installations in the following cities:

1. New York
2. Albuquerque
3. Atlanta
4. Seattle
5. Jacksonville
6. Oakland
7. St. Louis
8. Fort Worth
9. Dallas
10. San Antonio
11. Kansas City
12. Denver

13. Boston
14. Salt Lake City
15. Cleveland
16. Cincinnati
17. Los Angeles
18. Great Falls
19. Chicago
20. Norfolk
21. El Paso
22. Bakersfield
23. Fresno
24. Memphis
25. Wichita

In a few instances the installation visited was not indicated on the interview booklet. The above list includes all air route traffic centers in the continental United States except six and, in addition includes several installations other than centers.

Figures 6 and 7 show the percents of the total effective and ineffective incidents that were reported by the four occupational groups of interviewees. As was planned, more incidents were requested of seniors and controllers than from the other groups. This was believed to be appropriate inasmuch as these men presumably are most familiar with the job and have the best opportunity to observe the controller directly. Smaller numbers of communicators, airport controllers, and airlines personnel were interviewed because their contacts with the air route controller's job are largely maintained via the interphone. Even fewer assistants were interviewed because as trainees their knowledge of the job must necessarily be limited, although they are competent to report on those aspects of the controller's job that directly involve the assistant.

FIGURE 6.

PERCENTAGE OF JOB CLASSIFICATIONS OF ATC AND OTHER PERSONNEL INTERVIEWED FOR CRITICAL INCIDENTS

Effective Incidents N=581

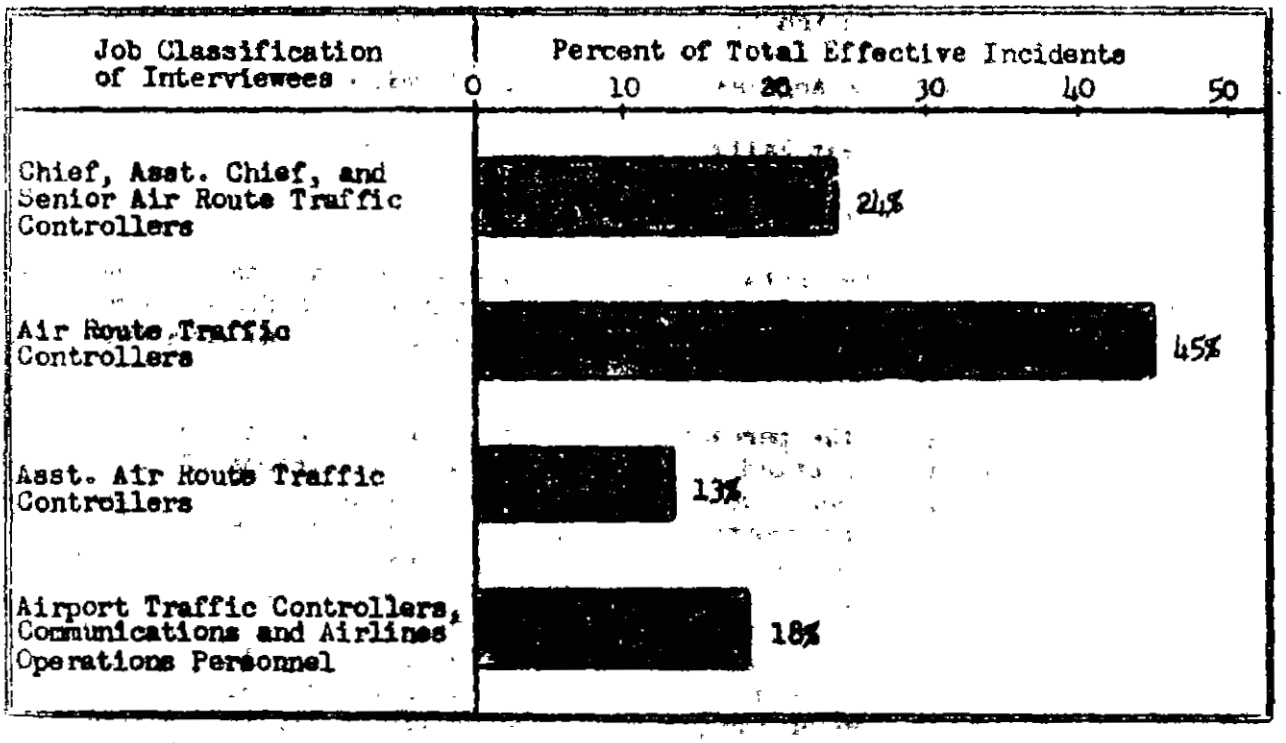
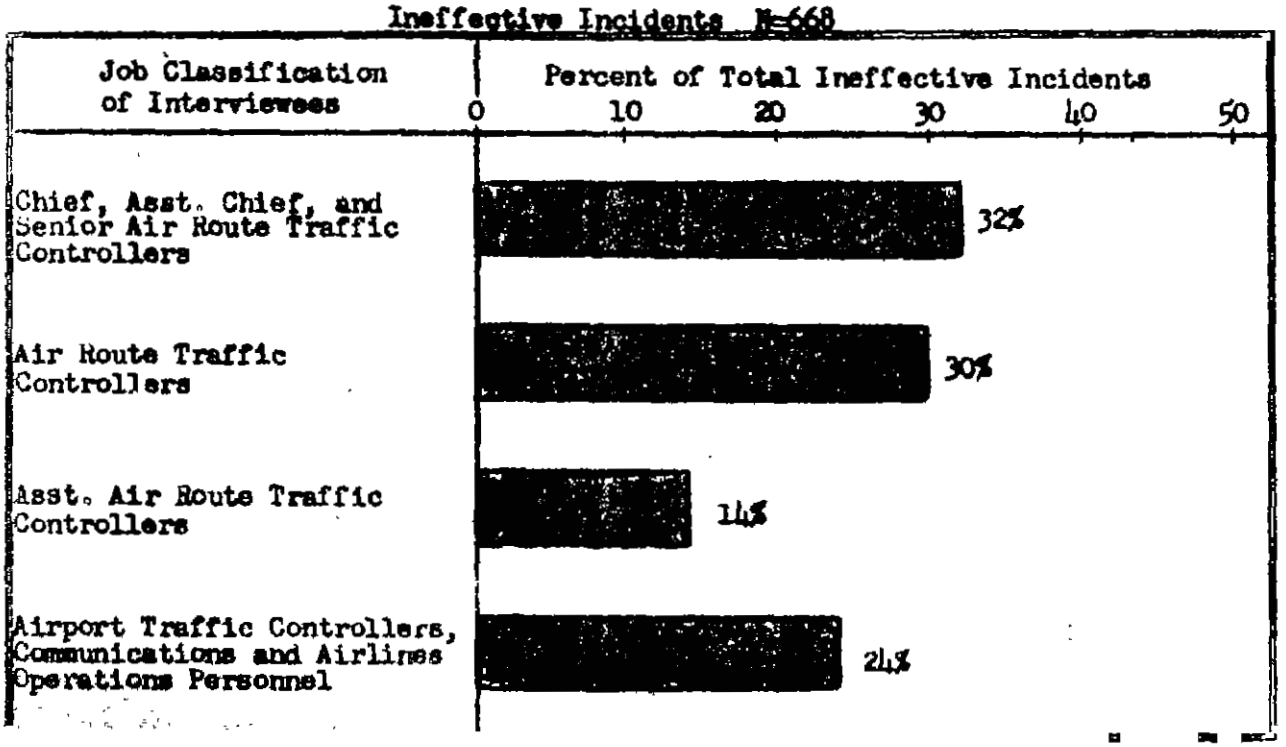


FIGURE 7.

PERCENTAGE OF JOB CLASSIFICATIONS OF ATC AND OTHER PERSONNEL INTERVIEWED FOR CRITICAL INCIDENTS

Ineffective Incidents N=668



Formulation of the Critical Requirements

The basic data from which the critical requirements of air route traffic controllers were determined were the 1249 critical behaviors collected in the interview phase of the study. Inasmuch as each of these behaviors was a description of performance on the part of a controller that had resulted in his having been judged successful or as having failed in some important aspect of the job, all were potential critical requirements. Many such reported behaviors were similar, however, and the next phase of the survey consisted of the classification and grouping of similar behaviors under general headings. These were then successively reduced, and critical requirements, in the form of behavioral statements encompassing each grouping of specific incidents, were formulated.

Each incident from the interview booklet was typed on 5" x 8" file cards with the information obtained from the responses to the data questions coded in spaces along the card's edge. These data included an interview number, the job classification of the interviewee, the center, the month in which the incident occurred, the watch and approximate hour of occurrence, the weather conditions (IFR, VFR, or Marginal) prevalent at the time of the incident, the recency of the incident in months, the question to which the incident was a response, and spaces for writing the classification of the behavior.

The Formulation of Categories

At least two general frames of reference are available to the investigator faced with the need for classifying behavioral incidents. He may approach the analysis by considering the individual on-the-job and classify the behaviors under headings consisting of the psychological traits or characteristics implied in the behavior. Or, he may approach the analysis from the point of view of the job itself and classify the behaviors in accordance with a list of job components that follows the sequence of operations of the job. The job of airline pilot lends itself to this latter type of classification; e.g., pre-flight checking, starting engines, taxiing, take-off, etc. A second type of classification from the point of view of the job might be called a functional analysis. Here the behaviors are classified under a series of job functions, each specific behavior being placed in that category which best illustrates the job-related goal involved. An example from the controller's job may help to clarify this type of analysis. If a controller is observed to have cleared a departing aircraft to climb to an altitude already occupied by another aircraft, the function of the job under which this specific act falls would be the "Assignment of Altitudes to Departing Aircraft." An even broader statement of the job function being performed would be "The Issuance of Departure Clearances." The fact that the behavior used here as an illustration is from an "ineffective" incident does not affect its classification at this stage.

For the present study, where the objective of the research was to construct a proficiency measure based on the critical requirements, it was believed that the latter technique would be most applicable. Ten general categories were developed from an initial study of approximately 300 incidents. To arrive at these, the analyst, as he read the incidents, asked himself the questions: "What was the controller's job-related goal?", "What aspect of the job was he engaged in at the time the critical behavior occurred?" It seemed that such an approach would make for easier discovery of the appropriate critical requirement by observers who would eventually apply the same approach in using an evaluation procedure based on the critical requirements of the job.

Seven of the general headings thus developed concern themselves with the goal of the controller. These are listed as follows:

I. Issuing Departure Clearances
II. Revising Flight Plans and Clearances
III. Aiding Aircraft in Trouble
IV. Coordinating with Other Agencies
V. Planning Approach Procedures
VI. Supervising Personnel
VII. Handling the Board

Many incidents, however, reported situations where the "criticalness" of the behavior was not primarily concerned with some aspect of controlling traffic per se. If, for example, a controller was indicated to be ineffective because he was unnecessarily harsh in his criticism of an associate, it was impossible to classify such a behavior under any of the above headings. To accommodate this type of behavior, reflecting attitudes and adjustments, three additional categories were developed:

VIII. Helping Other Controllers
IX. Maintaining Harmonious Relations with Others
X. Maintaining Emotional Control

Forty-seven sub-categories evolved as the classification of the individual incidents progressed. Ineffective and effective behaviors were recorded separately but were classified under the same major headings and sub-categories (less general statements of job function). When, from among the 501 effective and 668 ineffective incidents, behaviors were encountered that were identical to others previously recorded, the frequency of occurrence of the behavior first recorded was increased and the "duplicate" card was set aside, thus reducing the number of behaviors that had to be examined for the next step in the analysis.

The next step in the analysis was a further reduction of the number of behaviors. Behavioral statements were constructed that included closely related, but not necessarily idential, specific acts. For example, several incidents reporting the specific techniques by which controllers directed the emergency descents of aircraft out of hazardous conditions without causing delay to other traffic became simply, "Arranged for an emergency descent without penalizing other traffic."

Following in general the procedures used by Preston[26] in this stage of

the analysis, the separate effective and ineffective behaviors were next matched by placing behaviors with the same classification number side by side under their common headings. In cases where the opposites of the behaviors were not reported, the reported behaviors are listed singly. The complete classification at this stage is shown in Appendix F. For purposes of illustration, the matched classification of one general heading is shown below. The ineffective behaviors are those with the widest left-hand margin.

		No. of cases
I. ISSUING DEPARTURE CLEARANCES	Effective	27
	Ineffective	94
	Area Total	121
A. Assigning Altitudes	Effective	4
	Ineffective	42
	Sub-area Total	46
Cleared a large number of aircraft with minimum delay by careful allocation of available altitudes.		4
Assigned altitudes unnecessarily high or low and delayed traffic.		2
Assigned altitudes to aircraft without providing minimum separation requirements.		36
Assigned aircraft below minimum altitudes.		2
Failed to consider altitude requests but sent aircraft out in easiest possible way.		2
B. Assigning Climbing Courses	Effective	4
	Ineffective	37
	Sub-area Total	41
Expedited departures by utilizing the quickest and most efficient climb-out procedures under the circumstances.		4
Delayed traffic by using inefficient and time-consuming climb-out procedures.		6
Issued incomplete climb-out instructions with result that a confliction followed.		15
Issued climb-out instructions which failed to provide minimum separation requirements.		14
Delayed traffic by failure to issue climb-out instructions at the appropriate time.		2

C. Arranging Take-off Sequence	Effective	3
	Ineffective	2
	Sub-area Total	5
Arranged the take off sequence to take advantage of differences between speeds in aircraft.		2
Delayed fast aircraft by failing to take differences between speeds of aircraft into consideration.		1
Utilized the same take off procedures for a large group of aircraft thus expediting the flow of departure traffic.		1
Failed to make any arrangements for take off sequence of large group of aircraft with result that all aircraft were delayed.		1
D. Estimating or Preventing Take-Off Delays	Effective	16
	Ineffective	13
	Sub-area Total	29
Eliminated delays by keeping himself constantly informed of all information pertinent to departing aircraft.		2
Delayed aircraft by refusing to take advantage of information which would expedite flights.		1
Eliminated delays by utilizing all possible routes of flight.		3
Delayed aircraft by neglecting to use all available routes of flights.		4
Expedited departure clearances by issuing clearances immediately upon request.		1
Delayed aircraft by failing to issue a departure clearance promptly.		1
Expedited departures by arranging for aircraft to take delay time on the ground.		1
Expedited departures by preventing arrivals from blocking them.		4
Hindered departures by blocking them with over traffic and arrivals.		2
Prevented delays to departing aircraft by advising those involved of all information pertinent to departures.		3
Successfully worked out answers to untried departure procedures so that departures were expedited.		1

By issuing simultaneous but different instructions he was able to expedite departing aircraft.	1
Unnecessarily delayed departures by declaring an emergency when none existed.	2
Created hazards to airborne aircraft in attempting to avoid delays to departure.	2

Table 4 shows the distribution of the incidents among the categories formulated, or "job areas."

TABLE 4.

DISTRIBUTION OF CRITICAL BEHAVIORS AMONG THE JOB AREAS

Based on 581 Effective and 668 Ineffective Behaviors

	Effective		Ineffective	
	No.	%	No.	%
I. ISSUING DEPARTURE CLEARANCES	27	5	94	14
A. Assigning Altitudes				
B. Assigning Climbing Courses				
C. Arranging Take-Off Sequence				
D. Estimating or Preventing Take Off Delays				
II. REVISING FLIGHT PLANS AND CLEARANCES	79	14	67	10
A. Changing VFR-IFR Flight Plans				
B. Changing Destinations				
C. Changing Altitudes				
D. Changing Courses and Routes				
E. Changing Time Schedules				
III. AIDING AIRCRAFT IN TROUBLE	172	30	11	2
A. Clearing Airspace for Emergency Descents				
B. Locating Lost Aircraft				
C. Orienting Lost Pilots				
D. Organizing Rescue Facilities				
E. Clearing Airspace for Lost Aircraft				
F. Contacting Aircraft with Radio Failure				
G. Providing Alternate Bases				
H. Arranging Emergency Landings				

TABLE 4. - continued

		Effective		Ineffective	
		No.	%	No.	%
IV.	COORDINATING WITH OTHER AGENCIES	115	20	206	31
	A. Utilizing Communications Facilities B. Coordinating Inter-Sector Traffic C. Issuing or Requesting Pertinent Information D. Issuing or Requesting Information Promptly E. Issuing Traffic Advisories F. Issuing and Requesting Accurate Information G. Speaking Intelligibly H. Reducing Interphone Contacts I. Briefing Successor at the Board				
V.	PLANNING APPROACH SEQUENCES	52	9	85	13
	A. Arranging Holding and Stacking Patterns B. Organizing Approach Sequences C. Releasing Aircraft to Approach Control D. Determining the Saturation Point E. Estimating and Preventing Delay Time in Approaches				
VI.	SUPERVISING PERSONNEL	30	5	39	6
	A. Training Assistants B. Delegating Responsibility to Assistants C. Allocating Personnel				
VII.	HANDLING THE BOARD	7	1	33	5
	A. Removing Void Strips B. Posting Complete and Accurate Data C. Organizing the Board Quickly				
VIII.	HELPING OTHER CONTROLLERS	57	10	10	1
	A. Recognizing Conflictions in Other Sectors B. Assuming Another Controller's Responsibilities C. Helping in the Solution of Others' Problems				

TABLE 4. - continued

	Effective No.	Effective %	Ineffective No.	Ineffective %
IX. MAINTAINING HARMONIOUS RELATIONS WITH OTHERS	89			
A. Demonstrating Confidence in Others				
B. Criticizing Others				
C. Maintaining Good Public Relations				
D. Accepting Responsibility				
E. Obtaining Cooperation from Others				
X. MAINTAINING EMOTIONAL CONTROL	27	5	34	
A. Accepting Criticism				
B. Maintaining Composure Under Stress				
TOTALS	581	100.00	668	100.00

The largest number of ineffective incidents occurred in the job area having to do with coordinating with other agencies: towers, communications stations, other centers and controllers, etc. The largest number of effective incidents occurred in that aspect of the controller's job that deals with the aiding of aircraft in trouble: bringing aircraft down out of icing or other hazardous conditions, locating lost aircraft, and the like. Data reported later will demonstrate that the high frequency of effective incidents reported in this area may be due in part to a tendency of interviewees to recall incidents involving dramatic rescue, etc., more readily than less spectacular events.

The Critical Requirements

The critical requirements of an activity are not confined to any rigid, pre-determined framework or form. As previously mentioned, each separate effective behavior or the inferred opposite of each ineffective behavior reported is a potential critical requirement for the effective control of air traffic as long as it satisfies the criterion that its presence or absence results in success or failure on some critical aspect of the job. The various stages of the classification process were all statements of the critical requirements. The evaluation procedure developed in the research is also based on a list of such requirements presented in still a different form. The "Summary of Critical Requirements" that follows is a list of fairly general statements of the behaviors that differentiate between effective and ineffective air route traffic controllers, organized under the ten main job areas.

SUMMARY OF CRITICAL REQUIREMENTS

Area I. When handling departures, the effective controller:

Provides standard separation requirements and follows safety regulations when assigning climb-out courses and altitudes to departing aircraft.

Prevents delays to departing aircraft by utilizing all available routes, altitudes, and climb-out courses.

Utilizes the most appropriate altitudes, climb-out procedures and take-off sequences for type of aircraft and flight plan.

Expedites the flow of departures by issuing clearances and information promptly and in the order requested.

Devises new procedures when necessary in order to expedite departing traffic.

Obtains and utilizes all available information in order to expedite departing traffic.

Expedites departures by keeping departure courses clear of other traffic.

Area II. When revising clearances, the effective controller:

Revises clearances to change altitudes, destinations, routes or time schedules in order to provide standard separation requirements between aircraft.

Provides requested revisions of flight plans without delay or without causing conflictions.

Recommends changes of altitudes, destinations, routes, or time schedules in order to avoid hazards.

Issues clear and complete instructions regarding the revision of flight plans.

Avoids delay to aircraft by changing altitudes, destinations, routes, or time schedules.

Area III. When aiding aircraft in trouble, the effective controller:

Provides aircraft in trouble with airspace or descent courses free of other traffic and in sufficient time to insure safe descent.

Utilizes all available methods to contact, locate, or orient a lost aircraft.

Provides aircraft with safe and rapid passage to suitable alternate bases or emergency landing fields.

Area III.(cont.)

Anticipates requests for help from aircraft in emergencies and prepares his traffic beforehand to accommodate descents, reroutings and landings.

Institutes original procedures when available methods are inadequate for aiding aircraft in emergencies.

Persists in his attempts to contact, locate or orient aircraft until all possibilities for aiding the aircraft are exhausted.

Area IV. When coordinating with other agencies, the effective controller:

Reduces interphone time by the use of time-saving methods.

Arranges the traffic pattern in his sector to facilitate the safe flow of traffic in his own and others' sectors.

Issues or obtains information promptly.

Issues traffic or weather advisories to prevent hazards to aircraft.

Requests or issues all information pertinent to the traffic situation in his own or others' sectors.

Requests, issues or obtains sufficiently accurate information to avoid repeats, call backs or revisions of clearances.

Utilizes standard phraseology on the interphone and speaks at a rate enabling others to understand him.

Leaves the board for his successor with operations as complete as possible and provides successor with all information pertinent to the traffic situation.

Area V. When controlling approaching aircraft, the effective controller:

Maintains standard separation requirements when holding and stacking, approaching or releasing aircraft to the tower.

Keeps holding stacks, approach courses and destination area free from congestion by other traffic.

Makes careful use of the available holding fixes, altitudes and approach courses.

Institutes unusual or original time-saving procedures to hold or approach aircraft when standard procedures are inadequate to avoid delays.

Utilizes safe and appropriate altitudes, holding points, approach courses, and arrival sequences for approaching aircraft.

Issues or obtains all information necessary for safe approach of aircraft.

Area V. (cont.)

Places appropriate restrictions on approaching aircraft.

Provides for a revision of his approach procedures in case of weather change.

Area VI. When supervising other personnel, the effective controller:

Provides his assistant with correct and complete explanations which they can understand and apply.

Gives assistants the amount and kind of work which they are capable of performing without endangering traffic control.

Adds to the efficiency of center's training program by utilizing available training aids or by devising new ones.

Checks assistant's work and offers assistance whenever necessary to provide safe control.

Demonstrates confidence in his assistants by encouraging them to assume responsibility.

Requests sufficient personnel to handle volume of traffic and assigns assistants where they are most needed.

Area VII. When handling the board, the effective controller:

Keeps board clear of out-dated or unnecessary strips.

Posts slips which can be read by others without further clarification.

Writes legibly on strips.

Familiarizes himself with traffic picture within a few minutes after taking the board over.

Area VIII. The effective controller helps other controllers by:

Pointing out conflictions which he recognizes in other sectors and assisting the other controller if he needs help.

Assisting busier controllers if he can handle his own traffic safely at the same time.

Pointing out methods or procedures to solve other controllers' traffic problems.

Area IX. The effective controller maintains harmonious relations with others by:

Accepting the suggestions and practices of others without questioning them unless practices appear to be dangerous to aircraft.

Area IX. (cont.)

offering tactful criticism so that others are willing to accept it and act upon it.

Enhancing public relations of Air Traffic Control by giving information or assistance to outside agencies.

Explaining the traffic situation or the rationale of control practices to airline or other personnel to their satisfaction without disparaging ATC methods.

Conforming to the regulations of the center without complaining to other personnel.

Accepting the responsibility for his own errors and taking action to correct them.

Completing tasks which he has accepted or been assigned to.

Keeping himself up-to-date on control procedures and regulations.

Being able to obtain the help and cooperation of others when he needs it.

Area X. The effective controller indicates that he has <u>maintained emotional control</u> by:

Continuing to work and cooperate with those who have criticized him.

Accepting and applying the constructive criticism of his superiors.

Continuing at his job without "breaking up" under the stress of heavy traffic conditions.

Working under peak conditions without bothering other personnel with requests for advice and assistance.

Not becoming confused or making further errors in clearances following the discovery of a mistake.

Further Analyses of Data Obtained from the Incidents

In the course of collecting critical incidents, the interviewers obtained data on each incident regarding the watch and hour in which the incident occurred, the month of occurrence of the incident, the type of weather conditions prevailing in the sector of the controller involved in the incident, and the recency of the reported behavior. An analysis of these data provides some interesting additional information about the controller's job.

Controlling air traffic has been called a "fireman's job" Like the fireman who presumably plays poker between fires, some regard the controller's job as an occupation which fluctuates between all-out effort in instrument weather to complete inactivity when Visual Flight Rules apply. That this is an exaggerated statement has already been borne out by the preliminary time analysis of controller activities study[27]; nevertheless there is definite evidence that various activities increase in IFR weather. This is further substantiated by an examination of the number of critical behaviors reported to have occurred during three weather conditions; VFR, IFR, and Marginal or Borderline.

TABLE 5.

CRITICAL BEHAVIORS REPORTED TO HAVE OCCURRED DURING VFR, MARGINAL, AND IFR WEATHER CONDITIONS

Weather	Number of Effective Behaviors	Percent	Number of Ineffective Behaviors	Percent
IFR	441	75.91	462	69.17
Marginal	101	17.38	117	17.51
VFR	20	3.44	57	8.53
Not Specified	19	3.27	32	4.79
Totals	581	100.00	668	100.00

Table 5 shows that by far the largest number of critical behaviors, both effective and ineffective, occurred during IFR weather, with Marginal next, and VFR considerably lower. Apparently the opportunities for critical situations

[27] See Figure 4.

[illegible] greater during instrument weather [illegible] this is probably a function of the increased activity of controllers during such periods.

In the interpretation of Table 6, which indicates the frequency of occurrence of critical behaviors in each of the months of the year, it must be kept in mind that a majority of the interviews were conducted during the month of September and that interviewees were requested to report the most recent incidents that they could recall.

In spite of this, however, some significance can be attached to the fact that relatively large frequencies of report occur during February and March, two months during which air travel is hampered by bad weather. That the highest frequencies appear in September is very likely an indication that the interviewees were complying with the interviewer's request for recent incidents, for very few of the September incidents were for September of the previous year.

The relation between the quality of the critical incidents and the length of the interval between their occurrence and the date they are reported in an interview, has not yet been fully determined. The data presented in Table 7, however, apply to one aspect of this problem.

An examination of the above table reveals that in general the largest portion of incidents falls into the 0-4 months elapsed time interval, with the frequencies becoming progressively lower as the "age" of the incidents increases. However, one column does not conform to the general rule. Column III, the title of which is "Aiding Aircraft in Trouble" shows that more behaviors in this area were reported in incidents from 5-8 months and 9-12 months "old" than were reported in incidents that had occurred from less than one month to four months previous to the interview. This is particularly true of the effective behaviors. The frequency of 63 behaviors occurring from 5-8 months previous to the interview is larger than any other frequency in this category. The same trend is evident in the case of the ineffective behaviors although the numbers involved are quite small. Area III (effective) is characterized by reports of quite dramatic situations in which controllers frequently are responsible for such heroic acts as the prevention of disastrous crashes or other situations where the safety of pilots and aircraft is endangered. It is possible that the data in Table 7 indicate that, as more time elapses between the occurrence and the report of the incident, the content of the incident will tend to become more dramatic.

A comparison of the frequency of occurrence of the effective and ineffective behaviors among the various hours of the three watches (Table 8) seems to show clearly the effect of at least one trend. This is a tendency for ineffective behaviors to occur more frequently than effective near the end of the second and third watch. This is apparently a fatigue effect since it does not occur at the end of the first watch, where there is considerably more inactivity.[28]

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[28] See Figure 3.

TABLE 6.

MONTHS OF THE YEAR IN WHICH CRITICAL BEHAVIORS WERE REPORTED TO HAVE OCCURRED

Month	No. Effective Behaviors	%	No. Ineffective Behaviors	%
Dec.	21	3.61	32	4.79
Jan.	44	7.57	43	6.44
Feb.	66	11.36	58	8.68
Mar.	73	12.56	57	8.53
Apr.	49	8.43	54	8.08
May	44	7.57	46	6.89
June	42	7.23	53	7.93
July	30	5.16	61	9.13
Aug.	51	8.79	65	9.73
*Sept.	97	16.69	94	14.07
Oct.	26	4.49	40	5.99
Nov.	25	[illegible]	[illegible]	3.45
Not Spec.	13	[illegible]	[illegible]	6.29
Totals	581	100.00	668	100.00

*Interviews conducted in September.

TABLE 7.

RECENCY OF INCIDENTS GROUPED BY AREAS OF BEHAVIOR

Distribution of Critical Behaviors Classified by Amount of Elapsed Time Between Date of Report and Date of Actual Occurrence Among the Ten General Areas of Behavior

Effective Behaviors (N = 569*)

Time Interval	Areas of Behavior									
(months)	I	II	III	IV	V	VI	VII	VIII	IX	X
0 - 4	15	34	26	58	22	13	5	27	7	9
5 - 8	12	26	63	37	19	6	3	17	2	12
9 - 12	4	9	48	8	8	6	2	4	0	2
12- 24	2	5	20	7	0	2	0	4	2	2
over 24	1	3	11	0	4	0	0	2	0	0
Totals	34	77	168	110	53	27	10	54	11	25

Ineffective Behaviors (N = 640*)

Time Interval	Areas of Behaviors									
(months)	I	II	III	IV	V	VI	VII	VIII	IX	X
0 - 4	44	29	4	86	29	17	14	3	32	10
5 - 8	21	23	6	61	31	13	8	3	20	9
9 - 12	19	8	2	27	21	7	9	4	20	6
12- 24	3	5	0	8	5	3	0	0	6	4
over 24	5	1	0	2	2	0	2	1	5	2
Totals	92	66	12	184	88	40	33	12	83	31

*Incidents in which times were not specified are not included.

The great preponderance of ineffective over effective during the first hour of the third watch suggests that controllers coming on duty for the third watch may need a longer period of gradual orientation to the traffic situation than is ordinarily used. No apparent causes are hypothesized for the balance of the significant differences. This table should not be interpreted too strictly in terms of exact hours since interviewees were asked the approximate hour of the incident's occurrence and, since 60% of the reported incidents were over 4 months "old", the likelihood of exact recall is reduced. There is also the possibility that the bunching of incidents at 1000 and 2000 hours (3rd hour Watch 2 and 5th hour Watch 3) is due to a tendency on the part of the interviewees to arbitrarily choose these figures when asked the approximate hour - perhaps because our numerical system is based on multiples of 10.

TABLE 8.

COMPARISON OF PERCENTAGES OF TOTAL EFFECTIVE AND INEFFECTIVE BEHAVIORS* REPORTED TO HAVE OCCURRED AT VARIOUS HOURS OF THE THREE WATCHES

Watch 1 (0000 - 0800)

Hour	(-) Percent Ineffective	(+) Percent Effective	Difference	t-ratio ϕ
1	1.62	1.25	-.37	1.619
2	.48	.36	-.12	.834
3	1.46	3.03	1.57	3.607
4	.16	1.43	1.27	3.320
5	1.13	.71	-.42	1.692
6	.32	.89	.57	2.279
7	.16	.18	.02	.188
8	.81	1.25	.44	1.602

TABLE 8 - continued

Hour	Percent Ineffective	Percent Effective	Difference	t-ratio ϕ
Watch 2 (0800 - 1600)				
1	2.27	1.96	-.31	.853
2	4.21	4.64	.43	.818
3	8.74	9.99	1.25	1.673
4	6.15	6.60	.45	.723
5	5.34	3.75	-1.59	2.988
6	4.21	6.42	2.21	3.655
7	12.30	9.99	-2.31	2.905
8	11.16	6.42	-4.74	6.410
Watch 3 (1600 - 2400)				
1	8.90	2.14	-6.76	9.125
2	2.91	4.46	1.55	3.041
3	4.21	4.46	.25	.482
4	2.91	3.57	.66	1.438
5	5.82	7.13	1.31	2.056
6	3.72	3.74	.02	.042
7	6.15	4.64	-1.51	2.647
8	2.27	1.07	-1.20	3.394

* Effective N = 561, Ineffective N = 618 (Does not include behaviors in which the hour of the watch in which the incident occurred was not specified.)

ϕ t's reported are for the differences between correlated percentages - underlined t's are significant at the 5% or 1% level.

It may be more easily seen from Table 9 that the largest number of incidents, both effective and ineffective, occur in the second watch, with the third next and the first having the lowest frequency of report.

TABLE 9.

PERCENTAGE OF 616 INEFFECTIVE AND 561 EFFECTIVE BEHAVIORS OCCURRING ALONG THE THREE WATCHES*

Watch	No. Effective	Percent	No. Ineffective	Percent
1	52	9.27	38	6.17
2	319	56.86	342	55.52
3	190	33.87	236	38.31
Total	561	100.00	616	100.00

* Behaviors not specifying the watch in which they occurred are not included.

Development of a Measure of Proficiency

The fundamental purpose of evaluation procedures based on job analysis data of the type described in this report is to indicate the extent to which individuals meet the critical requirements of their jobs. Once the critical requirements were determined, the construction of an evaluation procedure became essentially a problem of organizing the analyses of the 1249 critical incidents in such a way as to facilitate the writing of items to cover all the critical behaviors. Regardless of the form that the critical requirements would eventually take in the proficiency measure, it was planned in advance that the procedure would consist of two sections: (1) a booklet composed of items which would consist of descriptions of effective and ineffective ways of meeting the critical requirements; and (2) a report form upon which to summarize the observations made throughout the rating period and by means of which an over-all proficiency score could be determined.

The actual evaluation items were evolved in the following manner: After all the specific critical behaviors had been listed, effective and ineffective statements were matched. If no opposite was found for a behavior and the frequency of report of that particular behavior was high enough to justify such action, an opposite was composed for it. After the items were matched, they were reworded in order to produce statements which were at once short and yet which included all the information necessary to convey the essential elements of effectiveness of ineffectiveness indicated in the original incidents.

Experimental Types

After the specific statements had been decided upon, it was then necessary to devise a usable form for presenting the items. Four different types of evaluation procedures were drawn up including the same statements used in different ways. The first type was a three point scale which contained statements corresponding in general to effective, ineffective, and "adequate" ways of performing. Actually, the two ends of this continuum of ways of performing on the job were superlatives. "Effective" included those behaviors which were outstandingly so, and "ineffective" involved actions which were so poor that they often resulted in the dismissal or transfer of the controller committing them. "Adequate" means that the controller had achieved a point midway between these two extremes; that he had met a standard of satisfactory performance. A similar type of scale was also considered, using five steps, with intermediate points between effective and adequate and between ineffective and adequate. Neither of these scales was used and the same objections applied to both.

Data were available from the study concerning specific ineffective and effective behaviors and the most valuable type of evaluation scale would probably include most of them in statements which would allow raters to recognize the behaviors without much interpretation. If the 3 or 5-point scales were used, and an attempt were made to include all of the data found in the study, the evaluation procedure would be of unusable length. If the statements were made more general in an attempt to include several effective or ineffective behaviors, the raters would be forced to interpret the statements and unnecessary subjectivity would be introduced. Although ratings of workers by supervisors inevitably involve judgments on the part of the rater, it is most desirable to provide rating officials with data upon which to make judgments that are as objective as possible.

A two point scale was also considered, in which the extremes of effective and ineffective behavior were listed and it was left up to the judgment of the observer as to whether or not the controller performed in accordance with one of these or whether he met an unspecified middle or "adequate" point on the scale. This type had the same disadvantages as the 3 and 5-point scales although in lesser degree, since only two statements would have to be presented for each behavior to be described. A considerable element of subjectivity would still be present since the decision as to what constitutes the middle point would be a matter of individual choice for each rater.

All of the scales using degrees of effective and ineffective performance necessitate presenting all types of performance in the same way, whether or not the particular behaviors fall into that kind of a continuum. Some tasks are either performed or they are not performed and a three or five point scale is useless to express this kind of item. For example, clearance information is presumably complete or not complete, and, if a controller is observed to issue an incomplete clearance and is therefore judged to be ineffective, would the middle point or satisfactory performance be a situation in which he issues partially complete clearances? Obviously not, for although "partial incompleteness" of information may result in less hazard to air traffic than complete lack of clearance information, it would no doubt still not be considered satisfactory performance. Furthermore, there are

also situations in which the opposite end of an ineffective act does not necessarily imply outstandingly effective performance. Should a controller, in assigning an altitude to a departing aircraft, climb him through the altitude of over-traffic, the resultant confliction would brand his behavior as ineffective. The logical opposite of this behavior would be that the controller assigned an altitude to the aircraft such that sufficient separation from other traffic was maintained. It seems doubtful, however, whether this statement is illustrative of really outstanding performance. On the contrary, it appears to be what is expected of him; i.e., the standard of acceptable performance. This same problem was encountered in the construction of the form finally chosen, but a way of surmounting the difficulty was devised.

Development of a Check List of Critical Requirements

The method chosen for presenting the critical requirements of the controller's job was the one which appeared to have the most advantages and the fewest difficulties. A check list was decided upon which would include all the statements of behaviors which had been reported to have made the difference between effective and ineffective control. These statements were sufficiently general to include all the behaviors, yet specific enough to be readily recognized. The observation form, or check list, followed the same outline as did the summary of critical requirements presented earlier in the report, except that sub-category headings are also included. Statements of effective and ineffective behavior were written that covered the data from the original incidents under the same headings and sub-categories as used in the final analysis of incidents.

The tentative form which follows on later pages consists of the 10 main job areas with their 47 sub-categories and a total of 313 separate items distributed among them. Although this number of items may appear to be discouragingly large, it will be possible to produce the check list in printed form in a booklet very few pages in length. The advantages of this system include the possibility of using all the specific statements of behavior without having a burdensome scale. The only demand made upon the judgment of the rater is that he choose that behavior from among those listed that most nearly approximates the action of the controller whom he observed.

The difficulty mentioned previously regarding the occasional appearance of an effective behavior which seems to be of a less outstanding degree of effectiveness than others may be overcome by underlining those items in the check list that are truly indicative of outstanding effectiveness and weighting them more heavily in the final scoring. The others may be considered to represent satisfactory performance on the job. None of the behavioral descriptions have been underlined in the tentative form attached to this report. The relative importance of the particular behaviors is believed to be a matter which can better be decided by controllers and their supervisors during the field tryouts of the form which will follow in subsequent phases of this study. The construction of a summary sheet from which to calculate an over-all proficiency score must also wait upon this additional research which will be under way early in January, 1949.

Introductory materials for the check list, in the form of instructions for its use, will cover the following points:

1. A brief explanation of the methods by which the form was devised.
2. An explanation of the need for frequent observations.
3. A request to the rater to become familiar with the entire booklet before attempting to record observations.
4. A definition of effective, ineffective, and satisfactory performance.
5. An explanation of the steps in recording, with an example included
   a. The differences between the first 7 and the last 3 main job areas.
   b. How to find the proper category under which to record.
6. An explanation of the scoring process.

The tentative form of the check list follows:

A CHECK LIST OF CRITICAL REQUIREMENTS
for the
EVALUATION OF AIR ROUTE TRAFFIC CONTROLLERS

I. ISSUING DEPARTURE CLEARANCES

A. Assigning Altitudes

____ 1. Assigned an altitude occupied by other a/c.	____ 1. Provided standard separation requirements.
____ 2. Failed to assign altitudes in order of request.	____ 2. Assigned altitudes in order of request.
____ 3. Ignored a/c type and limitations in his clearances.	____ 3. Assigned altitudes appropriate to a/c type and limitations
____ 4. Used high or low altitudes when others were available.	____ 4. Utilized all available altitudes.
____ 5. Assigned below minimum altitude.	____ 5. Devised a new procedure to gain additional altitudes.
____ 6. Ignored proposed flight plans in his clearances.	
_____	_____

B. Assigning Climbing Courses

____ 1. Assigned a course resulting in a confliction.	____ 1. Provided standard separation requirements.
____ 2. Failed to use all available climb-out procedures.	____ 2. Utilized all available climb-out procedures.
____ 3. Failed to issue the simplest climb-out instructions.	____ 3. Devised a new procedure to facilitate climb-out.
____ 4. Issued incomplete climbout instructions.	
____ 5. Assigned courses too late to prevent delay.	
_____	_____

C. Arranging the Takeoff Sequence

____ 1. Ignored the differences in speed between a/c in his clearance.	____ 1. Cleared fast a/c off before slow.
____ 2. Failed to make arrangements for a takeoff sequence of a mass flight.	____ 2. Utilized a single procedure to clear a mass flight.
_____	_____

D. Estimating or Preventing Takeoff Delays

____ 1. Ignored relevant information when issuing a clearance.	____ 1. Obtained all pertinent information for accelerating departures.
____ 2. Did not use all available routes.	
____ 3. Delayed issuing departure clearances.	____ 2. Used all available routes.
____ 4. Scheduled delay time in the air.	

D. (Continued)

____ 5. Blocked departures with arrivals and over traffic.	____ 3. Had clearances ready on request.
____ 6. Used a hazardous short-cut method.	____ 4. Scheduled delay time on the ground.
____ 7. Declared an emergency when none existed.	____ 5. Prevented arrivals from blocking departures.
	____ 6. Devised a new procedure which prevented delays.
	____ 7. Advised those involved of schedules.

II. REVISING FLIGHT PLANS AND CLEARANCES

A. Changing VFR-IFR Flight Plans

____ 1. Used VFR flight instead of providing standard separation requirements.	____ 1. Provided standard separation requirements.
____ 2. Utilized VFR flight in IFR weather.	____ 2. Kept traffic in continuous flight.
____ 3. Failed to advise pilot of change in flight plan.	

B. Changing Destinations

____ 1. Failed to provide standard separation requirements.	____ 1. Provided standard separation requirements.
____ 2. Changed destination without apparent reason.	____ 2. Recommended changes to avert hazards.
	____ 3. Anticipated changes and issued them on request.

C. Changing Altitudes

____ 1. Failed to use altitude changes to provide standard separation requirements.	____ 1. Provided standard separation requirements on receiving requests.
____ 2. Failed to provide standard separation requirements after need had been pointed out.	____ 2. Anticipated the need for changing altitudes.
____ 3. Issued irrelevant instructions.	____ 3. Applied only those restrictions which were relevant.
____ 4. Used an altitude previously vacated because of hazards.	____ 4. Assigned altitude suitable to type a/c.
____ 5. Sent one a/c through altitude of another without providing standard separation requirement.	

C. (continued)

_____ 6. Utilized an already filled altitude
_____ 7. Failed to give specific instructions.

D. Changing Courses and Routes

_____ 1. Failed to use alternate routes to provide standard separation requirements.
_____ 2. Delayed a/c instead of using available alternate routes.
_____ 3. Changed course of a/c to intersect course of another.

_____ 1. Changed courses to provide needed standard separation requirements.
_____ 2. Utilized alternate routes to avoid delays.
_____ 3. Utilized alternate routes to avoid hazards.
_____ 4. Anticipated the necessity of changing routes to

E. Changing Time Schedules

_____ 1. Failed to provide standard time separation when needed.

_____ 1. Provided standard time separation requirements.
_____ 2. Utilized change to avoid delays.

III. AIDING AIRCRAFT IN TROUBLE

A. Clearing Airspace for Emergency Descents

_____ 1. Failed to descend a/c upon request.
_____ 2. Failed to provide standard separation requirements.
_____ 3. Failed to prevent a/c from entering hazardous area.

_____ 1. Acted in sufficient time for safety of a/c.
_____ 2. Provided standard separation requirements during descent.
_____ 3. Anticipated necessity for clearing airspace.
_____ 4. Did not penalize other traffic.
_____ 5. Selected appropriate altitude for relieving emergency condition.

B. Locating Lost Aircraft

_____ 1. Failed to use all available means for locating a/c.

_____ 1. Used all standard means of locating a/c.

B. (continued)

____2. Suggested an impracticable and irregular method for locating a/c.	____2. Devised an original method for locating a/c.
____3. Failed to check location of a/c which had been lost.	____3. Continued search when it was no longer his responsibility

C. Orienting Lost Pilots

____1. Failed to put a/c in contact with direction finding agencies.	____1. Put a/c in contact with direction finding agencies.
____2. Failed to exhaust all standard means for orienting a lost pilot.	____2. Obtained information leading to location and orientation of a/c.
	____3. Continued the search after other agencies stopped.

D. Organizing Rescue Facilities

____1. Failed to alert rescue facilities in time for safety of a/c.	____1. Alerted rescue facilities on request.
	____2. Anticipated the need for rescue facilities.
	____3. Instituted his own rescue procedure.
	____4. Prevented duplication of rescue facilities.
	____5. Alerted sufficient facilities to cover the area.

E. Clearing Airspace for Lost Aircraft

____1. Sent a/c into same area as a lost a/c.	____1. Cleared all a/c out of area.
	____2. Cleared area into which a/c might go.
	____3. Notified pilot of clear airspace.

F. Contacting Aircraft with Radio Failure

____1. Delayed issuing information to a/c by blind broadcast.	____1. Anticipated a radio failure and prepared to use emergency methods.
____2. Failed to exhaust all means of contacting a/c.	____2. Utilized all radio facilities in area to establish contact.

F. (continued)

	____3. Utilized inter plane communication facilities.

G. Providing Alternate Bases

____1. Failed to provide an alternate when requested.	____1. Provided several alternates.
____2. Provided an alternate out of fuel range of a/c.	____2. Provided alternate within fuel range.
____3. Made no arrangements for providing alternates.	____3. Provided alternate suitable to a/c.
	____4. Prepared to handle requests for alternates in advance.
	____5. Provided alternate for a/c no longer his responsibility.

H. Providing for Emergency Landings

____1. Failed to make any arrangements for an emergency landing.	____1. Organized personnel and equipment at emergency base.
	____2. Issued complete instructions to pilot.
	____3. Arranged an escort for the approach.
	____4. Utilized all possible approach courses.

IV. COORDINATING WITH OTHER AGENCIES

A. Utilizing Communication Facilities

____1. Made individual calls instead of conferencing.	____1. Conferenced calls to ease interphone congestion.
	____2. Relayed information through other agencies.
	____3. Arranged to send information through seldom used communication channels.

B. Coordinating Inter-Sector Traffic

____1. Sent a/c from his sector at altitudes most convenient to himself.	____1. Arranged traffic to suit the pattern in other sectors.
____2. Recommended a revision of flight plans in another sector without a reason.	

B. (Continued)

____ 3. Would accept a/c from other areas only at altitudes convenient to him.	
____ 4. Failed to provide standard separation minimum for inter-sector traffic.	____ 2. Provided standard separation requirements for inter-sector traffic.
____ 5. Failed to use all the altitudes available for inter-sector traffic.	____ 3. Used all altitudes available for inter-sector traffic.
____ 6. Failed to restrict the use of altitudes by other centers.	____ 4. Restricted traffic from entering congested sector.
____ 7. Disregarded another controller's disapproval of a clearance.	____ 5. Kept altitudes open for inter-sector traffic.
____ 8. Failed to check with other controllers when sending a/c from his sector.	

C. Issuing or Requesting Pertinent Information

____ 1. Neglected to ask for essential information.	____ 1. Issued or requested information essential to the safety of the a/c.
____ 2. Issued or requested information at times inconvenient to others.	____ 2. Issued or requested essential information without bothering others.
____ 3. Issued or requested superfluous information.	____ 3. Issued or requested only essential information.
____ 4. Failed to issue expected approach or delay times.	____ 4. Issued expected approach or delay times.
____ 5. Failed to inform others of change in plans.	
____ 6. Failed to advise another controller of intersector traffic.	
____ 7. Argued control procedures on interphone.	
____ 8. Failed to explain clearance cancellation.	

D. Issuing or Requesting Information Promptly

____ 1. Delayed answering clearance requests or accepting information while performing routine tasks.	____ 1. Answered the interphone upon receipt of signal.
____ 2. Waited for requests before delivering flight plans.	____ 2. Anticipated necessity for issuing or obtaining information.
____ 3. Failed to stand by when requesting information.	____ 3. Avoided callbacks by standing by when obtaining information.

(continued)

____ 4. Failed to answer a request for a clearance.	____ 4. Issued or requested information in sufficient time to take action.
____ 5. Hesitated and made many amendments when issuing information.	
____ 6. Failed to repeat information as requested.	
____ 7. Delayed assigning available altitudes to other sectors.	

E. Issuing Traffic Advisories

____ 1. Failed to prevent hazards by issuing advisory information.	____ 1. Advised a/c in advance to avoid hazardous area.
____ 2. Refused to issue requested advisory information.	____ 2. Issued advisory to a/c not his responsibility.

F. Issuing and Requesting Accurate Information

____ 1. Issued or accepted incorrect information with subsequent callbacks or conflictions.	____ 1. Issued or obtained accurate information which did not need callbacks, revisions or repeats.
____ 2. Issued or obtained incomplete information with subsequent callbacks or conflictions.	____ 2. Issued or obtained complete information which did not need callbacks, revisions or repeats.
____ 3. Revised a clearance without cancelling the original.	
____ 4. Based his clearances on inaccurate data.	

G. Speaking Intelligibly

____ 1. Failed to use standard phraseology.	____ 1. Conformed to standard phraseology.
____ 2. Spoke so rapidly that repeats were necessary.	____ 2. Spoke at a rate which enabled communicator to copy information.
____ 3. Failed to enunciate clearly and made repeats necessary.	____ 3. Enunciated clearly making repeats unnecessary.

H. Reducing Interphone Contacts

____ 1. Made several calls where only one was needed.	____ 1. Handled several transactions during one call.

I. Briefing His Successor at the Board

____ 1. Failed to give his successor complete information.	____ 1 Advised his successor of all information pertinent to traffic.
____ 2. Failed to complete a particular operation before turning board over.	____ 2. Prepared all information needed to handle flights on successive watch.

V. PLANNING APPROACH PROCEDURES

A. Arranging Holding and Stacking Patterns

____ 1. Prevented approaches from using holding points by holding other traffic.	____ 1 Facilitated approaches and departures by method of stacking.
____ 2. Held a/c when he could have kept them in flight.	____ 2. Devised a makeshift holding point to expedite traffic.
____ 3. Failed to provide standard separation requirements for a/c in stack.	____ 3. Provided standard separation requirements for a/c in stack.
____ 4. Ignored special limitations of a/c when stacking.	
____ 5. Used holding as a punishment.	
____ 6. Made no provision for stacking if the weather closed in.	
____ 7. Utilized a prohibited holding point.	

B. Organizing Approach Sequences

____ 1. Failed to sequence a/c in order of arrival.	____ 1. Sequenced a/c according to order of arrival.
____ 2. Blocked approach courses with over traffic.	____ 2. Kept over traffic away from approach courses.
____ 3. Failed to give preference to a/c with low fuel supply.	____ 3. Gave preference to a/c low on fuel.
____ 4. Failed to provide standard separation requirements.	____ 4. Provided standard separation requirements.
____ 5. Gave indefinite instructions concerning use of approach courses.	____ 5. Carefully allocated approach courses to heavy traffic.
____ 6. Lowered approaching a/c before courses were open.	____ 6. Approached a/c at low altitudes.
____ 7. Made no provision for standard separation requirements in case of weather change.	____ 7. Sequenced approaches and handled an emergency simultaneously.

C. Releasing Aircraft to Approach Control

____ 1. Failed to provide standard separation requirements	____ 1. Provided standard separation requirements.

C. (continued)

____ 2. Released a/c to tower before a/c reached legal limit.	____ 2. Improved communication with a/c by releasing it to tower sooner than usual.
____ 3. Released a/c to tower at high altitudes when lower altitudes were available.	

D. Determining the Saturation Point

____ 1. Failed to restrict traffic from entering a congested area.	____ 1. Restricted traffic from entering a congested area.
	____ 2. Anticipated congestion and restricted traffic.

E. Estimating and Preventing Delay Time in Approaches

____ 1. Failed to obtain accurate approach times.	____ 1. Issued approach times in advance of approaches.
____ 2. Used an involved approach when simpler ones were possible.	____ 2. Utilized a VFR approach to avoid delayed IFR approach.
____ 3. Failed to utilize all available altitudes.	____ 3. Utilized all available approach courses.
____ 4. Blocked low altitudes with other traffic.	____ 4. Kept approach courses free of over traffic.
____ 5. Failed to provide standard separation requirements until a/c were on same course.	____ 5. Held a/c until needed altitudes were available.
____ 6. Allowed a/c to enter his sector in random order.	____ 6. Conferenced all personnel involved in a complex approach pattern.
____ 7. Placed irrelevant restrictions on a/c.	____ 7. Suggested alternates to a/c unable to take delay time.

VI. SUPERVISING PERSONNEL

A. Training Assistants

____ 1. Explained a procedure incorrectly.	____ 1. Provided a definite explanation of a procedure which assistant could understand.
____ 2. Gave an incomplete explanation of a procedure.	____ 2. Provided several solutions to a control problem.
____ 3. Refused to explain a control problem.	____ 3. Voluntarily revised a training aid.
____ 4. Neglected to give any instructions to an assistant.	____ 4. Noted and corrected an assistant's error.
____ 5. Did not apply a training aid as instructed.	
____ 6. Made a derogatory remark about the center's training program.	
____ 7. Failed to find an assistants error.	

B. Delegating Responsibility to Assistants

____ 1. Assigned an assistant to handle more work than he could.	____ 1. Encouraged his assistant to assume responsibility.
____ 2. Rejected the suggestions of his assistant.	____ 2. Offered help to assistant without "taking over".
____ 3. Did not supervise an assistant who was handling the board.	
____ 4. Refused to help a busy assistant.	

C. Allocating Personnel

____ 1. Failed to request aid when it was impossible to handle traffic without it.	____ 1. Asked for assistance with congested sector.
____ 2. Failed to anticipate personnel needs in advance of watch.	____ 2. Utilized assistants where they were needed.
	____ 3. Assigned personnel to tasks they were able to perform.

VII. HANDLING THE BOARD

A. Removing Void Strips

____ 1. Failed to remove strips from board after completion of flight.	____ 1. Kept only those strips needed for current flights.

B. Posting Complete and Accurate Data

____ 1. Posted information which others were unable to read.	____ 1. Posted information so that others could use it without requesting clarification.
____ 2. Failed to post all required traffic information.	____ 2. Posted all required information.
____ 3. Failed to post all required traffic information for his successor.	____ 3. Posted all required information for successor.
____ 4. Posted information on wrong strips.	
____ 5. Posted incorrect information.	

C. Organizing the Board Quickly

____ 1. Posted flights so slowly that others were inconvenienced.	____ 1. Familiarized himself with the board within a few minutes after taking over.

VIII. HELPING OTHER CONTROLLERS

A. Recognizing Conflictions in Other Sectors

____ 1. Failed to avert a confliction which he noticed in an adjacent sector.	____ 1. Pointed out a confliction to another controller. ____ 2. Volunteered to assist another controller with a confliction. ____ 3. Provided standard separation requirements for conflicting a/c in another sector.

B. Assuming another Controller's Responsibilities.

____ 1. Refused to assist an overworked controller. ____ 2. Neglected to do part of the work he offered to do.	____ 1. Took over some of a busy controller's work when he was not busy. ____ 2. Although busy himself, volunteered to take over part of another's work.

C. Helping in the Solution of Others' Problems

____ 1. Refused a request for advice.	____ 1. Pointed out the solution to another's problem. ____ 2. Pointed out procedures for avoiding other problems in the future. ____ 3. Corrected the misconceptions of others concerning control procedures.

IX. MAINTAINING HARMONIOUS RELATIONS WITH OTHERS

A. Demonstrating Confidence in Others

____ 1. Changed procedures instituted by another without reasonable cause. ____ 2. Ignored the suggestions of others. ____ 3. Checked up on the control procedures of others for no apparent reason. ____ 4. Rudely refused to accept the suggestions of others.	____ 1. Accepted the suggestions of others.

[illegible] others

_____ [illegible] [illegible]

_____ 1. Corrected errors so that others accepted criticism.
_____ 2. Allowed others to correct their own mistakes after they were pointed out.

C. Maintaining Good Public Relations

_____ 1. Was rude to airlines personnel.
_____ 2. Reprimanded airlines personnel.
_____ 3. Refused to give information or help to an outside agency.
_____ 4. Was criticized by airlines for failure to issue information.
_____ 5. Ridiculed center to airlines.

_____ 1. Diplomatically explained a traffic situation to airlines personnel.
_____ 2. Assisted in a situation unrelated to controlling activities.
_____ 3. Received a commendation from an outside agency for help which he had given them.

D. Accepting Responsibility

_____ 1. Ridiculed procedures and practices of the center.
_____ 2. Attempted to evade responsibility for a confliction by falsification.
_____ 3. Refused to conform to center regulations.
_____ 4. Refused to correct an error he had made.
_____ 5. Failed to get complete information before presenting findings of investigation.
_____ 6. Failed to keep himself up-to-date on control procedures.
_____ 7. Delayed performing a task and left it for another to do.
_____ 8. Left the board without informing anyone.
_____ 9. Refused to cooperate with other controllers.
_____ 10. Took sick leave when not ill.

_____ 1. Upheld procedures and practices of the center to others.
_____ 2. Accepted responsibility for his errors.
_____ 3. Remained overtime to complete a piece of work.

B. Obtaining Cooperation from Others

____ 1. Failed to get cooperation from others because he demanded it.	____ 1. Asked for help in such a way that others cooperated willingly.

I. MAINTAINING EMOTIONAL CONTROL

A. Accepting Criticism

____ 1. "Told off" person offering criticism.	____ 1. Accepted a just criticism without comment.
____ 2. Refused to cooperate after being criticized.	____ 2. Made an effort to correct error for which he had been criticized.
____ 3. Blamed someone else for his errors.	

B. Maintaining Composure under Stress

____ 1. Was unable to use control procedures under pressure of heavy workload.	____ 1. Did not become confused under pressure of heavy workload.
____ 2. Annoyed other workers by continually requesting help in an emergency.	____ 2. Worked entire shift under peak conditions without becoming flustered.
____ 3. Became physically ill during period of heavy traffic because he could not control traffic.	____ 3. Prepared for an emergency without becoming excited.
____ 4. Was unable to continue controlling traffic safely after making a mistake.	____ 4. Did not become disorganized after discovering an error he had made.

The Examination of Records

The logical first step in a program of research directed towards the development of measures of proficiency for air route traffic controllers was to examine the existing measures of proficiency available in Civil Aeronautics Administration files. Civil Service efficiency ratings, training examination scores, performance ratings, certification and area rating examination scores, years of controller experience, hours of flying time, and File Thirteen data were all considered as potential criteria of proficiency or as the components of composite criteria. The examination of Civil Service ratings revealed that they fail to discriminate adequately among employees and there were indications of the presence of halo effect in their use. In general, records were too incomplete or procedures not used uniformly enough to provide sufficient numbers of the other types of data upon which to apply statistical tests which would reveal significant trends or produce conclusive findings.

The Choice of Method of Job Analysis

In order to achieve the purposes of this research, it was then necessary to select a method for the analysis of the job under study. During the course of the survey of available methods, three general approaches to job analyses were considered. These were:

(1) Analyses of the worker on the job
(2) Analyses of the job requirements
(3) Analyses of the worker requirements

Since the principal objective of the research was to devise a procedure for evaluating the proficiency of air route traffic controllers, a technique was chosen that would provide data most readily adaptable to the construction of such measures. The method chosen was the critical requirement approach to job analysis which, it was felt, would satisfy the needs of the project because: (1) its end product is a statement of the abilities, characteristics and skills that are critical to success in the activity; and (2) these requirements are stated in behavioral terms.

The Analysis of Controller Activities

Before the critical requirement study was started, an activity analysis of the controller's job was undertaken as an exploratory first step to determine the usefulness of such a technique as an indicator of the relative importance of the various job components in terms of the time devoted to them. Observations were made of the activities of controllers during three watches at two centers. A total of 7397 such observations were made at 15-second intervals. Some interesting results were obtained that might have real significance for the job if the study were carried

out on a larger sample of centers. Watch 2 (0800-1600) appears to be the busiest period and, as is to be expected, controllers have less time for scanning the board and talking with their associates in IFR than in VFR weather. The amount of time spent on the interphone (the task which occupies most of the controller's time regardless of watch or weather) also increases in Watch 2 and in IFR weather. Indications of the operation of fatigue were also present in the data. It was concluded that although the activity analysis provided a picture of observable job components and served to give the investigators a better understanding of the job, other job analysis methods would better serve the primary purpose of the present project.

The Critical Requirement Study

The critical requirements of the job were determined by applying a method known as the critical incident technique. Aeronautical specialists of the Civil Aeronautics Administration were assigned to the American Institute for Research to act as interviewers and covered a substantial portion of the control towers, centers, and communications stations throughout the continental United States during the collection of incidents. These incidents were reports (by individuals in the best position to observe) of the specific behaviors of controllers in particular situations that were responsible for their having been considered especially effective or ineffective at the job. Each individual behavior was then classified under the job area in which it had occurred. Ten such categories evolved in the course of the analysis along with 47 sub-headings. Critical requirements were then formulated to cover the combined groups of behavior that were listed under the categories - one critical requirement for each set of matched effective and ineffective behaviors. The critical requirements were behavioral statements of what controllers had been observed to do on the job that made for excellent or failing performance.

Further Analyses of Incident Data

During the collection of incidents, data were obtained in addition to the descriptions of behavior. The highest frequency of report of critical behaviors was found to occur during the winter months and during IFR weather. Some indications were discovered that pointed to the possibility that the frequency of incidents in the "Aiding Aircraft in Trouble" area may have been increased beyond its true importance due to a tendency of interviewees to recall these spectacular events more readily. Corroborating the findings in the activity analysis, Watch 2 showed the highest frequency of report of incidents, and the first and last hours of the 3 watches (with the exception of the first hour of the second watch) were ones in which critical situations frequently arise.

The Development of a Measure of Proficiency

The development of a procedure for evaluating the proficiency of air route traffic controllers became a task of arranging statements of the critical behaviors in such a way that an observer could determine the extent to which controllers met the critical requirements of the job. Several ways of presenting the critical behaviors were tried and the method offering the fewest difficulties and the most advantages was chosen. The same framework of 10 main and 47 sub-categories that had been used in the analysis of the incidents was utilized as the foundation around which 313 specific check items were assembled. The items consist of statements of critical behaviors, effective and ineffective, stated with a degree of specificity that would enable the observer to easily recognize them and yet stated generally enough to encompass all the behaviors classified under their respective headings. Effective and ineffective behaviors are listed side by side. A tentative form of "The Check List of Critical Requirements for the Evaluation of Air Route Traffic Controllers" is included in the report. The rating process is planned as follows: Observations of controllers by rating officials will be made throughout the rating period and when critical behaviors are noted they will be indicated by a symbol on the appropriate item of the check list. For example, should a rater observe a controller clear a departing aircraft to climb through the altitude of over-traffic without providing the minimum separation requirements, he will first determine that job area in which the behavior occurred. In this case, it would be "Issuing Departure Clearances." A finer breakdown of this job area will reveal a sub-category named "Assigning Climbing Courses," under which the specific item will be found. An additional form will be provided during a supplementary phase of this research to be conducted in the near future. This will be a one-page form upon which the observations of the check list can be summarized and an over-all proficiency score calculated. It is also planned, in this second phase of the project, to determine, with the help of controllers and supervisory personnel, which effective statements indicate outstanding performance and which are indicative of satisfactory performance on the job. These degrees of effectiveness will be taken into account by assigning additional weight to the statements of outstanding job performance.

Recommendations

Once the critical requirements of an activity are determined, they have other uses than to form a basis on which to construct evaluation procedure. The areas of training and selection may be improved through a knowledge of the critical requirements. But the construction of an evaluation procedure is a necessary first step, for it provides the criterion against which new measures in these areas may be validated, or the effect of the institution of new procedures or changes can be determined. To be of value, the procedure must be proved practical for adoption and use. The extent to which different raters agree in their evaluation of an individual controller's proficiency must also be

determined. Similarly, tests must be applied to the procedure to reveal the extent to which it measures consistently. An evaluation procedure upon which many individuals score very high at the end of one rating period and then drop to the bottom of the scale on the next, can be presumed to have considerable intrinsic fault.

It is recommended, therefore, that a field tryout and reliability study be conducted on the tentative evaluation procedure developed during this project.

Studies of the type of the activity analysis reported here should be carried out on a more extensive sample of centers and weather conditions. Data from such studies can be applied to the solving of important problems of equipment design and controller workplace as well as other planning and policy problems.

Finally, so that other jobs in air traffic control may keep pace with the expected improvements in air route traffic control personnel procedures, similar studies are recommended for them.

APPENDIX A

LETTER OF AUTHORIZATION

DEPARTMENT OF COMMERCE
CIVIL AERONAUTICS ADMINISTRATION
WASHINGTON

(COPY)

TO : All Regional Administrators

FROM : Assistant Administrator for Federal Airways

SUBJECT : Research Program on Airways Operations Service

REFERENCE: A-170 Letter Dated February 5, 1948

The purpose of this letter is to describe the continuation of an important research project in Air Traffic Control and to indicate the types of co-operation desired of Air Traffic Control and Communication centers visited by research personnel. The immediate purpose of this phase of the research is to collect data which will act as a starting point for subsequent research aimed at the improvement of equipment, investigation of fatigue, improvement of working conditions, etc. The first step in the project is to develop reliable proficiency measures in the field of Air Route Traffic Control or an attempt to answer the question, "What constitutes efficient controlling?" Additional research in the fields of Airport Traffic Control and Communications is contemplated in the near future.

The American Institute for Research, a non-profit scientific research organization, is conducting the study under the sponsorship of the Committee on Aviation Psychology of the National Research Council with funds provided by the Civil Aeronautics Administration. We are unable to determine at this time which Centers, Towers and Stations will be visited by personnel from the American Institute for Research, however, they will identify themselves by presenting a copy of this letter. When the representatives of the American Institute for Research visit the Centers, Towers or Communication Stations for purposes of collecting data or for the experimental tryout of various procedures, they will do so with no idea in mind of using any data obtained for evaluating the proficiency of specific controllers. Individuals are assured of complete anonymity.

Centers, Towers and Communications Stations visited by these research personnel are requested to cooperate on this research project by:

1. Authorizing Center, Tower and Communications personnel to meet with research personnel in conferences.

2. Making facilities available to conduct interviews with Center, Tower and Communication personnel.

3. Giving American Institute for Research personnel authorization for access to all operating records or to take records of operations at the installations.

To: All Regional Administrators

4. Providing such other reasonable assistance as will facilitate the project.

Your cooperation in the carrying out of the research program will be greatly appreciated. It is requested that you advise all Centers, Towers and Stations in your region concerning the contents of this letter.

/s/ W. E. Kline

W E. Kline - A-40

APPENDIX B

TASK LIST OF CONTROLLER ACTIVITIES

July 23, 1948

CONTROLLER TASK LIST

I. Manual Activities

A. Sequences flight strips
B. Removes strip holders and drops them into chute
C. Writes changes or makes additions on strips
D. Manipulates interphone switches
E. Writes estimates received from centers on pad
F. Eats
G. Picks up and lays down interphone
H. Makes out daily activity log
I. Makes out irregularity report
J. Rests

II. Interphone Activities

A. Makes calls

1. Calls other centers to:

   a. request destinations
   b. inform of altitude changes or other corrections in estimates
   c. gives estimates of planes entering other control areas
   d. check interphone reception
   e. verify control data, estimates, destinations, routes, etc.
   f. request information regarding lost or overdue aircraft
   g. request approval on flights entering other control areas prior to departure from this airport

2. Calls towers (local or distant) to:

   a. issue clearances to departing aircraft
   b. advise of clearances of aircraft
   c. turn aircraft over to approach control
   d. revise estimates
   e. transmit pilot reports

3. Calls communications stations to:

   a. assign altitudes to aircraft (or changes in altitude)
   b. request position report of aircraft over check point
   c. request report of weather conditions from aircraft
   d. verify pilot reports on ETA, destination, etc.
   e. request aircraft to hold, change course, etc.
   f. relay calls to centers

g. issue weather advisory information
h. issue traffic advisory information
i. report condition of operation of navigational facilities

4. Calls weather bureau to:

a. relay cloud and weather information
b. request cloud and weather information

5. Calls military communications to:

a. request relay of control information if CAA communications unable to contact military aircraft
b. request information of Army flight service
c. relay information to Army flight service

6. Calls airline communications stations to:

a. issue clearances
b. check on suspected errors in pilot's report of ETA, position, etc.
c. request for cloud and weather conditions from aircraft
d. request aircraft to hold or change altitude or course
e. correct clearances
f. request position report of aircraft
g. advise of unusual delays enroute or at destination

7. Calls telephone maintenance department to correct malfunctions of interphone system

B. Receives calls

1. Receives calls from other centers
a. receives flight plans from adjacent centers
b. receives corrections in estimates
c. receives requests for verification of estimates
d. receives requests for approval of flight plans before aircraft enters his area

2. Receives calls from communications stations

a. receives relayed information from aircraft regarding:

(1) position
(2) altitude
(3) acknowledgements of receipt of messages sent
(4) time over check points
(5) altitude over check points
(6) requests for altitude changes or other clearance changes
(7) cloud or other weather conditions

(8) ETA over check point
(9) TAS
(10) teletype reports regarding navigational facilities

3. Receives calls from airlines communications

a. receives requests for clearances
b. receives progress reports
c. receives position reports (data similar to 2a above)
d. receives flight plan data prior to departure

4. Receives calls from towers

a. receives requests for clearances
b. receives altitude vacancies
c. receives speed of approach information
d. receives explanation of why aircraft held on ground if takeoff delayed 5 minutes or more

5. Receives calls from weather bureau

a. requests for weather data
b. receives weather data

6. Receives calls from military communications

a. receives relays of calls from military or other aircraft with whom military communications have been in contact
b. receives flight advisory information
c. receives information relative to lost or overdue aircraft

III. Visual Activities

A. Reads weather data
B. Reads flight strips
C. Reads "reading file"
D. Refers to GS calculating table
E. Looks out window — observes planes landing (not possible at all centers)
F. Coordinates with adjacent controllers
G. Watches clock
H. Scans board
I. Looks at sectional map
J. Looks at interphone switches

IV. Verbal Communication with Associates

A. With assistant controller

1. Informs assistant of position of plane
2. Asks for cloud and smoke information

3. Relays estimate to assistant
4. Discusses traffic and relative speeds of aircraft with assistant
5. Gives assistant on-the-job training

B. With other controllers

1. Asks if altitude desired by aircraft is available
2. Engages in social conversation with other controllers
3. Answers questions of other controllers regarding incoming planes
4. Discusses approach times and stacking altitudes
5. Requests advice of other controllers

C. With senior controller

1. Explains clearance given
2. Discusses weather conditions
3. Discusses problem of which aircraft to bring down first
4. Discusses coordination of centers with senior controller

D. With weather advisory man

1. Requests weather data -- forecasts
2. Offers weather data gained from interphone conversations

APPENDIX C

ACTIVITY ANALYSIS OBSERVATION FORM

AMERICAN INSTITUTE FOR RESEARCH
Cathedral of Learning
Pittsburgh 13, Pennsylvania

Activity Analysis, Air Route Traffic C
Observation Form (Tentative)
2 September 1948

Date ________ Center ________ Observer ________ Controller ________
Hour ______ Shift ________ Controller's yrs. of experience ______ Weather ________

ACTIVITIES

Writes on
Writes estimates
Eats
Rests
Activity Log
Irregularity Report
Miscellaneous

INTERPHONE ACTIVITIES

Makes calls to or receives from: Regarding:	Centers M*	Centers R*	Towers M	Towers R	CAA Comm M	CAA Comm R	Mil Comm M	Mil Comm R	Airline Comm M	Airline Comm R	Weather M	Weather R
Flight Plan Estimates												
Changes or verifications												
Interphone reception												
Unusual or emergency situations												
Clearances												
Changes or verifications												
Delays												
Position or progress reports												
Weather												
Control info. on terminating flts.												
Operation of nav. facs.												
Repeats												

VISUAL ACTIVITIES

Reads weather data
Scans board
Reads reading file
Refers to GS table or computer
Coordinates with adjacent controller
Reads map
Looks out window

VERBAL COMMUNICATION WITH ASSOCIATES (with) →	Asst J	Asst S	Other Controllers J	Other Controllers S	Senior J	Senior S	Weather Personnel J	Weather Personnel S	Chief J	Chief S	Other J	Other S

*M= Mak[es] *R= Receives

APPENDIX D

CAA LETTER AUTHORIZING THE ASSIGNMENT OF AERONAUTICAL SPECIALISTS TO ACT AS INTERVIEWERS

DEPARTMENT OF COMMERCE
CIVIL AERONAUTICS ADMINISTRATION
WASHINGTON

(COPY)

September 13, 1948

CIRCULAR LETTER

TO : All Regional Administrators

FROM : Assistant Administrator for Federal Airways

SUBJECT : Research Program on Airways Operations Service

REFERENCE: A-40 Circular Letter, dated July 20, 1948

The American Institute for Research has completed its plans for the subject research and is now ready to secure pertinent data on a nation-wide scale. Part of the plan involves the analyses of approximately fifteen hundred typical examples of air traffic control in critical traffic situations. Due to the complexity of the work, it is necessary that people thoroughly familiar with air route traffic control conduct the interviews and help in the analysis of the results. For this reason, the Washington Office is asking the help of each region. The services of one aeronautical specialist with air route experience is needed for a twelve-day period from each region. Two days of this period will be spent in Pittsburgh, Pa., for consultation and training, and the remaining time will be spent in the region conducting interviews with air route personnel in the centers.

It will be appreciated if each region detail one aeronautical specialist to attend the two-day training sessions to be held at the Hotel Webster Hall, Pittsburgh, Pa., commencing at 9:00 a.m., September 21, 1948. They are to report to Mr. Tom Gordon at the conference room of the American Institute for Research. The telephone number of the American Institute for Research is Schenley 3842.

After return to their respective regions, each specialist will conduct interviews and submit to the American Institute for Research a written report on each interview. These reports will be kept confidential in the files of the Institute and will not be open for study by any but their own research personnel.

The Chief Controller of the Pittsburgh Center has made hotel reservations to accommodate one man from each region for September 20, 21 and 22. In the event any regional representative does not intend to use his reservation, such information should be forwarded to the Chief Controller of the Pittsburgh Center as soon as possible.

/s/ W. E. Kline

APPENDIX E

INTERVIEWER MATERIALS

RULES FOR A GOOD INCIDENT

AMERICAN INSTITUTE FOR RESEARCH
Cathedral of Learning
Pittsburgh 13, Pa.

September 20, 1948.

RULES FOR A GOOD INCIDENT

1. An incident should be a report of an actual situation either experienced or observed by the interviewee, not situations read about or handed down from others.

2. An incident should have occurred recently enough to be remembered clearly and in detail. We would prefer to have incidents which occurred during the past six months.

3. An incident should include the following:

   (a) All the circumstances and conditions surrounding the incident which contributed to making the incident critical.

   (b) A very detailed account of the actual behavior of the person reported upon; i.e., a step-by-step account of everything the controller did.

   (c) A detailed account of the behavior of anyone else involved in the incident.

4. An incident should be a report of what was actually observed in the situation, of what was done, not inferences as to what underlying traits or characteristics were operative.

5. An incident should be a report of a situation about which the interviewee has definite conviction as to the effectiveness or ineffectiveness of the behavior observed in the situation, not a situation in which the effectiveness or ineffectiveness of observed behavior has not been clearly established by the interviewee.

6. An incident in which there was a series of acts or a number of contributing conditions should include a judgment by the interviewee of which act or condition was the most critical.

INTRODUCTORY STATEMENT FOR INTERVIEWERS

AMERICAN INSTITUTE FOR RESEARCH

Pittsburgh 13, Pennsylvania

September 21, 1948

INTRODUCTORY STATEMENT FOR INTERVIEWS

Clarification of Interviewer's Position

"I have been assigned on special duty to the American Institute for Research for a two-week period in order to carry out in this region one phase of a research project being conducted by that organization. They have asked one aeronautical specialist in each region to do this work because of our familiarity with the various jobs in Airway Traffic Control.

Confidential Nature of Information

"During this period all the information I obtain will go directly to the offices of the American Institute for Research. No information will go to the offices of this center, to the Regional Office or to the Washington offices of the Civil Aeronautics Administration. As a matter of fact, no names are to be used at any stage of this project. I have just spent two days at the Pittsburgh offices of this research organization, and I can assure you they will use this information only to help improve control procedures in general, not to make comparisons or throw stones at any one.

Purpose of Project

"The main purpose of this project is to develop improved procedures for evaluating the proficiency of controllers and communicators. I think all of us feel our present procedures for getting an accurate evaluation of a man's proficiency could stand some improvement. Anything they do to improve our procedures will benefit all of us. My job now is to collect information which will then be used as a basis for these research people to develop an improved evaluation procedure. I am <u>not</u> trying out some new evaluating procedure with you now.

What is Wanted from the Interviewee

"I have been asked merely to conduct interviews with a large number of CAA and airline personnel working in this field. Here is what I would like to get from you. Because of your intimate contact with the job of Air Route Traffic Controller, you have observed a large number of situations where Air Route Controllers demonstrated both effectiveness and ineffectiveness. We want to collect over 1,000 typical situations in which some act or way of operating on the part of controllers has proven to be either outstandingly effective or ineffective. I'll simply read you a few questions which I think will demonstrate what I'm after."

SAMPLE INTERVIEWER'S QUESTION BOOKLET

INTERVIEWER'S QUESTION BOOKLET

Interview Questions for:

AIR ROUTE TRAFFIC CONTROLLERS

DATA QUESTIONS ON THE INTERVIEWEE:

JOB TITLE _____

CENTER _____ REGION _____

DATE _____

NAME OF INTERVIEWER _____

LENGTH OF TIME FOR INTERVIEW _____

COMMENTS:

AMERICAN INSTITUTE FOR RESEARCH
Pittsburgh 13, Pennsylvania

September 21, 1948

C-L-1

If promotions were entirely dependent upon your judgment of a controller's effectiveness, think of the man you would recommend first for promotion and describe something he did in a specific situation at a specific time that illustrates his effectiveness.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What made the way he handled the situation outstanding?

(Continue incident on back of sheet)

Data Questions on the Incident:

(1) How long ago did the incident occur in months? _____
(2) Approximate time the incident occurred (24 hr. clock). _____ Shift ____ to ____
(3) What month was it? _____
(4) Weather (where applicable) VFR _____ MARGINAL _____ IFR _____

How would you describe the last time you observed a controller on your watch do something that you felt was a particularly effective piece of work. Describe the situation in detail.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What made the way he handled the situation outstanding?

(Continue incident on back of sheet)

Data Questions on the Incident:

(1) How long ago did the incident occur in months? _____
(2) Approximate time the incident occurred (24 hr. clock). _____ Shift____ to____
(3) What month was it? _____
(4) Weather (where applicable) VFR _____ MARGINAL _____ IFR _____

Think of the controller whom you would most like to have assigned the sector next to yours. No doubt your judgment is based on many observations of this individual in a number of situations but we would like you to describe in detail a recent specific situation you observed that illustrates your reason for choosing him to work next to you.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What was outstanding about the way he handled the situation?

(Continue incident on back of sheet)

Data Questions on the Incident:

(1) How long ago did the incident occur in months? _____
(2) Approximate time the incident occurred (24 hr. clock). _____ Shift____ to____
(3) What month was it? _____
(4) Weather (where applicable) VFR _____ MARGINAL _____ IFR _____

C-I-1

If it were within your authority to recommend a man for demotion, dismissal, or a warning rating, think of a controller whom you feel should be transferred or dismissed or issued a warning rating and describe the situation you observed that provided the "last straw" in the making of your decision.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What would have been the best way of acting in that situation?

(Continue incident on back of sheet)

Data Questions on the Incident:

(1) How long ago did the incident occur in months? _____
(2) Approximate time the incident occurred (24 hr. clock). _____ Shift _____ to _____
(3) What month was it? _____
(4) Weather (where applicable) VFR _____ MARGINAL _____ IFR _____

C-I-2

Think of the last time when the controller who preceded you at the board left you with a traffic situation that was confused and difficult to straighten out.

(a) What were the circumstances surrounding the situation?
(b) What had the previous controller done that made the situation difficult to straighten out?
(c) What did you do to remedy the situation?

(Continue incident on back of sheet)

Data Questions on the Incident:

(1) How long ago did the incident occur in months? _____
(2) Approximate time the incident occurred (24 hr. clock). _____ Shift____ to____
(3) What month was it? _____
(4) Weather (where applicable) VFR _____ MARGINAL _____ IFR _____

C-I-3

Think of the controller whom you would least like to have assigned the sector next to yours because of your lack of confidence in his control ability. No doubt your judgment is based on many observations of this individual in a number of situations, but we would like you to describe in detail one recent specific situation you observed that illustrates your reason for not wanting him to work next to you.

(a) What were the circumstances surrounding the situation?
(b) What did the controller do?
(c) What would have been the best way of acting in this situation?

(Continue incident on back of sheet)

Data Questions on the Incident:

(1) How long ago did the incident occur in months? _____
(2) Approximate time the incident occurred (24 hr. clock). _____ Shift____ to___
(3) What month was it? _____
(4) Weather (where applicable) VFR _____ MARGINAL _____ IFR _____

APPENDIX F

RESULTS OF SEPARATE CONTENT ANALYSES OF 581 EFFECTIVE INCIDENTS AND 668 INEFFECTIVE INCIDENTS GROUPED BY COMMON AREAS OF BEHAVIOR.

		No. of cases
I. ISSUING DEPARTURE CLEARANCES	Effective	27
	Ineffective	94
	Area Total	121
A. Assigning Altitudes	Effective	4
	Ineffective	42
	Sub-area Total	46
Cleared a large number of aircraft with minimum delay by careful allocation of available altitudes.		4
Assigned altitudes unnecessarily high or low and delayed traffic.		2
Assigned aircraft below minimum altitudes.		2
Assigned altitudes to aircraft without providing minimum separation requirements.		36
Failed to consider altitude requests but sent aircraft out in easiest possible way.		2
B. Assigning Climbing Courses	Effective	4
	Ineffective	37
	Sub-area Total	41
Expedited departures by utilising the quickest and most efficient climb-out procedures under the circumstances.		4
Delayed traffic by using inefficient and time-consuming climb-out procedures.		6
Issued incomplete climb-out instructions with result that a confliction followed.		15
Issued climb-out instructions which failed to provide minimum separation requirements.		14
Delayed traffic by failure to issue climb-out instructions at the appropriate time.		2
C. Arranging Take-Off Sequence	Effective	3
	Ineffective	2
	Sub-area Total	5
Arranged the take off sequence to take advantage of differences between speeds in aircraft.		2
Delayed fast aircraft by failing to take differences between speeds of aircraft into consideration		1
Utilized the same take-off procedures for a large group of aircraft thus expediting the flow of departure traffic		

	No of cases	
Failed to make any arrangements for take off sequence of large group of aircraft with result that all aircraft were delayed.		1
D. Estimating or Preventing Take-Off Delays	Effective	16
	Ineffective	13
	Sub-area Total	29
Eliminated delays by keeping himself constantly informed of all information pertinent to departing aircraft.		2
Delayed aircraft by refusing to take advantage of information which would expedite flights.		1
Eliminated delays by utilizing all possible routes of flight.		3
Delayed aircraft by neglecting to use all available routes of flights.		4
Expedited departure clearances by issuing clearances immediately upon request.		1
Delayed aircraft by failing to issue a departure clearance promptly.		1
Expedited departures by arranging for aircraft to take delay time on the ground.		1
Cleared pilot to take delay in air instead of on ground.		1
Expedited departures by preventing arrivals from blocking them.		4
Hindered departures by blocking them with over traffic and arrivals.		2
Prevented delays to departing aircraft by advising those involved of all information pertinent to departures.		3
Successfully worked out answers to untried departure procedures so that departures were expedited.		1
By issuing simultaneous but different instructions he was able to expedite departing aircraft.		1
Unnecessarily delayed departures by declaring an emergency when none existed.		2
Created hazards to airborne aircraft in attempting to avoid delays to departure.		2

		No. of cases
II. REVISING FLIGHT PLANS AND CLEARANCES	Effective	79
	Ineffective	67
	Area Total	146
A. Changing VFR-IFR Flight Plans	Effective	11
	Ineffective	8
	Sub-area Total	19
Revised flight plans for aircraft quickly while keeping all aircraft adequately separated in continuous orderly flight.		11
Attempted to change flight plans when such a procedure was obviously impossible and would lead to confliction.		5
Utilized VFR flight instead of providing standard separation minimum.		2
Failed to advise pilot of IFR cancellation.		1
B. Changing Destinations	Effective	15
	Ineffective	3
	Sub-area Total	18
Revised clearances of several aircraft to provide for destination changes and maintained separation from other traffic.		2
Failed to provide adequate separation for aircraft changing destination with resultant confliction.		2
Provided alternate flight plans for aircraft whose original plans could not be filled.		3
Anticipated the need for destination changes and arranged to have them ready on request.		1
Averted potentially hazardous situations by recommending destination changes.		8
Changed destination of an aircraft without giving pilot a reason for change.		1
C. Changing Altitudes	Effective	17
	Ineffective	47
	Sub-area Total	64
Provided immediate separation for aircraft by issuing altitude changes.		13
Caused a confliction by failure to revise altitudes of aircraft with insufficient separation.		13

		No. of cases
Refused a request for a dangerous altitude change and suggested an alternative plan.		1
Sent an aircraft into an altitude which had just been vacated because of hazardous conditions.		1
Took advantage of aircraft potentialities and assigned altitudes most suitable to particular aircraft.		1
Was able to change altitudes without holding or delay because he assigned altitudes before aircraft arrived in area.		2
Caused a confliction by sending aircraft to or through already filled altitudes.		29
Caused delay and congestion by attempting to issue only altitudes requested and not utilizing all available altitudes.		1
Issued an incomplete and dangerous change of altitude clearance revision.		2
Delayed aircraft needlessly by issuing unnecessary restrictions with changes of altitude.		1
D. Changing Courses and Routes	Effective	32
	Ineffective	7
	Sub-area Total	39
Changed course of aircraft to avoid hazards, confliction, terrain, weather, etc.		23
Created a confliction by changing the course of an aircraft to intersect the flight path of another.		5
Rerouted or changed courses of aircraft to prevent or shorten delays.		7
Delayed flights by failing to change courses of aircraft using altitude separation only.		1
Anticipated a hazardous situation and rerouted aircraft to avoid it.		2
Instructed an aircraft close in to the field to descend well to the right of course instead of rerouting.		1

		No. of cases
E. Changing Time Schedules	Effective	4
	Ineffective	2
	Sub-area Total	6
Provided immediate and adequate separation by clearing aircraft to lose time.		4
Failed to provide time separation needed for the safety of the aircraft.		2
III. AIDING AIRCRAFT IN TROUBLE	Effective	172
	Ineffective	11
	Area Total	183
A. Clearing Airspace for Emergency Descents	Effective	42
	Ineffective	7
	Sub-area Total	49
Descended aircraft in emergency immediately by analyzing traffic and clearing airspace in the area.		44
Failed to descend aircraft out of hazardous conditions even though requested to do so.		4
Descended several aircraft in emergency with adequate separation for all.		44
Cleared aircraft to climb out of hazardous conditions without providing adequate separation.		1
Anticipated the necessity for an emergency descent and cleared airspace for it.		2
Failed to take action to prevent aircraft entering hazardous conditions.		2
Arranged an emergency descent without penalising other traffic.		12
B. Locating Lost Aircraft	Effective	17
	Ineffective	3
	Sub-area Total	20
Used all possible means of communication to contact a lost aircraft.		7
Failed to exhaust every means for locating a lost aircraft.		1
Went beyond his responsibility to locate a lost aircraft.		1
Insisted that another person use unorthodox and unnecessary measures for locating a lost aircraft.		1
Utilized unusual or original measures for locating lost aircraft.		5
Failed to check the accuracy of a report of the location of an aircraft which had been		1

		No. of cases
C. Orienting Lost Pilots	Effective	22
	Ineffective	0
	Sub-area Total	22
Quickly oriented aircraft by enabling aircraft to contact directional finding agencies.		4
Oriented pilot himself by obtaining information leading to location of position of aircraft.		18
D. Organising Rescue Facilities	Effective	18
	Ineffective	0
	Sub-area Total	18
Alerted all possible rescue facilities in anticipation of an emergency.		10
Alerted rescue facilities immediately in an emergency.		6
Made rapid and safe arrangements for the rescue of aircraft.		2
E. Clearing Airspace for Lost Aircraft	Effective	19
	Ineffective	0
	Sub-area Total	19
Cleared aircraft out of area to protect a lost aircraft.		15
Anticipated an emergency and cleared airspace for aircraft which had failed to report.		4
F. Contacting Aircraft with Radio Failure	Effective	18
	Ineffective	1
	Sub-area Total	19
Anticipated a radio failure and made preparations for maintaining communications with aircraft.		1
Delayed issuing information to aircraft with radio failure and delayed landing of aircraft.		1
Maintained communications with aircraft with radio failure by utilising all possible methods of communication.		17

		No. of cases
G. Providing Alternate Bases	Effective	16
	Ineffective	0
	Sub-area Total	16
Provided a suitable alternate within fuel range of aircraft.		10
Provided suitable alternate for aircraft in advance of a missed approach.		1
Went beyond his responsibility to find an alternate base for an aircraft.		3
Anticipated an emergency and rerouted aircraft to alternate bases in fuel range.		2
H. Arranging Emergency Landings	Effective	20
	Ineffective	0
	Sub-area Total	20
Provided for a safe emergency landing by issuance of special instructions to aircraft in trouble.		7
Arranged a safe emergency landing by utilizing an original and effective method of preparing the field.		4
Arranged an unusual and safe method of approach in order to effect an emergency landing.		7
Anticipated possibility of an emergency landing and alerted all necessary facilities to aid the aircraft.		2
IV. COORDINATING WITH OTHER AGENCIES	Effective	115
	Ineffective	206
A. Utilizing Communications Facilities	Effective	19
	Ineffective	3
	Sub-area Total	22
Made maximum use of interphone circuits and reduced the use of interphone time.		13
Failed to make maximum use of interphone and caused unnecessary delays.		3
Utilized unusual procedures for maintaining communications when ordinary facilities were not adequate.		2

		No. of cases
B. Coordinating Inter-Sector Traffic	Effective	25
	Ineffective	42
	Sub-area Total	67
Arranged traffic in his sector to provide for safe and efficient control in another sector.		25
Failed to consider the control plans of other sectors when sending air-craft from his sector into another.		32
Failed to arrange traffic in his sector for convenient coordination with traffic from other areas.		8
Made unnecessary recommendations for revision of flight plans in another sector.		1
C. Issuing or Requesting Pertinent Information	Effective	21
	Ineffective	48
	Sub-area Total	69
Facilitated control in his own or other sectors by issuing or requesting essential information.		21
Delayed the flow of information and hindered control by issuing or requesting unnecessary information or by failure to take any action.		48
D. Issuing or Requesting Information Promptly	Effective	17
	Ineffective	45
	Sub-area Total	62
Speeded the flow of information by his prompt issuance or acceptance of control data.		17
Delayed the flow of information by issuing or accepting control data slowly or hesitantly or by failure to take any action.		45
E. Issuing Traffic Advisories	Effective	8
	Ineffective	5
	Sub-area Total	13
Issued advisory information to aircraft to prevent possible hazards.		8
Failed to issue advisory information to aircraft to prevent possible hazards.		5

		No of cases
F. Issuing and Requesting Accurate Information	Effective	11
	Ineffective	33
	Sub-area Total	44
Avoided the necessity for call-backs, repeats and revisions by issuing and requesting clear, complete, and accurate information.		11
Issued or requested inaccurate, or incomplete information necessitating call-backs for verification or with resultant conflictions.		28
Issued clearances based on inaccurate data.		5
G. Speaking Intelligibly	Effective	7
	Ineffective	13
	Sub-area Total	20
Conformed to standard phraseology and issued information in a clear manner making repeats unnecessary.		7
Deviated from standard phraseology or issued information in an unintelligible manner which necessitated repeats.		13
H. Reducing Interphone Contacts	Effective	6
	Ineffective	2
	Sub-area Total	8
Held the number of interphone contacts down to a minimum by the effective use of short-cut methods.		6
Made unnecessary interphone contacts.		2
I. Briefing Successor at the Board	Effective	1
	Ineffective	15
	Sub-area Total	16
Facilitated the control on subsequent watch by providing his successor with all pertinent information concerning the traffic picture.		1
Failed to provide his successor with all pertinent information concerning the traffic picture.		6
Left his successor with work undone when he should have prepared the board for him.		9

		No. of cases	
V.	PLANNING APPROACH PROCEDURES	Effective	52
		Ineffective	85
		Area Total	137
A.	Arranging Holding and Stacking Patterns	Effective	5
		Ineffective	24
		Sub-area Total	29
	Stacked aircraft in such a way that approaches and departures were facilitated.		3
	Stacked or held aircraft in such a way that all holding aircraft were delayed.		2
	Devised a makeshift holding fix when none was available in area and so expedited the flow of traffic.		2
	Delayed aircraft by holding them unnecessarily.		7
	Stacked aircraft without regard to special limitations.		1
	Failed to provide separation for aircraft in the stack.		11
	Made no provisions for stacking in case of bad weather.		1
	Held aircraft at a dangerous holding point.		1
	Failed to provide holding instructions for aircraft cleared to tower.		1
B.	Organizing Approach Sequences	Effective	15
		Ineffective	31
		Sub-area Total	46
	Arranged altitudes of approaching aircraft so that they were approaching in a sequence most favorable for landing.		9
	Failed to arrange altitudes of aircraft in sequence for landing and so delayed aircraft.		24
	Organized the approach sequence of a large group of aircraft by utilizing all approach courses and descending all aircraft with the same instructions.		1
	Arranged a descent without delay by using holding stacks for other aircraft.		1
	Devised an unusual approach procedure which permitted aircraft to land without delay which would otherwise have been incurred.		2

		No. of cases
Approached aircraft with lowest fuel supply first.		1
Approached aircraft without regard to fuel limitations.		1
Failed to provide for separation in case of weather change.		1
Caused a confliction by failing to separate approaching aircraft.		5
Was able to prevent delays to aircraft even though they filed flight plans at the last minute.		1
C. Releasing Aircraft to Approach Control	Effective	6
	Ineffective	5
	Sub-area Total	11
Released aircraft to tower prior to usual time of release in order to facilitate the flow of traffic and avoid conflictions.		6
Released aircraft to tower at an unnecessarily high altitude.		2
Turned aircraft over to tower without providing adequate separation.		1
Turned aircraft over to tower before legal limit was reached.		2
D. Determining the Saturation Point	Effective	13
	Ineffective	12
	Sub-area Total	25
Recognized the saturation point and acted promptly to restrict further traffic from entering the area.		13
Failed to restrict traffic entering area with resultant congestion and confliction.		12
E. Estimating and Preventing of Delay Time In Approaches	Effective	13
	Ineffective	13
	Sub-area Total	26
Prevented delays to approaches by issuing accurate approach times well in advance of approaches.		5
Failed to get accurate approach times and delayed aircraft as a result.		1

	No. of cases
Utilized a VFR approach to avoid delays which would have been incurred by the use of an IFR approach.	3
Delayed aircraft by using involved approaches when more simple ones could have been used.	1
By utilizing all possible descent courses he descended a group of aircraft quickly without delay to other aircraft.	1
Failed to utilize all available airspace so incurred unnecessary delays.	1
Prevented an approach delay by immediate and thorough coordination with all controllers in area concerned.	1
Failed to coordinate with other sectors and delayed aircraft by haphazard arrivals in his sector.	1
Avoided protracted delays by holding approaching aircraft until the needed altitudes were available.	2
Expedited the landing of special aircraft such as hospital ships.	1
Tied up a low altitude and prevented aircraft from making approaches without delay.	4
Placed unnecessary restrictions on approaching aircraft and unnecessarily delayed it.	1
Failed to provide separation between aircraft and was forced to delay all other aircraft to do so.	2
Failed to keep an altitude open for a missed approach.	2
VI. SUPERVISING PERSONNEL	Effective 30
	Ineffective 39
	Area Total 69
A. Training Assistants	Effective 12
	Ineffective 18
	Sub-area Total 30
Provided thorough explanations of procedures for inexperienced assistants which cleared up assistant's misunderstanding and enhanced his knowledge of control procedures.	8
Gave incorrect or incomplete explanations to assistant.	4

		No.of cases
Increased the efficiency of the center's training program by voluntarily devising training aids.		4
Decreased the efficiency of the center's training program by ridiculing training methods or failing to take them seriously.		2
Failed to find assistant's errors.		12
B. Delegating Responsibility to Assistants	Effective	6
	Ineffective	15
	Subarea Total	21
Encouraged an assistant to assume responsibility but offered to assist him whenever necessary.		4
Allowed an assistant to handle more of the work than was necessary.		14
Refused to allow an assistant to assume any responsibility.		1
Aided an assistant who was having trouble without "taking over".		2
C. Allocating Personnel	Effective	12
	Ineffective	6
	Sub-area Total	18
Recognized the fact that the sector could not be handled alone and arranged for assistance.		12
Failed to request aid when it was impossible to handle traffic without aid.		5
Failed to anticipate personnel needs and was forced to cancel a leave as a result of this.		1
VII. HANDLING THE BOARD	Effective	7
	Ineffective	33
	Area Total	40
A. Removing Void Strips	Effective	2
	Ineffective	3
	Sub-area Total	5
Eliminated unnecessary strips - kept a clean board.		2
Failed to remove unnecessary strips from the board.		3

		No. of cases
B. Posting Complete and Accurate Data	Effective	1
	Ineffective	29
	Sub-area Total	30
Posted information on the board clearly and accurately.		1
Posted inaccurate or illegible information on the board.		13
Neglected to post flight information or posted incomplete flight information so that confliction resulted.		7
Left position at the end of a watch with incomplete information posted.		9
C. Organising the Board Quickly	Effective	4
	Ineffective	1
	Sub-area Total	5
Familiarised himself with board a few minutes after taking over.		4
Posted flight so slowly that he delayed others.		1
VIII. HELPING OTHER CONTROLLERS	Effective	57
	Ineffective	10
	Area Total	67
A. Recognising Conflictions in Other Sectors	Effective	11
	Ineffective	2
	Sub-area Total	13
Aided another controller by calling his attention to a confliction or by correcting the situation himself.		11
Failed to take any action to avert a confliction which he noticed in an adjacent sector.		2
B. Assuming Another Controller's Responsibilities.	Effective	33
	Ineffective	6
	Sub-area Total	39
Volunteered to assist another controller who was very busy.		33
Failed to assist another controller who was overworked.		5
Aided another controller but neglected part of the work he offered to do.		1

		No. of cases
C. Helping in the Solution of Others' Problems	Effective	13
	Ineffective	2
	Sub-area Total	15
Suggested a solution for the immediate problem of another controller and showed him procedures for avoiding other problems in the future.		11
Refused a request for advice.		2
Correctly interpreted a situation which was confusing to others and corrected their misconceptions.		2
IX. MAINTAINED HARMONIOUS RELATIONS WITH OTHERS	Effective	15
	Ineffective	89
	Area Total	104
A. Demonstrating Confidence in Others	Effective	0
	Ineffective	20
	Sub-area Total	20
Indicated that he had no confidence in a fellow worker by refusing to accept or needlessly changing procedures used by the worker.		6
Indicated that he considered a fellow worker's ability to be inferior to his own by relieving him of his work in a boastful and pompous manner.		1
Rudely refused to accept the suggestions of other workers with resultant delays or conflictions.		13
B. Criticising Others	Effective	3
	Ineffective	13
	Sub-area Total	16
Criticised an assistant in such a way that the assistant accepted the criticism and changed his behavior.		3
Criticised a fellow worker in an unnecessarily harsh way.		13
C. Maintaining Good Public Relations	Effective	9
	Ineffective	12
	Sub-area Total	21
Diplomatically explained a difficult traffic situation so that pilots and airlines accepted his explanation.		4
Antagonized airline personnel by reprimanding them.		9

		No. of cases
Assisted or offered help in a situation not his responsibility so that the center received commendation from these outside agencies.		2
Refused to give information or help to an outside agency in a rude manner.		2
Impressed pilots with his controlling ability by clear, definite instructions and plans which he issued to them.		3
Impressed airlines unfavorably by failure to issue clearances until too late.		1
D. Accepting Responsibility	Effective	1
	Ineffective	44
	Sub-area Totals	45
Remained overtime to complete a piece of work.		1
Increased the workload of others by avoiding his responsibilities or passing them off onto others.		32
Refused to cooperate with center regulations.		4
Refused to accept the blame or make amends for an error which was his.		3
Angered personnel by reporting an investigation carried out with inconclusive and incomplete data.		1
Failed to keep himself up to date on control procedures.		1
Tried to evade blame for confliction by falsification.		3
E. Obtaining Cooperation from Others	Effective	2
	Ineffective	0
	Sub-area Total	2
Readily obtained the assistance of other personnel because of the tactful and persuasive manner in which he asked for help.		2
I. MAINTAINING EMOTIONAL CONTROL	Effective	27
	Ineffective	34
	Area Total	61
A. Accepting Criticism	Effective	0
	Ineffective	13
	Sub-area Total	13

		No of cases
	Became angry when criticized by another and "told off" the person offering criticism.	5
	Refused to accept the blame for his errors or to accept his actions as errors.	8
B. Maintaining Composure Under Stress	Effective	27
	Ineffective	21
	Sub-area Total	48
Remained calm and controlled although under great pressure and successfully handled the situation.		27
Became rattled in situation involving heavy traffic and was unable to use control procedures to straighten out the situation.		13
Became rattled and annoyed other workers by continually requesting help during an emergency.		2
Became physically ill during pressure of heavy traffic.		1
Became rattled upon discovering an error which he had made and was subsequently unable to control traffic as he had previously.		5