THE DEVELOPMENT OF A STANDARD FLIGHT-CHECK FOR THE AIRLINE TRANSPORT RATING BASED ON THE CRITICAL REQUIREMENTS OF THE AIRLINE PILOT'S JOB

prepared by

THOMAS GORDON

Report of a survey conducted by 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

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NATIONAL RESEARCH COUNCIL

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

Committee on Aviation Psychology

April 23, 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 Standard Flight-Check for the Airline Transport Rating Based on the Critical Requirements of the Airline Pilot's Job, by Thomas Gordon, 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.

The study described in this report represents a pioneering and significant effort in providing improved and objective measures of the proficiency of air transport pilots. It is commonly recognized, as pointed out in the report made to the President of the United States by the Special Board of Inquiry on Air Safety (December 29, 1947), that the proficiency of pilots is of major consequence today in commercial aviation. Procedures such as those described in the report will lead to greater objectivity and accuracy in determining whether pilots possess the proficiency required for the safe operation of transport airplanes.

The objective flight-check represents the results of nearly two years of direct research in this area. The completion of this task within the two-year period was made possible only by the utilization of other research results obtained in the nearly ten years of research conducted by the National Research Council Committee on Aviation Psychology and by the Military Services. Many of the developments so utilized reflect the continued interest of the Civil Aeronautics Administration in the support of research bearing upon human factors in aviation.

As indicated in the Foreword and in the body of the report, steps have been taken toward the tryout of a somewhat revised objective flight-check embodying changes suggested by the Air Line Pilots Association. These changes are the outgrowth of extensive consultation with the Air Line Pilots Association and with the other interested agencies with which the Committee on Aviation Psychology has been in close contact throughout this program with a view of facilitating the prompt implementation of the outcomes of research in the day-to-day work of the Civil Aeronautics Administration.

Cordially yours,

MSV

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

MSV:maf

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Many representatives of the airline industry generously gave information and advice based upon their extensive experiences. Mr. M. A. C. Johnson and other Eastern Air Line pilot personnel, Mr. William Arthur and members of his staff at American Airlines Training Center at Ardmore and Mr. Paul Frederickson and Mr. Harry Campbell of TWA contributed valuable technical assistance during the phase in which the flight-check was being developed. Mr. William Riley of Capital Airlines permitted the writer to observe a flight-check conducted by that Company.

There were many individuals whose cooperation made it possible to conduct the two try-outs of the flight-check. Dr. Frank Geldard, Dr. Glen Finch, Dr. M. S. Viteles, Col. John T. Fitzwater, Lt. Col. Anderson, Lt. Col. Wood and Lt. Col. Parker all contributed toward making the arrangements for the Barksdale Field try-out. Mr. J. S. Marriott, Mr. W. B. Barnes, Mr. W. W. Jarrell, Mr. Fred Lanter, Mr. W. W. Smith all made possible the try-out at the CAA Aeronautical Center.

Acknowledgments are due to Dr. Dean R. Brimhall for his initial interest and continuous support of the project. Other CAA personnel helped at various stages of the project, notably Mr. W. W. Jarrell and other members of the Airman Service and Mr. W. B. Barnes, Director of Flight Operations Service.

The writer is grateful for valuable suggestions provided by members of a pilot committee selected by the Air Line Pilots Association to review the first form of the experimental flight-check.

7 January 1949

Thomas Gordon
Director of Aviation Research
American Institute for Research

EDITORIAL FOREWORD

On June 15, 1947, the President of the United States appointed a Special Board of Inquiry on Air Safety to "study the pertinent data and information relating to the program for safety in air transportation and the factors, both mechanical and human, which enter into safe operation." In the report made by this Board on December 29, 1947, it is stated that:

> "Proficiency of pilots is of major consequence today in commercial aviation. Persons of only moderate or average competency cannot be entrusted with the responsibility of controlling modern airplanes in flight. Newer and more modern types of airplanes have intensified this responsibility. To date airplane design has not succeeded in reducing significantly the degree of proficiency needed in the pilot. Moreover, both as a matter of operation and as a matter of administrative regulation, the ultimate judgment on the safety of any operation rests with the pilot. The initiation of flight in many instances requires the concurrence of others but, once begun, its successful completion depends on the pilot." (page 55)

Earlier developments in the research program of the National Research Council Committee on Aviation Psychology had indicated the importance of improved proficiency measures as a device for increasing air transport safety. In particular, T. P. Wright, formerly Administrator of the Civil Aeronautics Administration, and D. R. Brimhall, Assistant to the Administrator for Research, had called attention to the necessity for surveying aspects of pilot characteristics and behavior which may contribute to accidents during flight and for developing improved procedures for the upgrading and certification of airline pilots. As a result, there was initiated, late in 1946, a comprehensive research program designed to reveal the critical requirements of the pilot's job and to develop an improved and objective procedure for examining the flight proficiency of airline pilots.

Reference to this research program is found in the report by the President's Special Board of Inquiry on Air Safety which mentions steps taken by the Board to consult with the National Research Council with the view of taking full advantage of the facilities of this agency for conducting research which, in the words of the Board the "government, by its nature, is not too well equipped to develop" and which makes possible the full utilization of the "expertness, that patience for research that only the best of our educational institutions possess." As a matter of fact, the development of this project has required not only the utilization of widespread research facilities, but it has involved close contact with and the cooperation of the airlines, the Air Line Pilots Association, the Air Transport Association, the Civil Aeronautics Administration, and the United States Air Force.

The research project has developed as a three-step program which is to be followed by a further field tryout of a somewhat revised objective flight-check in cooperation with the Air Line Pilots Association, the Air Transport Association, and the airlines.

The first step in this study, described in an earlier report,[1] involved an analysis of the CAA records for 1,278 pilots who had passed the physical examination for the Air Transport Certificate. These records were analyzed to obtain factual information on the certification history of pilots who are or aspire to be airline pilots.

The second step involved research of the survey type designed to reveal the special requirements and characteristics demanded of a safe air transport pilot by present-day operations. This survey, also described in an earlier report,[2] involved analysis of data gathered from interviews with over 250 airline pilots, from CAA and company records, and from other sources.

The present report on the third step in this long-range program describes the development of an objective flight-check for the Air Transport Rating Certificate. Just as the determination of the critical requirements of the job was based on extensive field research in which airline pilots themselves co-operated, rather than being a product of "armchair research," the development of the flight-check, based on these critical requirements, has involved extensive flight testing, conducted at the CAA Aeronautical Center, Oklahoma City, and at Barksdale Air Force Base, Shreveport, Louisiana, through the cooperation of the USAF Training Command.

In the development of the project it was recognized that an improved and serviceable flight-check should meet four major requirements: (1) it should be more reliable than current methods of evaluating flying proficiency, that is, measures of flight proficiency for given men, obtained by different check pilots, and on independent test flights, should be in essential agreement; (2) it should measure skills relevant to success as an airline pilot; (3) it should be practical, and (4) it should be acceptable to those whose job it would be to use it.

It is felt that the flight test described in this report meets these requirements. Of particular interest is the fact that high agreement was evident between flight test measures yielded by different examiners flying given pilots on <u>different days</u>, and in <u>different airplanes</u>. There seems sound reason for the opinion that research to date has yielded a procedure which shows considerable promise as a device for making sure that only pilots who have the necessary

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[1] Preston, H. O. <u>Analysis of CAA records on airline transport pilots</u>. Washington, D.C.: CAA Division of Research, Report No. 72, August 1947.

[2] Gordon, Thomas. <u>The airline pilot: A survey of the critical requirements of his job and of pilot evaluation and selection procedures</u>. Washington, D.C.: CAA Division of Research, Report No. 73, November 1947.

skills will be granted the Air Transport Rating Certificate. The objective flight-check developed in the investigation has recently been somewhat revised, in the main to overcome objections raised by the Air Line Pilots Association. Plans are under way for the tryout of the revised objective flight-check on air transport pilots with the cooperation of the Air Line Pilots Association, the Air Transport Association, and the airlines.

The investigation described in this report was carried out under the auspices of the National Research Council Committee on Aviation Psychology by the American Institute for Research. The program was conducted by Dr. Thomas Gordon under the general direction of Dr. John C. Flanagan. On page v are found acknowledgments to the many agencies and to the many individuals who cooperated with those responsible for the research program in producing the outcomes described in the report.

Morris S. Viteles, Chairman
Committee on Aviation Psychology

April 23, 1949

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SUMMARY

Objectives of the Study

The objective of this study was to develop a more accurate and reliable method of evaluating the flying proficiency of pilots based on an analysis of the critical requirements of his job. The study was conducted by the American Institute for Research under contract with the Committee on Aviation Psychology of the National Research Council and with funds from the Civil Aeronautics Administration.

For the purpose of this study, the Airline Transport Rating flight-examination was selected as the examination for which the new method would be developed. This meant that an effort would be made to develop an improved procedure which would measure the skills and qualities required of an airline pilot for successful functioning on the job. It was expected, however, that the new methods developed in this study would incorporate distinctive procedures and features which could also be applied to measures of the flying proficiency of private, commercial or military pilots.

Early in this project certain standards were set for the new procedure which would be developed. These were:

(1) That it be more reliable than current methods of evaluating flying proficiency. What was wanted was a method which when used by different check pilots would decrease the amount of disagreement shown by check pilots evaluating the same pilots.

(2) That it measure the skills which are most relevant to success or failure of the airline pilot on the job. What was wanted was an evaluation procedure that would measure the skills which had been found to make the difference between safe and efficient flying and flying which is not.

(3) That it be practical. Because of the difficult conditions under which pilots must be evaluated in the air, it was intended that efforts would be made to construct the new evaluation procedure to fit these conditions.

(4) That the new procedure be acceptable to those whose job it would be to use it.

General Plan of the Study

To accomplish the objective of developing an evaluation procedure that would meet the above standards, the project was carried out in five stages:

1. A survey was made of currently used methods of evaluating pilot proficiency.

2. A survey was made of all of the previous research studies aimed at the development of improved procedures of evaluating pilot proficiency.

3. A study was made for the purpose of determining the critical requirements of the airline pilot's job, through collecting from many different sources information which provided evidence as to the skills and qualities of airline pilots which had been proved to have made the difference between flying which was safe and effective and flying which was not.

4. Objective methods of measuring these critical requirements were devised on the basis of the findings from the previous phase of the study and in cooperation with airline check pilots and Civil Aeronautics Administration examiners.

5. The new procedure was subjected to an experimental try-out, revised on the basis of the results from this try-out, and then given a second experimental try-out. These try-outs were conducted to test the reliability, relevance, practicality and acceptability of the new procedure.

Specific Procedures of the Study and the Significant Results

The survey of currently used methods of evaluation included both a study of the various methods employed at present by the airlines, the Civil Aeronautics Administration and the military services and a review of the studies which throw light on the adequacy of these methods. In general, the method which is almost universally employed at present is of the subjective type, involving the giving of a single rating on over-all flying proficiency, giving several ratings on certain components of the job or giving ratings on very general traits and characteristics of the pilot. Studies of this type of evaluation method consistently have demonstrated that it does not result in a satisfactory amount of agreement between check pilots independently evaluating the proficiency of the same group of pilots. This lack of agreement has been reflected in coefficients of correlation between independent check pilots of approximately .35.

Studies have shown that this type of evaluation method does not discriminate between the abilities of a pilot in different aspects of the job. The method also does not always give an adequate range of the abilities of different pilots. Flight-examinations of this type have been shown to fail to predict scores on subsequent flight-examinations or success in later stages of training with any degree of accuracy. Correlations showing these relationships have varied from .00 to .39.

The survey of previous research aimed at developing improved measures of pilots' flying proficiency suggested that the most promising type of procedure was the one requiring objective observations to be made by check pilots during a standard flight and requiring the scoring of numerous small segments of the pilot's performance on the check flight. It was also apparent from the survey of previous studies that more research was needed to develop a single comprehensive flight-check composed of a large number of measures of various aspects of pilots' performance. The previous studies suggested a need for concentration of effort on devising a flight-check which was practical and acceptable to the check pilots.

In order to make the new procedure relevant to the job of the airline pilot and also acceptable to check pilots, a study was then made for the purpose of determining the critical requirements of the airline pilot's job. Data were obtained from the personnel records of currently employed and previously eliminated pilots, from the records of 121 airline accidents and from 532 critical incidents in which the pilot's behavior contributed to a near-accident or close call or was a factor in causing the pilot to be failed on a flight-examination. The airline accidents and critical incidents provided the best evidence of the critical requirements of the job. Two separate analyses of these data produced lists of the most critical aspects of pilots' performance, which provided the basis for the development of the new evaluation procedure.

The new evaluation procedure which was then developed incorporated the following characteristics:

1. The tasks required of the examinee were selected on the basis of the findings from the critical requirement determination.

2. The tasks were arranged into a standard flight.

3. The form which was provided for the check pilot contained certain distinctive features: (1) numerous graphic and pictorial items, (2) items which allowed the form to be used with different airplanes, and (3) items which minimized the check pilot's job of recording of performance.

4. The procedure relied most heavily on the objective-observation type of measures, but included more subjective items when necessary for relevance and practicality.

The first try-out of the flight-check involved administering it to 27 Air Force pilots on two successive flights on different days, during which flights two check pilots made independent observations. The two check pilots on the second flight were different from the two on the first flight. The observer-observer reliability of the flight-check was .85, and the ride-ride reliability was .58. The correlation between the average total score of the examinees and their experience level was .49, but there was no significant relationship between the total scores on the flight-check and the number of flying hours of these pilots.

The first form of the flight-check was revised on the basis of the results of the first try-out. The revised form was then administered to 26 Civil Aeronautics Administration examiners and instructors on two successive flights and with two independent observers on each flight. The observer-observer reliability of the flight-check was .86, and the ride-ride reliability was .76.

An evaluation of the flight-check was obtained from 24 of the Civil Aeronautics Administration check pilots participating in the last try-out by means of a questionnaire.

The most significant of the conclusions made from the results of the study are as follows:

1. The flight-check developed in this study is a reliable procedure for recording the performance of pilots having the training and experience similar to typical applicants for the Airline Transport Rating certificate.

2. Using a scoring procedure substantially similar to the one used in this study for arriving at an over-all measure of pilot proficiency, different check pilots independently observing the performance of a group of pilots of similar experience to those used in this study will assign scores which are in substantial agreement.

3. The flight-check developed in this study appears relevant to the requirements of the job of airline pilot on the basis of two types of evidence. First, it was devised to measure those requirements found critical for successful functioning as an airline pilot. Secondly, the scores on the flight-check and the experience level of pilots show a positive correlation significantly greater than zero.

4. Although Civil Aeronautics Administration check pilots see both certain advantages and disadvantages of this flight-check, the majority are either in favor of adopting it as the Airline Transport Rating flight-examination or in favor of continuing its try-out after some revisions.

THE DEVELOPMENT OF A STANDARD FLIGHT-CHECK FOR THE AIRLINE TRANSPORT RATING BASED ON THE CRITICAL REQUIREMENTS OF THE AIRLINE PILOT'S JOB

INTRODUCTION

Psychology already has made significant progress in measuring the achievement and capacities of the individual. This progress is clearly reflected in the history of the development of improved procedures for evaluating intelligence, aptitudes, knowledge, interests, physical growth, traits, personality, adjustment. One prominent aspect of this development has been the continual search for more objective methods of measurement — that is, those characterized by standardization of administration, observation, and scoring; by freedom from the influence of observer bias and differences in standards of performance; by specificity as to what is to be observed; and by quantitative methods of arriving at a final evaluation.

Within relatively recent times, psychologists have begun to apply their techniques of measurement to the problem of evaluating the complex skill of piloting an airplane. The need for more accurate measurement of this skill was realized just prior to the last war, but it was only after this country entered the war that this need became sufficiently acute to attract the attention of a large group of psychologists. The need for accurate methods of evaluating flying skill has become increasingly critical since the war with the rapid increase in civilian flying, both private and commercial, along with the continuing program of maintaining military preparedness.

The present study was an attempt to meet this need. The Civil Aeronautics Administration requested the Committee on Aviation Psychology of the National Research Council to sponsor research aimed at the development of improved procedures for evaluating the flying proficiency of pilots applying for the Airline Transport Rating. This rating is required of all pilots who fly scheduled or non-scheduled transport aircraft. To obtain this rating a pilot is required to pass a written examination covering his knowledge of essential pilot information and a flight examination intended to measure his flying proficiency. This project was limited to the development of an improved flight examination. The project was granted to the American Institute for Research under the immediate direction of the writer.

The study involved several different phases. These will be reported in the following order:

1. A survey of currently used methods of measuring pilot proficiency.

2. A review of previous research aimed at developing improved measures of pilot proficiency.

3. Determination of the critical skills required of the airline pilot.

4. Development of procedures for measuring these critical skills.

5. Evaluation of the new procedures.

CHAPTER I

CURRENTLY USED METHODS OF MEASURING PILOT PROFICIENCY

The Functions of Pilot Proficiency Measures

All civilian pilots at present must be evaluated by the Civil Aeronautics Administration to determine competency to receive the various pilot licenses and ratings, such as the private, commercial, instrument, and airline transport certificates. These licenses define and limit the type of flying a civilian pilot can engage in (contact or instrument), the kinds of airplanes he can fly and the use he makes of his flying (private or commercial). Each pilot in order to qualify for a particular license is required to pass both a written and a flight examination designed to measure his knowledge and flying proficiency. The safety of thousands (both pilots and passengers) and the consequent acceptance of flying by the public depend upon the accuracy with which the proficiency of all civilian pilots is determined.

Military aviation relies upon accurate evaluation of flying skill to determine whether pilots are qualified to proceed to advanced levels of training, to fly more complex aircraft, to engage in instrument flying, or to take a new type of airplane off the ground.

Airlines rely upon measures of flying proficiency to determine whether a pilot is qualified to "fly the line" as a copilot and later as a captain. In addition, each pilot is required by regulation to pass an instrument flight-check every six months as a means of checking on the degree to which he has maintained his proficiency in this type of flying. The extent to which evaluation is utilized in the airlines is high-lighted by the remark made to the investigator by an airline pilot, as follows:

> "The airline pilot is continually under pressure of job insecurity, because he is always being evaluated. Take a doctor, for example. He passes his 'Boards' and then he is a doctor. He isn't re-examined every few months to see how well he is doing. Not so with us. We get our license as an airline transport pilot, but then someone comes along and says he wants to make sure we're still on the ball."

In addition to these frequent and routine uses, measures of flying proficiency can be utilized for diagnosis of specific strengths and weaknesses so that the training of an individual pilot can be made more efficient. In general, however, currently used evaluation methods seldom serve this function. This is not to say that instructors themselves do not use diagnostic methods in their teaching, but that the proficiency measures commonly employed are not adequate for providing diagnostic information to the instructor. Rather the instructor relies on his memory of what his student has done and upon his own standards of how well he has done. Thus present diagnostic teaching depends upon the instructor's memory, which is far from infallible, and upon his particular standards, which are known to be different from those of other instructors.

To the psychologist or educator, pilot proficiency measures have yet another function. They may be used as criteria against which to test the validity of pilot selection procedures, training methods, changes in equipment design, improvements in working conditions. Research in any of these areas often depends for its validation upon some measure of the performance of the pilot. The best evidence that particular selection procedures are adequate is an increase in the proficiency of the pilots selected. If there exists no highly reliable measure of pilot proficiency, as in the Army Air Force selection program during World War II (13), less conclusive evidence must be used, such as a pass or fail criterion. Similarly, conclusive evidence of the relative effectiveness of different methods of training would be provided by measures of the proficiency of pilots trained by these methods. One of the few examples of such a use of measures of pilot proficiency is reported by Miller, Galt, and Gershenson in the Army Air Force Aviation Psychology Program Research Report No. 8 (18). In general, however, in military or civilian aviation there has been little modification of traditional pilot training methods, in part due to the lack of any way to determine the relative effectiveness of methods which otherwise might be experimentally introduced.

A serious problem in commercial aviation today remains unsolved partially because of the lack of a suitable criterion of pilot proficiency. This is the problem of the optimum number of crew members for large four-engine scheduled airline planes. Because the answer to this problem has had to be sought in the judgments of crew members themselves and because these judgments differ considerably, no solution has yet been reached. Here proficiency measures are not the sole criterion of optimum crew size, because such factors as economy, fatigue, and equipment must be considered, yet such measures certainly could be one useful criterion and an important one at that. The serious need for, as well as the difficulties involved in, developing criterion measures of pilot proficiency repeatedly has been affirmed by many investigators in this field (23, 6, 18, 11).

Thus, measures of flying proficiency are important for the function they may serve in (1) predicting pilots' future success in special assignments or advanced training, (2) qualifying pilots for special licenses or for graduation from training programs, (3) ascertaining maintenance of earlier achieved proficiency, (4) diagnosing specific strengths and weaknesses for teaching purposes, and (5) validating training methods, selection procedures, and changes in equipment or working conditions.

Methods of Evaluation Currently Used

Considering the extent to which evaluation of flying proficiency is needed and used in civilian and military aviation, it would be expected that a variety of evaluation methods was being used at present. Actually, however, this is not the case. Currently used techniques of measuring flying skill are surprisingly similar. There is extensive variation in what is measured but little variation in how it is measured. Actually only three basic types of evaluation methods are being used extensively in civilian and military aviation.

The Rated Work-Sample Method

The method of evaluation most frequently used at present is one in which the examinee is observed on a special test flight (called a check-ride or flight-check). At the completion of the flight-check the observer gives the examinee either an over-all rating on the total flight-check or a rating on each of various components of the flight-check. There is great variation in the extent to which the flight-check is broken down into smaller components or work-samples. With some methods the observer assigns a grade to each of ten to twenty maneuvers. Typical of this method are the flight-checks used by the Civil Aeronautics Administration for certificating private, commercial, and airline transport pilots. With others the observer gives a rating to various components of each maneuver. The Royal Canadian Air Force and Royal Air Force utilized such a system during the last war. Essentially theirs was a method involving standardization of the maneuvers to be given and the components of each maneuver to be evaluated. Standardization of the observers was approached through instructor and check-pilot training programs and traveling standardization boards.

This method, called the "Rated Work-Sample" method, is used extensively in military aviation, by the commercial airlines, and by the Civil Aeronautics Administration. The ratings assigned are usually points on a scale, ranging in size from two to one hundred points. These scales may be any of the following types:

1. A, B, C, D, E, F
2. Satisfactory, Unsatisfactory
3. Above Average, Average, Below Average
4. 5, 4, 3, 2, 1
5. Excellent, Good, Fair, Poor
6. 100, 99, 98, 97, 96, 95, 94 . . . . . . etc.

With the rated work-sample method of evaluation several different methods are employed for determining whether the individual passes or fails. If only one rating is given on the total flight-check performance, then, in order to pass, the examinee is simply required to obtain a certain rating or better. Where ratings are given on smaller work-samples, a final over-all rating may be assigned independently of the individual maneuver ratings; or the maneuver ratings may be averaged. A system of weighting individual maneuver ratings is seldom, if ever, employed. Frequently a multiple cut-off system is used whereby the examinee is required to obtain a certain rating or above on each component of the check-ride in order to pass.

The Method of Rating General Qualities

In this method the observer gives an over-all rating to one or more general qualities of flying proficiency. In the Army Air Force for a period it was customary for the check pilot to give ratings on four general qualities, namely, judgment, technique, progress, and attitude. Some airlines use a similar method of evaluation at present. For example, one airline rates such qualities as attention to detail, initiative, punctuality, judgment, sense of responsibility, self-control, emotional stability, self-confidence. Usually the rating of general qualities is an addition to the work-sample ratings, although in certain phases of the Army Air Force training program psychologists found that the former method was used exclusively (18).

The Essay-Type Grade Slip

In addition to the present tendency to rely upon subjective ratings of maneuvers or total check-rides, there is a common tendency to supplement such ratings with descriptive comments about the examinee's performance. These comments may be explanations of one or more of the maneuver ratings themselves, notations of exceptionally poor or good maneuvers, judgments about general pilot qualities, statements of amount of progress. In general, check pilots vary extensively in the kinds of comments which they append to the maneuver ratings. It is current practice to use these comments as justifications of the ratings rather than to use them as a basis for the ratings. Some Army Air Force pilot training supervisors, as well as instructors themselves, frequently have expressed a preference for such comments over maneuver ratings, and some attempts have been made to sponsor universal acceptance of a written "essay-type" grade slip. This type of evaluation is opposed on the grounds that it takes too much of the instructor's time, and is so much "paper-work."

Other Methods

In general, these are the three basic methods of evaluating flying proficiency in use today in military, commercial, and private aviation. There are a few organizations, however, which are trying out different methods. In a special evaluation program, one airline recently tried out a system whereby points were assigned on the basis of whether a pilot accomplished [illegible] specific unit of a maneuver within prescribed limits. A portion of the grade sheet used in this program is reproduced below to illustrate. A grade of from one to five is assigned each maneuver.

9. PRECISION TURNS (45° banks, changing direction 90 and 180 degrees) — Grade ______
   Plus or minus 100 ft. altitude tolerance
   Plus or minus 5° on headings
   Remarks:

10. ENGINE OUT. Engine out when in 45° bank — Grade ______
   Ability to hold altitude plus or minus 100 ft.
   Technique of preparation for single-engine operation
   Heading plus or minus 10 [illegible]
   [illegible] 105 MPH

[illegible] same airline has attempted to weight different components of the [illegible] ment approach, using a form reproduced in part below:

	Tolerance	Prescribed	Flown	Grade Max.	Grade Actual
Airspeed	130-150	140		10	
Away from Station Headings	10°	124		3	
Over Field Altitude	20 ft.	500 ft.		10	
Altitude Over Station	20 ft.	1000 ft.		5	

Another organization is using a system whereby each maneuver is broken down into components and the check pilot is required to write in how the pilot performed with respect to each component or to answer specific questions about his performance:

4. CLIMBS, CLIMBING TURNS AND TRACKING
   (1) Airspeed during climb averaged _____ mph
   (2) Knew which way to turn to intercept track
   _____ Yes _____ No
   (3) Maintained track within _____ Degrees
   Remarks:

With this method, however, there is no system of assigning points to either the components of the maneuver or the maneuver itself. The check-pilot simply rates the examinee on a five-point scale ranging from superior to poor. Furthermore, the check pilot fills out this form after the flight. This is true of all of the currently used methods which were studied in this investigation.

Among the methods being used at present there is much variation in what is being evaluated. In part, this is due to the differences in the requirements for various kinds of flying activity, although variation is apparent among organizations engaged in almost identical activities, such as the scheduled domestic commercial airlines.

To summarize, the methods of measuring flying proficiency currently employed in military, private, and commercial aviation show the following characteristics:

1. They require subjective ratings of work-samples of various degrees of specificity, subjective ratings of general qualities, or a combination of both.

2. These ratings are usually supplemented by brief descriptions of various aspects of the pilot's performance.

3. Ratings are made on either numerical or descriptive scales having from two to one hundred points.

4. Occasionally some attempt is made to standardize ratings by means of listing "points to be considered" by the check pilot or by establishing performance limits.

5. Over-all proficiency ratings are generally arrived at either independent of maneuver-ratings and quality-ratings or by averaging the latter with equal weights.

6. Ratings are made after the pilot has completed the check-ride.

7. There is extensive variation in the aspects of pilot performance which are rated.

Evaluation of Currently Used Methods

As early as 1941 Edgerton and Walker (4) collected ratings of maneuvers performed on daily flights by students in the first phase of the Civilian Pilot Training Program and found evidence of strong halo effect and extremely restricted ranges. Johnson and Boots (12) later found similar small ranges, as well as high intercorrelations between items and low reliabilities between instructor and inspector maneuver ratings on 178 civilian pilot trainees. Of additional interest were the inconsistencies they found between instructors' maneuver ratings on a five-point scale and their remarks written on the grade slips on the same day. Examples cited were:

Comments	Grades
"Above average"	All Grades 3
"Did poor on 360°"	Grade 3
"Normal"	Grade 1
"Excellent landings"	Grade 3

The present investigator in 1942 made an analysis of twenty-three hundred subjective maneuver-ratings assigned by instructors to a select group of pilots who had graduated from an instructor's course in the Army Air Force. It was discovered that 91 per cent of the ratings were C's and D's, which give the impression that nine out of ten of the graduates of this school were only average or below average in flying proficiency, as indicated by their grades!

Ben-Avi (18) has summarized some of the studies by aviation psychologists of methods used in the Army Air Force. In an attempt to find an adequate criterion of pilot proficiency, those investigators examined all available proficiency measures, all of which were of the "subjective" type. These included daily ratings, check-ride ratings, instructors' comments, and other training records. Two independent studies of the ability of average check-ride ratings at the primary level to predict various criteria of performance at later stages of training indicated low positive correlations ranging from .11 to .26. The correlation between two individual check-riders' subjective evaluations in another study at the primary level was .35. From several studies of "stage grades" and daily grades, all of which were of the rated work-sample type, it was concluded that the correlations among subjective grades for different aspects of flying were high, indicating the probable presence of a strong tendency for check pilots to give the same rating on all items. The stage grades and the daily grades did not predict success at the next level of training as well as the pilot selection tests used in the Army Air Force. The stage grades, in addition, did not correlate appreciably with the average check-ride grade, with a pass-fail criterion or with each other.

Preston (21) in a study of the records of both flight and written examinations of the Civil Aeronautics Administration found no relationship between scores made by pilots on the flight examinations for three different certificates. The private certificate is the first obtained by pilots, the commercial is next, and the airline transport the last. It may be noted below that these flight tests are not positively correlated:

Flight Examinations	r	σ_r	Number
Airline Transport and Commercial	.03	.035	788
Airline Transport and Private	.04	.040	620
Private and Commercial	-.15	.037	702

Neither the private flight test nor the commercial flight test predicts performance on the airline transport flight test. The method of grading on all three of these flight tests is that of assigning subjective ratings to each of a number of maneuvers. It is reasonable to assume that the unreliability of this type of evaluation procedure is partially responsible for the lack of correlation between the scores on the three flight tests. If any one of these flight-examinations should happen to correlate with some criterion, such as freedom from accidents, it is highly unlikely that the other two would be related to such a criterion. This study is significant from the standpoint of the present study, inasmuch as it is the Airline Transport Rating for which an evaluation procedure is to be prepared.

A recent study has been reported by Henneman, Hausman, and Mitchell (10). This study involved the examination and analysis of different training records of instrument flying as measures of the proficiency of Air Force pilots in this type of flying. This is a particularly significant study because, in contrast to the findings of other studies of current methods of measuring pilot proficiency, these investigators conclude from their findings that the methods investigated are "unusually satisfactory." The study dealt primarily with daily "mission grades" but they report some results of an analysis of flight-check grades. Relevant to the present study are their findings in regard to the reliability and validity of different flight-checks administered during the training period. The correlation between scores on a flight-check given at the end of the first phase of training and scores on the flight-check given at the end of the three-month course was .39 for 164 pilots. Two factors, however, might have affected this correlation. The investigators do not specify whether there were different check pilots for these two flight-checks, nor do they give information which would lead one to discount the influence of the second check pilot's knowledge of the results of the first check-ride. This influence may have increased the size of the correlations reported between several other measures of proficiency examined in this study, especially since instructors in such small training units frequently discuss among themselves the relative capabilities of their students.

The Army Air Force aviation psychologists have attempted to evaluate instructors' written comments on examinees' performance during flight-checks. In view of the widespread use of this method, their results are of considerable significance. Ben-Avi (18) and Crawford and Dailey (3) have reported one study in which comments from the training flight grade slips of six hundred and fifty aviation cadets were categorized in the following groups: Motor Technique, Perception, Motivation, Headwork, Emotional Difficulties. Quantitative scores derived from frequencies of comments in each category correlated .40 with success in Primary training, with considerable variation in the size of the separate correlations for each of the three populations studied. The instructor who wrote the comments, however, also made recommendations for elimination. Consequently, as the investigators caution, these correlations are spuriously high. The category scores predicted success in the next phase of training about as well as average check-ride grades, yielding a correlation of .25.

In summary, the findings from these studies of currently used evaluation methods suggest the following conclusions:

1. Currently used methods have not yet produced a satisfactory amount of agreement between check pilots who <u>independently</u> evaluate the proficiency of pilots.

2. These methods do not satisfactorily discriminate between relative proficiency in different aspects of piloting, as evidenced by high intercorrelations among maneuver ratings.

3. Present methods generally do not give adequate ranges of the abilities of pilots, although one study reported that a group of check pilots in the Air Force did demonstrate that discrimination can be achieved with rating-type methods.

4. Presently accepted methods of evaluation do not adequately predict success in later stages of training.

CHAPTER II

THE PROBLEM

The Objective of This Study

The reasons for the existence of a need for accurate measures of flying skill have already been noted. Furthermore the survey of currently used measures indicated that the methods almost universally employed are of a type which has not proved adequately reliable, predictive, or discriminative. The aim of this study was to "stand on the shoulders" of those who have already contributed much toward the development of improved pilot evaluation procedures with the hope that additional progress could be made.

Specifically, the objective was to develop a procedure for evaluating flying proficiency which would satisfy the following criteria:

1. It should be more reliable than current procedures.

2. It should measure the skills which are relevant to success or failure on the job.

3. It should be practical to the extent of fitting into the realities of the difficult conditions under which pilot performance must be observed.

4. It should be acceptable to those whose job it will be to use it.

Before presenting the methods which were employed to accomplish the above objective, it is important to examine each of the criteria established for these evaluation procedures and to present some of the special problems involved in satisfying each criterion.

Special Problems Involved in Reaching the Objective

The Problem of Reliability

One of the most difficult problems involved in developing procedures for evaluating pilot proficiency is that of making the instrument reliable. Rated work-sample methods have not been highly reliable and the rating of general traits even less reliable. Some success was achieved in the Royal Air Force and Royal Canadian Air Force in increasing the reliability of work-sample ratings by training the observers until they were in agreement as to the kind of performance which should be rated an "A" or a "3," etc. Furthermore the number of observers was kept small; that is, the evaluating function was taken out of the hands of the instructors and delegated to "examining boards." This is not always possible, however, and it usually is a more expensive procedure. Where it has not been possible to use a small number of special examiners trained to employ similar methods and similar standards, the reliability of evaluation methods has been even more difficult to achieve. This is probably due to any or all of the following factors:

1. Flying is a complex skill.

2. Communication between the pilot and the check pilot in the air is extremely difficult due to excessive noise, seating arrangements and the need for the observer to watch out for other traffic.

3. Pilot performance from one flight to the next is affected by many atmospheric variables, some of which are: (a) amount of turbulence, (b) wind direction and velocity, (c) extent of visibility, (d) density of the air.

4. Pilot performance is affected by variations in other conditions, such as: (a) amount of traffic, (b) differences in characteristics of different airplanes (even among airplanes of the same type there are large differences in engine power, stability, rigging, feel of the controls, weight, etc.), (c) the check pilot's manner of administering the flight-check, i.e., whether he is patient or impatient, uses praise or blame, etc.

5. Pilot performance is undoubtedly affected by changes in the physiological and mental condition of the pilot himself. Furthermore, an examinee on a second flight can improve one aspect of his performance at the expense of another.

6. The performance of the pilot is seldom recorded until after the flight is completed, which introduces the variable of differences in the ability of check pilots to remember what was done.

7. Check pilots have different standards of performance due to differences in their own proficiency or differences in their training.

8. Check pilots differ in their judgment of what aspects of the pilot's job are most critical.

9. Check pilots have different conceptions of a grading system. Some use it to justify their over-all impression of an examinee, some try to obtain a diagnostic picture of the pilot's strengths and weaknesses. Some use it to show progress in training, i.e., low ratings are given at first, high ratings later. Others use it to show differences among examinees at the same level of training, i.e., the best pilot among a group of pilots just beginning training would receive a high rating even though his proficiency is low compared with a trained pilot.

These factors contribute to the unreliability of pilot measures in two ways. First, they reduce the amount of agreement between two independent observers of the performance of a pilot on a single flight — the "observer-observer" reliability. Secondly, they reduce the amount of agreement between two observers, each of whom evaluates the performance of a pilot on a different check-ride -- the "ride-ride" or "test-retest" reliability. This last reliability measure gives an indication of the degree to which the flight-check measures permanent or consistent behavior of the pilot. The criterion of reliability established in this study for the evaluation procedure includes both the observer-observer and the ride-ride reliabilities.

How high these reliabilities must be before a pilot proficiency measure is considered adequate is a question that must be answered arbitrarily. The goal in this study was to achieve reliabilities which would be higher than those obtained with procedures used at present or with experimental procedures developed in previous studies. The objective flight-checks developed by aviation psychologists in the Army Air Force and reviewed later in this paper set a fairly high standard for reliability. In this project, however, several new techniques were employed which, it was hoped, would result in even higher reliabilities.

The Problem of Relevance

The job of developing a measure of pilot proficiency which is relevant or valid is far from a simple task. Relevance refers to the extent to which the test measures behavior of the pilot which is related to success or failure on the actual job. Consequently, it is important to devise a test which not only measures permanent or consistent skills of the pilot but also measures skills that are relevant. The investigator is faced with the problem of first selecting relevant tasks for his test and then evaluating the extent to which the test scores relate to success or failure on the job.

The selection of relevant tasks in flying is difficult for a number of reasons, some of which are:

1. It is inadvisable to devise tasks which require the plane and the pilot to be subjected to testing conditions which are as critical as the actual conditions of airline flying. Many of the actual conditions can be simulated, but others cannot.

2. The cost of operating modern high-powered aircraft prohibits long test flights. Consequently it is necessary to limit test flights to what is considered to be a "reasonable" length of time by the operators of the planes.

3. It is not possible during a routine passenger flight to measure all of the critical skills required of an airline pilot, because the presence of passengers prohibits the performance of a large number of essential maneuvers, such as engine-out landings, steep turns, etc. Thus, special check-flights must be utilized; yet on-the-job evaluation procedures are in other respects more relevant than these check-flights for measuring such skills as navigating, weather flying, etc.

4. There is much disagreement among expert pilots as to which tasks are the most relevant.

5. That which is a relevant task for measuring flying skill in one airplane may be quite different for measuring skill in flying other types of planes.

These are some of the difficulties facing the investigator in selecting test situations which are relevant. In this study an attempt was made to select relevant tasks by relatively systematic methods, yet it was found necessary to forsake rational methods when practical limitations made it inadvisable to include certain tasks in the evaluation procedures.

Not only is it difficult to select relevant tasks for inclusion in the evaluation procedures but it is equally difficult to test the procedures for relevance. The lack of a highly reliable and acceptable criterion of pilot proficiency is well known to psychologists who have done research in aviation. The aviation psychologists in the Army Air Force not only found existing criteria of flying proficiency unreliable, but also had difficulty developing adequate new criteria. Flanagan, Crawford, Dailey, Cowles, Henneman, and others (14, 9, 2, 6) have reported several research projects directed toward the examination of sources of criterion measures of pilot proficiency. It was found, in general, that no single proficiency measure covered the entire range of pilot duties with sufficient thoroughness. The need for an absolute criterion of pilot proficiency in terms of the basic requirements for overall flying proficiency was not satisfactorily met. Some of the criteria which have been investigated are:

1. Frequency of accidents
2. Pass or fail at various levels of training
3. Combat success
4. Proficiency and achievement records in training or on the job
5. Experience level
6. Judgment of experts

Frequency of accidents is an inadequate criterion of proficiency for the reason that too few accidents occur or have occurred in commercial airline flying. Even if it were possible to administer an experimental flight-check to an extremely large number of airline pilots, it is certain that only a small fraction of these would later have accidents.

A pass-fail criterion is easy to obtain if the group selected for testing is in training. This criterion was used extensively in the Army Air Force (18). Its disadvantages are that it gives only a two-fold classification of the subjects and that it is not always reliable itself. Its reliability, however, is generally higher than ratings on a single subjective type flight-check, because a pilot is seldom failed without being given flight-checks by several check-pilots.

Combat criteria were investigated extensively in the last war for validation of pilot selection methods, but were not used for validation of pilot proficiency measures. Such criteria are difficult to devise. As pointed out by Flanagan (6), there are many attenuating factors which obscure relationships between combat criteria and selection or evaluation measures. There are differences in opportunity to achieve combat "success," and there are differences in standards of success as used by superior officers in rating individuals under their supervision. Such factors require that very large samples be used in order to obtain satisfactory combat criteria. The aviation psychologists found, too, such biasing factors as the tendency for those receiving their training early in the war to receive higher ratings of combat proficiency. To control all such biasing factors is a difficult task.

Records of the performance of pilots in training or on the job potentially represent a good source of criterion data, for these records contain the evaluations made by a number of different check pilots on each pilot over a period of time. These records, however, have certain characteristics which reduce their adequacy as criteria. Some of these characteristics were apparent in the study of records made in this project and later reported in this paper. First, it is seldom that the records themselves have been kept carefully. Secondly, forms used by different airlines are not standardized. Thirdly, the forms used in each airline company are changed frequently. Lastly, there is evidence of the operation of a generalizing tendency in most records of this kind. That is, check pilots tend to give the same rating on all aspects of a pilot's performance.

The use of the criterion of differences in amount of training and experience is based upon the assumption that training curricula teach relevant kinds of flying skills or that experience itself assures the acquisition of relevant flying skills. If this assumption is correct, then a measure of the relevance of a test of flying proficiency would be obtained by administering the test to a group of airline copilots and a group of captains. It was hoped that this could be done in this project, but these plans did not materialize for reasons which will be pointed out later in this paper.

In lieu of adequate criteria of pilot proficiency the judgments of "experts" can be used as a measure of the relevance of the evaluation procedures, although this method is inferior to validation procedures. Furthermore, if the development of the procedures is based upon a careful study of the critical requirements of the pilot's job, the procedures will be relevant provided the test requires the pilot to perform tasks which call forth the critical kinds of behavior. In this study the investigator has relied heavily upon a thorough study of the pilot's job with an emphasis upon discovering the most critical requirements of the job. The relevance of the procedures developed from the job analysis also was checked against the judgment of a large group of "experts."

The Problem of the Acceptability of the Procedures

The problem of having new pilot evaluation procedures accepted by the operating agency has troubled most of the previous investigators in this field. Although several studies have reported the development of improved pilot proficiency measures and although aviation psychologists have known for at least ten years that the traditional methods are unreliable and nondiscriminative, the present study revealed that all of the major agencies employing pilot evaluation procedures still use the same basic method — that of rating large work-samples. Some of the reasons why it has been difficult for aviation psychologists to get their procedures adopted and put into application by the agencies for whom they have been developed are:

1. The agencies demonstrate a natural resistance to change which the researchers have not always dealt with as skillfully as they have the development of the measures themselves.

2. In an effort to develop flight-checks which are comprehensive, some investigators have developed procedures which call for the check pilot to record, in the air, a large number of observations. This meets with the objection of check pilots that the procedures are too complicated and too dangerous to use in the air. On the other hand, a flight-check which limits the observations to a small number is criticized by check pilots on the grounds that it "doesn't cover enough."

3. Flight-checks have usually been developed for use with only one type of airplane. Inasmuch as most of the agencies that must evaluate pilots use more than one type of plane, the new procedures can never be adopted for their entire program. It is not logical to expect that these agencies will always develop the new forms for use with their other planes.

4. The researcher who tries to develop a <u>completely</u> objective flight-check may fall into the error of leaving out of his test critical components of the job simply because they cannot be measured objectively. In this case, the check pilots are likely to complain, "What about 'smoothness of handling controls' and 'speed of taxiing,'" or, "Why don't you include 'ability to plan ahead?'" However, if the investigator attempts to include items to cover such job components he is likely to hear, "Who is to determine what a safe taxiing speed is -- it's all 'relative.'"

5. In striving for objectivity it is sometimes easy to fall into the error of constructing items which call for the check pilot to use points of reference which are not used by him in actual practice. For example on an instrument takeoff, during which maneuver the check pilot has to be constantly watching outside the cockpit, he will find it difficult to accept an item which calls for him to use the gyro-compass as a reference point, even though a more objective evaluation of direction could be obtained if he used this instrument. Check pilots, consequently, object strongly to items which force them to use unnatural points of reference.

6. There is also the "scoring dilemma." The check pilots will say, "Flying can't be reduced to points." Or they may challenge the investigator with, "What are you trying to do -- eliminate the check pilot entirely from evaluating the pilot?" Check pilots generally feel that performance on a check-ride must be evaluated "as a whole."

7. Another argument against quantifying performance is tied up intimately with the complicated configuration of attitudes and feelings of labor toward management. This problem was not encountered by previous investigators, inasmuch as most of their work was with government or military agencies. In this study, however, it was learned that labor takes the view that a method which "in any way separates the excellent pilots from the very good pilots, from the good pilots, etc., is entirely wrong and has the grave potential of causing serious labor-management difficulties."[1]

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[1]Taken from a letter written to the writer by the President of the Air Line Pilots Association.

CHAPTER III

OBJECTIVE MEASURES OF PILOT PROFICIENCY DEVELOPED BY PREVIOUS RESEARCH

Previous research aimed at the development of more objective methods of evaluating flying skill has been concentrated in the military services and in the Civil Aeronautics Administration private pilot program. By far the bulk of this research has been done by the Committee on Aviation Psychology of the National Research Council and by the Aviation Psychology Program of the Army Air Force. These two groups, along with the Royal Air Force, the Royal Canadian Air Force and the United States Navy, have developed pilot evaluation procedures which fall into three general types: (1) graphic and photographic procedures, (2) rating procedures, (3) objective-observation procedures.

Graphic and Photographic Procedures

The graphic method of recording flight performance involves the use of a mechanical flight recorder which records the effect of accelerations upon masses which are free to move in restricted planes. Photographic methods involve the utilization of motion photography to record the readings of flight instruments. A recorder of the movement of the flight controls is used in conjunction with the photographic method. Viteles and Backstrom (24) made a very thorough study of the R-S Ride Recorder and attempted to utilize the recorder for measuring flight performance. Two methods of analyzing the records qualitatively were examined: (1) rough quantification of the traces made by the instrument on waxpaper charts and (2) a description and clinical evaluation of the records. There was a significant and high degree of association between the two methods of analysis. Test-retest reliability was also fairly high, but the investigators caution that the ratings were not independent due to recognition of individual records resulting from growing familiarity with the records. The validity of the ratings as descriptive of the recorded flight performance was assumed, inasmuch as the traces were an objective record of the flight and the ratings based upon the traces were reliable and represented relative degrees of excellence of performance as compared with an aerodynamically ideal performance. The ratings, however, were not significantly associated with the pilot proficiency criteria of level of license held by the subjects and amount of flying time in the testing airplane, although the contingency coefficients were consistently positive.

In the second part of this study (19) quantitative scoring methods were used on the graphic records of the same 28 pilots. Some of the quantitative indices differentiated the three levels of experience represented in the group of students. Not every index differentiated all three experience groups and some of them did not differentiate any of the three groups. The five quantitative indices had reliabilities ranging from .09 to .84 with respect to consistency of performance on successive flights.

Williams, Macmillan and Jenkins (32) carried out studies of a different graphic recorder, the Friez analyzer. The flight-analyzer data did not differentiate between students rated "good" and "poor" in flying ability, even though this study utilized records of three maneuvers rather than only one, as in the previous study.

McFarland and Holway (15, 16) report studies involving the use of the Friez and Redhed recorders. Their results indicated that the apparatus furnished useful records of performance but gave no indication of the extent to which subjects met absolute flight standards. They criticize graphic methods in general on the basis that they fail to evaluate the performance of the pilot and rate instead only the performance of the plane. Consequently, they feel such methods do not provide a measure of the pilot's personal skills and judgment.

Using these results as a guide, the Civil Aeronautics Administration initiated work on the development of a new type recorder. This work, reported by McKay (17), has not progressed to the point where the recorder has been given extensive field try-out or experimental testing.

Using photographs of the instrument panel and control movements, Wapner, Festinger, and Odbert (29) obtained records of two successive flights made by students at approximately 35 hours of flight training. Photographs were taken of a number of instruments, making it possible to secure readings of nine different aspects of performance, such as: altitude, rate of climb, R.P.M., airspeed variation, ball bank deviations. Ratings based upon the films were made independently, but the ride-ride reliabilities of these ratings were very small. There was little evidence of a significant change in either direction in the performance of the pilots from the first to the second flight. The investigators caution against accepting a single flight as a criterion of proficiency and suggest that there is a need for more reliable methods of measuring pilot performance.

Viteles and Thompson (26, 27) describe the use of an improved photographic installation and the utilization of slow motion projection during the inspection of the films. The investigators on the basis of the photographs made ratings on different aspects of performance, made brief notes on specific items of performance, and assigned over-all ratings to the entire flight-check. Some of their ratings were made independently and some were composite ratings based on joint observation of discrepant cases. The final "Criterion Rating" resulted from a joint comparison of the two sets of composite ratings. Agreement between these various sets of measures on the same subjects was significantly high. Also the relationship between different sets of measures was high. Scores on an earlier flight predicted scores on a later flight to the extent of an r of .45, but this coefficient represents the relationship between scores assigned by the same observers. Furthermore, inasmuch as only two raters were involved, it is difficult to make generalizations concerning the reliability of these methods when used by a larger number of raters. As the investigators point out, the study does not indicate whether the photographed flight performance was representative of, or relevant to, the flight proficiency of the subjects.

In summarizing and evaluating the studies which have utilized graphic and photographic methods of measuring pilot proficiency, the following conclusions may be drawn:

1. The methods of recording the performance are highly objective but excessively costly in time and money.

2. The records themselves do not provide a measure of proficiency, so it is necessary to employ methods of evaluating the records. The reliability of these latter methods has not yet been established for graphic recordings and has been established for photographic recordings on only a small sample of raters.

3. Ride-ride reliabilities have not been adequately determined for either graphic or photographic methods in cases where ratings of the two rides are made by different raters and without knowledge of the ratings on the first ride.

4. Graphic and photographic records provide measures of what the plane is doing but not what the pilot is doing. Furthermore the methods do not provide a record of the plane's performance in relation to the ground. The measures are, therefore, not comprehensive.

5. None of the studies employing graphic or photographic methods has established the relevance of the observed performance with respect to flying proficiency.

6. These methods require specially equipped planes, and the equipment is costly.

7. The photographic records are not immediately available, requiring time for printing of the films. The rating of both the graphic and photographic records requires time and expense.

8. "When time and cost are relatively unimportant in comparison with accuracy and adequacy of data and when basic research is the primary aim, the graphic and photographic methods (and the resulting criterion data) have definite advantages" of providing a permanent record and of providing an opportunity for more than one observer to analyze the same performance (26, p.39).

Rating Methods

Mention has already been made of the study of Johnson and Boots (12) in which the Civil Aeronautics Administration rating-type of flight-check was found unreliable and non-discriminative. Viteles, Franzen, and Rogers (25) attempted to introduce weighting techniques to these procedures in order to learn if Civil Aeronautics Administration inspectors placed more emphasis upon certain maneuvers. The study found that certain maneuvers were more consistently related to flight failures than others, but there was no application of these results to the development of practical and improved procedures.

In 1940, Kelly (13) conducted a study in which an attempt was made to develop a rating scale for the evaluation of pilot proficiency at the private license level in the Civilian Pilot Training Program. The first form of the rating scale was a graphic type of scale calling for check pilots' subjective judgments on three aspects of pilot proficiency: (1) skill, (2) emotional stability, and (3) judgment. This scale was found to be wholly unsatisfactory due to high intercorrelations between the three items. Finally a fourteen-item scale was developed. Although the investigator apparently did not conduct a thorough job analysis from which to select relevant items, he does report that discussions with experienced pilots preceded the selection of items. A group of four hundred Civil Aeronautics Administration instructors were asked to select their best ten and their worst ten students and then rate them on the experimental form of the rating scale. From the analysis of results Kelly concluded that the items on the scale differentiated the two groups. In view of what is known about the tendency of instructors to use rating methods to justify their over-all judgments, this "validating" procedure is questionable. No reliability determinations were made, but a factor analysis isolated three factors: (1) skill, (2) judgment, and (3) emotional control. These factors, however, had fairly high intercorrelations when the various ratings in each factor were combined into a factor score. Wherry and Rogers (30) using the same data, but weighting the ratings, obtained much lower intercorrelations between factor scores. Although this study represents a step towards measuring more than one aspect of pilot proficiency, the scale itself remained unproven as a reliable, relevant and practical method of measuring pilot proficiency.

Rating methods were shown to be inadequate in a study by Festinger, Kogan, Odbert, and Wapner (5), in which an evaluation was made of a new type of scale developed in 1942 for the Civil Aeronautics Administration — Form ACA 342Z. The investigators concluded the ratings did not predict scores on a second flight-check and that the data indicated carelessness in observing, recording, and interpreting the form on the part of the check pilots.

Typical of some of the more elaborate and comprehensive rating methods are those developed in the Royal Canadian Air Force and Royal Air Force. These methods utilize the principle of standard flights in which prescribed maneuvers are performed by the examinee in a prescribed sequence. The advantages of the standard flight have been emphasized by Viteles and Thompson (27) and Edgerton and Walker (4), and they have been extensively utilized by other investigators in this country. In one study conducted at the Royal Air Force Empire Central Flying School (20), a method combining both objective observation and subjective ratings was evaluated. The method showed low test-retest reliabilities (.09, .12, .39, .42) and the investigators blame both the variability of the performance of the students and differences in the standards of observers. Reports of studies on present Royal Air Force methods of evaluating flying personnel have not appeared in the literature, but the procedures have been described (22). These methods have certain distinctive characteristics. They are definitely rating methods, but unlike other rating-type flight-checks they are extremely comprehensive. For example, the check pilot evaluates the examinee's competency in "warming up and testing the engines" by rating him on twenty-three separate items! Secondly, the Royal Air Force flight-checks require the examinee to perform an extremely large number of maneuvers. Each maneuver is broken down into smaller job components and the check pilot assigns a score on each. Each component has been given a "maximum" score as a guide for the check pilot. Failure on some of the items constitutes failure on the entire flight-check. No over-all final score is computed, but a profile of maneuver scores is provided on which the check pilot records a percentage score for each maneuver. Apparently whether or not an examinee passes or fails is not determined quantitatively but rather on the basis of the check pilot's judgment. Although lacking experimental data upon which to base an evaluation of these methods, the present investigator offers the following comments based upon his judgment of these procedures:

1. The procedures seem relevant, inasmuch as they are extremely comprehensive, requiring the pilot to perform job-related tasks.

2. The procedures, however, suffer from this comprehensiveness. A study of the most critical requirements of the pilot's job would seem to be in order so that the tests could be made less complex. It is doubtful if a check pilot could reliably observe all that he is required to observe. It is extremely doubtful if such a flight-check form could be used in flight.

3. No objective references are provided for the check pilot. He simply places a rating after the listed job component.

4. The idea of weighting items is a good one, and making some items so important that failure of any one means failure of the entire flight-test may be a useful procedure.

5. The profile provides a useful diagnostic picture of the examinee's performance.

Objective Observation Methods

In 1940, Edgerton and Walker (4) began work on a project, sponsored by the Committee on Aviation Psychology of the National Research Council, aimed at the development of a measure of private pilot proficiency which would be (1) more descriptive of what the plane and pilot were doing, (2) objectively scored, (3) more discriminating, (4) applicable for field use, and (5) more diagnostic and useful for criterion purposes. The procedures developed embodied (1) the standardized flight, (2) breaking down of maneuvers into smaller components, (3) liberal use of items describing the behavior of the pilot or the performance of the plane, (4) in-flight recording, (5) scoring of individual items, and (6) checklist type of items, e.g., the pilot does or does not perform an operation. The ride-ride reliabilities of the maneuver scores in the first form of the flight-check form were low ranging from -.13 to .56. Intercorrelations among items were high and the scores were not highly correlated with number of hours of flight training. This earlier version of the test was simplified and given an improved format. In a later study by the Committee on Aviation Psychology (19) further research was reported on the 1942 version of the Ohio State Flight Inventory. Two methods of scoring were devised, one a summation of maneuver grades and the other a profile score based upon the check pilot's qualitative evaluation of the entire performance. A correlation of .93 between these two types of scores on sixty-six cases indicated the amount of relationship between the two methods. An item analysis resulted in the development of a shorter form, scores on which correlated highly with scores on the longer form. The investigators point out several inadequacies remaining in the flight-check form: (1) it did not measure judgment aspects of piloting, (2) no adequate weighting method was found, and (3) it over-emphasized what the plane did at the expense of what the pilot was doing. Despite these inadequacies, the Ohio State Flight Inventory represents an important milestone in the development of improved methods of evaluating pilot proficiency. Maneuvers were broken down into smaller units, observations were made and recorded during the flight, the flight was made standard, and some items were of the objective type — that is, the check pilot uses instrument readings in recording the performance of the pilot. Those who later were to develop objective flight-checks found much to be learned from the Ohio State group's efforts. Two characteristics of the Ohio State Inventory, however, differentiate it from objective flight-checks developed later:

1. There is little use of the idea of "limits." The examinee, consequently, is not given a prescribed task to perform within certain limits of airspeed, altitude, heading, etc. The form, therefore, is more a record of observations than a test.

2. The standard item relating to airspeed, altitude, heading is one in which the examiner checks one of two alternatives, as for example:

   Altitude is . . . . (Constant /__/
   (Varies ___ ft.

   The serious objection to such items is that "constant" is not defined. If it means no variation, no pilot would ever receive that mark. If it means variation no greater than a certain amount, it would seem that that amount should be specified.

Walker, Wapner, Bakan, and Ewart (28) compared the performance of subjects as recorded by the Ohio State Flight Inventory with their performance as recorded by photographic methods. The number of check pilots was very small and comparisons were made on only five performance variables, so the results of this study are not conclusive. Nevertheless, the study suggested that check pilots' observations were far from accurate and that the degree of their accuracy should be determined more conclusively before routine use is made of the flight inventory.

Progress in the development of improved objective-observation types of flight-checks was accelerated by the efforts of Army Air Force aviation psychologists in World War II. Early in their program attention was concentrated on this type of measure of pilot proficiency rather than other types. An attempt was made to achieve absolute agreement among observers by using some permanent standard. Consequently, performance was defined where possible in terms of an instrument reading, a point on the plane, the position of the plane's wings in reference to the horizon, etc. With this type of measurement the check pilot makes an objective observation, then immediately records his observation by writing it down or making a check-mark on an appropriate scale or on a printed facsimile of the instrument dial. This represented an extension of the use of objective items as pioneered in the later forms of the Ohio State Flight Inventory.

Youts (18) reports the work done by personnel of the Army Air Force Psychological Research Project (Pilot) on the development of objective measures of flying skill at the primary level (first phase) of training. Working closely with "experts" in primary training, the investigators devised 256 items which were subjected to a preliminary try-out in the air. After the initial try-out of the item and consultation with the "experts," they selected 131 for more extensive try-out on groups of forty-five to ninety primary trainees. For each item, information was obtained on (1) reliability of test-retest on different days, (2) validity in differentiating between students differing in amount of training, (3) validity in predicting subsequent pass or fail in the primary training. Approximately 35 per cent of the reliabilities were significantly positive at the 2.5 per cent level or above. Also the same level of significance was reached by 25 per cent of those correlations indicating ability to discriminate between students at different levels of training and by 15 per cent of those indicating ability to predict subsequent pass or fail.

Additional studies made by this group were significant for throwing light on the sources of variation in measured flight performance. It was shown that the observer-observer reliabilities were higher than test-retest reliabilities, indicating that important sources of variation were outside of the observers, i.e., turbulence, differences in planes, variation in student's performance, etc. Of significance to the present study were the reliabilities of total scores obtained from summating scores on sixteen maneuvers. In one study sixteen of the best items were combined into a single flight-check, and reliabilities for the entire flight-check were computed. For two groups of forty-one and thirty-five students, test-retest reliabilities were .50 and .39. Most of this research at the primary level was aimed at the development of separate objective items rather than a comprehensive measure to test all of the critical skills of the pilot. Such a measure was prepared but not tested for reliability and relevance due to the end of the war. This flight-check contained the best of the individual measures developed in this program. One of these is reproduced below:

1. Take-Off, Climb, and First Turn

A. Application of Throttle During Take-Off Roll:
- (2) ____ Smoothly opens throttle to full position.
- (1) ____ Not opened full, uneven, or rammed.

B. At Take-Off, Student:
- (2) ____ Lets plane fly off.
- (1) ____ Pulls plane off the ground.
- (1) ____ Holds plane on ground.

C. A/S Range From 20 Ft. to Level-Off:
Check Highest and Lowest A/S.

←55	60	65	70	75	80	85	90→ m.p.h.
9	8	7	6	5	4	3	2

D. Altitude Range During First Turn:
Check Highest and Lowest.

←100	80	60	40	20	300 Ft.	20	40	60	80	100→
Less-Feet						More-Feet				
0	1	2	3	4	5	6	7	8	9	10

The use of multi-engine aircraft at the advanced level of training for further research in the development of objective flight-checks in the Army Air Force offered two advantages: (1) the observer sat side-by-side and could observe performance in greater detail and (2) there was room for a second observer. Ericksen (18) reports a study in which both subjective and objective types of items were included in a flight-check booklet and administered on two successive flights to the same group of 108 Army Air Force pilots with a different check pilot on each flight. The check pilots had not flown with the examinees before. The present investigator participated in the construction and administration of this flight-check. Twenty of the items were of the objective-observation type and eighteen of the subjective type. The two types had approximately equal test-retest (ride-ride) reliabilities, the median reliability for the former being .27 and for the latter .26. A sample maneuver from this flight-check is shown below:

SLOW FLYING

"At 4,000 Feet, With a Heading of 90°, Begin Slow Flying at 45 M.P.H. (UC-78) or 50 M.P.H. (AT-10). Maintain This Altitude and Heading.

To the rater.--Make observations during a 3-minute period, beginning with moment student reduces throttles. At the end of this time, cut the right mixture control.

1. Altitude deviations: Lowest ______ ft.
   Highest ______ ft.
2. Directional control: Starting heading ______ °
   Heading of maximum deviation ______ °
3. Air-speed control: Lowest ______ m.p.h.
   Highest ______ m.p.h.
4. Use of throttles to check approaching stall:
   _____ excellent
   _____ good
   _____ fair
   _____ poor
   _____ never approached a stall
5. Attitude of plane during maneuver:
   _____ nose too high
   _____ three-point
   _____ nose not high enough
   _____ fluctuated between too high and not high enough

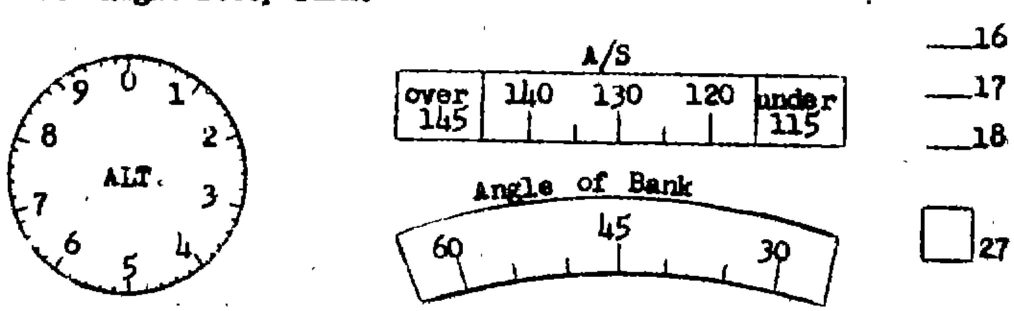
A revised twin-engine objective flight-check was later constructed in which certain principles were incorporated: (1) items were constructed so that check pilots did not have to write in maximum instrument deviations but could record successive deviations on a printed scale, (2) aspects of the job which could not be evaluated objectively were omitted. In other words, the final recommended flight-check did not include measures of all of the critical components of the pilot's job.

Ericksen (18) reports further attempts to develop objective measures of instrument flying skill at the multi-engine level of training in the Army Air Force. In the first study three different methods of scoring objective items were compared: (1) time sample, (2) range, and (3) limits methods. The investigators concluded that these methods yielded similar observer reliabilities, test-retest reliabilities, and validities. In another study a 34-item flight-check was administered to eighty advanced school students in an attempt to measure instrument flying skill in the B-25. The median odd-day versus even-day reliability for the thirty-four items was .25, based upon six administrations of the flight-check. These correlations ranged from -.25 to .64. It is significant that repeated administrations did not produce reliabilities higher than those obtained between only two administrations of the same flight-check. A third study involved the comparison of two groups of students only one of which had been given training involving daily evaluation of their skill by means of an objective flight-check. Both groups were given a similar objective flight-check at the end of their training. The results indicated that the group which had received training with the objective flight-check did significantly better than the other group on eleven out of fourteen of the flight-check items.

Hagin (18) summarizes the work on the development of objective measures of single-engine instrument flying in the Army Air Force. Of significance to the present study is one in which an 81-item scale was administered to sixty students on two rides on successive days by two different check pilots, none of which was a student's regular instructor. The item reliabilities ranged from -.32 to .40, 26 per cent being significant at the five per cent level of significance or better. The test-retest reliability of the total flight-check score was .46. The correlation between the total score and instructors' ratings of their students' instrument proficiency was .51. A sample item from this flight-check is reproduced below:

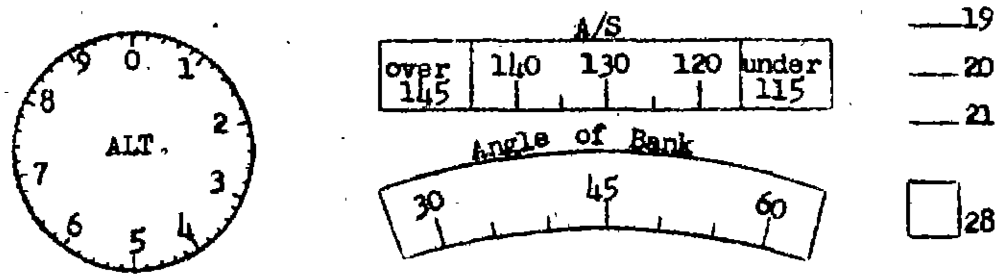
STEEP TURNS: "Set D/G on 0°. Now do a steep turn to the right with 45° of bank. Roll out on a heading of 180°. Use power if needed to hold your air speed." (Grade from start of turn to level flight.)

1. Right Steep Turn.



"Turn to a heading of 180°. Now do a steep turn to the left with 45° of bank. Roll out on a heading of 0°."

2. Left Steep Turn.



It is difficult to summarize all of the results of the work on the development of objective-observation type of flight-checks. Some conclusions are apparent from the results reviewed in this paper. Others are based on the accumulated experiences of the Army Air Force aviation psychologists, the implications of which are summarized by Miller (18). The following facts and principles seem to have a bearing on the present study:

1. Some objective-observation type flight-checks were shown to have high observer-observer reliabilities (as high as .80 or above on more than half of the items) and fairly high test-retest reliabilities (as high as .46 for an entire flight-check).

2. Reliabilities of objective items scored by different methods are not significantly different.

3. To make a flight-check comprehensive, relevant, and acceptable to training personnel some subjective items must be included.

4. Low test-retest reliabilities indicate the operation of a number of factors which cause day-to-day variability in the performance of pilots. This may be a function of external conditions affecting the flight of the plane or it may be a function of the kind of performance which is being evaluated, i.e., transitory aspects of performance rather than consistent qualities.

5. The most accurate measure of the reliability of pilot proficiency flight-checks is that in which comparisons are made between scores obtained on different flights administered on different days by different check pilots who know nothing about the skills of the examinees. Odd-even or split-half methods will greatly overestimate the kind of reliability which has practical significance.

6. No single method of combining maneuver scores into a total flight-check score was found superior to other methods. Combining by utilizing beta-weights, weights determined by expert pilots, or no weights at all yielded approximately equal reliabilities.

CHAPTER IV

DETERMINATION OF THE CRITICAL REQUIREMENTS OF THE AIRLINE PILOT'S JOB

The first step in the development of an evaluation procedure for a particular job should be the determination of the critical requirements for the job. The job of the military pilot previously had been studied by means of various job analysis approaches, but no adequate job analysis of the commercial airline pilot's job had been made at the time this study was initiated. Consequently, the plans for the project called for a job analysis as one of the first steps to be taken.

The General Approach Used in Determining the Critical Requirements of the Airline Pilot's Job

Frequently Used Job Analysis Methods

Although there is general agreement as to the desirability of basing an evaluation procedure on an initial job analysis, there is little agreement in regard to the techniques of job analysis which should be employed. Techniques employed have varied from the "armchair" approach, in which the psychologist relies upon his judgment of what is probably necessary for carrying out a particular job, to approaches utilizing detailed and elaborate time and motion study techniques.

One of the most useful procedures is for the investigator to learn the job himself, thus gaining first-hand knowledge of what seems to be required on the job. It is not always possible, however, for the investigator to learn the job, especially when the job requires highly specialized skills or extensive training. Even when it is possible, this method is usually expensive and time-consuming. The present investigator came to this project already trained as a military pilot and has found this experience extremely valuable at all stages of the study.

Psychologists in the past have also utilized systematic observations of the workers themselves as a means of learning about a job. This technique may be used to provide the analyst with a detailed description of what the workers do. Some analysts have utilized more elaborate observational techniques involving such techniques as photography or time-sampling.

Another frequently used technique of job analysis is that of contrasting the performance of a group of successful and a group of unsuccessful workers on standard test or work situations. The limitations of this approach stem from the difficulty of finding a reliable criterion upon which to base the choice of the two groups. A variation of this method is the utilization of records of the performance of workers in an attempt to find evidence of differences between successful and unsuccessful groups.

Psychologists have made use of the method of asking the workers to supply detailed descriptions of their activities or to write lists of the traits and abilities which they feel are required on the job. Frequently the same information is obtained from supervisors or even from top management.

No matter which of these job analysis methods is used, it is still necessary for the psychologist to translate the observational data into measurable units and then to determine the relative importance of each of the units with respect to success or failure on the job. In the past there was a tendency for the psychologist to infer from his observational data certain general traits, abilities and characteristics, such as intelligence, honesty, and stability. These descriptive terms became the items in the evaluation procedure and the workers were rated as to the degree to which they possessed such requirements. In some of the pilot proficiency measures being used at present, examples of such items have been found, e.g., "judgment," "skill," and "technique." Serious disadvantages of such terms have been recognized, for they are ambiguous and mean something different to each person who attempts to rate the extent to which workers manifest such attributes. Furthermore, many of the same general characteristics were soon found to be important for a large number of jobs, hence decreasing the value of job analysis procedures as a means of differentiating the requirements of different types of activities.

The Critical Requirement Approach

In order to eliminate the ambiguity and lack of discrimination inherent in job requirements expressed in general qualities, psychologists have begun to utilize behavioral descriptions of the requirements of a job. The requirements are stated in terms of what the worker must do to be successful on the job. This step represents a significant advancement in job analysis methods, although the practice by no means has become universal. Extensive use was made of this approach in many of the research studies of aircrew positions in the Army Air Force Aviation Psychology Program. It has been described clearly by Flanagan (6). Because of the advantages of obtaining behavioral descriptions of the requirements of the pilot's job, an attempt was made to utilize in this study those methods of job analysis which were considered most likely to produce requirements in terms of the pilot's actual behavior on the job.

An attempt was made also to employ methods of studying the pilot's job which would provide information as to the relative importance of the different requirements of the job. What was wanted was not merely a list of requirements but a list of the "<u>critical</u> requirements." "Critical requirements" are defined as those job requirements, expressed in behavioral terms, which have proved to be important factors in differentiating successful and unsuccessful performance on the job. The assumption underlying this definition is that the most critical differences between the effective and the less effective pilots will be revealed by focusing the job analysis upon situations where the behavior of pilots has proved to make a difference. To use a common expression of pilots, the critical requirement approach attempts to determine exactly "what separates the men from the boys." In most job analysis approaches it is common practice to submit a long list of job requirements to experts for judgments of the relative importance of the requirements for success on the job. By employing the critical requirement approach, the psychologist expects at the outset to obtain only those requirements which have proved to be critical. To accomplish this he utilizes all available sources of information which will contain evidence that particular skills or modes of behavior are critical.

In the present study five different sources of critical requirement information were examined:

1. Records of effective and ineffective achievement of airline pilots during their training.

2. Records of unfavorable comments made by check pilots on the flight-check forms of eliminated pilots.

3. Records of accidents.

4. Critical incidents which pilots had experienced and in which they had performed in such a way as to cause a near-accident or close call.

5. Specific errors made by eliminated pilots during their flight-checks, as reported by check pilots.

The procedures employed in examining these five sources will be presented in detail in the next section of this chapter. The data obtained from each of the five sources will be presented in the last section of this chapter.

Procedures Used in Examining Sources of Critical Requirement Information

Records of Achievement in Training

Each airline company maintains some kind of personnel record on each pilot presently employed and on those pilots who were hired but subsequently eliminated. Permission was obtained from one airline company to make a preliminary investigation of its files prior to examining the files of the other airlines. On the basis of this pilot study standard procedures were developed and used with additional airlines. A standardized form was prepared on which the desired file data were to be recorded. This form, called the "Company File Report Form," is reproduced in Appendix A. The method employed at each company was to obtain available achievement information on each pilot eliminated from the company during the period between initial hiring and time of "qualifying" as an airline captain. All the pilots eliminated in the previous five years were to be included in the sample. This group of eliminated pilots constituted an experimental group (the E-group). Then the same information was extracted from the files of an equal number of pilots presently employed as copilots or captains, matched with the E-group pilots on the basis of the approximate date of employment with the company. These pilots constituted the control group (C-group). All the work of recording the information from the files was done in the offices of the airlines, no names were used, and other identifying information was deleted.

The records of 432 pilots from five different airlines were examined and recorded. Of these, 288 were in the E-group. Records were obtained for only 144 C-group pilots due to the unforeseen reluctance of several local chairmen of the Air Line Pilots Association to having the files of currently employed pilots examined by individuals outside of the company. Before this matter was cleared up the study had progressed too far to return to this stage.

In the personnel files of the companies there were a number of records of scores, ratings, and comments on the achievement of the pilots in ground and flight training. The ratings given to E-group pilots on the last recorded flight-check administered before elimination were compared to the ratings given to C-group pilots on an identical flight-check given within plus or minus two months of the E-group flight-checks. The purpose of this comparison was to determine if there were significant differences between the matched groups in their performance on any of the maneuvers given on routine flight-checks. Most of the pilots had received ratings on a three-point scale corresponding to "Above Average," "Average," and "Below Average." A few received ratings on a four-point scale, "Excellent," "Good," "Fair," and "Poor.". After examination of the distribution of ratings on the four-point scale it was decided to convert these ratings to a three-point scale by grouping together the "Excellent" and "Good" ratings and considering these comparable to "Above Average" ratings. A score of three was assigned to "Above Average" ratings, two to "Average" ratings and one to "Below Average" ratings. The results of this study are presented in a later section of this chapter.

Records of Unfavorable Comments on Eliminated Pilots

On most of the flight-checks on file with the airline companies there were comments which had been written by check pilots. These comments related to the performance of a pilot on a particular flight-check. Some of the comments were descriptions of specific errors made by the pilot, others were descriptions of traits or general characteristics inferred by the check pilot from the performance of the pilot. Because the E-group pilots received most of the comments which were on the flight-check forms, it was decided to use only the comments on eliminated pilots. There were 1,214 unfavorable comments made by check pilots on the 288 eliminated pilots from five airline companies. Of these, only 265 were stated in behavioral terms and were related to the performance of the pilots. The remainder were stated in terms of various traits and characteristics. These data are summarized in the last section of this chapter.

Accident Records

In keeping with the general approach of utilizing sources of information on the critical requirements of the job, it was planned to make an analysis of the behavior of pilots which had contributed to accidents. It was felt that reports of accidents in which the behavior of pilots had been a contributing causal factor could be considered as evidence of the "criticalness" of various requirements of the job. The assumption is that if many accidents are caused by pilots forgetting to retract the landing gear, for example, then remembering to perform such an operation is a critical requirement of successful functioning on the job. The Civil Aeronautics Board maintains records of the investigations of all aircraft accidents. After a preliminary examination of these records it was decided to make a study of all domestic accidents of the scheduled commercial airlines for the period of 1938 through 1946, in which the behavior of the pilot had been judged to be a contributing factor in the accident. The judgment of the accident analysts of the Civil Aeronautics Board was accepted as the criterion for inclusion of an accident in the sample used in this study. From these accident reports were extracted the following data, although not every report contained all of this information:

1. Type of plane.
2. Time of accident (day or night).
3. Flight reference at time of accident (instrument, contact, simulated instrument).
4. Phase of flight at time of accident.
5. Description of the circumstances leading up to or surrounding the accident.
6. Description of the contributory behavior of the pilot.

A total of 185 accident reports were extracted from the files, but 64 were discarded because of insufficient data or insufficient evidence that the pilot behavior had been a contributing factor. This left a total of 121 accidents in the sample. These data are summarized later in this chapter.

Critical Incidents

Although accidents were considered to be a rich source of information about the critical requirements of airline pilots, it was recognized that the number of airline accidents would be small. Also it was felt that the critical requirements should be based upon other kinds of critical behavior than just those which had caused accidents, inasmuch as there are more criteria of pilot proficiency than safety. To accomplish this it was decided that the critical incident technique would be employed.

The critical incident technique.--This technique was utilized in the Aviation Psychology Program in several studies of combat leadership described in the volume edited by Wickert (31) and in studies of mission failures described in the volume edited by Flanagan (6). The name, "Critical Incident Technique," however, was apparently not used until it gradually emerged as the label for the technique during the course of the present project and a similar project carried out by the American Institute for Research on the evaluation of Air Force officers.[1]

The technique involves the collection of a large number of incidents in which the participants in the job being studied have actually demonstrated particularly effective or ineffective behavior. These incidents may be

[1]This study was under the immediate direction of H. O. Preston, American Institute for Research.

collected by means of the individual or group interview or by questionnaires. They may be obtained from the participants themselves, from supervisors of the participants, or from any others who have an opportunity to observe and evaluate the performance of the participants. Instead of relying upon statements of opinion as to what is required for the job, this technique utilizes first-hand accounts of actual incidents involving critical behavior, furnished by those who know the job best. The technique does not require the participant to formulate critical requirements in terms of traits, abilities, and characteristics, as do some other job analysis techniques. Rather it calls upon the worker to report the type of information he is best fitted to supply — namely, actual experiences and observed incidents. The technique is an economical way to obtain a large amount of job information which the investigator could not duplicate even if he learned the job himself.

In order to insure that the incidents collected will provide the best data from which to derive the critical requirements certain precautions should be taken:

1. Questions must be stated so that incidents are reports of actual behavior either experienced or observed by the interviewee, not situations handed down from others.

2. In order to avoid getting only dramatic incidents, the questions should ask for the "most recent" or "last" situation. This helps insure getting a representative sample of critical incidents. It also helps limit the incidents to those that are easier to remember.

3. Interviewers should make sure that the interviewee has included enough detail in the incident to permit others to understand and classify it. This detail should include circumstances, a step-by-step account of everything that the participant did, a description of the behavior of others involved in the incident.

4. The questions should be so stated and the interviewers should be so instructed that incidents include only reports of what was actually observed, not inferences as to the underlying traits or characteristics which were involved.

5. The questions should be so stated that the interviewee reports incidents about which he has definite convictions as to the effectiveness or ineffectiveness of the behavior observed in the situation. If several behaviors are involved, the interviewer should try to learn which behavior was the most effective

General plan of the interview program.—It was decided that the critical incident technique would provide the bulk of the data for the determination of the critical requirements. The individual interview was selected as the means of obtaining critical incidents primarily for the following reasons:

1. It was felt that the purpose of the study could be transmitted to the pilots better in a personal interview.

2. It was felt that an interviewer could reduce the amount of resistance which it was expected would be shown by pilots when asked to relate an incident in which they erred in some way.

3. It was hoped that the interviewer would make sure that the pilots related incidents in sufficient detail to enable the investigator to extract the specific behavior of the pilot from the incident.

4. It was expected that pilots would have definite feelings and attitudes about the problem of evaluation, the Civil Aeronautics Administration, psychologists, management, safety, etc. The interview would allow them to release such feelings.

Originally, the project plans called for interviews with pilots, airline company check pilots, Civil Aeronautics Administration check pilots (or examiners), control tower operators, and airline supervisory personnel. A preliminary try-out of interviews with control tower operators indicated that this was not a promising source of information pertaining to the behavior of pilots. Supervisory personnel were contacted, but primarily for the purpose of explaining the project and obtaining their permission to interview their pilots and examine the personnel files of the airline companies. The general plan was to devise questions which would elicit incidents which the interviewees had experienced themselves and which had been brought on by some kind of ineffective behavior on their part. In order to insure obtaining incidents which would be typical, rather than only the dramatic or unusual incidents, it was decided to ask each interviewee for the "last incident" or "the most recent incident" which he had experienced. It was also decided to use other questions for the purpose of giving the pilots an opportunity to express their attitudes and to give their opinions about the problem of evaluation and about causes of unsafe airline flying. The general procedure was to devise tentative questions and to try these on a small sample of interviewees prior to deciding on the final group of questions.

<u>The pilot interviews</u>.--Following a try-out of a number of different questions, nine were selected for inclusion in the standard interview with pilots. The first two were designed to elicit critical incidents and the remainder were for the purposes indicated above. The nine questions used are listed in Appendix B in a booklet called, "Questions for the Airline Pilot Interview." This booklet was given to each interviewer. It contains a fuller explanation of each question, its purpose, the information which the question was intended to elicit, and examples of satisfactory answers taken from recorded preliminary interviews. Comments as to the adequacy of the interviewers' techniques were added following the sample answers. These questions were reproduced on an 8 1/2 by 11 inch heavy card for use by the interviewers during the interviews. Below each question was listed the essential information which the interviewer was to obtain by the question.

Each interviewer was given a manual which contained a description of the project; a description of the general plan of the interviewing program; an explanation of the nature of the type of interview desired; comments as to desirable attitudes for a skilled interviewer; a discussion of interviewing techniques, such as ways of initiating an interview, introducing the questions, responding to the interviewee, note-taking and handling various problems which frequently arise during an interview; an explanation of how to arrange the interviews; and instructions for reporting the interview data in the booklets specially prepared for this purpose. The "Manual for Interviewers" is presented as Appendix C.

A form was devised to be used for recording the information obtained in the pilot interviews. These forms served the function of having the interview information reported by all the interviewers in a standardized way. Information given in response to each question of the interview was thus recorded on a page designated for that information. This greatly facilitated the processing of the information.

The nature of the interviews.--In order to accomplish the objectives of the interview, it was decided that an attempt would be made to utilize some of the principles of the non-directive type of interview in this situation. Some structure was provided by the standardized questions which defined the areas in which discussion was to take place. Nevertheless, the interviewers were instructed to use techniques which would encourage interviewees to feel free to express any attitudes, opinions, or feelings. An effort was made to foster in the interviewers certain basic attitudes which have been found to be desirable in this type of interviewing, such as:

1. The interviewer should consider the interviewee as an individual rather than as a statistic or as just another source of data. Because the interviewee is an individual, he will have feelings, he will want to feel important, he will cherish his own ideas and beliefs, he will defend those ideas if he feels they are not accepted, he will be cautious and at times even suspicious.

2. The interviewer should assume the role of a neutral person. He has nothing to defend, no preconceived ideas as to what is correct or incorrect. He is not a judge.

3. The interviewer should take the attitude that he is not the expert -- the expert is the interviewee. It is the interviewee who knows his field and the interviewer must rely on the expertness of the interviewee in order to obtain the data for this study. It is a mistake for an interviewer to attempt to show how much about flying he knows. "A little knowledge is a dangerous thing" is even more applicable in an interview with someone with years of accumulated knowledge.

4. The interviewer should be willing to let the interviewee take the responsibility for carrying on the interview. His attitude should be one that says, "You know more what to tell me than I do." The interviewer only decides the area by asking his questions, then directs his efforts at encouraging responses to the questions.

Interviewers were instructed to begin the interview by informing the pilots of the following:

1. That the interviewer represents the A.I.R. which has been authorized by the C.A.A. to carry out this investigation, and that the project has been discussed with the Air Line Pilots Association, which has informed all council chairmen and officers of the project.

2. That the purpose of the study is to get as complete an understanding as possible of the job of airline pilots in order to determine what specific qualities and characteristics good airline pilots have which differentiate them from poor airline pilots.

3. That such an understanding is necessary in order later to determine fair and accurate ways of selecting and certifying airline pilots.

4. That the investigators feel that pilots (or CAA examiners, check pilots, etc.) are in an excellent position to give help on this problem

5. That in this study we are not dealing with the individual pilot but only with pilots in general. Similarly we are not using the names of the particular persons contributing their opinions and ideas to this investigation.

Interviewers were instructed to take notes during the interview, being cautioned that when interviewing is done in a field with which interviewers are not too familiar gross misinterpretations occur when interviewers take insufficient notes and rely too heavily on their memory. It was suggested, too, that interviewers try to record verbatim statements.

Establishing the interviewing program in the field.--Eighteen cities were selected as places for interviewing. These particular cities were selected because of both the availability of pilots and the availability of psychologists who could supervise the program at each locale. Each supervisor was assigned a quota of pilots to be interviewed based upon estimates of the number of pilots available in his city. Supervisors were asked to assume the responsibility for selecting and training interviewers. They were encouraged, however, to select men with experience in interviewing as well as some familiarity with flying. A large number of the interviewers fulfilled these requirements, although it became apparent that one or two of them lacked either sufficient interviewing skill or familiarity with pilot jargon. A small number of interviewers were ex-pilots. Almost all of the interviewers were graduate students in psychology or related fields. Supervisors were requested to make certain that their interviewers became thoroughly familiar with the information prepared for them by the central office staff and the procedures for carrying out the program. Supervisors also were requested to conduct training sessions during which these matters would be discussed. Supervisors were asked to have each interviewer conduct an early interview in the presence of either the supervisor or another interviewer, during which each would fill out an Interview Summary Form independently. The two forms were to be compared, and the techniques of the interviewer discussed. These two forms furnished data for a rough check on the reliability with which interview information was recorded and reported.

There were fifteen such interviews conducted. The recorded information obtained from those questions asking pilots for examples of critical incidents provided the data upon which was based the comparison of the records of the interviewer and his observer in each of the interviews. The fifteen interviewers reported forty-five incidents. There were five different kinds of information which interviewers were requested to obtain about each incident: (1) type of plane, (2) time of incident, (3) flight reference (instrument, contact, or hooded), (4) phase of flight, and (5) behavior of the pilot. For the forty-five incidents, this would have made a total of 225 items upon which to base a comparison of the reporting of each interviewer and his observer. There were a few incidents, however, which were really double incidents. Although these were reported by the interviewers as only one incident, each contained two examples of pilot behavior. These double incidents raised the total number of possible items to 240. The results of the comparison are summarized below:

	Number of Items	Per Cent of Total
Items which both interviewer and observer reported	157	65.4
Items which neither interviewer nor observer reported	54	22.5
Items which one reported and the other didn't	29	12.1
Total	240	100.0

	Number of Items	Per Cent of Total
Items which both interviewer and observer reported	157	100.0
With complete agreement	155	98.7
With disagreement	2	1.3

From these results it would appear that interviewers agreed on items which they both reported, but that occasionally one failed to record items which another did record. Furthermore, it would appear that the interviewers were only 65 per cent effective in obtaining from the pilots all of the information desired about an incident.

Continuous communication with supervisors was effected through frequent memoranda from the central office. These served to keep field representatives informed as to changes in the procedures and the status of the project.

Contacts with all of the airline companies whose pilots were to be interviewed were established by the central office staff. Supervisors established contacts with regional or local airline company officials before contacting their pilots. In most of the cities, the supervisors also contacted the local chairmen of the Air Line Pilots Association. Prior to the initiation of the entire project, the president of the Air Line Pilots Association and officers of the Air Transport Association had been informed personally about the project, its objectives, and the manner in which it would be carried on. Each of these organizations informed its members of the project by letter, enclosing a copy of a write-up of the proposed project.

The total number of airline pilot interviews conducted was 270. Of these, 70 per cent were conducted with airline captains and 30 per cent with airline copilots. The pilots interviewed represented eleven scheduled airlines. Sixty-seven of the pilots were employed by non-scheduled airline companies. Seven flew with one of the military transport services. Six pilots did not reveal for whom they flew.

The interviews with check pilots.--It was felt that experienced airline and Civil Aeronautics Administration check pilots were in a position to furnish specific critical incidents which they had experienced during flight-checks — incidents in which the pilot being evaluated behaved in such a way that the check pilot felt the situation became critical or judged him so ineffective as to be failed on that flight-check. It was expected, too, that the check pilots might give valuable comments and suggestions concerning the present methods of evaluating airline pilots.

Interviews with the airline and Civil Aeronautics Administration check pilots were carried out concurrently with the interviews with the airline pilots. The same interviewers were used and no additional training program was initiated for these interviewers. Fourteen cities were selected in which to obtain interviews, these cities containing approximately three-fourths of the currently employed Civil Aeronautics Administration examiners. In addition, in these cities were located the main offices or regional offices of almost all of the major scheduled airline companies.

On the basis of the preliminary try-out of different questions, the following six were devised for the interviews with check pilots:

QUESTION #1: "First, we would like to draw on your experience as a check pilot to get examples of what pilots do on check-rides. Would you think back on the last pilot you failed on a check-ride and tell me exactly what he did which caused you to fail him?"

QUESTION #2: "Now, I would like for you to recall the last time you had to take over the controls from a pilot you were checking because you felt the situation was pretty critical. Could you describe the situation and tell me just what the pilot did or might have done if you hadn't taken over?"

QUESTION #3: "When you check a pilot, what are the things you particularly look for which you feel differentiate a good airline pilot from a poor one?"

QUESTION #4: "If you ran an airline and had the problem of keeping check on whether captains were doing a good job, how would you do it?"

QUESTION #5: "What characteristics, traits or abilities which differentiate the good airline captain from the poor are not being evaluated adequately by present methods of evaluation?"

QUESTION #6: "How would you change the present instrument check so that more of these desirable characteristics, traits, and abilities of the good airline pilot could be evaluated?"

As in the airline pilot interview program, an interviewers' guide was furnished each interviewer. Also a booklet was prepared which explained the purpose of each question and noted the type of information desired from each question. Standardized forms for recording the information obtained from the interviewers were prepared, as in the airline pilot interview program. The total number of interviews conducted with Civil Aeronautics Administration examiners was forty-two, representing approximately two-thirds of all those qualified to give flight-checks to airline pilots. The total number of interviews conducted with airline company check pilots was sixteen, representing only a small percentage of all airline check pilots.

Analysis of Data Obtained from the Five Sources of Information on Critical Requirements

Results of Analysis of Records of Achievement in Training

The records of achievement contained in the personnel files of the airline companies proved somewhat disappointing as a source of information pertaining to the critical requirements of the pilot's job. An analysis was made of the scores and ratings given to both E-group and C-group pilots on flight-checks given by airline check pilots. There were three general types of flight-check forms in the files, although there were many variations within these three groups. The first type is simply a form on which airline captains rate their copilots after a regular scheduled flight. Usually ratings are made on very general qualities, such as: "Flying Ability," "Judgment," "Instrument Flying," "Route Knowledge," "Progress," "Industry," etc. Ratings are generally made on a three-point scale. Comments are frequently added by the rating captains. The second type is a form on which check pilots rate the captains on a scheduled flight. Usually ratings are made on somewhat more specific aspects of the job, such as: "Duties Prior to Takeoff," "Takeoff and Climb," "Instrument Approach," "Landing," etc. Occasionally the form is one in which the check pilot makes ratings on even more specific aspects of the job, such as:

Preparation of the Flight Plan

1. Discussion of flight with dispatcher.
2. Discussion of flight with meteorologist.
3. Discussion of flight with copilot.
4. Selection of cruising altitudes.
5. Choice of alternates.
6. Fuel requirements.

The third type of flight-check form is a type used by some airlines for recording the pilots' performance on practice hooded flights (simulated instrument flights) or on the six-months instrument check required of all pilots. On this type of form the required maneuvers are frequently broken down into small components, such as:

Instrument Takeoff

1. Proper application of power.
2. Direction held during takeoff.
3. Timing proper takeoff: fast--slow--proper.
4. Initial climb-out: direction--angle--establishment of proper airspeed.

The following inadequacies were found in this material:

1. There was a great amount of variation between airlines as to the adequacy of their training records.

2. Within a single airline the number of flight records contained in the pilots' files varied considerably. Some pilots had almost no records of performance on previous flight-checks.

3. There was little consistency in the record forms used from year to year by each airline. Changes in the flight-check forms had been very frequent. This reduced the size of the sample of pilots on which similar records were available.

4. There was evidence of a strong tendency for check pilots to employ the same rating for all of the various items on the flight-check form for a given pilot.

Because of the lack of standardization in records, noted above, comparisons could not be made between all of the 288 eliminated pilots and the 144 control pilots. Also it was necessary to combine some of the very specific items on the flight-checks into more general items in order to compare scores on different types of flight-checks. E-group and C-group pilots were compared on fifteen aspects, t-ratios being computed to test the significance of the differences in mean ratings of the two groups. The results of this comparison are summarized in Table 1. It will be noted that on all but one of the variables the C-group pilots had higher mean ratings than the matched E-group pilots, the differences being significant at the 1 per cent level. Ratings on these flight-checks seem to differentiate between the successful pilots and those who were subsequently eliminated. These data must be interpreted, however, in terms of the amount of intercorrelation between ratings on the different job components. The nature of the data did not make the computation of intercorrelations practical, but an inspection of the ratings received by each pilot indicated that there was little variation in the ratings which a pilot received on the various components of a single flight-check. There was a definite tendency for a pilot to receive the same rating on each item on the flight-check. Furthermore, that the flight-check ratings discriminated between successful and eliminated pilots could be due in part to the fact that eliminations from training are based to a great

TABLE 1

MEAN DIFFERENCES BETWEEN RATINGS OF MATCHED PAIRS OF ELIMINATED COPILOTS (E) AND SUCCESSFUL COPILOTS (C) ON CERTAIN JOB COMPONENTS EVALUATED BY CAPTAINS ON IDENTICAL FLIGHT-CHECK FORMS

Job Components	Number of Pilots in Each Group	Number Ratings on Each Group	Mean Difference (C-E)	S.E. of Mean Difference	t-ratio	Level of Significance
Contact Flying Ability Flight Performance Navigation Enroute Flying Ability Air Work Execution of Flight	85	107	.64	.101	6.337	1%
Instrument Flying Ability General Instrument Work Letdown and Approach Use of Navigational Aids Smoothness and Accuracy Beam Orientation	85	363	2.89	.688	4.201	1%
Approach and Landing (Contact)	28	148	3.11	.611	5.090	1%
Takeoff and Climb (Contact)	28	201	1.73	.352	4.915	1%
Flight Planning and Analysis	57	97	.66	.131	5.038	1%
Demonstration of Route Knowledge	57	57	.43	.089	4.831	1%
Demonstration of Knowledge of Mechanical Details	42	42	.04	.065	.615	not significant
Observance and Knowledge of Regulations	77	154	.60	.161	3.727	1%
General Progress in Comparison with Others	51	51	.78	.105	7.414	1%
Judgment	57	57	.61	.086	7.093	1%
Alertness and Speed of Reactions	55	97	1.16	.189	6.110	1%
Appearance	59	59	.31	.069	4.493	1%
Personality	56	87	.76	.133	5.736	1%
Industry	58	58	.59	.111	5.315	1%
Cooperativeness	60	64	.37	.079	4.684	1%

extent upon these records. It was expected that some of the maneuvers or items on which the pilots were given ratings would prove more differentiating than others, in which case these results might have suggested that some components of the pilot's job are more critical than others. However, with the exception of the one component, "Demonstration of Knowledge of Mechanical Details," all of the components appear equally critical.

Additional information pertaining to the relative importance of performance on various maneuvers and other aspects of the job was obtained from an analysis of the ratings obtained by 176 eliminated pilots on all flight-checks kept on record in their personnel files. For these pilots, the per cent of all ratings which were below average was computed for each of twenty categories of pilot behavior. The total number of ratings on the 176 eliminated pilots was 17,974. Of these, 4,077, or 22.7 per cent, were below-average ratings. The per cent of below-average ratings for each category of pilot behavior is shown in Table 2. Although it was not feasible to match these 176 eliminated pilots with successful pilot controls, these comparative percentages of below-average grades for the various components of the pilot's job give some indication of the extent to which they differentiate the eliminated pilot from the successful. In Table 1 it was shown that ratings on many of these same components significantly differentiated between eliminated and successful pilots. Furthermore, these below-average ratings represent scores which are below the standards established by the airlines for an average pilot. Consequently, the job components receiving the largest number of below-average ratings are probably more critical than other components of the job.

One further indication of the kinds of behavior which are critical was obtained from an analysis of the percentage of below-average ratings on 35 eliminated pilots who had been given ratings on an "Instrument Approach Report." These pilots had received ratings on very specific parts of the instrument approach. Some indication of the aspects of this particular component of the job which are critical is obtained from this analysis, presented in Table 3. It appears from these results that "Holding Altitude" from the time the plane passes the station outbound on the approach leg until it reaches the field is a critical requirement of the pilot's job, for items covering this aspect of the instrument approach rank first, second, third, fifth, and tenth in per cent of below-average ratings.

The results of the analysis of ratings received by successful and eliminated pilots on flight-checks kept on record in their personnel files are far from conclusive because of the inadequacies of these data. They do give some indication, however, of the relative degree to which performance on different job components is associated with a pass-fail criterion. It should be noted, however, that these job components represent large segments of behavior and, hence, are somewhat too general for use in evaluation procedures. Furthermore, many of these components are stated in terms of general traits and characteristics, which detracts from their value as potential items in an evaluation procedure. The job components in Table 3, however, would seem to be more applicable for inclusion in an evaluation procedure.

TABLE 2

PER CENT OF ALL RATINGS WHICH WERE BELOW AVERAGE ON VARIOUS JOB COMPONENTS RATED BY CAPTAINS ON ALL FLIGHT-CHECK FORMS ON RECORD FOR 176 ELIMINATED AIRLINE COPILOTS

Job Components	Number of Ratings Received	Number of Below Average Ratings	Per Cent of Below Average Ratings
Unusual Maneuvers	22	10	45.5
Navigation: Dead Reckoning	210	84	40.0
Takeoff, Climb (Contact)	1,134	437	38.5
Approach, Landing, Go-around	1,178	394	33.4
Control of Airspeed and Heading (On Instruments)	478	139	29.1
Radio Technique	459	117	25.5
Instrument Approach	3,681	939	25.5
Slow Flight and Stalls	417	103	24.7
General Instrument Flying and Orientation Procedures	793	195	24.6
Single-Engine Operation	647	157	24.3
Ability to Progress	813	187	23.0
Ground Operation of Plane	1,072	209	19.5
Knowledge of Equipment, Procedures, Regulations and Route Facilities	2,615	509	19.5
Banks and Turns	659	118	17.9
Over-all Flying Ability	764	127	16.6
General Ability to Handle Plane	123	19	15.4
Descent and Climb: Spirals	562	85	15.1
Takeoff, Climb (Instrument)	306	44	14.4
General Competency	74	8	10.8
Pre- and Post-Flight Procedures	1,967	196	10.0
Total	17,974	4,077	22.7*

*22.7% of all ratings were below average

TABLE [illegible]

PER CENT OF BELOW AVERAGE RATINGS RECEIVED BY 35 ELIMINATED COPILOTS ON VARIOUS PARTS OF THE INSTRUMENT APPROACH PROCEDURE

Job Components	Number of Ratings Received	Number of Below Average Ratings	Per Cent of Below Average Ratings
Maintaining Altitude on Return to Station	[illegible]	47	51.4
Maintaining Altitude on Procedure Turn (In)	[illegible]	42	46.7
Maintaining Altitude Prior to Procedure Turn	91	40	44.0
Maintaining Heading in Return to Station	86	29	33.7
Maintaining Altitude over Field	86	24	27.9
Maintaining Heading on Procedure Turn (In)	87	2[illegible]	26.4
Maintaining Heading from Station to Field	83	20	24.1
Maintaining Heading on Initial Approach	82	18	22.0
Maintaining Heading on Procedure Turn (Out)	85	19	22.4
Maintaining Altitude over Station	86	18	20.9
Maintaining Constant Rate of Descent	84	18	21.4
Maintaining Altitude on Initial Approach	88	17	19.3
Ability to Detect Station on Final Approach	84	15	17.9
Maintaining Constant Airspeed	86	15	17.4
Timing (Station to Pull Out)	84	14	16.7
Pull Out	85	8	9.4
Ability to Detect Station on Initial Approach	88	8	9.1
Knowledge of Procedure	84	7	8.3
Range Signal Reaction	84	6	7.1
Control of Signal Volume	85	5	5.9

Results of Analysis of Records of Unfavorable Comments on Eliminated Pilots

Additional information pertaining to the critical requirements of airline pilots was obtained from a content analysis of 1,214 unfavorable comments written by airline captains and check pilots on the flight-check forms of the 288 eliminated pilots making up the E-group. Only a small proportion of these comments dealt with specific behavior of the pilots. Four-fifths of the comments referred to general traits and characteristics. Table 4 shows how the behavioral comments were distributed, and Table 5 presents the classification of the comments on general traits and characteristics. These data may be interpreted in much the same way as the data in Tables 1, 2, and 3. Although indicative of the kinds of pilot behavior and pilot characteristics which check pilots judge to be unsatisfactory, the results of this analysis have limited value for the following reasons:

1. They admit no comparison of the differences between the pilot behavior of successful pilots and eliminated pilots.

2. Most of the comments are expressed in terms of broad general characteristics rather than in behavioral terms. Even those which were expressed in behavioral terms related to very general behavior patterns.

The data suggest, however, that eliminated pilots (1) were weak in handling controls, (2) lacked essential pilot information, (3) lacked consistency of flying, (4) were not precise, (5) made errors in operating controls, and (6) navigated poorly.

Content Analysis of Accident Records and Critical Incidents

The results of the analysis of both accident records and critical incidents will be presented together, inasmuch as these data were analyzed by means of the same procedures. The accident records are henceforth considered as critical incidents, too. As the interviewers sent in their Interview Summary Sheets the incidents which they had recorded were typed on cards, one incident to a card. A card was also typed for each accident report.

First content analysis.—Table 6 shows the various sources of the data used in the first content analysis. The first step in the analysis was to extract from each incident the specific pilot behavior which contributed toward making the incident critical. Care was taken by the investigator to avoid making inferences and interpretations from the material reported by the interviewers. When it was not clear from reading the incident what behavior of the pilot was ineffective, the incident was not used. Frequently, in one critical incident more than one ineffective pilot act was involved. Sample incidents and the behavioral statements extracted from each are presented in Appendix D. A total of 787 separate statements of ineffective pilot behavior were obtained from the 653 critical incidents. First, sorting all of the identical acts yielded 87 different categories of ineffective pilot behavior. For example, the following categories were among the eighty-seven

TABLE [illegible]

FREQUENCY OF CAPTAINS' UNFAVORABLE COMMENTS ON VARIOUS ASPECTS OF THE PERFORMANCE OF 158 ELIMINATED AIRLINE PILOTS ON FLIGHT CHECKS

Aspects of Performance	Frequency	
A. Handled Controls Poorly in General		89
1. Handled plane roughly, overcontrolled	64	
2. Flew mechanically	15	
3. Did not coordinate controls	10	
B. Demonstrated Lack of Essential Pilot Information		50
1. Procedures, rules	21	
2. Route, facilities, navigational aids, airports	16	
3. Meteorology	9	
4. Navigational techniques	3	
5. Equipment of airplane	1	
C. Demonstrated Inconsistent or Erratic Flying		27
D. Demonstrated Lack of Precision and Accuracy		26
E. Operated Controls and Switches Incorrectly		16
1. Forgot to operate a control	14	
2. Confused two controls	1	
3. Made improper adjustment of a control	1	
F. Demonstrated Poor Navigating and Orienting		11
1. Flew incorrect heading to intersect, parallel or fly down beam	7	
2. Flew incorrect heading to reach destination	2	
3. Became disoriented on instrument flight	1	
4. Did not know or keep track of position on contact flight	1	
G. Operated Radio Poorly or Did Not Attend to Radio		10
1. Did not speak distinctly on radio	5	
2. Misinterpreted or failed to hear range signals	3	
3. Did not maintain listening watch on radio	1	
4. Improperly tuned or controlled volume of radio	1	
H. Demonstrated Poor Cockpit Procedures		8
1. Failed to use or incorrectly used checklist	4	
2. Executed single-engine sequence incorrectly	4	
I. Demonstrated Poor Alignment with Runway		5
J. Demonstrated Poor Reading and Checking of Instruments, Dials and Gauges		4
K. Made Poor Judgment of Type of Landing or Poor Recovery from Missed Landing		4
L. Miscellaneous		15
Total		265

FREQUENCY OF [illegible] COMMENTS ON VARIOUS
TRAITS, ABILITIES AND CHARACTERISTICS [illegible]
[illegible]

Traits, Abilities and Characteristics	Frequency
Inadequate Thinking and Learning	232
Inability to Get Along with People	105
Nervous Behavior	96
Unfavorable Attitude and Interest	82
Inability to Attend or Remain Alert	57
Lack of Initiative, Aggressiveness, Forcefulness	55
Lack of Industry, Effort	52
Slow Reaction	39
Carelessness and Tendency to Err Frequently	37
Overconcern for Obtaining Favorable Evaluation	29
Irresponsible, Unreliable, Undependable, Insincere	29
Poor Pilot Aptitude	27
Poor First Impression, Poor Appearance	23
Lack of Pep and Vitality	19
Tendency to Become Confused	17
Lack of Confidence	14
Inability to Divide Attention	14
Lack of Coordination Between Pilot Knowledge and Skills	14
Lack of Adequate Motor Coordination	6
Poor Speech, Unpleasant Voice	2
Total	949

produced by the first sorting

Categories	Number of acts extracted from incidents
Forgot to operate a control or switch	41
Confused two controls or switches	31
Improperly adjusted or moved in the wrong direction a control or switch	24
Inadvertently operated a control or a switch	6

These four different categories are all related to the operation of controls and, therefore, produce a cluster which defines a critical job component, "Operating Controls and Switches." Twenty-one such job components resulted from grouping all of the eighty-seven categories. These are listed in Table 7, and the frequencies of specific ineffective acts extracted from the three different sources of critical incidents are indicated for each job component.

TABLE 6

SOURCES OF DATA FOR CONTENT ANALYSIS OF CRITICAL INCIDENTS

Critical Incidents	Source	Number of Interviews	Number of Incidents Collected	Number of Incidents Used
Airline Accidents	CAB Accident Reports	——	185	121
Pilot Incidents (Near-accidents)	Pilot Interviews (Questions #1, #2, and #7)	270	601	395
Flight-check Incidents (Near-accidents and Reasons for Failure)	Check Pilot Interviews (Questions #1 and #2)	58	137	137
	Total	328	923	653

The rank order of the twenty-one job components based on frequency of ineffective acts extracted from accidents is different from their rank order based upon frequency of acts extracted from pilot incidents, and likewise from flight-check incidents. To answer the question, "To what extent are similar indices of the relative 'criticalness' of the job components obtained from analyses of ineffective behavior in each of the three kinds of incidents,"

TABLE 7

CRITICAL COMPONENTS OF THE JOB OF AIRLINE PILOT AS DETERMINED FROM INEFFECTIVE ACTS EXTRACTED FROM ACCIDENT REPORTS, PILOT INCIDENTS AND FLIGHT-CHECK INCIDENTS

Critical Job Components	Frequency of Ineffective Acts In: Accidents	Pilot Incidents	Flight-Check Incidents	Total
1. Establishing and maintaining angle of glide, rate of descent, and gliding speed on approach to landing	47	41	11	99
2. Operating controls and switches	15	44	33	92
3. Navigating and orienting	4	39	19	62
4. Maintaining safe airspeed and attitude, recovering from stalls and spins	11	28	18	57
5. Following instrument flight procedures and observing instrument flight regulations	5	27	13	45
6. Carrying out cockpit procedures and routines	7	31	4	42
7. Establishing and maintaining alignment with runway on approach or takeoff climb	3	31	5	39
8. Attending, remaining alert, maintaining lookout	14	23	1	38
9. Utilizing and applying essential pilot information	0	19	18	37
10. Reading, checking and observing instruments, dials and gauges	1	26	7	34
11. Preparing and planning of flight	2	27	3	32
12. Judging type of landing or recovering from missed or poor landing	1	23	8	32
13. Breaking angle of glide on landing	1	25	5	31
14. Obtaining and utilizing instructions and information from control personnel	3	21	0	24
15. Reacting in an organized manner to unusual or emergency situations	0	17	7	24
16. Operating plane safely on ground	7	15	1	23
17. Flying with precision and accuracy	0	7	15	22
18. Operating and attending to radio	0	7	10	17
19. Handling of controls smoothly and with coordination	0	6	8	14
20. Preventing plane from undue stress	0	5	7	12
21. Taking safety precautions	2	5	4	11
Total	123	467	197	787

rho coefficients were computed to determine the correlations between the three different rank orders. These are shown in Table 8.

TABLE 8

CORRELATIONS BETWEEN RANK ORDER OF 21 CRITICAL
JOB COMPONENTS AS DETERMINED FROM
THREE SOURCES OF PILOT BEHAVIOR
(Spearman Rho Coefficients)

	Pilot Incidents	Flight-check Incidents
Accidents	.71 (S.E.=.12)*	-.04 (S.E.=.23)
Pilot Incidents		.28 (S.E.=.22)

*An r of .43 is necessary for significance at the 5 per cent level and an r of .55 for significance at the 1 per cent level (8).

The relatively high correlation between the rank orders of job components determined from analysis of airline accidents and from analysis of critical incidents reported by pilots justifies the use of the critical incident technique to supplement the limited amount of data obtainable from accident reports. The low negative correlation between the rank orders of job components as determined from analyses of accidents and of flight-check incidents could be interpreted as an indication that the kind of pilot behavior which causes check pilots to "take over the controls" or to fail an examinee on a flight-check is not related to the kind of pilot behavior which causes accidents. It may well be that present flight-checks do not provide an adequate evaluation of the extent to which pilots demonstrate proficiency in the most critical components of the job of airline flying. The check pilots seem to be emphasizing proficiency in different aspects of the job, such as flying the plane smoothly and keeping within precise limits of altitude and heading. Such requirements, however, probably are important from the standpoint of the comfort of passengers. A somewhat different interpretation of this lack of relationship is that by utilizing critical incidents obtained from different sources the investigator will arrive at a more comprehensive list of critical requirements than if he uses only a single source. As stated earlier, there probably are more criteria of effective and ineffective behavior than whether or not the pilot flies safely. It appears that he must also be precise, must demonstrate certain essential knowledge, must handle the controls smoothly, etc.

Table 9 shows all of the categories of ineffective behavior which made up the clusters of job components, along with the frequencies of their occurrence in critical incidents obtained from all sources.

Second content analysis.—Although the classification of behaviors shown in Table 9 provided a comprehensive picture of the critical requirements

[illegible]

INEFFECTIVE PILOT BEHAVIOR CONTRIBUTING TO CRITICAL SITUATIONS IN AIRLINE FLYING AND THE FREQUENCY WITH WHICH THEY WERE CONTRIBUTING FACTORS

Ineffective Behavior Grouped by Job Components	Frequency	
1. Establishing and Maintaining Angle of Glide, Rate of Descent, and Gliding Speed on Approach to Landing		99
Made approach with improper glide angle and/or with too much airspeed — overshot	77	
Made approach with improper glide angle and/or too little airspeed — undershot	22	
2. Operating Controls and Switches		92
Forgot to operate a control or switch	41	
Confused two controls or switches	31	
Made improper adjustment or moved control or switch to wrong position	14	
Inadvertently operated a control or switch	6	
3. Navigating and Orienting		62
Became disoriented on instruments	27	
Did not observe or misinterpreted landmarks	8	
Flew incorrect heading to line up with runway	7	
Flew incorrect heading to intersect, parallel, or fly down beam	7	
Flew incorrect heading to reach destination	6	
Did not make allowances for change of wind velocity or direction in navigating	4	
Did not know or keep track of position on contact flight	3	
4. Maintaining Safe Airspeed and Attitude, Recovering from Stalls and Spins		57
Allowed airspeed to drop too close to stalling speed or executed maneuver at too low an airspeed	21	
Assumed dangerous attitude or did not correct attitude soon enough	18	
Stalled out in maneuver	14	
Did not recover from stall or near-stall correctly or soon enough	3	
Allowed plane to go into spin	1	
5. Following Instrument Flight Procedures and Observing Instrument Flight Regulations		45
Made letdown below minimum altitude or when conditions were below minimums or flew to unsafe altitude	22	
Used incorrect orientation, approach or letdown procedures (with knowledge of position)	12	
Flew partially or entirely contact instead of entirely instrument	7	
Attempted flight through clouds or overcast on contact clearance	2	
Did not maintain assigned altitude	2	

TABLE 9 - Continued

Ineffective Behavior Grouped by Job Components	Frequency	
6. Carrying Out Cockpit Procedures		42
Failed to use or incorrectly used cockpit checklist	14	
Did not respond, or responded incorrectly to cockpit signal or made response to cockpit signal prematurely or when no signal was given	12	
Demonstrated lack of coordination among crew	11	
Executed single-engine sequence incorrectly	3	
Gave incorrect cockpit signal	1	
Did not make check on ice with flashlight	1	
7. Establishing and Maintaining Alignment with Runway on Approach or Takeoff Climb		39
Drifted or failed to align with runway on approach, during round-out, or on takeoff climb	33	
Used incorrect method or poor technique to correct for drift on approach, round-out, or takeoff climb	6	
8. Attending, Remaining Alert, Maintaining Lookout		38
Did not clear area or observe collision object	24	
Did not see edge of runway or taxi strip or observe holes in runway	8	
Let attention lapse, fell asleep	5	
Did not observe wind tee	1	
9. Utilizing and Applying Essential Pilot Information		37
Lacked knowledge of navigational techniques	12	
Lacked knowledge of equipment of airplane	8	
Misjudged weather conditions	6	
Lacked knowledge of route, facilities, navigational aids, airport characteristics	6	
Lacked knowledge of procedures, rules	5	
10. Reading, Checking and Observing Instruments, Dials and Gauges		34
Did not observe readings of instruments or took eyes off instruments	16	
Did not cross-check one instrument with another	11	
Confused two instruments	5	
Misread instrument	2	
11. Preparing and Planning of Flight		32
Planned flight or made flight despite knowledge of unsafe conditions	15	
Did not carry out necessary inspections or learn of condition of airplane and equipment	12	
Did not file or filed incorrect flight plan	3	
Did not obtain sufficient weather information	1	
Did not obtain sufficient information about route facilities	1	

TABLE 9 - Continued

Ineffective Behavior Grouped by Job Components	Frequency	
12. Judging Type of Landing or Recovering from Missed or Poor Landing		32
Made type of landing inappropriate to landing conditions or type of airplane	11	
Made type of recovery from poor or missed landing inappropriate to landing conditions or type of plane	10	
Did not go-around after poor approach or missed landing	8	
Attempted go-around under unsafe conditions or when unnecessary	2	
Selected poor or wrong field for landing	1	
13. Breaking Angle of Glide on Landing		31
Levelled off or reduced angle of glide too high on landing	18	
Did not level off or reduce angle of glide high enough on landing	13	
14. Obtaining and Utilizing Instructions and Information from Control Personnel		24
Did not obtain necessary information from control personnel	9	
Misinterpreted or disregarded instructions from control personnel	7	
Accepted instructions against own judgment or without thinking of consequences	5	
Taxied without proper clearance	2	
Asked for wrong instructions from control personnel	1	
15. Reacting to Unusual or Emergency Situations		24
Became excited, tense, confused, disorganized, frozen	17	
Gave up flight controls, stopped flying, "quit"	7	
16. Operating Plane on Ground		23
Did not maintain directional control on landing or takeoff run	15	
Taxied into or too close to observed collision object	3	
Misused brakes (no loss of directional control)	3	
Taxied too fast	1	
Did not apply sufficient power on takeoff run	1	
17. Flying with Precision and Accuracy		22
Lost or gained excessive altitude (not dangerous)	13	
Varied heading or made too large heading corrections	3	
Climbed with improper angle or airspeed	3	
Varied degree of bank, rate of turn, rate of descent	2	
Varied airspeed (not dangerous)	1	

TABLE 9 - Continued

Ineffective Behavior Grouped by Job Components	Frequency	
18. Operating and Attending to Radio		17
Misinterpreted or responded slowly to radio range signals	14	
Did not maintain listening watch on radio or make radio position check frequently enough	3	
19. General Handling of Controls		14
Handled plane roughly, overcontrolled	12	
Did not coordinate controls	2	
20. Subjecting Plane to Undue Stress		12
Executed maneuver at dangerously high airspeed	6	
Flew in turbulence at excessive airspeed	3	
Flew through bad weather instead of around it	2	
Let R.P.M. build up too high	1	
21. Taking Safety Precautions		11
Landed downwind	5	
Landed too close behind other aircraft	2	
Did not open window on landing	1	
Cut all throttles to check horn instead of only one	1	
Took hands off throttles or controls	1	
Flew at dangerously low altitude	1	
Total	787	787

of airline flying and a measure of their relative importance, it was felt that a different kind of classification of the ineffective behaviors might be more useful as a basis for developing specific evaluation procedures. For example, as shown in Table 9, there were seventy-seven instances in which pilots made an approach with an improper glide angle and/or with too much airspeed. For purposes of developing a flight-check it is important, however, to know the conditions under which such landing errors occur, i.e., whether under cross-wind conditions, low visibility conditions or with engine failure. Consequently, in order to relate the various categories of critical behavior to actual maneuvers and to different conditions, a second content analysis of the incidents was attempted. This time, not only was the specific ineffective behavior extracted from each incident but also the maneuver which was being performed and the conditions under which the maneuver was executed. A somewhat different and more useful picture of the critical requirements of the job was obtained in this way. Table 10 shows how 733 specific ineffective acts were classified into twenty-four critical job components. The total number of instances of ineffective behavior is only 733 as compared with the 787 which made up the first content analysis due to the fact that some incidents did not clearly indicate in what maneuver the ineffective behavior occurred. Such incidents were not used in the second content analysis. The classification of ineffective behavior into more functional job components provided additional information about the importance of various aspects of the job. This classification better indicates the conditions under which critical ineffective behavior occurred most frequently. From the standpoint of developing an evaluation procedure this information was more useful than the information derived from the first content analysis. For example, it is clear from inspection of Table 10 that a relevant flight examination should be weighted heavily with approaches and landings under cross-wind and reduced visibility conditions. To find out the specific critical requirements of performing reduced visibility landings, for example, it is only necessary to examine the specific ineffective behavior classified under these maneuvers, as shown in Table 11. Each of these categories of ineffective behavior, when stated positively, represents a critical requirement for performing effectively that particular part of the job of airline pilot.

The categories of specific ineffective behavior classified under each of the twenty-four job components are presented in Table 18 in Appendix E. These data, grouped as they are by job components, not only show what parts of the pilot's job are critical but also provide the basis for establishing the kind of behavior that is required for the safe and effective accomplishment of the parts of the job.[1]

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[1]For additional information about other aspects of this job analysis pertaining to problems of selection of airline pilots, pilot fatigue and unsafe conditions contributing to critical situations in airline flying, see the previous report by the present investigator (7).

TABLE 10

CRITICAL COMPONENTS OF THE JOB OF AIRLINE PILOT AS DETERMINED FROM INEFFECTIVE ACTS EXTRACTED FROM ACCIDENT REPORTS, PILOT INCIDENTS AND FLIGHT-CHECK INCIDENTS (Second Content Analysis)

Critical Job Components	Frequency of Ineffective Acts in:			
	Accidents	Pilot Incidents	Flight-Check Incidents	Total
Planning and Preparing for Flight				
1. Obtaining information about conditions to be encountered in flight	0	7	3	10
2. Checking on the condition of the airplane and its equipment prior to flight	1	7	1	9
Controlling the Flight of the Airplane Within Prescribed Limits in the Performance of Routinely Used Maneuvers				
3. Taxiing	3	1	2	6
4. Taking off under normal conditions	6	13	5	24
5. Taking off under conditions of reduced visibility	0	3	3	6
6. Taking off under cross-wind conditions	0	2	0	2
7. Making a contact approach and landing under normal conditions	16	85	33	134
8. Making a contact approach and landing under conditions of reduced visibility	25	40	20	85
9. Making a contact approach and landing under cross-wind conditions	14	54	5	73
10. Making instrument approaches by means of reference to different types of radio aids	0	10	23	33
11. Recovering from a missed instrument approach or missed landing	1	3	3	7
12. Other maneuvers	0	4	1	5
Controlling the Flight of the Airplane Within Prescribed Limits Under Unusual or Emergency Conditions				
13. Recovering from sudden engine failure and performing maneuvers with an engine out	3	3	23	29
14. Operating the airplane when the air is turbulent, when runways are slippery, when icing conditions are present, etc.	23	11	2	36
15. Controlling the airplane in unusual attitudes or at minimum airspeeds	0	3	20	23

TABLE 10 - Continued

Critical Job Components	Frequency of Ineffective Acts in:			
	Accidents	Pilot Incidents	Flight-Check Incidents	Total
Employing Procedures to Locate or Keep Track of Position in Flight or to Fly a Prescribed Course				
16. Navigating and orienting	7	13	41	61
17. Communicating with traffic control personnel	0	7	2	9
Operating Equipment of Plane and Carrying Out Cockpit Procedures				
18. Remembering to carry out certain prescribed or appropriate tasks in connection with the operation of the equipment of the airplane	7	19	11	37
19. Operating the controls, dials and switches of the plane's equipment in a correct manner	8	17	28	53
Adhering to Prescribed Policies or Regulations and Taking Precautions Consistent with Safety				
20. Conforming to regulations and policies	5	21	4	30
21. Keeping a constant lookout for possible collision objects and remaining attentive and alert	13	8	3	24
22. Taking special precautions or remaining on safe side	2	11	4	17
Remaining Emotionally Organized and Working Efficiently with Others				
23. Remaining emotionally organized in emergency situations	0	8	7	15
24. Working efficiently with other crew members	0	4	1	5
Total	134	354	245	733

TABLE 11

FREQUENCY OF INEFFECTIVE BEHAVIOR OCCURRING IN CRITICAL INCIDENTS INVOLVING APPROACHES AND LANDINGS UNDER LOW VISIBILITY CONDITIONS

Ineffective Behavior	Frequency of Ineffective Acts in:			
	Accidents	Pilot Incidents	Flight-Check Incidents	Total
1. Failing to align with runway or flying incorrect heading from station to field	0	11	9	20
2. Failing to keep within sight of field while circling	0	2	0	2
3. Failing to locate field after becoming contact; mistaking landmark for field	0	3	0	3
4. Failing to hold constant altitude when circling field	2	2	2	6
5. Failing to hold proper glide angle in descent	17	10	6	33
6. Failing to hold proper airspeed in descent	0	4	2	6
7. Failing to go-around after overshooting	1	3	0	4
8. Turning too steeply when close to ground	0	1	1	2
9. Levelling off too high or too low	1	2	0	3
10. Flying partially instruments and partially contact	0	1	0	1
11. Failing to stay aligned with runway on roll	1	0	0	1
12. Landing in field adjacent to airport	1	0	0	1
13. Landing downwind	2	0	0	2
14. Failing to plan approach	0	1	0	1
Total	25	40	20	85

CHAPTER V

THE DEVELOPMENT OF THE EVALUATION PROCEDURES

Preliminary Study of the Present Airline Transport Rating Flight-Check

The first step in the development of the new measure of flying skill was a study of the flight examination currently used for the Airline Transport Rating by the Civil Aeronautics Administration. It was felt that a thorough understanding of the strengths and weaknesses of this flight-check, along with the attitudes of Civil Aeronautics Administration agents towards it, would be helpful in devising new flight-check procedures. The methods employed in this phase were (1) to observe a flight-check being administered; (2) to conduct interviews and hold conferences with Civil Aeronautics Administration agents who administer this flight-check and with Civil Aeronautics Administration personnel responsible for certifying pilots for the various ratings; (3) to study airline company six-month instrument flight-checks which are patterned after the Civil Aeronautics Administration Airline Transport Rating flight-check; (4) to examine answers to those questions in the check pilot interviews which were devised to elicit opinions and attitudes toward present methods of evaluation. The application of these methods and the results obtained are presented in the following sections of this paper.

Observation of a Flight-check Being Administered

Arrangements were made by the local Civil Aeronautics Administration Air Carrier Inspector for the investigator to fly as observer on a routine six-month instrument check administered by a chief pilot of one of the scheduled airlines. The observations made during this flight can be summarized as follows:

1. There was no set order in which tasks were presented to the examinee.

2. The check pilot took no notes and made no records during the flight.

3. The check pilot used the flight-check for instructional as well as for evaluation purposes.

4. Communication between check pilot and examinee was frequent, due in part to the latter's lack of previous knowledge of what tasks he was required to perform.

5. The check pilot spent considerable time watching out for other airplanes.

Interviews and Conferences with Civil Aeronautics Administration Personnel

The primary objective of conducting interviews and conferences with Civil Aeronautics Administration personnel was to enlist the cooperation and encourage the participation of those who are responsible for administering the certification program and those who actually give the flight-checks to examinees. Early in the study a conference was arranged with representatives from the Flight Operations, Medical, and Airman's Services of the Washington office of the Civil Aeronautics Administration, at which time the group was told about results of the study of critical requirements and informed about the aims of the phase involving the development of new procedures. Following the general conference, the investigator met with a smaller group from the Flight Operations and Airman's Services, the two offices responsible for the contents, standards, and administration procedures of flight examinations used for certifying pilots. Members of this group participated in formulating specific plans. Suggestions were made as to the cities where the most interviews with Civil Aeronautics Administration agents could be obtained. This group took responsibility for sending to all of the Civil Aeronautics Administration Regional Offices a letter which explained the purposes of the project and which requested the cooperation of the Regions.

As part of the indoctrination of the investigator, the written examination required for certification as an airline pilot was examined. In addition, time was spent becoming familiar with the records of the flight examination which are maintained in Washington, for the purpose of determining the feasibility of making an item analysis of a sample of these flight-checks in order to determine the relative difficulty of the various items of the test. It was decided, however, that this would not be undertaken in view of the difficulties Preston (21) encountered in his study of these same records.

Several field trips were made to Civil Aeronautics Administration offices and centers. Conferences with training personnel at the Civil Aeronautics Administration Aeronautical Center were especially fruitful.[1] The instructors at the Center made valuable suggestions for improving the Airline Transport Rating flight-check. They were particularly helpful in demonstrating to the investigator the nature of existing attitudes and feelings about objective type flight-checks, standard flights and "numerical scoring systems." Finally, they gave help on more specific problems related to the sequence with which maneuvers should be combined into a total flight-check.

Additional conferences were held with Civil Aeronautics Administration agents from Region V in Kansas City and from Region III in Chicago. The pertinent information obtained from all of these conferences can be summarized

[1]Assistance was received during this phase from Mr. Charles M. Wharton who helped the writer conduct these conferences and gave valuable suggestions in regard to plans for the project.

as follows:

1. Almost all Civil Aeronautics Administration agents and instructors feel the present flight-check could be improved. There is little agreement, however, as to what the improvements should be.

2. There is universal objection to the loop-hole in present regulations which allows pilots to take the Airline Transport Rating flight-check in single-engine planes or inadequately equipped twin-engine planes.

3. The check pilot is seriously handicapped by the necessity of acting as a safety pilot. Recommended procedure: have all Airline Transport Rating flight-checks administered by a check pilot sitting in the jump seat.

4. Those giving the present flight-check show extreme differences in: (1) the maneuvers which they require the examinee to perform, (2) the standards of performance which they require on each maneuver, and (3) the degree to which they use "pet" maneuvers, not required by regulation, as a basis for their judgments of pass or fail.

5. Some Civil Aeronautics Administration agents admit holding examinees to extremely fine tolerances on maneuvers because they feel that, in the absence of measures of such traits as "judgment," "headwork," etc., the best predictor of flying skill is the degree to which pilots can fly within extremely small tolerances.

6. Some Civil Aeronautics Administration agents object to regulations which allow a failed examinee to take a retest on only those maneuvers which he failed on the first flight-check. They would also prefer a flight-check which indicated more than one degree of "failure."

7. Civil Aeronautics Administration agents, as a whole, are not aware of the unreliability of the present flight-check. They feel that few differences among instructors occur at either ends of the distribution of pilot proficiency. There may be differences in judging "borderline cases," but not the clear-cut "passes" and "failures," as they express it.

8. Civil Aeronautics Administration agents express the following significant attitudes toward objective flight-check procedures: (a) they feel a need for more efficient methods of in-flight recording yet feel their duties as a safety pilot prohibit recording in the air; (b) they feel that a standardized flight-check will make it impossible to use "surprise tasks" or pet maneuvers; (c) they feel examinees would "study for the test"; (d) they express concern over "replacing the check pilot with mechanical methods of grading."

The conferences with Civil Aeronautics Administration personnel made the investigator aware of such attitudes. In the later stages of the project, the recognition of the sources of resistance to objective flight-checks was an important factor which influenced the type of evaluation procedure finally developed.

The Study of Airline Six-month Instrument Flight-checks

Airline companies pattern their six-month instrument checks after the Civil Aeronautics Administration Airline Transport Rating flight-check. It was considered advisable, therefore, to study the airline flight-checks in some detail in order to (1) obtain an approximation of the importance attached by the airlines to various maneuvers and (2) observe the kind of flight-checks the airlines have developed to meet their own evaluation needs. Some knowledge of these flight-checks previously had been gained from the study of the personnel files of the five airlines, as reported in Chapter IV. In order to obtain a wider sample of airline flight-checks a letter was sent to fifteen airlines, requesting copies of their six-month instrument flight-check form. Thirteen airlines complied. An analysis of their flight-checks revealed the following:

1. Seventy-one different maneuvers were included in the flight-checks of the thirteen airlines, although the average flight-check contains only fifteen to twenty maneuvers. This shows the amount of variation in the content of the different flight-checks.

2. The maneuvers which are used by more than half of the thirteen airlines are shown in Table 12.

TABLE 12

MANEUVERS MOST FREQUENTLY INCLUDED IN THE INSTRUMENT FLIGHT-CHECKS OF 13 AIRLINES

Maneuver	Number of Airlines Including Maneuver
Instrument Approach	13
Engine-out Procedure and Maneuvering	12
Stall Approach and Recovery	12
Steep Turns	12
Climbs, Spiral Climbs, Climbing Turns	12
Instrument Takeoff (Optional with three airlines)	11
Radio Range Orientation	11
Loop Orientation	11
Emergency Pull-up Procedure	10
Pre-flight Procedure	9
Tracking	9
Minimum Speed Maneuvering	8
Engine-out Landings	8
Recovery from Unusual Positions	7

It seemed clear from this analysis that there was little agreement among different airlines on critical components of the job. However, the tasks which are considered critical by the largest number of airlines were noted and were later used as one more guide in developing the new procedures.

The Study of Responses of Check Pilots to Certain Interview Questions

It will be recalled that Questions 4 and 6 of both the pilot and the check pilot interviews were intended to elicit attitudes and opinions towards present methods of evaluation. The responses of the interviewees were classified, and the results are summarized in Table 13. Although the comments were made about the airlines' six-month instrument flight-check rather than the Civil Aeronautics Administration Airline Transport Rating flight-check, it was felt there would be value in taking these suggestions into consideration when devising the new flight-check procedures. Many of the suggestions refer to things beyond the scope of this study, but they are pertinent to more general problems of evaluation.

The Selection and Arrangement of Tasks for the Flight-check

This phase of the study involved a consideration of all of the results obtained from the analysis of the job, the study of the present Airline Transport Rating flight-check and the sampling of the attitudes and opinions of pilots and check pilots. The task was to select job-related tasks which would be identical with or similar to the job components which had been proved critical in the job analysis. These tasks then had to be arranged efficiently into a standard flight. Prior to beginning this phase of the project a conference was held with a group of psychologists with previous experience in the development of objective flight-checks.[1] This phase of the project was carried out in close cooperation with expert pilots and check pilots from three different airline companies.[2]

The Critical Job Components

The twenty-four job components resulting from the second content analysis, summarized in Table 10, fall into three categories: (1) job components which are directly related to particular maneuvers and procedures routinely performed on the job, (2) job components related to maneuvers and procedures performed only under unusual conditions, (3) job components which are not related to maneuvers but cut across all maneuvers. The first twelve components and the sixteenth component in Table 10 are directly related to maneuvers and procedures routinely performed:

1. Obtaining information about conditions to be encountered in flight

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[1]The consulting psychologists who provided valuable assistance at this planning conference included Drs. P. J. Rulon, N. E. Miller, R. P. Youtz, S. C. Ericksen, R. N. Hobbs.

[2]American Airlines, Eastern Air Lines, and TWA.

TABLE 13

SUGGESTIONS OF AIRLINE PILOTS, CAA AGENTS AND AIRLINE CHECK PILOTS FOR IMPROVING PRESENT INSTRUMENT FLIGHT CHECKS

	Suggestions	Number of Times Mentioned
1.	Pilots should be given more opportunity for practicing skills required on flight-checks	51
2.	The flight-check should be given under actual conditions of instrument flying	38
3.	Pilots should be evaluated more on their possession of various psychological traits, such as emotional stability, judgment, speed of reaction, temperament, etc.	22
4.	Stalls and other obsolete and infrequently used maneuvers should be omitted	17
5.	Should be more evaluation of pilot's knowledge of new airway facilities, new equipment, recent developments, etc.	12
6.	Check pilots should try to eliminate the pilot's mental hazard during the flight-check	12
7.	Should be a better selection of check pilots	10
8.	The flight-checks and methods of administering them should be standardized	8
9.	The flight-checks should be changed occasionally	8
10.	Checks should be given more frequently	6
11.	There should be more emphasis upon the instrument approaches and letdowns	6
12.	There should be more new maneuvers (none specified)	5
13.	The personality factor should be eliminated from the check pilots' judgments	5
14.	Others (mentioned by less than five interviewees)	65
	Total	265

2. Checking on the condition of the airplane and its equipment prior to flight
3. Taxiing
4. Taking off under normal conditions
5. Taking off under conditions of reduced visibility
6. Taking off under cross-wind conditions
7. Making a contact approach and landing under normal conditions
8. Making a contact approach and landing under conditions of reduced visibility
9. Making a contact approach and landing under cross-wind conditions
10. Making instrument approaches by means of reference to different types of radio aids
11. Recovering from a missed instrument approach or missed landing
12. Other maneuvers
16. Navigating and orienting

These components are identical with maneuvers and procedures which are performed routinely on scheduled flights by airline pilots and could be easily duplicated in a test situation.

The second group of job components are related to maneuvers and procedures performed only under unusual and emergency conditions. These job components can be duplicated in a flight-check but only to the extent that the unusual and emergency conditions can be duplicated. Most of the latter, however, can only be simulated in the test situation. Consequently, they lose some of their relevance to the actual job requirements. There are three such job components:

13. Recovering from sudden engine failure and performing maneuvers with engine out
14. Controlling the flight of the plane in turbulence, in icing conditions, on slippery runways or under other unusual conditions
15. Controlling the flight of plane in unusual attitudes or at minimum airspeeds

The remainder of the critical job components in Table 10, cut across all maneuvers which pilots must fly either routinely or under unusual conditions. In other words, these are distinct components of the job which are not directly related to controlling the airplane through time and space. All but one have to do with: (1) operating the complex equipment of the airplane in a correct manner or according to prescribed procedures, (2) adhering to prescribed regulations, safety policies and precautions, (3) remaining emotionally organized and working efficiently with others. These eight critical components are as follows:

17. Communicating with traffic control personnel
18. Remembering to carry out certain prescribed or appropriate tasks in connection with the operation of the equipment of the airplane
19. Operating the controls, dials and switches of the plane's equipment in a correct manner

20. Conforming to regulations and policies
21. Keeping a constant lookout for possible collision objects and remaining attentive and alert
22. Taking special precautions or remaining on safe side
23. Remaining emotionally organized in emergency situations
24. Working efficiently with other crew members

These critical job components could not be incorporated into the flight-check as tasks. Rather, it was necessary to consider whether the other tasks to be included in the flight-check would require examinees to demonstrate effective or ineffective behavior of the kind represented in these eight components of the job. For example, "forgetting to place props in high R.P.M." is an example of ineffective behavior which has been classified under the job component, No. 18, "Remembering to carry out certain prescribed or appropriate tasks in connection with the operation of the equipment of the airplane." The occurrence of this particular ineffective act is not a function of any particular maneuver or task the pilot must perform. It can occur during the performance of many maneuvers.

It became apparent that the investigator would have to make certain that the tasks he selected for the flight-check were such that this kind of error would have a chance to occur. This proved to be the most difficult problem in the development of the evaluation procedures. The five critical job components, numbers 20 through 24 in Table 10, are defined by types of ineffective behavior which are much less likely to occur in a test situation than on a routine flight. For example, it is not likely that an examinee will fail to conform to some regulation during a flight-check. On the contrary he is more likely to lean over backwards to conform to all regulations and safety policies.

Similarly, it is difficult to devise a task which will be enough of an emergency situation to make it likely that an examinee become emotionally disorganized. Even though it were feasible to devise such a test situation without endangering personnel or equipment, the mere presence of a check pilot tends to allay whatever fears or feelings of insecurity that an examinee might have in such situations. It is possible, however, that such tasks as responding to sudden engine failures (simulated, of course) on a flight-check provide a rough screening of examinees who show tendencies to become emotionally disorganized very easily.

Devising Tasks Appropriate to the Critical Job Components

Eighteen different tasks were finally selected for inclusion in the first form of the flight-check. These tasks were decided upon after a consideration of all of the critical requirement data and after extensive consultation with check pilots and training personnel of three scheduled airlines[1] and with personnel of the Airman Service of the Aviation Safety Office of the Civil Aeronautics Administration. These groups contributed valuable suggestions as to the maneuvers and tasks which might be used in the first form. They helped also in devising a suitable sequence for the eighteen tasks, so that the flight-check would be in the form of a standard flight.

[1]American Airline personnel at Ardmore, Oklahoma; Eastern Air Lines personnel at Miami, Florida; and TWA personnel at Kansas City, Missouri.

Following is a list of the eighteen tasks used in the first form of the experimental flight-check, along with the numbers of the critical job components which these tasks represented. The numbers of the critical job components are those used in Table 10.

Flight-check Tasks	Critical Job Components
1. Preparation for Flight	(1), (2)
2. Inspection of Airplane	(2)
3. Cockpit Familiarization Check	(19)
4. Before-starting Cockpit Check and Starting Procedure	(18), (19)
5. Taxiing	(3), (21)
6. Before Takeoff Procedures	(18), (19)
7. Instrument Takeoff	(5)
8. Intercepting a Predetermined Track and Tracking Away from Station in Climb	(16), (18)
9. Minimum Speed Maneuvering and Approach to Stall	(15)
10. Steep Turns with Engine Failure(s)	(15), (13), (19)
11. Rapid Descent and Pull-up	(11), (15)
12. Manual Loop Orientation and Tracking	(16), (19)
13. ADF Approach with Engine Failure	(10), (19), (23)
14. Engine-out Landing	(13)
15. Takeoff and Landing under Simulated 400 and 1 Conditions	(5), (8)
16. Cross-wind Takeoff with Engine Failure	(6), (13), (24), (19)
17. Cross-wind Landing	(9)
18. I.L.S. Approach	(10), (18)

These eighteen tasks include all of the twenty-four critical job components except seven. Three of these seven are: "Taking off under normal conditions," "Making contact approach and landing under normal conditions," and "Controlling flight of plane in 'other' maneuvers" (all very elementary maneuvers such as, straight and level flight, normal turns, etc.). No specific tasks were included in the flight-check to cover these three job components, because the kinds of ineffective acts which occurred in these job components are measured elsewhere in the flight-check in tasks which are more difficult to perform. A fourth critical job component was not represented by a task in the flight-check. This was "Controlling the flight of the plane in turbulence, in icing conditions, on slippery runways or under other unusual conditions." Such unusual conditions normally cannot be duplicated in the test situation unless the flight-check could be conducted in very bad weather conditions. From the standpoint of safety this is not practical. Frequently, however, some of the critical requirements for performing maneuvers under unusual conditions are the same as for performing maneuvers under normal conditions. For example, the two most frequent categories of ineffective acts which occurred in "Operating the airplane in turbulence, when runways are slippery and icing conditions are present" are (1) allowing airspeed to get too low with wing ice and (2) landing long (overshooting) on slippery runway.[1] These are errors

[1] See Appendix E, Table 18.

which also occur with high frequency in job components which can be included in an evaluation procedure although out of their actual context.

The fifth job component not specifically included as a task in the flight-check was "Communicating with traffic control personnel." There is some opportunity for the examinee to communicate with control tower operators during the orientation maneuvers. In general, however, it was felt that performance on this component of the job could be evaluated adequately only by observing the examinee on a routine flight of considerable length. The 20th and 22nd components were not included as specific tasks for the reasons indicated previously.

Arranging the Tasks into a Standard Flight

As the project progressed the investigator learned some of the factors which had to be considered in arranging the maneuvers into a standard flight. The following are requirements for an acceptable sequence:

1. Maneuvers have to be arranged so that it is not necessary to make large changes in altitude between maneuvers.

2. The arrangement should make it unnecessary to fly long periods of time between maneuvers.

3. The arrangement should make it unnecessary for check pilots to put up and take down the simulated blind flying equipment frequently.

Although there were later improvements in the sequence of maneuvers, the first form of the flight-check had a sequence which adequately met these requirements.

The Selection of Items for Each Task in the Flight-Check

As mentioned previously, one source of difficulty in getting check pilots to accept an objective flight-check has been the complexity of the form on which they are required to record observations. An attempt was made to meet this problem by a relatively systematic approach. First, it was apparent that check pilots could not possibly make and record observations on every aspect of an examinee's performance of a particular task. For example, reference to Table 11 shows that there were fourteen kinds of ineffective behavior which occurred in that particular job component. This is too large a number of items to require a check pilot to mark in the air. The problem became one of deciding which of all the possible errors that can occur in the performance of a maneuver should be selected for observation by the check pilot.

In order to obtain data which would provide a relatively empirical basis for this selection, the "Maneuver Analysis Survey" was undertaken. This was an attempt to find out, for each maneuver to be used in the flight-check, which of the several kinds of critical ineffective behavior are demonstrated most frequently by examinees on flight-checks. The critical flight-check incidents provided some evidence of the frequency with which the various kinds of critical behavior were demonstrated by pilots on flight-checks, but the number of ineffective acts was rather small. It was hoped that the "Maneuver Analysis Survey" would supplement these more limited data.

For example, once it was known that five particular kinds of critical ineffective behavior are demonstrated most frequently on a particular maneuver, then items could be constructed for recording check pilots' observations of these five kinds of behavior. Stated simply, the check pilot can't record everything, so a way had to be found to make it easier for him to record the errors that are going to occur most frequently.

The "Maneuver Analysis Survey" involved obtaining the judgments of check pilots as to the errors which are made most frequently by examinees while performing each of thirty-three different maneuvers and operations.[1] Each check pilot was asked to list the most, the next most, and the third most frequent error, specifying exactly in what part of the maneuver the errors occurred. Booklets containing a list of the thirty-three maneuvers and spaces for recording the three errors were mailed to fifty-nine Civil Aeronautics Administration Air Carrier Inspectors. A number of booklets were also left with the operations personnel of five airlines with the request that they have as many check pilots as possible fill out the booklets. Fifty-three booklets were completed and returned in time to be used. This represented about thirty per cent of the booklets made available for distribution.

Errors were tabulated for each of the thirty-three maneuvers. An index of frequency was obtained for each error by weighting the most frequent error, 3; the next most, 2; and the third most, 1. The results for one of the thirty-three maneuvers are presented below for illustration:

RAPID DESCENT AND PULL-UP

Acts Judged by Check Pilots as Frequent Errors Occurring on Flight-checks	Index of Frequency
1. Not holding constant airspeed in descent due to improper use of power or not coordinating power and attitude	144
2. Waiting too long to retract gear and/or flaps	115
3. Climbing at too low or too high airspeed; slow applying power; applying insufficient power	104
4. Going below minimum altitude in descent	58
5. Not holding proper heading on recovery or in climb	57
6. Maintaining improper rate of descent due to improperly using power or not coordinating power and attitude	45

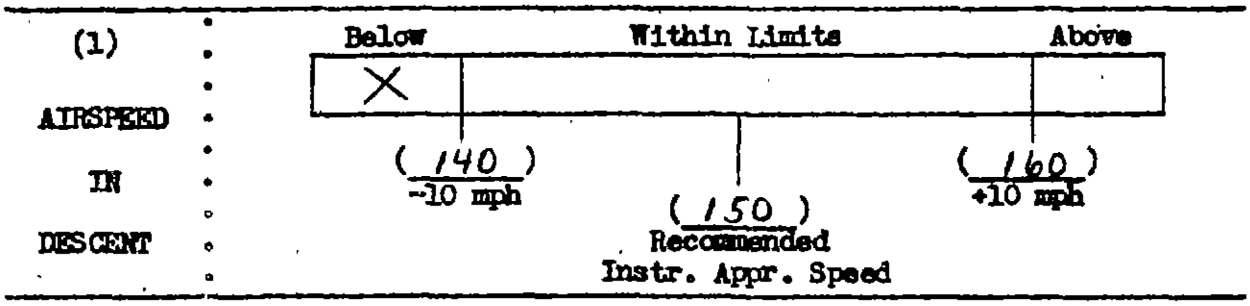
[1]The survey was begun before it was decided which maneuvers and procedures would be included in the flight-check. Consequently, all maneuvers that could be thought of were included in the survey.

Acts Judged by Check Pilots as Frequent Errors Occurring on Flight-checks	Index of Frequency
7. Exceeding power limits or using improper power settings in pull-up; failing to call for emergency power and RPM settings	41
8. Not taking steps to prevent excessive engine cooling	31
9. Remaining at minimum altitude too long; failing to use clock; generally poor timing	29
10. Using excessive manifold pressure for particular RPM settings; exceeding BMEP limits; applying power too rapidly; slow advancing props	26

Such data as these, for each of the eighteen tasks included in the first form of the flight-check, provided the basis for deciding what items should be constructed for a particular maneuver. An example may make this clearer.

The Maneuver Analysis data for Rapid Descent and Pull-up, for example, show that failure to hold correct airspeed in descent is a frequent error made on this maneuver. The job analysis data indicated that failing to hold proper airspeed in the descent is a critical requirement (Table 18, Appendix E, Component #8). Thus, an item was constructed for recording airspeed on this maneuver. A judgment also had to be made as to the maximum number of observations which a check pilot could make during a single maneuver. Furthermore, it was necessary to try to avoid having two items which would require the check pilot to observe parallel phenomena, such as variations in airspeed and variations in altitude. This would require watching two instruments at once. Occasionally it was necessary to devise an item which called for observing behavior which was not necessarily critical. This was necessitated in order that an examinee would not sacrifice accuracy in one part of the task in order to improve his performance in another. For example, holding altitude in a steep turn was shown to be a critical requirement. Yet one examinee by forgetting about the constancy of the angle of bank might hold his altitude better than an examinee who concentrated on both bank and altitude. Consequently, an item covering constancy of bank was included in this maneuver.

One of the difficulties in getting acceptance of objective checks has been that they have not been adaptable for use with different types of aircraft. Most agencies involved in pilot evaluation use a number of different plane types. It was felt that it would be desirable to incorporate into the flight-check sufficient flexibility to enable its use with different types of planes. Consequently, another criterion used in developing items was that the item not call for observations which have relevance for only one or two types of airplanes and not for all types. A special type of item was devised for recording the plane's altitude, heading, and airspeed; and this basic type of item was used in all maneuvers involving these three variables. A sample item of this type will illustrate. The check pilot prior to the flight fills in the recommended instrument approach speed for the airplane being used and during the flight he observes the airspeed on the approach, marking in one of the three boxes in the sample item shown below:



It will be remembered that there were some critical requirements which were shown to be unrelated to specific job components and some critical requirements which were derived from comments about general traits and characteristics of pilots (see Table 5). Although it was doubtful if an objective evaluation of the extent to which pilots demonstrate these critical requirements could be obtained on a single flight-check, an attempt was made to include some items to cover such characteristics. A seventeen-item checklist was devised on which the check pilot recorded the number of times he observed the examinee demonstrate each of the characteristics. Two sample items are shown below:

	Always	Almost all the time	Only part of the time	Seldom
(1) <u>Handled Controls Smoothly</u> Flew in a smooth manner; handled flight controls without overcontrolling or jerkiness	( )	( )	( )	( )

	Always	Almost all the time	Only part of the time	Seldom
(2) <u>Followed Safety Precautions</u> Took no unnecessary chances, adhered to rules to the letter; followed safety regulations and procedures	( )	( )	( )	( )

In Appendix G are listed all of the maneuvers and tasks included in the first form of the flight-check and the names of the items under each. The last part of the flight-check, the "Checklist of Critical Pilot Behavior," described above, is reproduced along with the flight-check maneuvers in Appendix G.

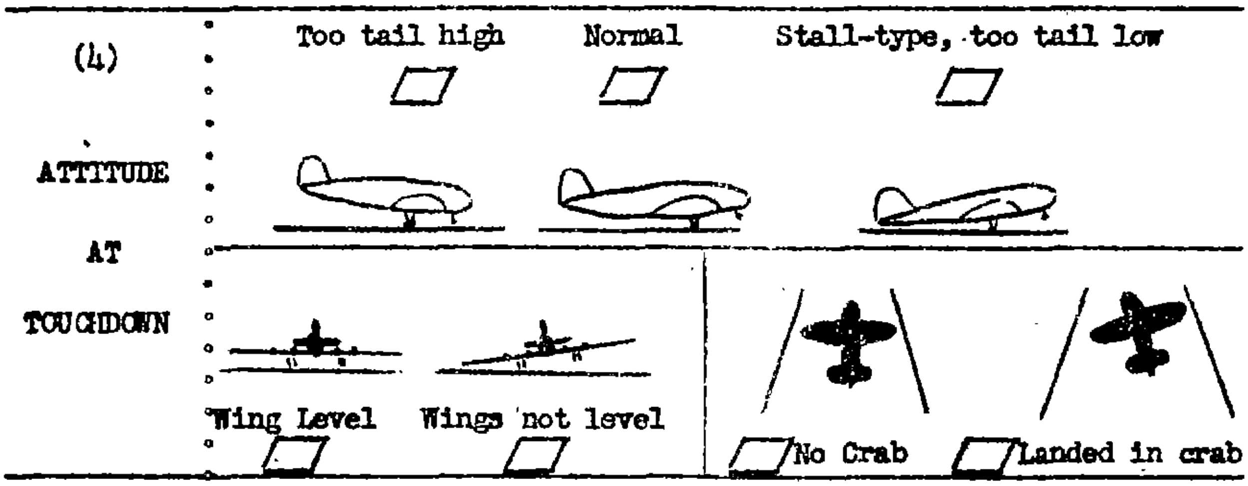
The Development of Graphic and Pictorial Items and an Improved Flight-check Format

The difficult problem of devising an objective flight-check which is comprehensive yet can be used in the air without diverting too much of the check pilot's attention from keeping a close watch for other traffic and dangerous conditions brought on by the examinee has been previously emphasized. During the project, the investigator considered the possibility of utilizing some of the visual aid techniques which were so successfully employed in the military services in the preparation of training manuals.[1] One of the techniques was

[1] The writer was assigned for one year to Headquarters, Army Air Forces, Office of Flying Safety, where these techniques were used extensively in the preparation of air crew training manuals.

the use of graphic and pictorial displays for illustrating how maneuvers should be performed. Not only did this technique help pilots to learn maneuvers but it enhanced the general appearance of the manuals and helped insure their acceptance by pilots.

The investigator felt that if graphic and pictorial displays helped pilots visualize and learn maneuvers they should also help check pilots, in two ways: (1) by providing reference points or by defining the limits within which maneuvers should be performed and (2) by decreasing the amount of time to locate an item (or alternatives within an item) on the flight-check form and to record an observation. In the sample item shown below, the positions of the plane help define the various alternatives and also help the check pilot locate quickly the picture which corresponds to the actual attitude of the plane at the point of "touching down" on a cross-wind landing.



If such items were found to help check pilots in these two ways, it was felt that the observer-observer reliability of the flight-check might be increased and the job of the check pilot might be made less difficult. Examples of other items of this type may be seen in the second form of the flight-check, reproduced in Appendix H.

An attempt was made to develop a format for the flight-check form which would also help the check pilot in using the form in the air.[1] Some of the principles followed in the format are:

1. Each maneuver should be on a separate page.
2. Items of a maneuver should be clearly separated.
3. There should be a minimum use of words.
4. Pages should be of heavy quality for easy turning.
5. The flight-check should be bound in heavy stock to provide a backing on which the check pilot could easily write.

[1]In this phase of the project, Leonard N. Conklin, of R. R. Donnelly and Sons, Chicago, was consulted on problems of layout and reproduction. A number of his ideas and suggestions have been incorporated into the flight-check form.

CHAPTER VI

THE EXPERIMENTAL TRY-OUT OF THE FLIGHT-CHECK

The First Try-out: Administration of the Flight-check to Air Force Pilots

Permission was obtained from the United States Air Force for an experimental try-out of the first form of the flight-check on twenty-seven rated B-25 pilots.[1] The purposes of this try-out were: (1) to test the observer-observer reliability of the flight-check, (2) to test the ride-ride or test-retest reliability of the flight-check, (3) to obtain additional evidence of the relevance of the flight-check, (4) to obtain data upon which to make an item analysis of the flight-check, and (5) to test the practicality of the flight-check.

The Sample

The sample of examinees was a group of twenty-seven Air Force pilots, all qualified on the TB-25 airplane, a twin-engine advanced trainer and medium bomber. Twenty-four of the pilots were regular instructors in the Advanced Twin-engine school, and the remaining three were instructors in the Instrument School. These twenty-four regular instructors were hand-picked by supervisory personnel in order that some would be experienced instructors and some relatively inexperienced. The sample contained, then, three groups with different experience:

	Number	Description of Experience
Group I	3	Instructors picked for their skill in flying on instruments as well as their skill in instructing rated pilots in instrument flying. Pilots supposedly representing the "cream-of-the-crop" in precision flying on instruments.

[1]Through the initial efforts of Dr. Frank Geldard the project enlisted the cooperation of Col. John T. Fitzwater, Headquarters Air Force Training Command, who was instrumental in encouraging the participation of Barksdale Field base personnel and in obtaining approval for the project in his command. The formal approval came from Headquarters Air Force as a result of a request from Dr. M. S. Viteles to Dr. Glen Finch, Human Resources Division, Headquarters Air Force. Lt. Col. Anderson, Lt. Col. Wood and Lt. Col. Parker were responsible for arranging the details of the try-out at Barksdale Field. The writer took responsibility for introducing the project and supervising the try-out proceedings.

	Number	Description of Experience
Group II	13	Experienced instructors of cadets in Advanced School. Skilled in contact flying but not necessarily in instrument flying.
Group III	11	Relatively new and inexperienced instructors of cadets in Advanced School.

The check pilots, or observers, were all Instrument School instructors in the same experience category as the three examinees in Group I, who also acted as observers on some of the flights. Thirty different observers participated in the try-out. This represented almost all of the instructors in the Instrument School.

Procedures

Briefing.--The present investigator met with all of the observers and all of the examinees on the first day. They were told about the purpose of the project and the procedure to be followed in the try-out. Copies of the flight-check were then made available to the examinees while the investigator briefed the observers on each maneuver. After the first day of testing another briefing was held during which the investigator pointed out certain errors in the use of the form which he had observed the first day. The investigator flew as a third observer on one of the flights, talked with some of the observers after the first flight, and examined some of their completed flight-check forms.

The point which was most emphasized in the first briefing was the necessity for filling out the forms independently. It was stressed that this was a test of the flight-check, not of the observers or the examinees.

Procedures.--Each of the twenty-seven examinees made a flight on each of two consecutive days. On the first flight each was observed by two check pilots and on the second flight by two different check pilots. Table 14 gives the plan of the two flights for each examinee, showing the combinations of the pairs of the thirty different observers. One observer sat in the right-hand seat (copilot's seat) and the other in the jump seat immediately behind the right-hand seat. Each examinee was scored by four different observers, hereafter called A, B, C, and D. Observers A and C were right-seat observers and B and D jump seat. Approximately ten different airplanes, all TB-25's, were flown on the first day of testing alone, and the heterogeneity introduced by the use of different planes was further increased by replacing some of these with other planes on subsequent days.

Results of Try-out

Scoring.--A scoring key was developed for each maneuver on the flight-check. No statistical procedures were employed in determining item weights, although the items were scored differently on authoritative grounds. A system of plus (favorable) scores and minus (unfavorable) scores was used for each item, performances judged neutral receiving scores of 0. Assigning the scores to the various items was done on the basis of a consideration of several factors:

1. Items found to be critical in the job analysis were given higher plus scores for favorable performance and higher minus scores for unfavorable than items not found to be critical.

TABLE 14

PLAN OF FLIGHTS WITH 27 EXAMINEES (Barksdale Field)

	Observers			
	First Flight		Second Flight	
Examinees	Right Seat (A)	Jump Seat (B)	Right Seat (C)	Jump Seat (D)
1	O_1	O_2	O_3	O_4
2	O_5	O_6	O_7	O_8
3	O_9	O_{10}	O_{11}	O_{12}
4	O_4	O_3	O_2	O_1
5	O_{13}	O_{14}	O_9	O_{10}
6	O_{15}	O_{16}	O_{17}	O_{18}
7	O_{19}	O_{20}	O_{21}	O_{22}
8	O_{23}	O_{24}	O_{25}	O_{26}
9	O_{27}	O_{28}	O_{29}	O_{30}
10	O_{14}	O_{13}	O_{19}	O_{20}
11	O_{16}	O_{15}	O_{13}	O_{14}
12	O_{20}	O_{19}	O_{23}	O_{24}
13	O_{24}	O_{23}	O_{28}	O_7
14	O_{28}	O_3	O_{22}	O_{12}
15	O_{12}	O_8	O_{26}	O_{25}
16	O_{18}	O_{17}	O_{30}	O_{29}
17	O_{22}	O_{21}	O_2	O_1
18	O_{25}	O_{26}	O_6	O_5
19	O_{29}	O_{30}	O_{10}	O_9
20	O_1	O_2	O_{11}	O_{19}
21	O_6	O_5	O_{24}	O_{23}
22	O_9	O_{10}	O_3	O_4
23	O_7	O_{11}	O_5	O_{22}
24	O_4	O_3	O_{17}	O_{18}
25 (also O_{14})	O_8	O_{12}	O_{11}	O_{23}
26 (also O_{24})	O_5	O_2	O_{18}	O_{22}
27 (also O_{23})	O_3	O_{24}	O_4	O_{19}

2. In scoring categories on a 3-point item, a relatively larger score value either positive or negative was assigned to categories representing extreme deviations as shown by low frequencies of occurrence.

Each item received a numerical score, and the score for a maneuver was the sum of the scores of all its items. The total flight-check score was the sum of all the maneuver scores. Separate totals were obtained for the flight-check plus the Checklist and the flight-check without the Checklist.

Reliabilities.—Observer-observer and ride-ride product moment reliability coefficients were computed for each maneuver, for the total flight-check without the Checklist and for the total flight-check including the Checklist. These correlations are given in Table 15. The means and standard deviations for the flight-check scores are given in Tables 19 and 20 in Appendix F.

Validity or relevance indications.— It will be remembered that the twenty-seven examinees were divided by their supervisors into three groups on the basis of their experience. In order to determine if the scores on the flight-check were related to the amount of experience of the examinees, a product moment coefficient was computed between experience ratings and flight-check scores. Examinees in Group I were given a rating of 2, those in Group II a rating of 1, and those in Group III a rating of 0. These ratings were correlated with the average of the four total scores given to each of the twenty-seven examinees. This correlation was .49, which is significant at the one per cent level.[1]

A correlation was computed between the mean flight-check scores and the number of flying hours of the twenty-seven examinees. This correlation was .16, which is not significant. Of interest, however, is the fact that none of the seven examinees with less than 2,000 flying hours received a mean total flight-check score above the median for the group of twenty-seven examinees. This is an indication that the flight-check differentiated pilots with less than 2,000 flying hours from pilots with more, but the lack of correlation indicates that the flight-check scores do not differentiate among those with more than 2,000 hours. Flight-check scores were correlated with number of TB-25 flying hours, but this correlation was practically zero (.07).[2]

Item analysis.— In order to obtain an indication of the internal consistency of the flight-check and the relative contribution of each item to the total flight-check score, an item analysis was made. The results are presented in detail in Appendix G. This analysis shows for each item the per cent of pilots in the upper and lower quarters (determined by Mean Total flight-check scores) who received favorable (positive) scores.[3]

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[1]The t-value obtained was 4.015, using Formula 10:42: Kelley, T. L., Fundamentals of statistics. Boston: Harvard University Press, 1947.

[2]Number of flying hours was consistently found to be a poor criterion of proficiency in the Army Air Force Aviation Psychology Program (18).

[3]The per cents are based upon N = 28 for each item, inasmuch as each of the seven examinees in upper quarter and the seven examinees in the lower quarter received a score from each of four check pilots, A, B, C, and D.

TABLE 15

OBSERVER-OBSERVER AND RIDE-RIDE RELIABILITIES
OF MANEUVERS AND TOTAL FLIGHT-CHECK
FROM AIR FORCE TRY-OUT

A = Right Seat Observers, First Flight
B = Jump Seat Observers, First Flight
C = Right Seat Observers, Second Flight
D = Jump Seat Observers, Second Flight

	Number of Pilots	Reliability Coefficients							
		AB	AC	AD	BC	BD	CD	O_1O_2*	R_1R_2*
1. Preparation for Flight	27	.88	.18	.34	.28	.46	.87	.88	.32
2. Inspection of Airplane	27	.88	.41	.04	.31	-.09	.47	.74	.18
3. Cockpit Familiarization Check	27	.74	-.03	-.03	.23	.25	.87	.82	.11
4. Before Starting Cockpit Check and Starting Procedure	27	.70	-.09	-.34	-.07	-.31	.99	.94	-.21
5. Taxiing	27	.67	.28	.23	.26	.31	.52	.60	.27
6. Before Takeoff Procedure	27	.45	-.01	-.13	.24	.01	.36	.41	.09
7. Instrument Takeoff	27	.63	.24	.16	.48	.38	.44	.54	.32
8. Intercepting a Predetermined Track and Tracking Away from Station in Climb	27	.79	.40	.26	.39	.01	.61	.71	.27
9. Minimum Speed Maneuvering and Approach to Stall	27	.72	.17	.32	.07	.03	.42	.59	.15
10. Steep Turns with Engine Failure(s)	27	.75	.22	.28	.21	.29	.83	.80	.25
11. Rapid Descent and Pull-up	27	.80	.41	.31	.51	.42	.93	.88	.42
12. Manual Loop Orientation and Tracking	23	.81	.66	.53	.63	.49	.87	.85	.58
13. ADF Approach with Engine Failure	27	.67	.12	.31	.27	.11	.41	.55	.21
14. Engine-Out Landing	27	.82	-.02	.11	-.13	-.03	.50	.70	-.02
15. Takeoff and Landing Under Simulated 400 and 1 Conditions	24	.68	.20	.18	.34	.45	.74	.71	.30
16. Crosswind Takeoff with Engine Failure	27	.62	.52	.54	.36	.61	.49	.56	.51
17. Crosswind Landing	27	.42	.22	.47	.24	.35	.46	.44	.32
18. ILS Approach	22	.79	.14	.15	.06	.09	.66	.73	.11
19. Positive Checklist	22	.85	.51	.51	.45	.48	.54	.73	.49
20. Total Flight-check (without Checklist)	27	.87	.49	.49	.59	.50	.76	.82	.52
21. Total Flight-check (including Checklist)	22	.91	.61	.61	.60	.51	.75	.85	.58

*O_1O_2 is the combined observer-observer coefficient (AB+CD). R_1R_2 is the combined ride-ride coefficient (AC+AD+BC+BD). These coefficients were combined using the z-transformation technique.

Revision of Flight-check and Second Experimental Try-out

Revisions

On the basis of the data obtained from the first try-out, the flight-check was revised in the following ways:

1. Items on which observers showed little agreement were revised in various ways, in order to increase their objectivity.

2. The sequence of maneuvers was altered.

3. Some of the directions for the check pilot and for the examinee were clarified.

4. More graphic and pictorial items were added to replace items where words were used previously.

5. The flight-check form was printed, whereas the first form had been dittoed.

6. Items which the Air Force pilots objected to for various reasons were replaced with others or eliminated entirely.

Valuable criticisms and suggestions were also received from a committee of airline pilots, representing the Air Line Pilots Association.[1] This committee had been selected for the purpose of reviewing the flight-check prior to an experimental try-out on a sample of airline pilots. Before sanctioning such a try-out, this association was desirous of making a careful study of the flight-check itself and the implications of objective evaluation of airline pilots for future labor-management relations. The present investigator attended two meetings of this committee and a third was conducted at which he was not present. The committee offered valuable suggestions for improving the flight-check, which were incorporated into the second form.

The second form of the flight-check is presented, in full, in Appendix H. This is the form which was used in the second try-out of the flight-check.

Second Try-out of Flight-check with CAA Personnel

Permission was obtained for a second try-out of the flight-check at the Civil Aeronautics Administration Aeronautical Center, Oklahoma City.[2]

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[1]Records of correspondence and other communications with the Air Line Pilots Association during the course of this project are on file with the Committee on Aviation Psychology of the National Research Council.

[2]Arrangements were made in Washington through the cooperation of Mr. W. W. Jarrell, Chief of Airman's Branch; Mr. W. B. Barnes, Chief of Flight Operations Branch. Final authority for the try-out was provided by Mr. J. S. Marriott, Assistant Administrator for the Safety Regulations Division. Earlier approval for the try-out had been obtained by the writer from Mr. F. M. Lanter, Director of the Center.

This try-out involved the testing of twenty-seven Civil Aeronautics Administration pilots on two successive flights on different days with two independent observers on each flight. The twenty-seven pilots can be classified in four groups as follows:

		Number of Examinees
1.	Civil Aeronautics Administration Agents being trained at the Center to administer the Airline Transport Rating flight-check.	8
2.	Instructor personnel at the Center.	6
3.	Civil Aeronautics Administration Agents who are qualified to give the Airline Transport Rating flight-check and who were brought into the Center especially for the try-out.	10
4.	Other Civil Aeronautics Administration Agents	3

Unlike the try-out in the Air Force this try-out had to be set up so that most of the pilots acted as both examinees and observers. The general plan of the try-out, however, was the same as the plan followed at Barksdale Field. Thirty different observers participated. Of the twenty-seven examinees, all but three acted as observers, too. Most of the flight-checks were conducted in the DC-3 airplane, a type used extensively by the airlines. A few of the checks were conducted in the DC-4 airplane, also used by many airlines. Table 16 shows the plan of the try-out.

Observer-observer and ride-ride reliabilities based upon this try-out are given in Table 17. It can be seen from this table that the observer-observer reliabilities obtained from this sample are comparable to those obtained from the Air Force sample. The ride-ride reliabilities increased considerably, however, suggesting that the revisions of items of the first form of the flight-check may have decreased the variation in evaluations of performance on two successive rides. This is particularly significant in view of the difficulties encountered by previous investigators in trying to eliminate this variation.[1]

To obtain an indication of the internal consistency of the flight-check and the relative contribution of each item to the total flight-check score, an item analysis was made. The results are presented in detail in Appendix I. This analysis shows the per cent of <u>unfavorable</u> or minus scores on each item for the upper and lower twenty-seven per cent of the examinees as determined by their Mean Total flight-check scores. The per cents are based upon N = 28 for each item since each of the seven examinees in the upper twenty-seven per cent and seven examinees in the lower twenty-seven per cent received a score from each of four check pilots -- A, B, C, and D.

[1] See, particularly, the discussion of this problem by Miller and Ericksen (18).

TABLE 16

PLAN OF FLIGHTS WITH 27 EXAMINEES
(Oklahoma City)

Examinees	Observers			
	First Flight		Second Flight	
	Right Seat (A)	Jump Seat (B)	Right Seat (C)	Jump Seat (D)
1	O_2	O_3	O_6	O_5
2	O_1	O_3	O_4	O_6
3	O_1	O_2	O_5	O_4
4	O_6	O_5	O_2	O_4
5	O_4	O_6	O_1	O_3
6	O_5	O_4	O_1	O_2
7	O_{12}	O_{14}	O_{13}	O_8
8	O_{12}	O_{28}	O_7	O_{13}
9	O_{12}	O_{28}	(Cancelled Flight)	
10	O_{29}	O_7	O_{30}	O_{27}
11	O_{27}	O_{30}	O_{29}	O_7
12	O_{16}	O_{17}	O_{14}	O_{13}
13	O_{14}	O_{15}	O_{12}	O_{16}
14	O_{15}	O_{13}	O_{17}	O_{12}
15	O_{13}	O_{14}	O_{16}	O_{17}
16	O_{17}	O_{12}	O_{13}	O_{15}
17	O_{12}	O_{16}	O_{15}	O_{14}
18	O_{12}	O_{13}	O_{11}	O_{15}
19	O_{11}	O_{15}	O_{13}	O_{18}
20	O_{11}	O_{15}	O_{13}	O_{19}
21	O_{22}	O_{23}	O_{26}	O_{25}
22	O_{23}	O_{21}	O_{24}	O_{25}
23	O_{21}	O_{22}	O_{26}	O_{24}
24	O_{26}	O_{25}	O_{22}	O_{23}
25	O_{24}	O_{26}	O_{21}	O_{22}
26	O_{25}	O_{24}	O_{21}	O_{23}
27	O_{18}	O_{13}	O_{11}	O_{15}

TABLE 17

OBSERVER-OBSERVER AND RIDE-RIDE RELIABILITIES
OF MANEUVERS AND TOTAL FLIGHT-CHECK
FROM CAA — OKLAHOMA TRY-OUT

A - Right Seat Observers, First Flight
B - Jump Seat Observers, First Flight
C - Right Seat Observers, Second Flight
D - Jump Seat Observers, Second Flight

	Number of Pilots	Reliability Coefficients							
		AB	CD	AC	AD	BC	BD	O_1O_2*	R_1R_2*
1. Preparation for Flight	21	.16	-.05	.30	-.09	.25	.20	.06	.17
2. Equipment Familiarization Check	23	.64	.45	.33	-.01	.30	.17	.55	.20
3. Cockpit Familiarization Check	26	.74	.88	.03	-.17	.25	.06	.82	.04
4. Starting Procedure	26	.51	.34	.02	.12	.12	-.12	.43	.04
5. Taxiing	26	.62	.30	.16	.40	-.01	.10	.48	.17
6. Before Takeoff Procedure	26	.55	-.13	.32	-.03	.26	-.17	.24	.10
7. Instrument Takeoff	25	.54	.69	.43	.46	.22	.43	.62	.39
8. Intercepting a Predetermined Track and Tracking Away from Station in Climb	26	.39	.62	.05	-.09	-.20	-.35	.51	-.15
9. Minimum Speed Maneuvering and Approach to Stall	26	.58	.62	.44	.12	.57	.35	.60	.38
10. Steep Turns with Engine Failure(s)	26	.44	.66	.51	.54	.37	.58	.56	.50
11. Rapid Descent and Pull-Up	26	.55	.71	.16	.42	.50	.62	.64	.44
12. Manual Loop Orientation and Tracking	25	.89	.29	.19	-.10	.15	.06	.70	.08
13. ADF Approach with Engine Failure	26	.75	.74	.20	.14	.39	.31	.75	.26
14. Engine-out Landing	25	.50	.54	.15	.16	.30	.42	.52	.26
15. Crosswind Takeoff with Engine Failure After Takeoff	23	.57	.64	.08	-.05	.07	.15	.61	.06
16. Approach Under Simulated 400 and 1 Conditions (Contact)	26	.55	.60	.07	.21	-.14	.07	.58	.05
17. ILS Approach	21	.63	.72	.32	.32	.06	.26	.68	.24
**18. Crosswind Landing	22	.52	.40	.43	.32	.10	.01	.47	.22
Total Score	26	.84	.87	.81	.75	.74	.74	.86	.76

**Check List and Total Score including check list omitted due to small number of cases with check list.

* O_1O_2 is the combined observer-observer coefficient (AB + CD). R_1R_2 is the combined ride-ride coefficient (AC + AD + BC + BD). These coefficients were combined using the z-transformation technique.

An Evaluation of the Flight-check by CAA Agents Participating in the Try-out

Twenty-four of the thirty CAA agents who used the flight-check in the second try-out were asked to fill out a brief questionnaire which asked for their comments and criticisms of the flight-check. An analysis was made of their written responses on the questionnaire, in order to obtain an indication of the degree to which the flight-check satisfied the criterion of being acceptable to those who would use it.

Fifteen of the twenty-four agents felt that this type of flight-check was a fairer or somewhat fairer way of grading. Five considered it a somewhat less fair way and two thought it definitely less fair. Two of the agents did not respond to this question. All of the agents felt that the flight-check needed revision, sixteen of whom felt it needed only "some revision." There were thirteen suggestions that the revisions should be changes in the order of some of the maneuvers, eleven suggestions that new maneuvers might be added to the present ones, three suggestions that some of the present maneuvers be replaced by new ones, and three suggestions that some of the maneuvers should be eliminated and none added.

Almost all of the agents felt that even after they became familiar with the form they could administer it only with some hazard involved. Nineteen of the twenty-four agents felt this way, four felt it would involve extreme hazard, and only one agent felt this type of flight-check would involve no increased hazard. Apparently, even though special efforts were made to decrease the amount of time for recording observations, the agents did not accept the idea of in-flight recording. These results fit in with the suggestion made by a number of the airline check pilots and Civil Aeronautics Administration inspectors in the interview — namely, that check pilots should do all of the flight testing in the jump seat with a safety pilot in the right-hand seat.

When asked what they would like to see done with the experimental flight-check, four agents indicated they would like to see it adopted after only some revisions, fourteen felt it should be revised and tried out some more, four felt it should be "discarded as an unsuccessful experiment," one checked two answers and one didn't reply. It appears that 75 per cent of the agents accepted this type of flight-check enough to feel it should either be adopted or tried out some more.

There were fifteen suggestions for the addition of particular maneuvers. Nine of these were suggestions for adding more emergency maneuvers and a maneuver covering radio range work. There were thirty-one suggestions pertaining to revisions of particular aspects of maneuvers in the flight-check, the most frequent being to eliminate telling the examinee that the check pilot would cut an engine on engine-out maneuvers. When asked to comment on the advantages and disadvantages of the flight-check and to state their own attitudes about the flight-check as a whole, the agents made about as many positive comments as negative. There were fifty-three negative comments. Those mentioned by at least three agents were:

1. Too much of the check pilot's attention was required in filling in the flight-check form in the air.

2. The flight-check made evaluation too "mechanical" or "stereotyped."

3. The examinee is prepared for emergency maneuvers.

4. The flight-check was too "restrictive" upon the check pilot, "too cut and dried."

5. It eliminates the judgment of the check pilot.

There were forty-seven positive comments. Those mentioned by at least three agents were:

1. It provides a record of exactly what the examinee did and thus makes it unnecessary for the check pilot to remember what was done.

2. The flight-check called for an evaluation of examinees' ability to prepare for flight, something which is lacking on present flight-check forms.

3. The flight-check would be helpful to new or inexperienced check pilots because it tells them what to look for and what tasks to require of the examinee.

4. It gives the applicant a more standardized test.

5. It permits quick grading of the most critical aspects of performance; the pictorial items are good.

6. Allows applicant to know what is required of him.

7. It decreases differences in check pilots' personal opinions, standards, etc.

CHAPTER VII

DISCUSSION OF RESULTS AND CONCLUSIONS

The objective of this study was to develop an improved method of evaluating the flying proficiency of pilots. For the purpose of this study, the Airline Transport Rating flight-examination was selected as the examination for which the new procedure would be developed. The four criteria established for the new procedure were: (1) that it be more reliable than current methods of evaluation, (2) that it measure the skills which are most relevant to success or failure on the job, (3) that it be practical, (4) that it be acceptable to those whose job it would be to use it.

To accomplish the objective of developing a procedure which would satisfy these criteria, the investigator surveyed currently used methods of evaluating pilot proficiency, studied previous research aimed at the development of improved procedures, utilized a particular job analysis approach for determining the critical requirements of the airline pilot's job, developed objective methods of measuring these critical requirements, and finally conducted two try-outs of the new procedure to test its adequacy.

The survey of currently used methods of evaluating pilot proficiency indicated that these methods are primarily of the subjective type, involving the giving of ratings on over-all flying proficiency, on large segments of the performance of pilots on the job, or on general traits and characteristics. Studies have repeatedly demonstrated that these methods (1) do not produce a satisfactory amount of agreement between check pilots who independently evaluate pilots' proficiency, (2) do not discriminate between the proficiencies of a pilot in different aspects of the job, (3) do not give an adequate range of the abilities of different pilots, and (4) do not adequately predict success in later stages of training.

The study of previous research in measuring pilot proficiency suggested that the most promising type of evaluation procedure was the objective-observation method. This method seemed most likely to satisfy the criteria established for the procedure to be developed in this study. Previous investigators had demonstrated that such measures could be developed which were both fairly reliable and relevant, although when compared with proficiency tests developed by educators and psychologists in some other fields the best of these pilot proficiency tests were not entirely adequate. It was also apparent from the survey of previous studies that, although many reliable measures of different aspects of pilot performance had been developed, more research was needed for the purpose of developing a total flight-check composed of measures of a large number of aspects of the pilot's job. A single comprehensive flight-examination needed to be developed and tested. Furthermore, it seemed apparent that more effort was needed to develop the type of proficiency measure which would be more acceptable to check pilots, inasmuch as none of the experimental methods developed by research had been adopted by the agencies for whom they had been developed.

In addition, what seemed to be needed as a basis for developing an improved evaluation procedure was a determination of the critical requirements of the pilot's job. By first determining these critical requirements it was hoped that it would be possible to develop an evaluation procedure which would be more relevant than others. In addition, it was expected that a flight-check based upon a study of the critical requirements might be more reliable because it would be measuring more consistent and fundamental qualities of pilot performance rather than those which change from one flight to the next. Lastly, it was felt that a flight-check which measured the critical requirements would have more chance of being practical and acceptable to those who would use it.

The determination of the critical requirements of the airline pilot's job involved obtaining from a number of different sources data which provided information about the qualities of pilots which made for success or failure on the job. The least productive of these sources were the records of flight examinations taken by airline pilots during their training. Reports of accidents, however, provided examples of specific behavior which had contributed to airline accidents and, consequently, could be considered as critical behavior. The most productive of all the sources were the critical incidents obtained from airline pilots, check pilots and CAA examiners. The utilization of this technique, the "critical incident technique", enabled the collection of a much larger number of examples of critical pilot behavior than would have been obtained through analysis of accident reports alone. Furthermore, it was shown that the relative "criticalness" of various aspects of pilot performance as determined from analysis of these critical incidents experienced by pilots was correlated with the relative "criticalness" of those determined from the analysis of accident reports. Thus, this study demonstrated the usefulness of the "critical incident technique" as a method of determining the critical requirements of a job. Such a technique taps sources of job analysis data which are otherwise not obtainable from records of past achievement.

It should be emphasized, however, that this study demonstrated that it is possible to analyze critical incidents in different ways. For example, in this study the first content analysis of the critical incidents, while of possible usefulness as a basis for developing selection procedures, was not as useful as a basis for developing an evaluation procedure as was the second content analysis in which emphasis was placed upon the components of the job in which critical behavior occurred. This finding suggests that an investigator should give careful consideration to the use to which he intends putting his job analysis information before beginning an analysis of such data as are provided by critical incidents.

The job analysis data from all sources provided a sound basis for establishing the critical requirements of the airline pilot's job. Certain requirements stood out sharply from others as being basic to success or failure on the job, thus providing an indication of the relative degree to which different components of the job are critical. These data made it possible to assign lower or higher values to different kinds of pilot behavior in the evaluation procedure.

In developing the experimental flight-check an attempt was made to devise tasks for the examinee which were identical with the components of the job which were found to be critical. This effort was not entirely successful, inasmuch as not all of the critical job components could be directly incorporated as tasks in the flight-check, due to time and safety limitations. Where possible, however, an attempt was made to devise tasks which closely simulated the critical job component, when the actual critical job component could not be duplicated on the flight-check. For those critical components of the job related to performance that cut across specific tasks on the flight-check, it was necessary to devise a checklist type of form on which the check pilot, on the basis of a number of observations, made judgments of the extent to which the examinee demonstrated certain critical qualities of performance.

To what extent the findings from the critical requirement analysis were translated into actual measures of the ability of pilots to meet these requirements can be only partially determined by comparing the tasks incorporated in the flight-check and the critical job components resulting from the job analysis. Additional evidence of this must come from actual validation of the flight-check against such criteria as the incidence of accidents and near-accidents or the achievement of success or failure on the job or in training. As mentioned earlier, however, reliable criteria of this kind have not been available and are difficult to devise. Actually, it can be argued that the flight-check itself is a better criterion measure than most of the measures which are available for validating the flight-check. This state of affairs does not eliminate the necessity to validate the flight-check, but it does require that a thorough and careful job analysis be relied upon for evidence of the flight-check's relevance.

In this study, there were available only three external measures of the proficiency of the pilots used in the try-outs, and these were available only for those pilots in the Air Force sample. Only one of these, an experience classification, was significantly correlated with the flight-check scores. There was evidence, however, that above average flight-check scores were not obtained by pilots with less than 2000 hours of total flying time. It has been the experience of aviation psychologists that the number of flying hours is seldom correlated with either selection or proficiency measures, so the lack of correlation found in this study between the flight-check scores and total flying hours or TB-25 flying hours cannot be interpreted as an indication that the flight-check lacks validity. More adequate evidence of the relevance of the flight-check should and can be obtained by using it to certify pilots for the Airline Transport Rating and then conducting follow-up studies of these pilots after they have been airline pilots for a relatively long period of time.

The results of the two try-outs of the flight-check permit the conclusion that the flight-check developed in this study is more reliable than either currently employed evaluation procedures or experimental procedures developed in previous research projects. The observer-observer reliability of the total flight-check score as determined from both try-outs is very high. It is significant that the observer-observer reliability of the total flight-check score for the second try-out was almost identical with that for the first try-out. The high observer-observer reliability coefficients are all the more significant because a large number of different check pilots were involved in both try-outs. This permits a much broader generalization from the findings -- namely, that the flight-check is objective and reliable even when used by a large number of check pilots differing in experience, training and proficiency. The findings can also be generalized to both military and civilian pilots. Other conditions of the try-outs make the high observer-observer reliabilities even more significant. First, the check pilots in the Air Force try-out were not the regular instructors of the examinees. They knew practically nothing of the flying skills of the pilots who acted as examinees. In the CAA try-out this was also true except that a small number of the examinees were instructors at the Center and they were evaluated by other Center instructors. Secondly, the seating arrangement for the second observer on each flight required him to sit behind the first observer. Some of the check pilots reported that it was harder to see some of the instruments from that position. This might have introduced some variation between observers that can not be attributed to the flight-check. Thirdly, in both try-outs the two observers did not always stay together as a pair each time they flew with an examinee. Thus it can't be said that the flight-check is reliable only if two check pilots get practice in evaluating together.

The ride-ride reliabilities obtained in this study are considerably higher than those reported in other studies. Several distinctive characteristics of the flight-check may have contributed to this. First, it is likely that the flight-check is measuring skills and behaviors which are relatively permanent and consistent, due to the fact that the flight-check was based upon the critical requirements of the job. Secondly, more gross observations are permitted by the graphic and pictorial items, whereas the kinds of items used most frequently in previous objective flight checks require observations of small segments of performance which are more likely to vary from one flight to the next.

The high ride-ride reliabilities obtained with this type of flight-check throw some doubt upon the conclusion reached by previous investigators that more than one administration of a flight-check is necessary for a reliable measure of flight performance. Furthermore, it may be that, although there is considerable variation from flight to flight in pilots' proficiency in performing certain kinds of tasks, as has been emphasized by previous investigators, there may not be as much variation in their proficiency in performing the <u>more critical</u> aspects of the job.

The ride-ride reliabilities are even more significant when it is considered that the two flights were flown on different days, thus permitting the operation of the variable of differences in weather conditions. The two flights were also generally flown in two different airplanes, thus permitting the operation of the variable of differences in the characteristics of airplanes.

In appraising the ride-ride reliability and the observer-observer reliability of the flight-check, it is important to consider that unusually high reliabilities were obtained in spite of the fact that the procedures were new and unfamiliar to the check pilots. Only a minimum amount of training was given them, and all of this was in the nature of briefing prior to their first flight. This seems to be a very important point to consider; for, actually, as check pilots become more familiar with this type of flight-check its reliability may increase.

Another requirement established for the flight-check was that it be practical for use under the different conditions of testing and that it be acceptable to those who would administer it. The results from the analysis of the questionnaires completed by the CAA agents participating as check pilots in the secbnd try-out give some indication of the practicality of the flight-check and the degree of acceptance of it by these pilots. Most of them feel that it is a fairer way of evaluating a pilot and that it should be adopted by the CAA or revised and tried out again. It is apparent, however, that the check pilots are concerned about having to use in-flight recording procedures while being required to act as a safety pilot. It may well be that these two functions should be divided between two pilots, so that the check-pilot can devote his entire attention to the matter of recording performance. This view is held by a large number of the CAA agents responsible for evaluating applicants for the Airline Transport Rating. Most of them feel that there should be a representative of the airline in the airplane during the flight-check. This person would be responsible for the safety of the flight and the safe operation of the equipment. The frequently used procedure of giving flight examinations to the entire crew would permit this.

One other possibility has occurred to the writer for relieving the check-pilot of some of his duties so that he could devote more time to evaluation. This would involve having the check-pilot record on the flight-check form only when a pilot's performance varied from the desired performance. After the flight he could then check all of the items where the pilot's performance was correct. In the air he would only record when the pilot varied from the correct performance.

The objections of the CAA check-pilots pertaining to the mechanical and stereotyped aspects of the flight-check seem to the writer to be less important than the objection discussed above. Attitudes such as those expressed by the check-pilots are almost always initially expressed when objective methods are proposed or introduced as a substitute for subjective methods in any field of measurement. In the opinion of the investigator, as the check-pilots become more familiar with this type of flight-check, objections of this sort would be outweighed by the advantages inherent in the flight-check, i.e. decreasing differences in standards, having a permanent record of the flight, reducing the amount of time now spent writing up grade slips and flight reports. The investigator has one recommendation for increasing the flexibility of the flight-check. This would be to allow each check-pilot to give one or two tasks of his own choosing in addition to those in the standard sequence.

On the basis of the results obtained in this study, the following conclusions are submitted:

1. Methods of evaluating pilot proficiency which are currently used by the airlines, by the CAA and in the military services are generally of the subjective type and have been shown in numerous studies to be unreliable, non-discriminative and of little value for predicting success in later training.

2. The critical incident technique is an extremely useful method for obtaining information about the critical requirements of a job. It provides information not otherwise obtainable from records of achievement, thus increasing the sample of incidents involving critical behavior. The kinds of behavior which appear critical in incidents obtained in interviews with participants on the job are significantly related to the kinds of behavior proven to have contributed to actual accidents.

3. Basing the flight-check developed in this study on the study of the critical requirements of the airline pilot's job may have increased the possibility of measuring pilot skills which are more consistent and permanent from one flight to the next than would be skills which are less critical.

4. The flight-check developed in this study is a reliable procedure for recording the performance of pilots having the training and experience similar to typical applicants for the Airline Transport Rating certificate.

5. Using a scoring procedure substantially similar to the one used in this study for arriving at an over-all measure of pilot proficiency, different check-pilots independently observing the performance of a group of pilots of similar experience to those used in this study will assign scores which are in substantial agreement.

6. The flight-check developed in this study appears relevant to the requirements of the job of airline pilot on the basis of two types of evidence. First, it was devised to measure those requirements found critical for successful functioning as an airline pilot. Secondly, the scores on the flight-check and the experience level of pilots show a positive correlation significantly greater than zero.

7. The utilization of graphic and pictorial items in an evaluation form which requires making numerous observations and recordings to be made may contribute greatly to its reliability and may make the procedure more acceptable and more practical.

8. Through the use of special types of items, it appears possible to develop a flight-check form which is applicable for use with a number of different types of airplanes.

9. The majority of CAA check-pilots who used the flight-check developed in this study are either in favor of adopting it as the Airline Transport Rating flight-check or in favor of continuing its try-out after some revisions.

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APPENDIX A

COMPANY FILE REPORT FORM

APPENDIX A

AMERICAN INSTITUTE FOR RESEARCH
Incorporated
Cathedral of Learning
Pittsburgh 13, Pennsylvania

CAA Project I

May 28, 1947

COMPANY FILE REPORT FORM

1. Code ____ ____ ____

2. Date of Birth ______________________
3. Marital Status: Married _____ Single _____
4. Highest School Grade completed ________
5. Attendance in Night or Technical School: ___ Months
6. Date of Employment ______________________
7. Date of Termination ______________________
8. Status at termination: Student Copilot _________; Copilot _____; Student Captain ________; Captain ________
9. Reason for termination ______________________

11. Civilian Ground Training:

Type	Months
Total	

12. Flying hours:
Civilian ______
Military: Total ______
S.E. ______
T.E. ______
4-E. ______
Airline
Total ______

10. Standard Tests at time of employment:

Name of Test	Form	Score	Variations or Part-scores

Student First Officer (Student Copilot) Proficiency Record

13. Ground School grades:

Name of Course	Grade

14. Written tests:

Name	Grade

Explanation of grading system:

15. Routine flight checks:

Date	Name of Check	Form	Results and Comments

16. Special Flight Checks (Check-outs, Equipment checks, etc):

Date	Name of Check	Form	Results and Comments

First Officer (Copilot) Proficiency Record

17. Ground School grades:

Name of Course	Grade
______________	______
______________	______
______________	______
______________	______

18. Written Tests:

Name	Grade
______________	______
______________	______
______________	______
______________	______

19. Routine flight checks:

Date	Name of check	Form	Results and Comments

20. Special Flight Checks:

Date	Name of check	Form	Results and Comments

Student Captain Proficiency Record

21. Ground school grades

Name of Course	Grade

22. Written tests:

Name	Grade

23. Routine flight checks:

Date	Name of check	Form	Results and Comments

24. Special Flight Checks:

Date	Name of check	Form	Results and Comments

Captain's Proficiency Record

25. Ground School grades:

Name of Course	Grade

26. Written Tests:

Name	Grade

27. Routine Flight checks:

Date	Name of check	Form	Results and Comments

28. Special Flight checks:

Date	Name of check	Form	Results and Comments

APPENDIX B

QUESTIONS FOR THE AIRLINE PILOT INTERVIEW

APPENDIX B

QUESTIONS FOR THE AIRLINE PILOT INTERVIEW

QUESTION #1

"Probably all pilots who have flown a lot have done something at one time or another that got them into an uncomfortable situation or even a near accident. We would like to get from each pilot several examples of such things that he has done. First, could you describe the most recent situation in which you did something like this and tell me just what you did?"

The purpose of this question is twofold. First, it has been worded in such a way as to obtain an example of specific behavior of a pilot, something which that pilot did. It is essential that the question evoke this type of response. It may be necessary to reword the question and ask it a second time in order that the pilot understands what is wanted. Secondly, the question specifically asks for the most recent example. This is important to assure us that all of the incidents we obtain will represent a fairly random sample of typical things pilots do that get them into dangerous situations. It is important, therefore, that the interviewer obtain the most recent incident. It is expected that from some pilots interviewers may be able to obtain more than one incident. Consequently, after the pilot has given his most recent incident, the interviewer should then ask the pilot if he can recall other such incidents. It would be desirable if interviewers could obtain more than one incident, but the number should not exceed three because of time limitations. It will be left up to the interviewer to judge each example the pilot gives and to determine if secondary questions are necessary in order to obtain what is needed. As a guide for the interviewer, the essential information to be obtained from this question can be summarized as follows:

1. The most recent example of something the pilot did that resulted in a dangerous situation or near accident. What was the unsafe act?
2. Conditions under which the incident occurred: location, traffic, weather, instrument or contact flight, day or night flight, etc.

3. Type of airplane being flown and information about other equipment involved in the incident: engine failure, instruments misread, controls confused, radio inoperative, etc.
4. Pilot's opinion as to reasons for the unsafe act. What were the contributing causes of the unsafe act?

It is expected that some pilots will give incidents which were dangerous but were not brought on by an unsafe act of the pilot. These pilots may find it difficult to admit that they committed an unsafe act. The interviewer might remind the pilot that we want examples of what pilots do rather than examples of situations made unsafe by others. The interviewer also might re-emphasize the fact that we are not interested in particular pilots and that these examples will be treated anonymously. If the interviewer still cannot obtain an adequate response for Question #1, he should try the following Alternative Question:

Alternative Question (Alt. #1): "Well, perhaps you could recall the most recent incident where you observed some other pilot do something that got him in such a spot."

Following is an example of a fairly satisfactory answer to Question #1:

Pilot: "We took off at Washington with about a 700-800 foot ceiling. The visibility was only about 1 mile and there was rain on the windshield. We were only about 400 feet off the ground at the time. There was another pilot riding jump seat and if it hadn't been for the fact that he saw this other plane and yelled we would have hit him sure. That was really a close one."

(Comment: The pilot has given the situation and the conditions under which the incident occurred, but he has not stated what the pilot or copilot did to bring on this situation. Consequently, the interviewer found it necessary to make an additional comment).

Interviewer: "I'm not sure I understand just what you did to bring on this situation."

Pilot: "Well, it was really the control tower operator's fault for clearing us to take off with another plane in that position in the traffic pattern."

(Comment: The pilot seems to be a bit defensive and puts the blame on the control tower operator. Note next that the interviewer does not ask the pilot if he was at fault in any way but makes a simple reflection of the pilot's statement. The result is that the pilot later tells why he was at fault).

Interviewer: "It was really the control tower operator's error that caused this situation to occur, is that right?"

Pilot: "Yes. It was his error at first. He shouldn't have cleared us. Still we were so busy in the cockpit that we didn't look out for other planes. The copilot was reducing power—that shows how low we were! I was busy getting ready to fly instruments. I would like to emphasize that in the DC-4 you have to do so much you don't have enough time to look around."

(Comment: Simply by showing an interest and by trying to understand him the interviewer skillfully brought out the specific unsafe act of the pilot. In addition he obtained the pilot's opinion as to possible reasons for the unsafe act, namely the complexity of a particular airplane.)

QUESTION #2

(Captains) "Now, I would like for you to recall the last time you had to take over the controls from a copilot because you felt the situation was pretty critical. Could you describe that situation and tell me just what the copilot did or might have done if you hadn't taken over?"

(Copilots) "Now, I would like for you to recall the last time the captain you were flying with took over the controls from you because he felt the situation was pretty critical. Could you describe this situation and tell me just what you did or what he thought you might have done if he hadn't taken over?"

The purpose of this question is to get examples of what less competent pilots do or might do in critical situations in airline flying. The answers to this question should be in terms of behavior of the pilot. What did he do or what might he have done? It is expected that from some pilots interviewers may be able to obtain more than one situation. Consequently, after the pilot has given the most recent situation, the interviewer should then ask the pilot if he can recall other such situations. It would be desirable if interviewers could obtain more than one situation but the number should not exceed three because of time limitations. Because of the nature of the information desired, it is necessary to have somewhat different questions for the captain and the copilot. Here again it is important to get the most recent example. The interviewer should make this clear to the interviewee. It will be left up to the interviewer to judge the pilot's answer to the question and to determine if secondary questions are necessary in order to obtain the needed information about the situation. As a guide for the interviewer, the essential information to be obtained from this question can be summarized as follows:

1. The most recent example of what the copilot did or might have done if allowed to continue flying the plane.
2. Conditions under which the captain took over: location, traffic, weather, instrument or contact flight, day or night flight, etc.

3. Type of airplane being flown and information about other equipment involved in the incident: engine failure, instruments misread, controls confused, radio inoperative, etc.

It is expected that some of the pilots may not be able to give an example of such a situation. If, after giving the pilot sufficient opportunity to answer Question #2, the interviewer does not obtain an example, he should try the following Alternative Questions:

Alternative Question (Alt. #2) (Captains): "Well, then, perhaps you could tell me about the last time that you felt that the situation was so critical that you would not have wanted the average copilot to fly the airplane. Could you describe that situation and tell me what unsafe act an average copilot might have done in that situation?"

Alternative Question (Alt. #2) (Copilots): "Well, then, perhaps you could tell me about the last time that you felt that the situation was so critical that you preferred that the captain fly the airplane. Could you describe that situation and tell me what you might have done in that situation?"

Following is an example of a fairly satisfactory answer to Question #2:

Pilot: "We were landing at Winston-Salem, North Carolina, at night. The runway we had to land on was a very short one. Well, my copilot had been flying the plane so I thought I'd let him land it. As he turned on the approach, I could see he was too high, so I took over and cut off all the power and put my flaps down right away. Even at that we didn't touch until we were about a third of the way down the runway."

(Comment: The pilot has described the situation briefly but has omitted some important information).

Interviewer: "Even with your taking over it was close, huh?"

(Comment: Note that the interviewer does not ask further questions but simply makes a response which shows the pilot that he is listening and is understanding what he is saying).

Pilot: "I'll say. He would have overshot for sure. Those DC-3's float a lot more than the DC-4's. I guess he had been flying the bigger ships quite a bit. Then, too, the weather wasn't too hot--poor visibility, light rain. Course, with the rain, that made it worse because if he had to use a lot of brake at the end of the runway we would have been sunk."

(Comment: Here the pilot voluntarily has filled in the gaps in his original description. By giving the kind of response he gave, the interviewer obtained the additional information he needed: the type of plane, weather conditions, more about what the copilot might have done).

QUESTION #3

"In addition to these specific incidents which you have described, we are anxious to get your opinions on causes of unsafe airline flying in general. Obviously, there are a great number of causes, but I would like to hear what you feel are some of the most important. What are the important causes of unsafe airline flying?"

This question is designed to provide us with the opinions of airline pilots as to the important factors contributing to unsafe airline flying. It is expected that the question will provoke opinions on many different aspects of airline operations, such as training, evaluation, communication, equipment, pilot traits, morale, dispatching, maintenance. Such information will be of value to us in later projects and certainly of value to the airlines themselves. The interviewer may wish to ask additional questions in order to obtain more opinions from the pilots. This, of course, will depend upon the judgment of the interviewer. It should be noted that this question is intended to obtain opinions whereas the previous questions were for obtaining specific incidents and behavior of pilots in those incidents. The interviewer, however, should make certain that he completely understands what the pilot means when he states an opinion on causes of unsafe airline flying. It may be necessary to encourage the pilots to be more specific in order that the interviewer understands what is being stated.

QUESTION #4

"If you ran an airline and had the problem of keeping check on whether captains were doing a good job, how would you do it?"

The purpose of this question is twofold: first, to obtain pilots' attitudes towards present methods of evaluating captains; secondly, to obtain their ideas for improving these methods. The question is worded in such a general way that the pilot may express attitudes or opinions about various evaluation procedures.

QUESTION #5

"What characteristics, traits or abilities which differentiate the good airline captain from the poor are not being evaluated adequately by present methods of evaluation?"

It is expected that this question might produce two things: first, it should tell us what characteristics, traits or abilities pilots feel are possessed by the good airline captain: secondly, it should tell us if they feel these other characteristics, traits or abilities should be evaluated.

QUESTION #6

"How would you change the present instrument check so that more of these desirable characteristics, traits and abilities of the good airline pilot could be evaluated?"

The purpose of this question is to get specific ideas from pilots on ways of improving the instrument check so that it would measure more of the qualities which the good airline captain has.

QUESTION #7

"We are also interested in determining to what extent pilot fatigue may be a factor in airline accidents. Can you recall a situation where fatigue in any way might have contributed to an accident or a near-accident? Would you describe that situation and tell me just what the pilot did as a result of his fatigue?"

If a pilot can recall such an incident, the interviewer should obtain from him certain essential information about the situation. The interviewer should first give the pilot opportunity to furnish this information voluntarily, but it may be necessary to ask additional questions. Following is the essential information which the interviewer must get:

1. Type of airplane and how many consecutive hours the pilot had been flying at the time of the incident.
2. Kind of flight: overseas or domestic, day or night, a long hop or a flight with stops, instrument or contact flight.
3. How long pilot had been assigned to flight.

QUESTION #8

"I would like to get more of your ideas about this problem of fatigue. What causes pilot fatigue for the most part? What are important fatigue-producing factors in airline flying?"

It is important that the interviewer encourage the pilot to give specific causes which would be of value to airline companies. If the pilot already has indicated that he felt fatigue was not a problem, this question, of course, would not be asked.

QUESTION #9

"Well, I've asked you a lost of questions and you have given me some very good ideas. Now, perhaps you have something further to say on these problems which you haven't mentioned already. If you do, I would like very much to get some of your other ideas."

The purpose of this question is to get any ideas or attitudes relative to these problems which might not have been expressed in response to the questions. In addition, by allowing the pilot to express himself in this way, the interview is terminated on a good note.

APPENDIX C

MANUAL FOR INTERVIEWERS

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MANUAL FOR INTERVIEWERS

Project on

REQUIREMENTS FOR AIRLINE PILOTS

Under Sponsorship of

Committee on Selection and Training of Aircraft Pilots

of the NATIONAL RESEARCH COUNCIL

and

The Assistant for Research of the

CIVIL AERONAUTICS ADMINISTRATION

May 1947

AMERICAN INSTITUTE FOR RESEARCH
Incorporated

Cathedral of Learning
Pittsburgh 13, Pennsylvania

DESCRIPTION OF THE PROJECT

The Committee on Selection and Training of Aircraft Pilots of the National Research Council has requested the American Institute for Research to make a survey during the next several weeks of procedures for selecting, certifying, and upgrading airline pilots. The funds for this project have been supplied by the Civil Aeronautics Administration. The Civil Aeronautics Board has also expressed an interest in this study.

This study is strictly a research project; and the results of the survey will be presented in statistical form, with recommendations regarding current procedures. It is not the intent of the study to evaluate specific airline pilots or to compare different groups of pilots. No data regarding specified individuals will be presented to either the Civil Aeronautics Administration or any of the airline companies.

The primary objective of the study is to survey all sources of information regarding the requirements for effective work as an airline pilot. It is anticipated that this survey will lead to a more accurate definition of the specific skills, information, types of judgment, aptitudes, and personality and temperament which are essential to insure a long career as a safe airline pilot.

Sources of Information

It is proposed that this survey include all of the promising sources of information regarding the characteristics of safe airline pilots. One of the primary sources is expected to be the pilots themselves. It is planned that a representative sample of pilots from almost all airline companies and with varying amounts of experience, be interviewed. A systematic tabulation of their analyses of situations involving accidents or near-accidents would be made. Various types of emergency situations would be studied to determine the specific skills, abilities, or information most useful in avoiding a serious accident.

A second source of information will be the airline company check pilots. These men will be requested to provide information regarding the specific types of skill and ability which they regard as most important in examining pilots. They will be especially asked to describe actual incidents illustrating poor judgment, bad habits, or unsuitable temperament on the part of a pilot to whom they have recently given a check flight.

A similar survey would be made of other company employees, in charge of the training and supervision of pilots. This part of the survey would stress especially long-range training procedures, special problems with respect to new equipment, and similar matters.

Another source of information will be the company personnel files. These records are to be examined to obtain information regarding all pilots separated from the company either for failure "on the line" or in captains' school. Again, the examiners of the company files are not concerned with individual pilots and consequently the names of pilots would not be taken from the files. For purposes of comparison, a control group of individuals who are successful would also be studied. It is anticipated that by studying the records for a group of approximately a thousand pilots, half of whom were unsuccessful and separated from the company and half of whom were successful, valuable information regarding requirements for successful work as a pilot can be obtained.

A small number of control tower operators and other similar types of ground personnel are to be requested to provide information regarding safe and unsafe pilots. These reports would be similar to those obtained from pilots, but would be concerned more especially with observations with respect to landings and take-offs. The individuals in these groups would be asked to report specific incidents which they believed typified behavior characteristics of safe and unsafe pilots.

CAA inspectors and examiners would be requested to provide a statement of the principal reasons for failing each of the last few men who did not pass an airline transport pilot's examination which they gave. These would be amplified by detailed reports of incidents which confirmed their opinion that the applicant should be failed. The examiner might also be asked if the pilot could have done anything after this incident which would have compensated for this error. Similar reports would be obtained from the inspectors and examiners regarding the things which pleased them most about the best pilots whom they had recently examined.

The last source of information which is proposed to be included in this survey is the CAA record files. These files are to be analyzed with respect to flight examination records, personal records regarding pilots, and accidents.

It is anticipated that this comprehensive survey of sources of information regarding pilot requirements will provide a sound basis for further studies and research on the problem of improving current procedures for selecting, certifying, training and upgrading airline pilots.

The findings of this study will be made available to all of the cooperating organizations. It is believed that this survey will provide valuable information which can be used to the advantage of all concerned.

STANDARD PROCEDURES FOR INTERVIEWING

General Plan of Interviewing Program

The general plan of the program calls for interviewing around 500 airline pilots at approximately twenty large cities throughout the country. This interviewing will be accomplished during the month of May. As soon as this airline pilot interviewing program is underway, the plans call for interviewing approximately 100 C.A.A. flight examiners, 100 airline company check pilots, and 100 other individuals who are in positions where they observe airline pilots. It is proposed that all of these interviews be completed by at loaset the end of the first week in June.

Interviewers will work under the supervision of a person who has been selected as supervisor of a particular city or area. The supervisor will be responsible for obtaining interviewers and also will assist them in learning the interview methods and procedures. Standard operating procedures for interviewing have been written for the interviewers. These procedures are to be followed closely in order that the interviewing be standardized at all of the interviewing localities. In addition, standard procedures have been prepared to assist interviewers in classifying the interview data and in preparing the reports of their interviews. Again, these procedures must be followed closely to insure accuracy of tabulation of the interview information.

The purpose of the interview program is primarily for obtaining first-hand information on what airline pilots do, how they behave, or what acts they perform in those situations which they themselves judge as being the critical situations in airline flying. This information will be one of the main sources from which to determine the critical requirements for the safe airline pilot. The interview, then, is designed primarily to furnish specific examples of pilot behavior. A secondary function of the interview is to furnish opinions of key personnel as to causes of unsafe airline flying, causes of pilot fatigue and ways of improving methods of evaluating airline pilots.

The Nature of the Interview

In order to accomplish the objectives stated above, the interview has been designed as a relatively informal, semi-structured situation. The informality of the interview will depend largely upon the attitudes and techniques of the interviewer. The structure of the interview is provided by the standardized questions which define the areas in which discussion will take place. Our experiences with attempts to obtain information of the kind desired in this study has convinced us of the importance of two factors which determine the success of an interview: the attitudes of the interviewer and the kinds of responses he makes during the interview.

The Attitudes of the Interviewer

The degree to which an interviewee will express opinions and attitudes or talk freely about his experiences to another person depends upon the "atmosphere" created by the interviewer or the "rapport" established between the interviewer and the interviewee. The most favorable atmosphere is one which is best described as "permissive." In a permissive atmosphere an interviewee feels free to express almost any attitude or opinion. This is because he feels that no matter what he says he will be understood, he feels that no matter what attitudes he expresses they will be accepted by the interviewer, he feels his ideas are worthwhile and respected. How well an interviewer can create such a permissive atmosphere in an interview depends mostly upon his own attitudes. The interviewer may follow certain rules and be familiar with particular techniques, but neither rules nor techniques will cover up faulty attitudes.

It is difficult to label and describe the desirable attitudes of an interviewer. Nevertheless, an attempt is made at listing certain of these attitudes as follows:

1. The interviewer should consider the interviewee as an individual rather than as a statistic or as just another source of data. Because the interviewee is an individual, he will have feelings, he will want to feel important, he will cherish his own ideas and beliefs, he will defend those ideas if he feels they are not accepted, he will be cautious and at times even suspicious.

2. The interviewer should assume the role of a neutral person. He has nothing to defend, no preconceived ideas as to what is correct or incorrect. He is not a judge.

3. The interviewer should take the attitude that he is not the expert -- the expert is the interviewee. It is the interviewee who knows his field and the interviewer must rely on the expertness of the interviewee in order to obtain the data for this study. It is a mistake for an interviewer to attempt to show how much about flying he knows. "A little knowledge is a dangerous thing" is even more applicable in an interview with someone with years of accumulated knowledge.

4. The interviewer should be willing to let the interviewee take the responsibility for carrying on the interview. His attitude should be one that says, "You know more what to tell me than I do." The interviewer only decides the area by asking his questions, then directs his efforts at encouraging responses to the question.

<u>The Techniques of the Interviewer</u>

1. <u>Beginning the Interview</u>. This is usually the phase of the interview which gives an interviewer the most difficulty. This is almost always because of the insecurity of the interviewer -- not the interviewee. Often the interviewer feels that he must get the interview going smoothly right away and then feels uncomfortable when it doesn't. Most interviews will develop slowly. This is characteristic of almost any situation in which two people begin to establish a relationship. Consequently, the interviewer should strive to appear at ease himself, thus helping the interviewee to relax. It is important not to create the impression of haste or impatience. Some small talk at the beginning of the interview may be helpful. Also it is important for the interviewer to establish his identity and the purpose of the interview fairly soon after starting the interview. This should be done briefly, however, because a long-winded introduction can detract from the informality which the interviewer will want to create. Exactly how to begin this introduction will depend upon the local situation.

For example, in this program if has not been possible for A.I.R. representatives to contact all the people who are to be interviewed. In most cases, the only contact with an airline will have been a letter to a top executive. Consequently, some of the interviewees may know only a little about the project; others will know nothing. It is essential, then, that the interviewer use his own judgment as to how to begin. There are, however, a few important things which the interviewee should understand. He might know some of these things already, or may have to be told about them by the interviewer. In any event, he should be informed of the following:

1. That the interviewer represents the A.I.R. which has been authorized by the C.A.A. to carry out this investigation, and that the project has been discussed with the Air Line Pilots Association, which has informed all council chairmen and officers of the project.

2. That the purpose of the study is to get as complete an understanding as possible of the job of airline pilots in order to determine what specific qualities and characteristics good airline pilots have which differentiate them from poor airline pilots.

3. That such an understanding is necessary in order later to determine fair and accurate ways of selecting and certifying airline pilots.

4. That the investigators feel that pilots (or CAA examiners, check pilots, etc.) are in an excellent position to give help on this problem.

5. That in this study we are not dealing with the individual pilot but only with pilots in general. Similarly we are not using the names of the particular persons contributing their opinions and ideas to this investigation.

It is expected that as the interview progresses interviewees will ask questions or express attitudes indicating some lack of understanding of the study, even though the introduction has been carefully made. These questions can be handled best simply by answering them when they arise. In other words, interviewers should not expect to settle all issues in the introduction to the interview. Too long an introduction will be as bad as no introduction.

2. The Questions. A certain amount of structure has been given the interview by formulating questions to be asked of the interviewee. These questions are different for each type of person to be interviewed, i.e. pilots, C.A.A. examiners, airline company check pilots, etc. These questions have been designed very carefully and worded in the best possible way to obtain the information needed in this study. The interviewer should study carefully the questions and their explanations in order that he is very familiar with the wording of the questions and knows exactly the information which each is designed to obtain. This is very important inasmuch as the interviewer will want to ask each question very much as it has been formulated, yet without sounding as if he had memorized it. As an aid to the interviewer we have prepared an "Interviewer's Guide" for use during each interview. This is simply a list of the questions and brief reminders of the essential information to be obtained from each. Interviewers may feel more secure by having this guide during the interview, perhaps making an explanation to the interviewee such as the following:

"I think I can let you know most clearly the kinds of things we are after if I just ask these questions which I have here."

The purpose of these standard questions is to establish clearly the specific area in which information is desired. It is natural, however, to expect that interviewers may have to repeat questions or elaborate somewhat upon their first statement of the question when it does not produce an adequate response. The standardized questions should touch off the first spark and the interviewee then should begin to respond. The interviewer at this point, however, cannot just sit back and listen. His function now is to encourage the interviewee to elaborate certain points, to give additional details and sometimes even to get back on the subject when he has strayed a little. All of this is accomplished by the responses of the interviewer to the statements of the interviewee.

3. Interviewer's Responses. When an interviewee seems to be responding adequately to a question, the interviewer should need only to display his genuine interest by an occasional "I see" or "Uh-huh." It is most important for an interviewee to feel he is being understood—not just "listened-to." This can be displayed if the interviewer occasionally makes a kind of restatement of the essential aspects of what the interviewee is expressing, such as:

> Interviewee: "The way they make you take these darn instrument checks every six months, it's no wonder pilots feel that way. When doctors once get their degree, they're through being examined. Not pilots—they never get through being checked and evaluated."
> Interviewer: "It really makes you feel pretty insecure about your job."

These three responses, the simple "I see" or "Uh-huh," the restatement of the essential content and thereflection of feelings, constitute the interviewer's main tools. Experience has shown that with desirable attitudes and the skillful use of these three kinds of responses an interviewer is most successful at encouraging interviewees to express their real feelings and attitudes and to furnish the information desired by the interviewer.

4. Note-taking. An important problem in interviewing is how to record what transpires during the interview. In the absence of electrical recording equipment, it is usually necessary for the interviewer to take notes. The problem then becomes to avoid letting the note-taking destroy the relationship or interfere with the other functions of the interviewer. Studies have demonstrated that the interviewer can recall more if he takes notes during the interview than if he does not, even though he may write up the interview immediately afterwards. Consequently, for the interviewing in this project it is requested that the interviewer take notes during the interview. Then, immediately afterwards, the interviewer will fill out the "Interview Summary Forms," using his interview notes. In this kind of interviewing where specific, and often fairly technical, information is being obtained, note-taking during the interview is probably even more necessary than in other kinds of interviewing. It has been our experience, too, that when interviewing is done in a field with which interviewers are not too familiar, gross misinterpretations of information occur when interviewers take insufficient notes and rely too heavily upon their memory. In addition, there is one other important reason for recommending that interviewers take very complete notes. We feel that this investigation will be made more significant if we can include in the reports of the study a number of direct quotations from interviewees. To accomplish this, we are suggesting that interviewers

attempt to get some verbatim statements which they feel would make good examples to include in reports of the program. Whenever verbatim statements are written in the "Interview Summary Forms," the interviewer should place such statements within quotation marks.

Interviewers will turn in both their interview notes and their "Interview Summary Forms" on each interview at the end of the day on which the interview was conducted. The job of tabulating and analyzing interview data will be facilitated greatly if, as soon as interview notes and summary reports are turned in, supervisors will forward them immediately to the American Institute for Research, Cathedral of Learning, Pittsburgh 13, Pennsylvania. Interview notes should be taken on 8 1/2 x 11" paper to insure a standard size for all notes.

5. Special Problems. It is impossible to foresee all problems which may confront an interviewer. Nevertheless, some problems almost always arise, and it is well for interviewers to have done some thinking about them beforehand. One of these problems is in regard to the length of interviews. Several of the interviews for pilots and the interviews for CAA examiners have been accomplished already. Their lengths varied from one to two hours, the average being around one hour and one-half. The length of a particular interview will depend upon many factors: the amount of time the interviewee can spare, his willingness to cooperate, the richness of his experience, and, of course, the skill of the interviewer. Probably the best interviews are obtained, however, when the interviewer informs the interviewee about how long the interview will take. Each interviewer will learn from experience about how long his own interviews take and can use this as a standard. It follows, of course, that interviewers should not extend the sessions much beyond the amount of time decided upon. Rather, they should conduct their interviews in such a way as to complete the questions in the allotted time.

Another problem is where to conduct the interview. This will depend for the most part upon the local situation. Because of the nature of the information requested from interviewees, however, every attempt should be made to secure a private or semi-private place for these interviews. In this connection, one other problem will arise. Occasionally, interviewers will find that a captain and his copilot may want to be interviewed together. This probably should be avoided because of the nature of Question #2. It may be possible, however, to interview two or three captains or copilots so long as they aren't mixed. This already has been tried with some of our preliminary interviews. If the interviewer has had training and experience in group interviewing, he may try out this procedure. He could decide himself if it seemed to be a good procedure for this type of interview.

Another problem confronting interviewers is what to do when an interviewee has a tendency to stray from the subject and to get off on topics of his own choosing. Here the interviewer is torn between a desire to get certain information and a reluctance to interrupt the interviewee. This situation may occur when an interviewee seems to have something to get off his chest, when he has not understood a question, and only occasionally when an interviewee is deliberately side-stepping a question. It is seldom than an interviewer should have to interrupt an interviewee. This may completely destroy the rapport of the interview. A better procedure is to help the interviewee "get it off his chest" by reflecting his feelings accurately. Then when he has expressed himself, the interviewer might make some such response as:

"I can sure understand just how you feel about that. Well, could we return for a minute to these incidents we're after. Could you recall such an incident?"

Or when it appears that the interviewee might have misunderstood the question, the interviewer might simply say:

"I guess I really didn't make it very clear what I would like to get. Perhaps if I just stated that question again for you it would help."

When an interviewer runs across an interviewee who seems to be uncooperative and who appears to be holding back information, very little can be accomplished by trying to force the information out of him. The interviewer's only recourse is to try to understand why this person doesn't want to cooperate, accept that reason, and attempt to understand what he is willing to tell you.

Finally, there is the problem of what the interviewer does when there are innumerable "long pauses" during an interview. The pause is frequently a rather unnerving experience for an interviewer. It goes without saying, however, that when an interviewer successfully has transferred the responsibility for carrying the interview to the interviewee, the latter is more inclined to "feel" the pauses and to fill them himself. On the other hand, when an interviewer shows by his attitude that he is "in charge," the interviewee will feel that it's the interviewer's job to keep the conversation going, not his; such an interviewer usually finds it is he who has to keep it going and, consequently, there will be pauses. In general, it might be stated that when long pauses become frequent, the interviewer can try the following, in the order given:

a. Wait out the pause, for the interviewee may only be thinking of what to say next. By waiting out pauses, the interviewer also reinforces the fact that he wants the interviewee to carry the ball.
b. If the pause becomes too long, try and restate the essence of the interviewee's previous comments as follows:
   "If I understand correctly what you have been saying, you think that fatigue is a real problem."
   Such a response invariably stimulates further comment, and, furthermore, it demonstrates that the interviewee is really being understood.
c. It may be necessary to reflect the difficulty which the interviewee is having with some response like the following:
   "It's sort of hard to pull these incidents out of the past in a few minutes, is that right?"
d. Finally, it may be necessary to proceed to the next question after trying one final attempt such as:
   "You've sort of exhausted that topic, as far as you're concerned, eh."

Arranging the Interviews

The responsibility for arranging interviews will have to be assumed by the supervisors of interviewers or in some cases by the interviewers themselves. Some of the larger airline companies will have been contacted by members of the staff of A.I.R. Even where this has been done, however, word of the project may not have gotten to regional offices or turn-around points for these companies. Consequently, it will be necessary in most cases for the supervisor to arrange an appointment with the captain in charge of that particular office. In some instances, this person is called a "Regional

Chief Pilot," a "Chief Pilot," a "Regional Director of Operations," or a "Regional Director of Transportation." In some instances, the main offices of the airline will be located in the same city where the interviewing is to be done. In this case, it is probably best for the supervisor to contact the "Director of Operations" or the "Director of Transportation" of the airline company.

These persons will undoubtedly indicate to the supervisor the best procedures for actually contacting the pilots. Usually, this will be a chief dispatcher or some such person who has records of all flights and knows when crews would be available. It has been our experience, however, that it is mostly up to the interviewer to make actual arrangements for interviews. He may have to make contact with pilots in several different places: operations, pilot ready rooms, hotels where pilots stay during lay-overs (overnight stops), etc.

It will probably make the interviewer's job easier if the supervisor first has contacted the pilot in charge of operations in that city. Then the interviewer is able to tell the interviewees that this person has been contacted and everything has been cleared through him.

An inevitable response of pilots has been to ask if this project has the approval of the Air Line Pilots Association, the pilots' union. The interviewer should say that this organization has been informed of the project and that Mr. Behnke, the head of the pilots' union, has expressed his personal desire to cooperate and has written to all of the council chairmen and officers.

At a particular city, interviewers will find that some pilots are based at that city and others are merely at a turn-around point. The latter means that they have a wait at this city before taking out another flight. These waits vary from about one to eight hours for pilots who don't lay-over (stay overnight). It is important for the interviewer to get pilots who have sufficient time between flights for an hour or hour-and-a-half interview. This information can be obtained from the operations or dispatching offices. About four hours between time of arrival and the time of departure will generally be required in order for pilots to squeeze in an interview. Pilots who are based (have their home) at the city may have two or three days off between flights.

The Fatigue Rating Scale

A somewhat separate part of this study is the obtaining of pilots' ratings on factors contributing to fatigue. A rating scale has been constructed for this purpose. It is intended that this scale be administered by the interviewer at the end of the interview. This could be done rather informally, asking the pilots to fill out the scale themselves while the interviewer looks on. The completed rating scale then should be attached to the "Interview Summary Forms" and turned in to the supervisor. The instructions for administering the rating scale are self-explanatory and should be studied carefully by the interviewer before he begins any interviews.

INSTRUCTIONS FOR THE USE OF THE PILOT INTERVIEW SUMMARY FORMS

The Pilot Interview Summary Forms are the final record of data collected during each interview. For this reason it is essential that the material is presented clearly, neatly, and accurately. Use ink, and write legibly. When it is necessary to check items, place the check mark (X) directly on the line next to the word to be checked so that there will be no question about which item was checked. Complete these forms directly from the notes taken during the interview.

On the cover page, write your full name after the word "Interviewer," the date of the interview below, and the approximate length of the interview under the date. Give the name of the city in which the interview takes place in the space following "Location." Check whether the interviewee is a captain or copilot. Below, write the name of the airline employing the pilot interviewee. The space for comments may be used to report such things as the interviewee's reaction to anything which you feel of importance to those who will analyze the interview data. It is also your opportunity to make any suggestions or criticisms of questions, instructions or materials used in the interview.

On Questions #1 and #2, note that you are asked to check whether the interviewee answered the preferred or alternate question. Indicate by quotation marks the statements that are in the pilot's own words. It is important that we have a reasonably complete record of what the interviewee actually said in answer to these questions and we are especially interested in getting direct quotations in the answers to the question.

Indicate any grouping or separation of ideas, attitudes, causes, etc., by numbering each group or item clearly. When reporting the answers to Questions #3, 4, 5, 6, 8, and 9, keep this in mind. On the Summary Form for Question #7, there are three fill-in items and four pairs of items to be checked. Complete these items as indicated even though they are included in the description of the incident.

If, while answering Question #9, the interviewee makes any comment referring to previous questions in the interview, include these statements under the appropriate question rather than under Question #9.

If an interviewee did not answer a question for some reason or another, indicate this on the Summary Form for that question and state briefly why you think he didn't answer the question.

The Summary Forms for each interview should be completed immediately after the interview. This is very important. Scheduling of interviews should be planned so that there will be time at the end of each to fill out the forms.

When the interviewing schedule for each day is completed, clip the notes for each interview with the completed Interview Summary Forms for that interview. Give all the Summary Forms, together with notes, to your supervisor.

APPENDIX D

SAMPLE CRITICAL INCIDENTS AND THE CATEGORIES OF INEFFECTIVE BEHAVIOR EXTRACTED FROM EACH

APPENDIX D

SAMPLE CRITICAL INCIDENTS AND THE CATEGORIES OF INEFFECTIVE BEHAVIOR EXTRACTED FROM EACH

OPERATING EQUIPMENT OF PLANE AND CARRYING OUT COCKPIT PROCEDURES

Remembering to Carry Out Certain Prescribed or Appropriate Tasks in Connection with the Operation of the Equipment of the Airplane

(a) Forgot to switch tanks while holding

"We were flying a DC-3 on instruments, waiting our turn to come into La Guardia. There were planes above us at every 1,000 ft.; therefore it was necessary to maintain our altitude and position in order not to get in any other plane's path. We were listening to airway clearances and talking to the company all the time and we got so interested or so involved with what we were doing we didn't shift fuel tanks. We were both sitting up holding; we were on auxiliary tanks, and suddenly we heard both cough at the same time. We realized immediately what had happened and we went to full tanks immediately and put the fuel pumps on."

CONTROLLING THE FLIGHT OF THE AIRPLANE WITHIN PRESCRIBED LIMITS IN THE PERFORMANCE OF ROUTINELY USED MANEUVERS

Making a Contact Approach and Landing Under Normal Conditions

(a) Levelled off too soon or too late
(b) Failed to hold proper glide angle

"We were flying a DC-4 and making a night landing — my copilot made a very nice approach but he forgot to level off and he approached the runway at a rather steep angle. He didn't pull out soon enough so I took over the controls, pulled back on the stick and we landed a little hard. 'I was afraid that he would let the plane hit nosewheel first and this might have damaged the gear.'"

PLANNING AND PREPARING FOR FLIGHT

Checking on the Condition of the Airplane and Its Equipment Prior To Flight

(a) Took off with flag still out

"Flying a DC-3 with a new fellow. He was doing good. Taking off from Knoxville. Just as he was to get off the ground he yelled, 'Goddam,' and opened the window and reached for the flag. I had so much confidence in him that I had my feet off the pedals. When I saw him do it I reached for the controls. He pulled the throttles closed, the worst thing he could do.

We went off the runway but the ground was good and we got back on again. I asked him why he had done it and he said that he didn't know — he had acted on an impulse and forgot all about the plane in his excitement at seeing that he had forgotten the flag. It is a standing joke around the airport when anybody leaves the flag out, and we hate to be caught that way. It was a case of lack of experience."

CONTROLLING THE FLIGHT OF THE AIRPLANE WITHIN PRESCRIBED LIMITS IN THE PERFORMANCE OF ROUTINELY USED MANEUVERS

Making a Contact Approach and Landing Under Cross-Wind Conditions

(a) Failed to hold straight roll on runway; using aileron improperly

"The copilot was landing the plane and on a cross-wind landing the correct use of the aileron is very important. The plane started to ground loop and he used the aileron to aggravate rather than to correct it. I took over and applied aileron to the windward side. Rolled it full into the wind. Pushed forward on the column. Your natural tendency is to want to get the tail on the ground to stop a ground loop. But I put the tail up and that way I lose the lift on the wings and I can get the wheels on the ground and it's easier to control. C-47."

APPENDIX E

CATEGORIES OF SPECIFIC INEFFECTIVE BEHAVIOR

APPENDIX E

TABLE 18

INEFFECTIVE PILOT BEHAVIOR CONTRIBUTING TO CRITICAL SITUATIONS IN AIRLINE FLYING AND THE FREQUENCY WITH WHICH THEY WERE CONTRIBUTING FACTORS (Second Content Analysis)

Ineffective Behavior Grouped by Job Components	Frequency	
Planning and Preparing for Flight		
1. Obtaining information about conditions to be encountered in flight		10
Failed to study terrain en route	1	
Did not take into consideration unfavorable winds in computing fuel requirements	3	
Made inaccurate forecast of weather conditions en route or at destination	2	
Did not learn of change of position of fan marker	1	
Did not learn en route radio facilities	1	
Made poor flight plan	1	
Chose wrong alternate	1	
2. Checking on the condition of the airplane and its equipment prior to flight		9
Took off without sufficient fuel	3	
Failed to check on amount of fuel	2	
Took off with plane incorrectly loaded	1	
Took off with flag still out	1	
Took off without checking damage after taxi accident	1	
Used incorrect procedure in engine run-up and check	1	
Controlling the Flight of the Airplane Within Prescribed Limits in the Performance of Routinely Used Maneuvers		
3. Taxiing		6
Hit plane because he was taxiing too fast	1	
Ran off runway when making turn at end of roll	1	
Failed to hold directional control and straight roll	2	
Applied brakes too quickly; poor use of brakes	2	
4. Taking off under normal conditions		24
Applied power incorrectly	2	
Failed to hold straight roll	3	
Lined up with wrong runway	1	
Held improper rate of climb and/or airspeed in climb	4	
Overcontrolled rudders	2	
Read tachometers instead of manifold pressure gauges	2	
Allowed plane to become airborne too soon	2	
Retracted gear too soon	5	
Reduced power too soon after takeoff	1	
Used brakes too hard	1	
Let throttles slip back	1	

TABLE 18 – Continued

Ineffective Behavior Grouped by Job Components	Frequency	
5. Taking off under conditions of reduced visibility		6
Held improper rate of climb and/or airspeed in climb	2	
Failed to realize horizon was not working by not cross-checking other instruments	1	
Incorrectly used ILS instrument instead of gyro	1	
Failed to hold constant heading in climb	1	
Took off in heavy fog and went off runway	1	
6. Taking off under cross-wind conditions		2
Let wind drift plane off course on climb	2	
7. Making a contact approach and landing under normal conditions		134
Failed to line up with correct runway or to keep alignment with runway during approach	4	
Failed to hold proper airspeed in glide	22	
Failed to hold proper glide angle	33	
Levelled out too soon or too late	44	
Varied direction on landing roll	3	
Failed to go-around when necessary	5	
Recovered improperly from bad landing	11	
Made 3-point landing instead of wheel	1	
Landed with feet on brakes, used too much brake on roll, applied brakes too soon	3	
Caught foot in rudder causing loss of directional control	1	
Misread altimeter on approach	1	
Confused direction of landing runway	5	
Landed long and overshot to avoid hitting other planes	1	
8. Making a contact approach and landing under conditions of reduced visibility		85
Failed to align with runway; flew incorrect heading from station to field	20	
Failed to keep within sight of field while circling	2	
Failed to locate field after becoming contact; mistook landmark for field	3	
Failed to hold constant altitude when circling field	6	
Failed to hold proper glide angle in descent resulting in under- or over-shooting	33	
Failed to hold proper airspeed in descent	6	
Failed to go-around when necessary after overshooting	4	
Turned too steeply when too close to ground	2	
Levelled off improperly	3	
Flew partially instruments and partially contact	1	
Failed to stay aligned with runway on roll	1	
Landed in field adjacent to airport	1	
Landed downwind (overshot)	2	
Failed to plan approach	1	

TABLE 18 - Continued

Ineffective Behavior Grouped by Job Components	Frequency	
9. Making a contact approach and landing under cross-wind conditions		73
Improperly lined up with runway; did not correct for drift in glide	4	
Failed to hold proper airspeed in glide	9	
Failed to establish or to hold proper glide angle	7	
Levelled out improperly	6	
Failed to keep wings level in level-out and/or roll	9	
Used improper type of landing (wheel or tail-low)	4	
Failed to hold straight path over runway during level-off	20	
Failed to hold plane on ground after touchdown	1	
Failed to hold straight roll on runway; using aileron improperly	5	
Failed to keep hand on throttles or taking off power on landing	1	
Pushed forward on wheel too soon after touchdown	1	
Recovered improperly from bad landing	5	
Used too much elevator trim when possibility of going around was imminent	1	
10. Making instrument approaches by means of reference to different types of radio aids		34
Overshot heading on procedure turn	1	
Failed to cross-check on magnetic and gyro compass	1	
Began let-down on wrong leg	1	
Missed range station or failed to recognize station	13	
Used incorrect approach procedures, forgot procedure	5	
Letdown before passing station	2	
Became disoriented	4	
Tracked poorly, bracketed poorly	3	
Made poor estimate of distance to station	4	
11. Recovering from a missed instrument approach or missed landing		7
Retracted flaps before gear	1	
Retracted gear but not flaps	1	
Retracted flaps rather than gear	2	
Failed to change heading to avoid skyscraper	1	
Made jerky emergency pull-up	1	
Did not retract gear or flaps	1	
12. Other maneuvers		5
Flew incorrect heading on contact flight	1	
Let plane get out of control on straight and level instrument flight	3	
Lost altitude in turns	1	

TABLE 18 - Continued

Ineffective Behavior Grouped by Job Components	Frequency	
Controlling the Flight of the Airplane Within Prescribed Limits Under Unusual or Emergency Conditions		
13. Recovering from sudden engine failure and performing maneuvers with an engine out		29
Made excessive skidding turn on forced landing	1	
Chose wrong field on forced landing	1	
Made approach too high, too fast	4	
Began letdown too soon, lost too much altitude initially; made glide angle too low	4	
Attempted go-around with flaps down	1	
Allowed turn to become too steep	1	
Became excited and applied excessive power resulting in overshooting	1	
Let airspeed get too low or too fast	5	
Levelled out too soon or too late	2	
Recovered poorly from bad landing	1	
Failed to retract landing gear	4	
Varied heading excessively	3	
Went below minimum safe altitude	1	
14. Operating the airplane when the air is turbulent, when runways are slippery, when icing conditions are present, etc.		36
Used incorrect instruments as references	1	
Held improper attitude	1	
Became frightened and flew ship in uncoordinated manner	1	
Did not reduce speed in turbulence	2	
Overcontrolled in turbulence	1	
Used incorrect type of landing when runway was slippery	1	
Allowed airspeed to get too low with wing ice	8	
Lost directional control on icy runway and used brake instead of throttle	2	
Landed long and overshot on slippery runway; put up flaps too soon on roll	15	
Allowed airspeed to get too fast	1	
Struck a deep hole in runway	1	
Levelled off too high with dust film on runway	1	
Let plane stall due to lack of knowledge of stalling speeds	1	
15. Controlling the airplane in unusual attitudes or at minimum airspeeds		23
Read turn indicator wrong	1	
Allowed airspeed to build up too high	6	
Did not use trim tabs in recovering	1	
Allowed airspeed to get too low	2	
Raised both flaps and gear instead of just gear	1	
Made recovery from steep bank in opposite direction	1	
Spun inadvertently out of stall or turn, lost excessive altitude	4	

TABLE 18 -- Continued

Ineffective Behavior Grouped by Job Components	Frequency	
Lost excessive altitude in steep turn	4	
Let plane go into secondary stall in recovering from stall	1	
Did not get nose low enough in stall recovery	1	
Lacked coordination in steep turns	1	
Employing Procedures to Locate or Keep Track of Position in Flight or to Fly a Prescribed Course		
16. Navigating and orienting		61
Misused calculator	1	
Made procedure turn in wrong direction	1	
Tuned in to wrong radio station; failed to identify station	4	
Demonstrated incompetency to fly without radio compass	1	
Took an inadequate visual fix or couldn't take fix; didn't cross-check it with radio fix	2	
Flew for long period while getting wrong quadrant signal; didn't recognize signals	5	
Failed to cross-check location using other radio aids	2	
Failed to keep listening watch on radio	1	
Failed to make frequent enough position fixes	1	
Became disoriented, demonstrated inability to orient self correctly	19	
Letdown into mountain or ground because of being off course; flew at unsafe altitude	7	
Took heading toward mountain while working ADF problem	1	
Made wrong turn in tracking or following range leg; poor tracking	11	
Used wrong radio range procedures	4	
Paralleled track instead of intersecting it	1	
17. Communicating with traffic control personnel		9
Gave wrong instructions to tower operator	1	
Missed or forgot instructions from ATC and flew at wrong altitude	3	
Failed to obtain information from tower as to runway being used	1	
Misunderstood instructions as to assigned altitude	1	
Cut off range signals by talking too much on radio	1	
Failed to get approach instructions from traffic control before letting down	2	

TABLE 18 -- Continued

Ineffective Behavior Grouped by Job Components	Frequency	
Operating Equipment of Plane and Carrying Out Cockpit Procedures		
18. Remembering to carry out certain prescribed or appropriate tasks in connection with the operation of the equipment of the airplane		37
Forgot to put mixture controls in correct position	3	
Landed without going through checklist, forgetting to switch gas tanks, lower gear, etc.	6	
Failed to place props in high RPM position	2	
Forgot to uncage gyro	3	
Forgot to close or open cowl flaps	2	
Forgot to fasten seat belt	1	
Forgot to operate hydraulic by-pass valve on forced landing or engine-out	2	
Forgot to extend flaps on forced landing	1	
Forgot to switch tanks while holding	2	
Forgot to turn on windshield de-icer	1	
Failed to rotate trim tabs when ice was accumulating	1	
Failed to use carburetor heat in icing conditions	1	
Forgot to switch tanks on cross-country flight	2	
Did not check on fuel supply in flight	1	
Forgot to get altimeter setting and correct altimeter before letdown	2	
Failed to check on item not on checklist	1	
Forgot to shift blowers	1	
Forgot to switch vacuum selector after engine failure	1	
Forgot to retract flaps	1	
Forgot to operate hydraulic selector	1	
Lowered gear too late	1	
Forgot to feather bad engine	2	
19. Operating the controls, dials and switches of the plane's equipment in a correct manner		53
Confused two controls (throttles, props, mixture controls, flaps, gear, switches, fuel valves, feathering buttons)	29	
Unlocked tailwheel at too high speed	1	
Placed flap handle in wrong position	1	
Inadvertently retracted wheels	1	
Did not operate prop de-icers correctly	1	
Latched gear before gear was all the way down	1	
Used or started to use wrong procedure (reached for wabble pump rather than cross-feed)	1	
Put landing gear handle in locked position before gear was down	1	
Did not know how to operate radio; used wrong radio system, tuned to wrong station	5	
Adjusted rudders unevenly	1	
Inadvertently retracted landing gear	2	
Turned tank selector valve off, did not place selector in correct position	2	

TABLE 18 - Continued

Ineffective Behavior Grouped by Job Components	Frequency	
Caused vapor lock by excessive use of wabble pump after fuel pressure drop	1	
Moved mixture controls in wrong direction	1	
Used incorrect procedure in use of electric props	1	
Pulled back on all 4 throttles for horn check instead of only one	1	
Did not operate fuel system controls correctly	3	
Adhering to Prescribed Policies or Regulations and Taking Precautions Consistent with Safety		
20. Conforming to regulations and policies		30
Landed without learning velocity of wind	1	
Descended too low or below minimum altitude	11	
Failed to use company letdown procedures	1	
Was not tuned into tower frequency and thus failed to hear instructions for taxiing	1	
Taxiied without clearance	3	
Letdown out of icing level without calling in for permission	1	
Began letdown in mountainous terrain	1	
Descended or climbed without clearance through poor visibility level	4	
Flew at high rate of climb with high cylinder head temperatures rather than take time to circle for altitude	1	
Failed to climb on assigned side of leg	1	
Flew contact instead of instrument	2	
Forgot to obtain clearance for takeoff	1	
Failed to use pre-takeoff check	1	
Flew partially contact and partially instrument	1	
21. Keeping a constant lookout for possible collision objects and remaining attentive and alert		24
Landed too close behind other aircraft	2	
Failed to notice other airplane	5	
Let attention be diverted and taxiied off runway	1	
Hit parked plane, obstruction, ground vehicle, etc.	9	
Failed to see other airplane while in straight and level flight	5	
Failed to notice plane was moving	1	
Dozed off while flying at night	1	
22. Taking special precautions or remaining on safe side		17
Failed to stop takeoff when airspeed indicator failed	1	
Flew to an alternate when not sure of weather there	1	
Continued flight with low fuel supply instead of landing to refuel	1	
Continued flight into station instead of returning to destination or landing at intermediate field	3	
Failed to keep listening watch on radio	1	
Feathered propellor at too low an altitude	1	

TABLE 18 - Continued

Ineffective Behavior Grouped by Job Components	Frequency	
Took off despite knowledge of inadequacy of radio equipment	1	
Took off despite knowledge of unsafe condition of plane	1	
Disregarded dead engine and tried taking off hoping windmilling would start it	1	
Let controls flap in wind	1	
Parked plane in wrong position	1	
Made too steep a turn after takeoff	1	
Took both hands off wheel	3	
Remaining Emotionally Organized and Working Efficiently with Others		
23. Remaining emotionally organized in emergency situations		15
Froze on controls, became excited	4	
Copilot "froze" necessitating captain's taking over	1	
Became frightened and flew ship in uncoordinated manner	1	
Went to pieces, cried, lost control	1	
Became panicky, lost control	1	
Became so excited that he missed instructions from tower as to condition of runway	1	
Became excited and applied excessive power resulting in overshooting	1	
Feathered good engine because he thought he saw smoke	1	
Froze when other plane nearly caused collision	1	
Demonstrated fear of feathering engine	2	
Blew up on check	1	
24. Working efficiently with other crew members		5
Both pilots tried to handle controls or both pilots assumed other was on controls	2	
Failed to respond to command to lower flaps	1	
Copilot misunderstood captain's directions for heading to take-up	1	
Could not take criticism	1	

APPENDIX F

MEANS AND STANDARD DEVIATIONS FOR RELIABILITY AND VALIDITY DATA FROM AIR FORCE TRY-OUT

APPENDIX F

TABLE 19

STANDARD DEVIATIONS FOR RELIABILITY DATA FROM AIR FORCE TRY-OUT

	A	B	C	D
1. Preparation for Flight	7.3096	7.4444	7.0344	7.8722
2. Inspection of Airplane	1.0185	1.1967	0.5970	0.6241
3. Cockpit Familiarization Check	3.5293	3.4396	3.2374	3.2374
4. Before Starting Cockpit Check and Starting Procedure	1.2570	1.3374	1.1804	0.8478
5. Taxiing	1.3859	1.5326	1.0633	1.6848
6. Before Takeoff Procedure	1.7530	1.6033	1.4237	0.9485
7. Instrument Takeoff	5.5200	5.6659	5.7389	4.8226
8. Intercepting a Predetermined Track and Tracking Away from Station in Climb	4.2974	4.5700	4.4970	4.6296
9. Minimum Speed Maneuvering and Approach to Stall	3.0581	2.9856	2.5422	2.8174
10. Steep Turns with Engine Failure(s)	2.1185	2.3630	1.7785	1.8378
11. Rapid Descent and Pull-up	8.7304	9.0444	8.8319	7.4152
12. Manual Loop Orientation and Tracking	4.7078	5.9635	5.4922	5.6843
13. ADF Approach with Engine Failure	4.5811	3.8793	4.8674	4.7761
14. Engine-Out Landing	3.8430	3.5281	4.3767	3.4441
15. Takeoff and Landing Under Simulated 400 and 1 Conditions	8.7763	6.7142	9.1379	9.3179
16. Crosswind Takeoff with Engine Failure	2.1552	2.7100	1.8489	1.5433
17. Crosswind Landing	5.5737	6.2615	8.2269	6.0185
18. ILS Approach	7.1409	6.8177	7.3464	7.0109
19. Positive Checklist	7.5600	5.7868	4.6382	4.5800
20. Total Flight-check (without Checklist)	38.2837	41.5211	40.6219	38.2537
21. Total Flight-check (including Checklist)	46.5164	48.3282	43.5300	39.3732

TABLE 20

MEANS FOR RELIABILITY DATA
FROM AIR FORCE TRY-OUT

	A	B	C	D
1. Preparation for Flight	-.44	-.27	4.00	3.26
2. Inspection of Airplane	3.33	3.11	3.70	3.59
3. Cockpit Familiarization Check	1.63	1.85	3.04	2.96
4. Before Starting Cockpit Check and Starting Procedure	3.63	3.63	3.70	3.85
5. Taxiing	3.07	2.85	3.41	2.70
6. Before Takeoff Procedure	4.04	3.85	4.52	4.63
7. Instrument takeoff	6.22	6.52	7.26	7.33
8. Intercepting a Predetermined Track and Tracking Away from Station in Climb	3.22	3.07	4.33	4.89
9. Minimum Speed Maneuvering and Approach to Stall	3.59	3.78	3.59	3.63
10. Steep Turns with Engine Failure(s)	1.74	1.48	1.85	1.74
11. Rapid Descent and Pull-up	8.33	8.56	11.00	11.89
12. Manual Loop Orientation and Tracking	1.52	1.78	3.09	3.35
13. ADF Approach with Engine Failure	1.11	1.63	1.30	1.81
14. Engine-Out Landing	5.52	4.81	3.74	4.37
15. Takeoff and Landing Under Simulated 400 and 1 Conditions	7.87	8.46	7.21	6.58
16. Crosswind Takeoff with Engine Failure	4.15	3.63	4.37	4.63
17. Crosswind Landing	19.52	18.41	16.63	17.22
18. ILS Approach	3.23	2.86	6.59	6.41
19. Positive Checklist	34.55	34.68	37.82	37.45
20. Total Flight-check (without checklist)	79.52	78.19	90.85	92.30
21. Total Flight-check (including checklist)	115.41	112.59	130.86	133.54

TABLE 21

MEANS FOR VALIDITY DATA
FROM AIR FORCE TRY-OUT

TOTAL SCORE	EXPERIENCE CATEGORY	TOTAL NUMBER OF FLYING HOURS	TWIN-ENGINE FLYING HOURS
85.30	0.7037	2416.81	1488.93

APPENDIX G

A. THE MANEUVERS INCLUDED IN THE FIRST FORM OF THE FLIGHT-CHECK AND THE ITEMS UNDER EACH

B. RESULTS OF ITEM ANALYSIS OF FIRST TRY-OUT OF FLIGHT-CHECK*

C. CHECK-LIST OF OBSERVATIONS MADE DURING THE FLIGHT-CHECK

*Per cent of favorable scores received on each item by examinees who were in the Upper Quarter of the group of 27 on the basis of Total Score compared with the per cent of favorable scores received on each item by examinees who were in the Lower Quarter. There were 28 scores given on each item to the seven examinees in the Upper Quarter and 28 scores given to the seven examinees in the Lower Quarter, inasmuch as each examinee was rated by four different check pilots. Total score is the average of the four total scores obtained from the four check pilots.

APPENDIX G

THE MANEUVERS INCLUDED IN THE FIRST FORM OF THE FLIGHT-CHECK AND THE ITEMS UNDER EACH

	Upper	Lower
PREPARATION FOR FLIGHT		
1. Comprehension of Weather Map	82	36
2. Analysis of Weather Sequence Reports	78	40
3. Use of Pilot Weather Reports	50	0
4. Use of Weather Forecasts	39	7
5. Analysis of Winds Aloft	58	32
6. Use of Reports of Airport Conditions	54	36
7. Use of Reports of Airways Facilities	68	26
8. Familiarization with Procedures for Computing Gross Weight		
9. Determination of Fuel Requirement		
INSPECTION OF AIRPLANE		
1. Completeness of Outside Visual Inspection	93	54
2. Manner of Checking	100	89
3. Completeness of Inside Visual Inspection	96	78
4. Manner of Checking	100	93
COCKPIT FAMILIARIZATION CHECK		
1. Familiarity Demonstrated	42	36
2. Number of Items Located Correctly	67	34
BEFORE-STARTING COCKPIT CHECK AND STARTING PROCEDURE		
1. Use of Before-Starting Checklist	100	100
2. Manner of Checking	100	82
3. Adherence to Prescribed Starting Procedure	100	90
4. Manner of Starting	100	86
TAXIING		
1. Clearance to Taxi		
2. Speed	96	78
3. Use of Brakes	86	60
4. Attention and Alertness	100	75
5. Smoothness of Taxiing	86	46
BEFORE-TAKEOFF PROCEDURES		
1. R.P.M. and/or B.M.E.P. Check	100	93
2. Check of Engine Instruments During Run-up	93	89
3. Use of Pre-takeoff Check	100	100
4. Manner of Checking	93	96
5. Completeness of Pre-takeoff Check	89	66

	Upper	Lower
INSTRUMENT TAKEOFF		
1. Power Application	78	74
2. Heading on Roll	78	54
3. Attitude Prior to Becoming Airborne	86	88
4. Flight Path After Leaving Runway	86	44
5. Climb -- Airspeed	61	40
6. Climb — Heading	81	68
7. Assistance from Check Pilot	89	75
INTERCEPTING A PREDETERMINED TRACK AND TRACKING AWAY FROM STATION IN CLIMB		
1. Setting Azimuth Dial		
2. Direction of Turn to Intercept Track	100	78
3. Interception Angle	93	78
4. Leading Track	44	32
5. Accuracy of Tracking	93	25
6. Constancy of Airspeed	70	40
MINIMUM SPEED MANEUVERING AND APPROACH TO STALL		
1. Airspeed During Maneuvering	86	86
2. Altitude During Maneuvering	57	25
3. Attitude During Approach to Stall	96-96*	60-73*
4. Recognition of Approaching Stall	71	54
5. Attitude in Recovery	75	68
6. Application of Power in Recovery	86-78*	78-52*
STEEP TURNS WITH ENGINE FAILURE(S)		
1. Holding Altitude in Turns	52	7
2. Constancy of Degree of Bank	40	18
3. Speed of Recovery After Engine Failure	100	86
4. Recognition of Bad Engine	96	93
5. Engine-out Procedure	82	50
RAPID DESCENT AND PULL-UP		
1. Airspeed and Heading in Descent	100-90*	93-76*
2. Stopping Descent at Minimum Altitude	55	10
3. Accuracy of Timing	86	46
4. Gear Up	100	45
5. Use of Power	89-92*	61-42*
6. Airspeed in Climb	75	36
MANUAL LOOP ORIENTATION AND TRACKING		
1. Tuning for Null	90	29
2. Speed of Orientation	78	29
3. Accuracy of Estimate of Distance to Station	62	22
4. Accuracy of Tracking	67	7

*Three separate scores on these items

	Upper	Lower
ADF APPROACH WITH ENGINE FAILURE		
1. Tuning	(Omitted)	
2. Hitting Track After Procedure Turn	54	48
3. Tracking Inbound to Station	48	22
4. Airspeed on Letdown from Station	71	22
5. Recognition of Station	96	64
6. Tracking from Station to Field	52	24
ENGINE-OUT LANDING		
1. Coordination on Approach	96	78
2. Glide Angle	68	60
3. Airspeed on Final Approach	68	36
4. Extension of Gear	100	78
5. Extension of Flaps	89	68
6. Touchdown	93	78
TAKEOFF AND LANDING UNDER SIMULATED 400 AND 1 CONDITIONS		
1. Remaining Within 1 Mile of Field	86	95
2. Adequacy of Pattern	75	56
3. Maintaining Altitude	71	7
4. "Over-the-Fence" Airspeed	79	60
5. Approach to Runway	82	64
6. Touchdown	90	83
CROSSWIND TAKEOFF WITH ENGINE FAILURE		
1. Heading on Roll	100	93
2. Length of Roll	96	82
3. Engine-out Procedure	90	51
4. Recognition of Bad Engine	100	93
5. Getting Engine-out Climb Speed	90	61
6. Directional Control	86	36
CROSS-WIND LANDING		
1. "Over-the-Fence" Airspeed	81	71
2. Alignment with Runway on Final Approach	93	57
3. Starting Flareout or Level-out	90	63
4. Attitude at Touchdown	93-96-100*	71-96-90*
5. Alignment Above Runway	93	88
6. Heading on Roll	100	96
ILS APPROACH		
1. Pre-landing Check	100	81
2. Initial Inbound Bracketing	59	18
3. Airspeed During Approach	56	34
4. Localizer	45	18
5. Glide Path	44	19
6. Altitude Over Inner Marker	74	41

*Three separate scores on these items.

CHECKLIST OF OBSERVATIONS MADE DURING THE FLIGHT-CHECK

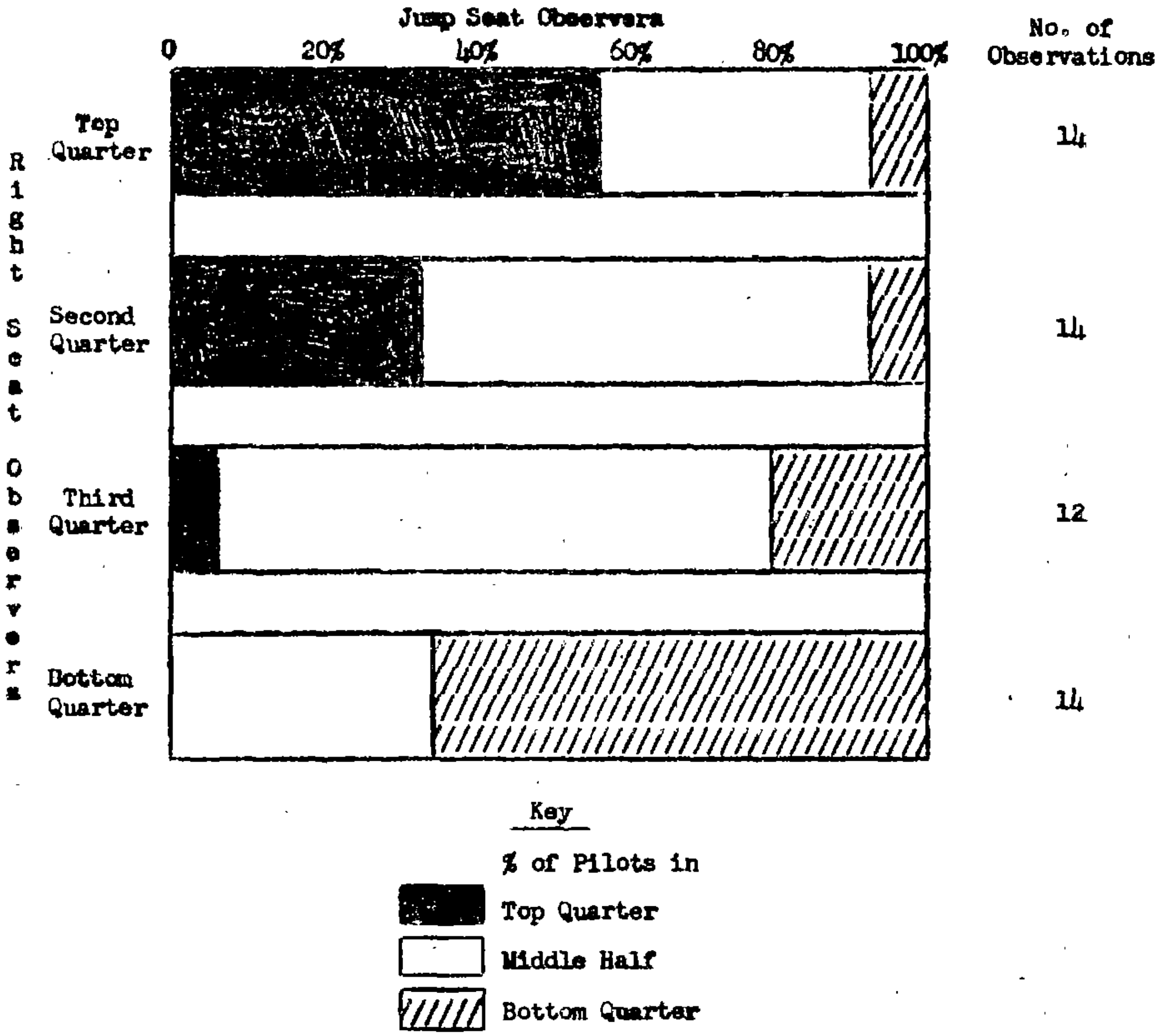
Following is a list of specific acts which have been judged as desirable from the standpoint of good piloting. Immediately after the flight-check, go over each one and check how often you actually observed each one during the flight-check.

SPECIFIC ACTS	HOW OFTEN OBSERVED DURING FLIGHT-CHECK			
	Always	Almost all the time	Only part of the time	Seldom
(1) Handled Controls Smoothly Flew in a smooth manner; handled flight controls without overcontrolling or jerkiness	( )	( )	( )	( )
(2) Flew with Controls Well Coordinated Flew with controls coordinated, flew without badly cross-controlling	( )	( )	( )	( )
(3) Remained Alert Alert in recognizing changes in conditions inside or outside the cockpit. Examples: windshift, changes in instrument readings; radio signals; an approaching plane, etc.	( )	( )	( )	( )
(4) Planned Ahead Anticipated and planned far enough ahead to cope effectively with future situations	( )	( )	( )	( )
(5) Reacted Quickly to Situations Was quick to make a decision or react to situations calling for immediate judgment or action	( )	( )	( )	( )
(6) Made Good Judgments or Decisions Made good judgments as to the most effective or appropriate course of action in situations; thought before he acted	( )	( )	( )	( )

SPECIFIC ACTS	HOW OFTEN OBSERVED DURING FLIGHT-CHECK			
(7) Demonstrated Adequate Pilot Information Showed a good working knowledge of essential pilot information. Examples: knowledge of weather, equipment, navigation, theory of flight, mechanical problems, etc.	Always ( )	Almost all the time ( )	Only part of the time ( )	Seldom ( )
(8) Demonstrated Adequate Confidence Acted in a sure, quiet manner with apparent confidence in his performance and without cockiness, or bragging; was not overly apologetic for errors	Always ( )	Almost all the time ( )	Only part of the time ( )	Seldom ( )
(9) Demonstrated Independence Acted on his own without hesitation; was not overly dependent upon check pilot; showed initiative	Always ( )	Almost all the time ( )	Only part of the time ( )	Seldom ( )
(10) Remained Relaxed Lacked any indication of tenseness such as jerky action or muscular tension; was relaxed in flight	Always ( )	Almost all the time ( )	Only part of the time ( )	Seldom ( )
(11) Followed Safety Precautions Took no unnecessary chances, adhered to rules to the letter; followed safety regulations and procedures	Always ( )	Almost all the time ( )	Only part of the time ( )	Seldom ( )

FIGURE 1

OBSERVER-OBSERVER AGREEMENT SHOWN BY PERCENTAGE OF EXAMINEES[1] ASSIGNED TO QUARTERS[2] BY PAIRS OF INDEPENDENT OBSERVERS



[1]Number of examinees = 27
[2]Rating in quarters determined from total scores on flight-check

FIGURE 2

RIDE-RIDE AGREEMENT AS SHOWN BY THE NUMBER OF EXAMINEES ASSIGNED TO QUARTERS BY PAIRS OF INDEPENDENT OBSERVERS

Observers in First Flight (Quarters)	Observers in Second Flight: 1st	2nd	3rd	4th
1st	6	5	0	3
2nd	3	5	4	2
3rd	5	2	4	1
4th	0	2	4	8

APPENDIX H

THE SECOND FORM OF THE FLIGHT-CHECK

A STANDARDIZED FORM

FOR THE

ATR FLIGHT-CHECK

(Second Revision)

An experimental form devised for in-flight recording of the performance of a pilot on the Airline Transport Rating Flight-check. An attempt to provide a way for a check pilot to keep an accurate record of what was done with only a minimum of writing.

prepared by

THE AMERICAN INSTITUTE FOR RESEARCH

under the auspices of

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COMMITTEE ON AVIATION PSYCHOLOGY

with funds from the

CIVIL AERONAUTICS ADMINISTRATION

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THE AMERICAN INSTITUTE FOR RESEARCH, INC.
Pittsburgh 13, Pennsylvania

HOW THIS FLIGHT-CHECK WAS DEVISED

This is not just one pilot's idea of what a flight-check should be or what should be in one. Rather it is based upon over a year's careful research into the nature of airline flying. During this period approximately 500 airline pilots and Civil Aeronautics Administration agents have contributed their ideas.

Step by step, here is how this flight-check was developed:

(1) The Civil Aeronautics Administration furnished funds to the National Research Council, Committee on Aviation Psychology to do research aimed at determining the job requirements of the airline pilot's job and developing a more standardized method of evaluating flying proficiency. This committee contracted with an independent research organization to conduct this project, in order to insure complete impartiality in gathering the research data.

(2) First, all scheduled airline accidents in the last nine years were carefully analyzed. This was for the purpose of determining the critical situations which airline pilots encounter.

(3) Then over 300 airline pilots were interviewed to obtain additional examples of critical situations they personally had encountered.

(4) All flight-checks being used by the Civil Aeronautics Administration and airline companies were studied to learn what kinds of things they were requiring of airline pilots.

(5) On the basis of the findings of this research and the judgments of airline pilots and Civil Aeronautics Administration agents, a list of maneuvers was prepared and submitted to all Civil Aeronautics Administration agents and airline company check pilots who at present are authorized to give the Airline Transport Rating flight-check.

(6) These pilots filled out forms which, when analyzed, showed in which components of each maneuver applicants for this rating most frequently have difficulties.

(7) Finally, for each maneuver we devised the best ways to record an applicant's performance on these critical components. Those ways of recording were selected which minimized writing on the part of a check pilot, yet reduced differences in the judgment of different check pilots.

In general, all this means that the things the check pilot is asked to observe and record in this flight-check form are those components of airline flying which have been determined to be the most critical and difficult. This does not mean that he will not observe other aspects of the examinee's performance, for there is room on each maneuver for writing in additional errors or comments.

WHAT THIS STANDARDIZED FORM IS NOT

It is not a substitute for the experience of the check pilot. No "form" or "blank" can take the place of the judgment and skill required of a check pilot in evaluating flying proficiency. The form is really a device to help the check pilot — a tool to help him record what he observes. The pictures and graphic representations throughout the form are intended as aids for the check pilot in making judgments. They make it possible for him to make a judgment more quickly, and they help to define the limits of the various alternatives from which he must choose. The check pilot should always select the picture which comes closest to representing the plane's actual attitude, flight path or ground path.

HOW YOU CAN USE THIS FORM

It is intended that this form can be used to the best advantage by following these suggestions:

(1) Before the flight, the check pilot should go through the form and fill in all the blanks between parentheses, (______), which call for prescribed airspeeds, altitudes, headings, etc. These have been left blank so that this form can be used for different airplanes and under different conditions.

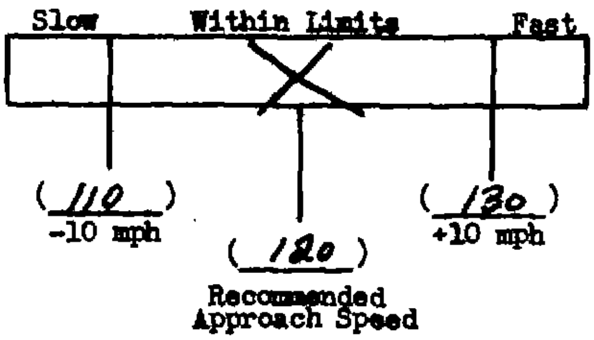
(2) Then the check pilot should turn the form over to the examinee, so that he will know what is required of him. He should know what standards he is required to meet on each maneuver.

(3) The check pilot should take the form with him on the flight-check, of course. Pilots who have already tried out the form have found that it takes less than a minute to record an examinee's performance on a maneuver.

(4) Before each maneuver, read the instructions to the examinee, which have been underscored.

(5) Try to record as the examinee flies through a maneuver. When this is not practical, record immediately afterwards and always before the examinee is given the next maneuver.

(6) Place an "X" in the appropriate box, ☐, or at the appropriate point on a scale, 1 2 3 4 5 minutes. For those items where limits are prescribed, place your "X" inside one of the three spaces within the box.



(7) Record errors for which there are no items on the flight-check form under "COMMENTS." Also, if you need to explain a rating or make a record of some condition which you felt affected your rating, make a note under "COMMENTS."

PREPARATION FOR FLIGHT

In order to evaluate the examinee's competency in planning and preparing for a typical flight, you should select at random some city to which a flight might be made. In selecting a city try to find one which would require the examinee to fly through some weather en route. Then TELL EXAMINEE: "Go through the procedures which you would use if you were actually preparing for a flight to (__________). I will probably ask you questions from time to time about the procedures you use."

	More than Adequate	Adequate	Definitely Inadequate
WEATHER			
(1) Comprehension of Weather Map (Demonstrating ability to read and interpret weather map information for the over-all picture of air masses, fronts and pressure systems)	☐	☐	☐
(2) Analysis of Sequence Reports (Demonstrating ability to relate recent weather reports to weather map information)	☐	☐	☐
(3) Use of Pilot Reports (Utilizing all pilot reports of weather along route)	☐	☐	☐
(4) Use of Forecasts (Comprehending forecasts for route, destination and alternate; checking against own analysis of weather)	☐	☐	☐
(5) Analysis of Winds Aloft (Checking strength and direction of winds aloft and analyzing trends of wind changes)	☐	☐	☐
ROUTE FACILITIES			
(1) Use of Reports of Airport Conditions (Obtaining all available information as to conditions of airports en route)	☐	☐	☐
(2) Use of Reports of Airways Facilities (Obtaining all available information as to status of airways facilities, paying particular attention to recent changes)	☐	☐	☐
OTHER			
(1) Preparation of Flight Plan (Utilizing and integrating all available information to arrive at a flight plan that is appropriate to the particular conditions under which the flight must be made)	☐	☐	☐
(2) Check on Airplane (Assuring adequacy of load manifest and completion of ramp maintenance; assuring that plane has been adequately inspected and is in	☐	☐	☐

EQUIPMENT FAMILIARIZATION CHECK

The purpose of this part of the flight-check is to provide an evaluation of the examinee's familiarity with the airplane and its equipment. The examinee is to carry out an inspection of the airplane, both outside and inside, during which the examiner will ask questions to determine the examinee's familiarity with the aircraft. The examinee may use a written checklist of items to be inspected on a visual check, or he may rely upon his memory. He is not to be evaluated on the thoroughness of the inspection. The inspecting is simply to enable the examiner to make judgments about his knowledge of the airplane.

TELL EXAMINEE: "Carry out an outside and inside visual inspection of the plane, checking things you feel should be checked before a flight, assuming no ground crew is available to make this inspection and you are solely responsible for it. You may use a written checklist if you wish. Call out each item as you inspect it and tell me exactly what you are looking for or what you are checking. I will ask you questions while you make this inspection in order to determine your familiarity with the plane and its equipment. You will not be evaluated on the thoroughness of your inspection as much as on how well you demonstrate a knowledge of what you are checking."

(1) FAMILIARITY SHOWN ON OUTSIDE INSPECTION	Demonstrated thorough familiarity with airplane ☐	Demonstrated some unfamiliarity with airplane ☐	Demonstrated serious lack of familiarity with airplane ☐
(2) FAMILIARITY SHOWN ON INSIDE INSPECTION	Demonstrated thorough familiarity with airplane ☐	Demonstrated some unfamiliarity with airplane ☐	Demonstrated serious lack of familiarity with airplane ☐

COMMENTS

COCKPIT FAMILIARIZATION CHECK

When the examinee is seated on the pilot's side, TELL EXAMINEE: "In order to check on your familiarity with the cockpit of this plane, I will read off 25 items which you are then to touch as rapidly as possible. You will be evaluated mostly on your accuracy but how quickly you can locate an item is also an indication of your familiarity with the plane. You will make a good score, however, if you proceed at a rate of speed which will assure that you touch the correct control, valve or switch first. Work rapidly but do not make errors. If you make an error do not correct it, for I will call off the next item as soon as you have touched something."

Consider an item correct only if the examinee touches it before touching anything else. Begin timing as you call off the first item and end the timing when the examinee touches the 25th item. IMPORTANT: So that you don't forget what time it was when you started timing, just before you call off the first item write down the exact time you plan to begin timing.

Call off each of the following items. Be sure you call off the next item immediately after the examinee has touched something in response to the previous item. Check all incorrect items in the space to the left of each item. If the airplane you are using does not have any of the following items, go through the list and cross off as many items as it does not have. Then write in as many additional items as will make 25 items in the list.

Check Errors		Check Errors	
___	Landing gear handle or switch	___	Engine fire warning light (any engine)
___	Flap handle or switch	___	Fuel pressure gauge (any engine)
___	Tank selector valve	___	Oil pressure gauge (any engine)
___	Mixture controls	___	Fuel quantity gauges
___	Cowl flap control	___	Landing gear warning lights
___	Feathering buttons or switches	___	Oil pressure warning light
___	Rudder trim tab control	___	Clock
___	Elevator trim tab control	___	Pressure altimeter
___	Cross-feed valve	___	Landing gear position indicator
___	Emergency brake handle	___	Ignition switch (any engine)
___	Engine selector fuel valve (any engine)	___	Master battery switch
___	Emergency landing gear extension control	___	Booster pump switch (any engine)
		___	Carburetor temperature gauge (any engine)
___	-----------------	___	-----------------
___	-----------------	___	-----------------
___	-----------------	___	-----------------

(1) TIME TO COMPLETE ITEMS	Began timing at (______)	Time to complete 25 items ______ seconds
(2) NUMBER OF ITEMS CORRECT	(Place an X to indicate total items correct) 25 24 23 22 21 20 19 18 17 16 15 Less than 15	

COMMENTS

STARTING PROCEDURE

After completing the familiarization check TELL EXAMINEE: "Now you take charge of the plane and go through the procedures you use for preparing the plane for starting. Then start the engines and get ready for taxiing away from the ramp. When you are ready, taxi out to takeoff position."

(1) USE OF PRE-STARTING CHECKLIST	Used written checklist ☐		Did not use written checklist ☐
(2) COMPLETENESS OF PRE-STARTING CHECK	Checked all items on checklist ☐		Missed one or more items ☐
(3) MANNER OF CHECKING	Careful and sure ☐	Hesitating and unsure ☐	Careless and hurried ☐
(4) STARTING PROCEDURE	Used prescribed procedure ☐	Deviated somewhat from prescribed procedure ☐	Used poor procedure ☐
(5) HANDLING OF ENGINES	Smooth ☐	Somewhat rough ☐	Very rough ☐
(6) TUNING AND CHECKING RADIO	Made ground check and tuned properly ☐		Failed to make ground check <u>or</u> tuned improperly ☐

COMMENTS

TAXIING

(1) CLEARANCE TO TAXI	Obtained clearance to taxi ☐		Failed to obtain clearance to taxi ☐
(2) SPEED OF TAXIING	Consider the existing conditions for taxiing: Slow	Somewhat fast	Definitely fast
(3) APPLICATION OF BRAKES	Smooth and gentle ☐	Somewhat rough ☐	Definitely too rough ☐
(4) USE OF BRAKE	Used only when necessary ☐	Used somewhat too frequently ☐	Used excessively ☐
(5) ATTENTION AND ALERTNESS	Kept adequate lookout for other traffic ☐	Did not always keep adequate lookout ☐	Seldom kept adequate lookout ☐
(6) USE OF THROTTLES	Always smooth ☐	At times somewhat rough and jerky ☐	At times very rough and jerky ☐
(7) CAUTION	Never had to come close to other airplanes ☐	Was very cautious when close to other airplanes ☐	Was not cautious enough when close to other airplanes ☐
(8) CHECK OF FLIGHT INSTRUMENTS	Checked while taxiing ☐		Failed to check while taxiing ☐

COMMENTS

BEFORE TAKEOFF PROCEDURES

Includes run-up and pre-takeoff check. TELL EXAMINEE: "When you are ready, go through your run-up and pre-takeoff check. Then you will make an instrument takeoff, after which you are to track away from (______) station."

(1) POSITIONING PLANE FOR RUN-UP	Positioned plane properly ☐	Positioned plane improperly ☐	With respect to: Keeping engines cool ___ Preventing blasting ___ Observing other planes ___
(2) CHECK OF ENGINE INSTRUMENTS DURING RUN-UP	Checked all important instruments ☐		Missed one or more important instruments ☐
(3) CHECK OF INSTRUMENTS DURING RUN-UP	Careful, sure ☐	Hesitating, unsure ☐	Careless or hurried ☐
(4) HANDLING OF ENGINES IN RUN-UP	Smooth, unhurried ☐		Rough, hurried ☐
(5) PRE-TAKEOFF CHECK	Checked every item on written checklist ☐	Missed one or more items on written checklist ☐	Did not use written checklist ☐
(6) MANNER OF EXECUTING PRE-TAKEOFF CHECK	Careful, sure ☐	Hesitating, unsure ☐	Careless or hurried ☐

COMMENTS

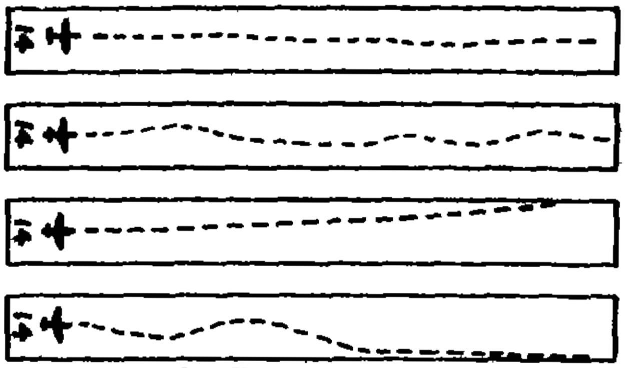
INSTRUMENT TAKEOFF

TELL EXAMINEE: "Line the plane up with the runway yourself. When you have it the way you want it, hold it with brake until I give the signal for takeoff."

(1) POWER APPLICATION

- ☐ Smooth and positive
- ☐ Jerky or hesitant
- ☐ Excessively rapid

(2) HEADING ON ROLL



- ☐ Straight path, only slight deviations, stayed in center
- ☐ Large deviations, yet stayed in center of runway
- ☐ Off toward edge of runway, yet fairly straight path
- ☐ Off toward edge of runway, plus large deviations

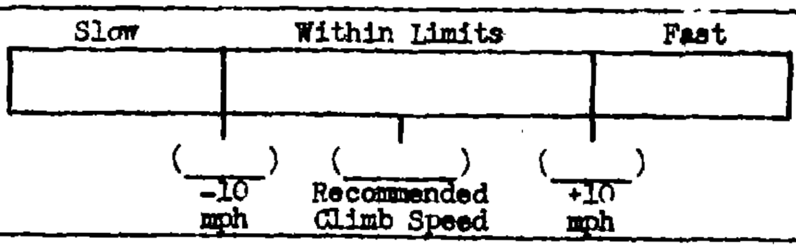
(3) ATTITUDE AT END OF ROLL

- ☐ Normal
- ☐ Too tail-low
- ☐ Too tail-high; held on ground too long

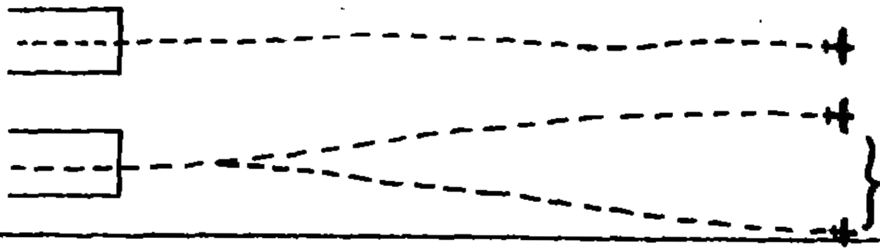
(4) FLIGHT PATH JUST AFTER BECOMING AIRBORNE

- ☐ Pulled up steep
- ☐ Normal
- ☐ Held down
- ☐ Dropped back

(5) AIRSPEED IN CLIMB



(6) HEADING IN CLIMB



- ☐ Fairly straight path
- ☐ Off to either side

(7) CHECK-PILOT ASSISTANCE

- ☐ Assistance not necessary
- ☐ Assistance necessary

COMMENTS

INTERCEPTING A PREDETERMINED TRACK AND TRACKING AWAY FROM STATION IN CLIMB

TELL EXAMINEE: "As soon as you have established your climb at the recommended airspeed of (______) mph, turn to intercept a track of (______)° away from station (______). Continue your climb, holding a constant airspeed at all times.

(1) SETTING GYRO OR AZIMUTH

☐ Set gyro or azimuth with magnetic compass

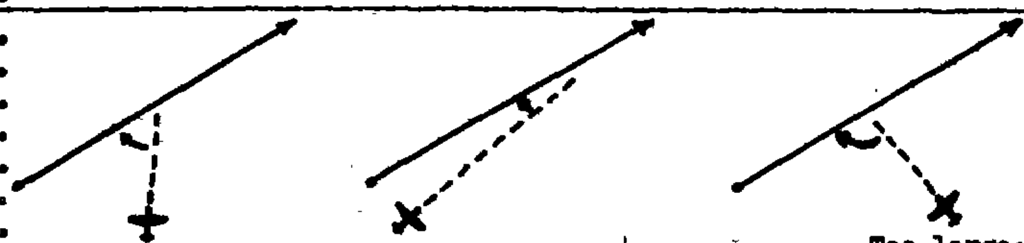
☐ Did not set gyro or azimuth with magnetic compass

(2) DIRECTION OF TURN TO INTERCEPT TRACK

☐ Turned right direction to intercept track quickest

☐ Turned opposite direction to intercept track quickest

(3) INTERCEPTION ANGLE

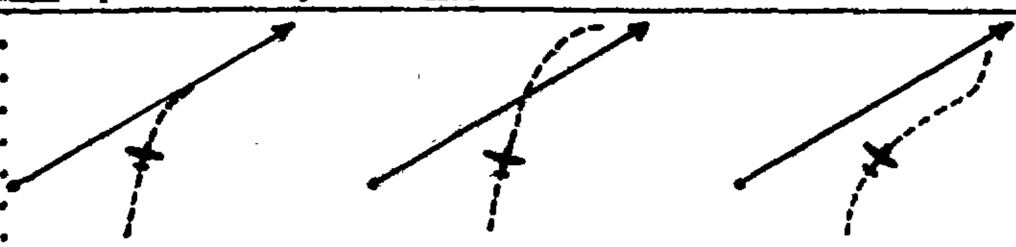


☐ Angle correct for quick interception

☐ Angle too small

☐ Too large; heading toward station at interception

(4) LEADING TRACK AT INTERCEPTION

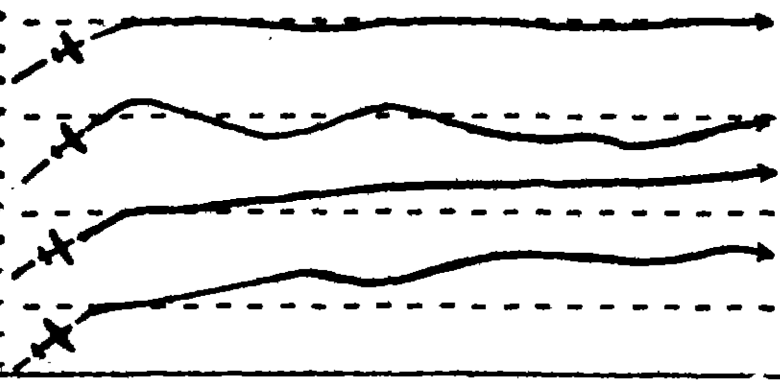


☐ Led track proper amount

☐ Overshot track

☐ Undershot track

(5) ACCURACY OF TRACKING



☐ Held track well

☐ Erratic, but close to track

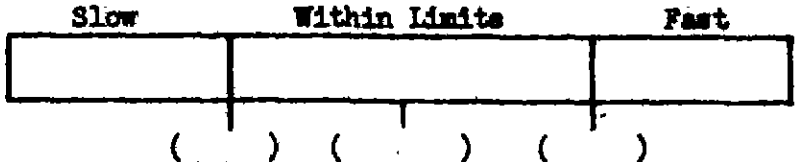
☐ Drifted off track; made no corrections

☐ Drifted off plus erratic

☐ Couldn't track at all

(6) AIRSPEED IN CLIMB

Slow | Within Limits | Fast



(______) -10 mph | (______) Recommended Climb Speed | (______) +10 mph

COMMENTS

MINIMUM SPEED MANEUVERING AND APPROACH TO STALL

TELL EXAMINEE: "Slow the plane down to recommended minimum maneuvering speed or about 15-20 mph above wheels-up, flaps-up stalling speed. In this plane this speed is (______) mph. When you reach this speed make shallow turns alternating 180° to the right and left. Make two turns to the right and two to the left, maintaining a constant airspeed and a constant altitude. Then when I give the signal pull the plane up slowly until it approaches a stall, without changing your power settings. Just before the plane reaches a complete stall, recover with the least loss of altitude. This part of the test begins when you roll into the first turn."

(1) AIRSPEED DURING MANEUVERING

Slow | Within Limits | Fast

(______) -10 mph

(______) Recommended Minimum Maneuvering Speed

(______) +10 mph

(2) ALTITUDE DURING MANEUVERING

Above — (______) +50 ft.

Within Limits — (______) Starting altitude

Below — (______) -50 ft.

(3) ATTITUDE DURING APPROACH TO STALL

Kept wing-level attitude throughout maneuver

Let plane get in wing-low attitude

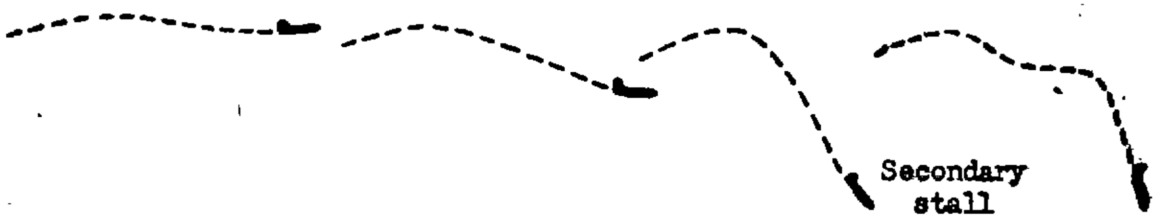
(4) RECOGNITION OF STALLING POINT

Recovered just before nose would have dropped

Recovered after nose had dropped

Recovered long before nose would have dropped

(5) RECOVERY



(6) POWER IN RECOVERY

Correct amount

Insufficient

Excessive

(7) USE OF AILERON IN RECOVERY

Did not use too much aileron

Used too much aileron

COMMENTS

STEEP TURNS WITH ENGINE FAILURE(S)

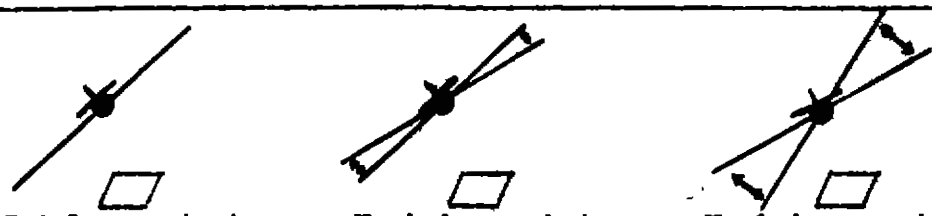
TELL EXAMINEE: "Make three 180° steep turns (45° bank) alternating to the right and left. At some time I will cut an engine. You are to recover and go through the engine-out procedures, holding a constant altitude."

Wait until sometime during the third steep turn and then cut the inside engine.

(1) HOLDING ALTITUDE IN TURNS

Above
(______) +50 ft.
Within Limits
(______) Prescribed altitude
(______) -50 ft.
Below

(2) CONSTANCY OF DEGREE OF BANK



☐ Fairly constant ☐ Varied somewhat ☐ Varied excessively

(3) SPEED OF RECOVERY AFTER ENGINE FAILURE

☐ Recovered to level flight immediately
☐ Too slow in recovering to level flight

(4) ENGINE-OUT PROCEDURE

☐ Followed prescribed procedure
☐ Varied procedure but accomplished every item
☐ Forgot important item in procedure

(5) ALTITUDE DURING ENGINE-OUT PROCEDURE

Above
(______) +50 ft.
Within Limits
(______) Altitude when engine was cut
(______) -50 ft.
Below

COMMENTS

RAPID DESCENT AND PULL-UP

This maneuver is to be given at altitude rather than on an actual instrument approach. Have the examinee begin the maneuver at an altitude of 5300, 4300 or 3300 feet indicated altitude. TELL EXAMINEE: "You are to assume that you are 1300 feet above field elevation, making an instrument approach inbound toward the station. When I signal that you have passed the station, you are to make a rapid descent at 1000 feet per minute. Stop your descent at 300 feet above field elevation. Two minutes after passing station, begin a missed approach procedure. Descend at recommended instrument approach speed, which is (______) mph. Hold a constant heading. Climb away at recommended climb speed, which is (______) mph. As soon as the second hand on the clock is at the 60 second mark, begin your descent."

---

(1) AIRSPEED IN DESCENT

Slow	Within Limits	Fast

(_____) −10 mph | (_______) Recommended Instr. Appr. Speed | (_____) +10 mph

---

(2) HEADING IN DESCENT

Within Limits	Beyond Limits

(_____) Heading at start of descent | (_____) ±5°

---

(3) HOLDING ALTITUDE AT MINIMUM ALTITUDE

Above

(______) +20 ft.

Within Limits — (______) Minimum altitude

(______) −20 ft.

Below

---

(4) ACCURACY OF TIMING

Applied power for pull-up:

- ☐ Before 115 seconds elapsed time
- ☐ Between 115-125 seconds elapsed time
- ☐ After 125 seconds elapsed time

---

(5) USE OF POWER

Prescribed power settings are:
(____) in. & (____) rpm

Correct settings	Incorrect
☐	☐

---

(6) AIRSPEED IN CLIMB

Slow	Within Limits	Fast

(_____) −10 mph | (_______) Recommended Climb Speed | (_____) +10 mph

---

COMMENTS

MANUAL LOOP ORIENTATION AND TRACKING

Be sure that examinee is disoriented. If he is not, take over long enough to do so. Have him take over when you are somewhere within 10 minutes from the station. Then TELL EXAMINEE: "Use the manual loop to locate your position relative to (______) radio station. When you have done this, calculate how far you are from the station in minutes and tell me. Then immediately track to the station using only the manual loop. Maintain a constant altitude throughout."

---

(1) TUNING FOR NULL

- ☐ Tuned for good null width
- ☐ Did not tune for good null width

---

(2) KNOWLEDGE OF MANUAL LOOP PROCEDURE

- ☐ Demonstrated adequate knowledge of procedure
- ☐ Demonstrated inadequate knowledge of procedure

---

(3) ALTITUDE DURING ORIENTATION

- Above — (______) +50 ft.
- Within Limits — (______) Altitude at start of orientation
- Below — (______) -50 ft.

---

(4) ACCURACY OF ESTIMATE OF TIME TO STATION

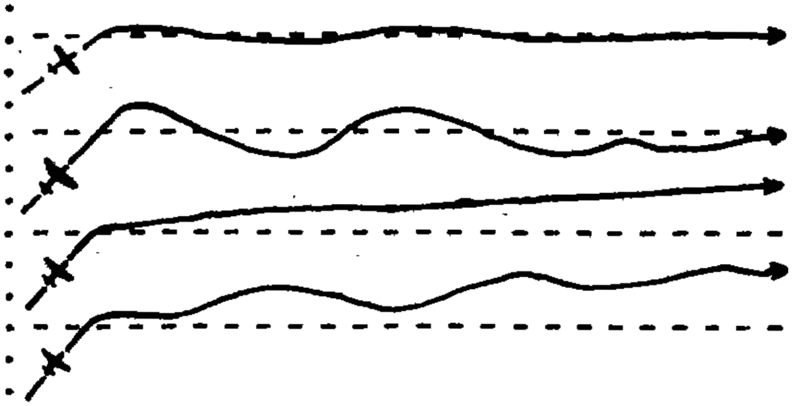
Fill in at start: (____) sec. Examinee's estimate; (____ min. ____ sec.) Time at start of tracking; (____ min. ____ sec.) Time at crossing station

Examinee was accurate within:

30 sec.	60 sec.	90 sec.	120 sec.	Over 120 sec.
☐	☐	☐	☐	☐

---

(5) ACCURACY OF TRACKING



- ☐ Held track well
- ☐ Erratic, but close to track
- ☐ Drifted off track; made no corrections
- ☐ Drifted off plus erratic
- ☐ Couldn't track at all

---

(6) RECOGNITION OF STATION

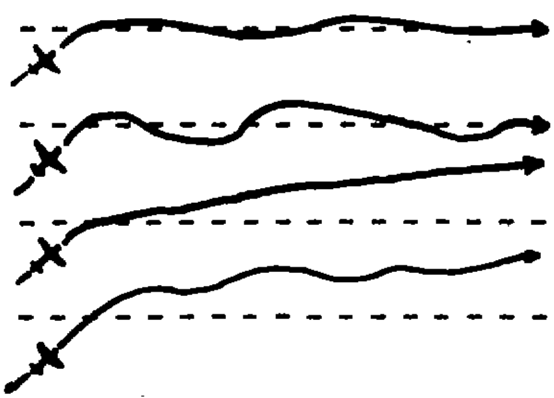
- ☐ Recognized when station passed
- ☐ Did not recognize when station passed

COMMENTS

ADF APPROACH WITH ENGINE FAILURE

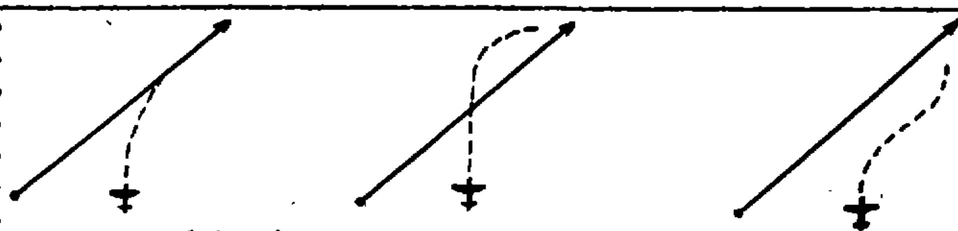
When the examinee has crossed the station after tracking with manual loop, TELL EXAMINEE: "Now turn on your ADF equipment and make a standard instrument approach using only the ADF. At some time during the maneuver I will cut an engine. Begin the letdown from the station and descend at a constant airspeed of (______) mph. When you reach your minimum altitude stop your descent and prepare for an engine-out landing."

(1) ACCURACY OF TRACKING OUTBOUND AND INBOUND



Outbound	Inbound	
☐	☐	Held track well
☐	☐	Erratic, but close to track
☐	☐	Drifted off track; made no corrections
☐	☐	Drifted off plus erratic
☐	☐	Couldn't track at all

(2) HITTING TRACK AFTER PROCEDURE TURN

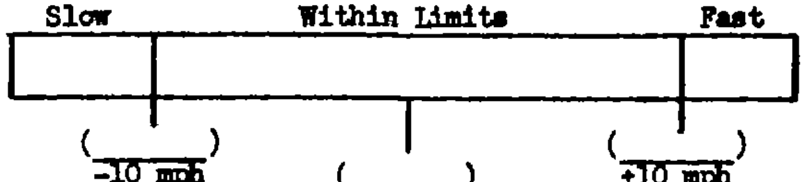


☐ Led track proper amount ☐ Overshot track ☐ Undershot track

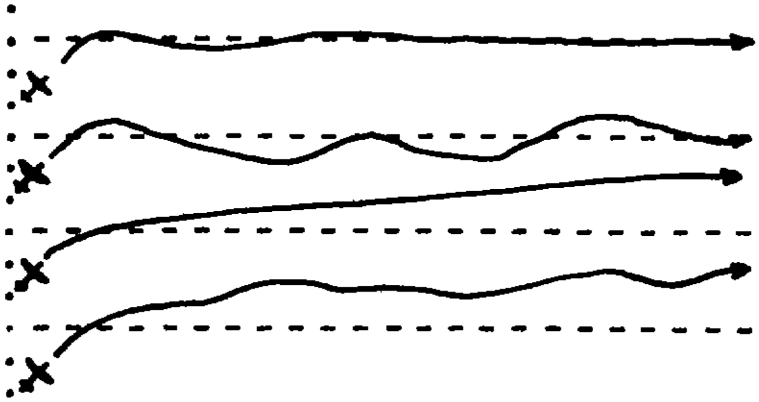
(3) TRACKING INBOUND

Check one of the ☐'s under "Inbound" in Item (1)

(4) AIRSPEED ON LETDOWN FROM STATION



(5) TRACKING FROM STATION TO FIELD



☐ Held track well

☐ Erratic, but close to track

☐ Drifted off track; no corrections

☐ Drifted off track plus erratic

☐ Couldn't track at all

COMMENTS

ENGINE-OUT LANDING

When the examinee is ready, TELL EXAMINEE: "Make an engine-out landing."

(1) COORDINATION ON APPROACH

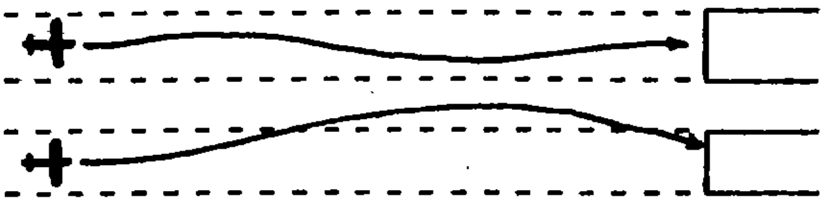
☐ Kept plane coordinated by trimming or holding

☐ Did not keep plane coordinated

(2) GLIDE ANGLE

☐ Too steep ☐ Normal ☐ Too flat ☐ Erratic

(3) ALIGNMENT WITH RUNWAY



☐ Kept within width of runway

☐ Went beyond width of runway

(4) "OVER-THE-FENCE" AIRSPEED

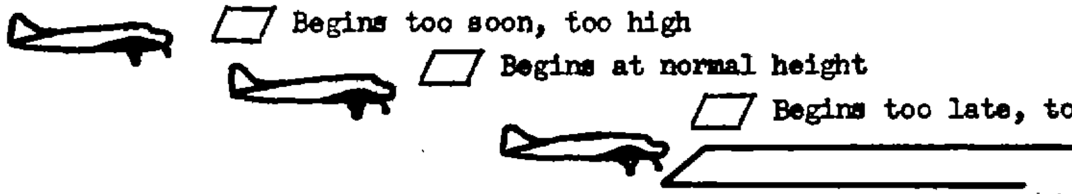
Slow | Within Limits | Fast

(____) -10 mph

(________) Recommended "Over-the-Fence" Speed

(____) +10 mph

(5) BEGINNING FLARE-OUT



☐ Begins too soon, too high

☐ Begins at normal height

☐ Begins too late, too low

(6) TOUCH-DOWN

☐ Needed power from bad engine to make runway

☐ Touched down in first third

☐ Touched down beyond first third

☐ Made go-around because of over-shooting

(7) LANDING

☐ Smooth ☐ Somewhat hard ☐ Very hard

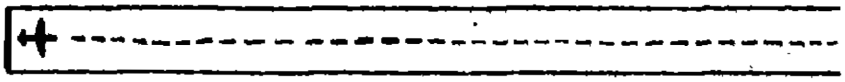
COMMENTS

CROSSWIND TAKEOFF AND
ENGINE FAILURE AFTER TAKEOFF

Select a runway which is at least 30° from the direction of the wind. TELL EXAMINEE: "Obtain clearance from the tower to take off on runway No. (______). At some time after takeoff I will cut an engine. After completing the procedure, bring the bad engine back. Then make an approach for landing on this same runway."

(1) HEADING ON ROLL

☐ Straight path



☐ Varied heading or rolled to side

(2) LENGTH OF ROLL

☐ Pulled plane off too soon and at too low airspeed

☐ Correct

☐ Held plane on ground too long

(3) ENGINE-OUT PROCEDURE

☐ Followed prescribed procedure

☐ Did not follow prescribed procedure

(4) RECOGNITION OF BAD ENGINE

☐ Recognized immediately

☐ Slow to recognize

☐ Demonstrated confusion of good and bad engine

(5) GETTING ENGINE-OUT CLIMB SPEED

Recommended Engine-out Climb Speed for Plane (______) mph

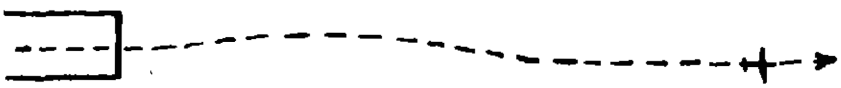
☐ Had this speed when engine was cut and stayed there or above

☐ Got this speed as quickly as possible

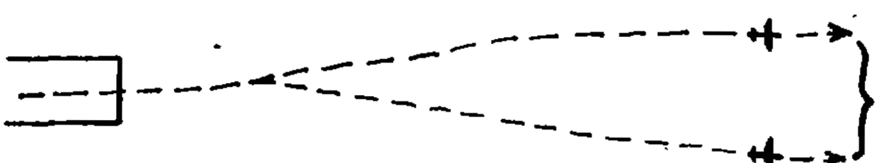
☐ Did not get this speed quickly enough

☐ Went below this speed after engine was cut

(6) HEADING IN CLIMB



☐ Fairly straight path



☐ Off to either side

COMMENTS

APPROACH UNDER SIMULATED 400 AND 1 CONDITIONS (CONTACT)

After examinee has brought the bad engine back in, TELL EXAMINEE: "Drop down to an altitude of 400 ft. above field elevation. Make a straight-in approach to the (______) runway, holding this altitude. You are to assume there is a 400 foot ceiling and one mile visibility. When we get within one mile of the field I will signal to you. At that time you are to assume you have been instructed not to land straight ahead but to circle the field and make another approach to this same runway. Your task is to circle back in such a way that you always stay within one mile of the field, so you can keep it in sight. Also you are to get no higher than 400 ft. and no lower than 350 ft., until you begin your final approach, so you can keep below the ceiling."

(1) REMAINING WITHIN 1 MILE OF FIELD

☐ Remained within 1 mile at all times

☐ Went beyond 1 mile from field

(2) ADEQUACY OF PATTERN

☐ Well planned pattern without necessity of excessively steep turns

☐ Poorly planned pattern necessitating excessively steep turns or going beyond 1 mile from field

(3) MAINTAINING ALTITUDE

Above

(______) 400 ft. above field elevation

Within Limits

(______) 350 ft. above field elevation

Below

(4) APPROACH TO RUNWAY

☐ Too steep ☐ Normal ☐ Too flat ☐ Erratic

(5) "OVER-THE-FENCE" AIRSPEED

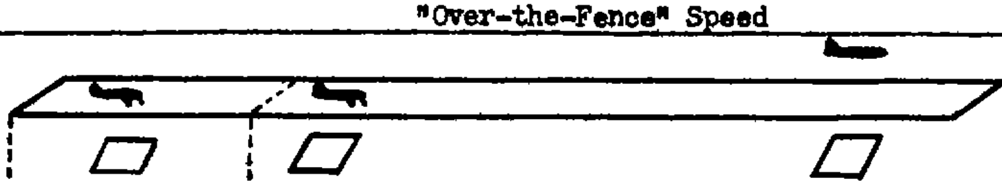
Slow | Within Limits | Fast

(______) -5 mph

(______) Recommended "Over-the-Fence" Speed

(______) +5 mph

(6) TOUCH DOWN



☐ Touched down in first third

☐ Touched down beyond first third

☐ Made go around because of overshooting

COMMENTS

ILS APPROACH

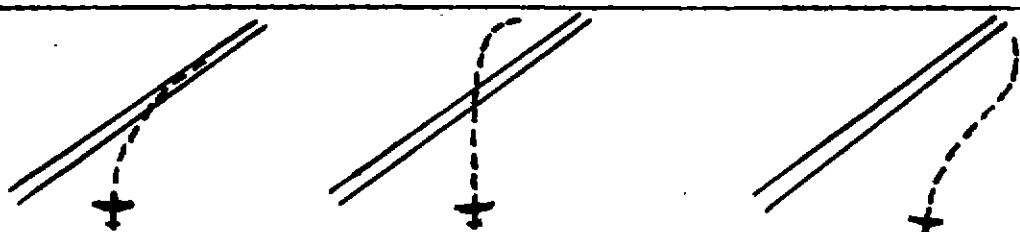
Have the examinee make a normal takeoff in preparation for an ILS Approach. TELL EXAMINEE: "Take off and climb to the prescribed altitude for beginning an ILS Approach. Use the prescribed procedure for this station holding a constant airspeed of (_____) mph. After you reach your minimum altitude go on contact and make a cross-wind landing on runway No. (______)."

Choose a runway which is at least 30° from the direction of the wind for the cross-wind landing.

(1) PRE-LANDING CHECK

☐ Accomplished correctly ☐ Accomplished incorrectly ☐ Not accomplished

(2) HITTING LOCALIZER AFTER PROCEDURE TURN



☐ Led localizer proper amount ☐ Overshot localizer ☐ Undershot localizer

(3) AIRSPEED DURING APPROACH

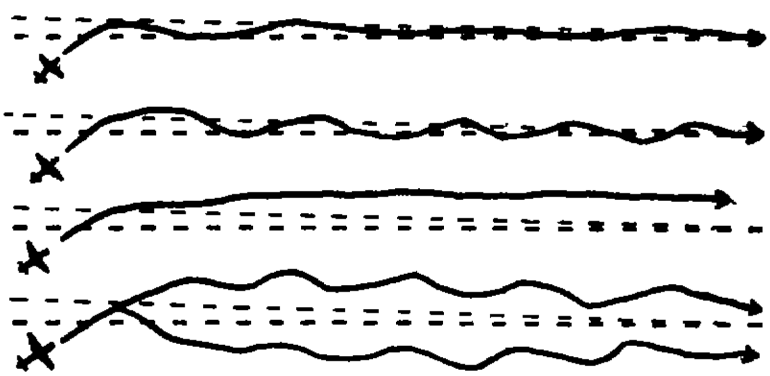
Slow | Within Limits | Fast

(______) -10 mph

(______) Recommended ILS Approach Speed

(______) +10 mph

(4) MAINTAINING LOCALIZER PATH



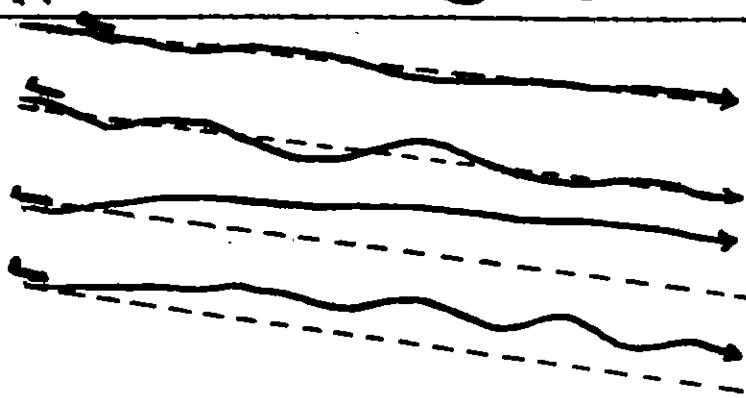
☐ Held path well

☐ Erratic, but close to path

☐ Off to side

☐ Off to side plus erratic

(5) MAINTAINING GLIDE PATH



☐ Held path well

☐ Erratic, but close to path

☐ Either above or below

☐ Either above or below plus erratic

(6) ALTITUDE OVER BOUNDARY MARKER

Above (______) +20ft.

Within Limits (______) Prescribed Altitude

(______) -20ft.

COMMENTS

C R O S S - W I N D   L A N D I N G

When examinee has reached minimum altitude after ILS approach, TELL EXAMINEE: "Now make a cross-wind landing on runway No. (______)."

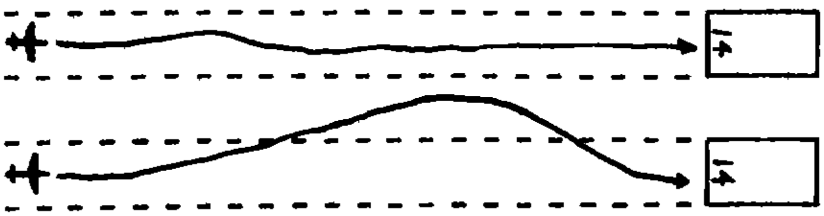
(1) "OVER-THE-FENCE" AIRSPEED

Slow | Within Limits | Fast

(______) -5 mph   (______) Recommended   (______) +5 mph

"Over-the-Fence" Speed

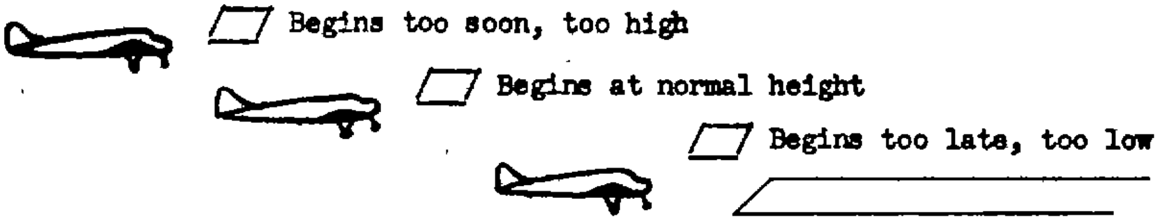
(2) ALIGNMENT WITH RUNWAY ON FINAL APPROACH



☐ Kept within width of runway

☐ Did not keep within width of runway

(3) STARTING FLAREOUT OR LEVEL-OUT



☐ Begins too soon, too high

☐ Begins at normal height

☐ Begins too late, too low

(4) ATTITUDE AT TOUCHDOWN

☐ Too tail-high   ☐ Normal   ☐ Too tail-low

(5) TAKING OFF CRAB BEFORE TOUCH-DOWN

☐ No crab

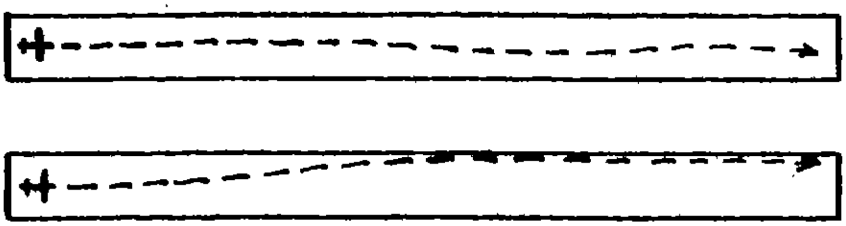
☐ Landed in crab

(6) ALIGNMENT ABOVE RUNWAY

☐ Plane was not drifting when wheels hit

☐ Plane was drifting when wheels hit

(7) HEADING ON ROLL



☐ Fairly straight path

☐ Rolled to side

COMMENTS

FILL IN AFTER THE FLIGHT

Name of examinee: ______________________________

Examinee is: _____ Employed by an airline: ______________________________
(Name of Airline)

_____ Not employed by airline

Check-pilots: #1 ______________________________
(Name)

#2 ______________________________
(Name)

Check-pilot #1 is: _____ Airline check-pilot: ______________________________
(Name of Airline)

_____ CAA Inspector

Check-pilot #2 is: _____ Airline check-pilot: ______________________________
(Name of Airline)

_____ CAA Inspector

Flight-check administered at: ______________________________
(City) (State)

Plane in which flight-check was given: ______________________________

Length of time taken for flight-check: ______________________________

APPENDIX I

RESULTS OF ITEM ANALYSIS
OF THE
SECOND TRYOUT OF THE FLIGHT-CHECK

APPENDIX I

TABLE 22

28 Jan. 49

RESULTS OF ITEM ANALYSIS OF THE SECOND TRYOUT OF THE FLIGHT-CHECK

(CAA Examiners, Oklahoma City, December 1948)

The scores of two groups of examinees provided the basic data for this table. The first group consisted of the 7 examinees whose over-all scores on the flight-check showed them to be in the upper 27% of the total group, and the second group was made up of those pilots in the lower 27%. Each pilot was observed by four different check pilots. Since there were 7 pilots in each group, 28 scores were available on each item for each group. The data that make up the table show the percent of these 28 scores which were unfavorable on each item for both the upper and lower groups.

Maneuver and Item	Percent of 28 Scores That Were Unfavorable	
	Upper	Lower
1. PREPARATION FOR FLIGHT		
(1) Comprehension of Weather Map	3.5	3.5
(2) Analysis of Sequence Reports	0	3.5
(3) Use of Pilot Reports	0	0
(4) Use of Forecasts	0	3.5
(5) Analysis of Winds Aloft	3.5	0
(1) Use of Reports of Airport Conditions	3.5	0
(2) Use of Reports of Airways Facilities	0	3.5
(1) Preparation of Flight Plan	0	0
(2) Check on Airplane	0	0
2. EQUIPMENT FAMILIARIZATION CHECK		
(1) Familiarity Shown on Outside Inspection	0	0
(2) Familiarity Shown on Inside Inspection	0	3.5
3. COCKPIT FAMILIARIZATION CHECK		
(1) Time to Complete Items	3.5	39.5
(2) Number of Items Correct	3.5	25.0
4. STARTING PROCEDURE		
(1) Use of Pre-Starting Checklist	0	0
(2) Completeness of Pre-Checking Checklist	3.5	10.5
(3) Manner of Checking	3.5	14.25
(4) Starting Procedure	0	10.75
(5) Handling of Engines	7.0	10.75
(6) Tuning and Checking Radio	3.5	21.5

Maneuver and Item	Upper	Lower
5. TAXIING		
(1) Clearance to Taxi	0	0
(2) Speed of Taxiing	0	7
(3) Application of Brakes	3.5	0
(4) Use of Brake	14.25	18
(5) Attention and Alertness	3.5	3.5
(6) Use of Throttles	10.5	21.5
(7) Caution	0	7
(8) Check of Flight Instruments	10.5	39.25
6. BEFORE TAKEOFF PROCEDURES		
(1) Positioning Plane for Run-up	0	7
(2) Check of Engine Instruments During Run-up	7	7
(3) Check of Instruments During Run-up	3.5	17.75
(4) Handling of Engines in Run-up	0	7
(5) Pre-Takeoff Check	7	21.5
(6) Manner of Executing Pre-Takeoff Check	0	25
7. INSTRUMENT TAKEOFF		
(1) Power Application	0	28.75
(2) Heading on Roll	14.25	46.75
(3) Attitude at End of Roll	3.5	39.25
(4) Flight Path Just After Becoming Airborne	3.5	41
(5) Airspeed in Climb	7	43
(6) Heading in Climb	10.75	28.75
(7) Check-Pilot Assistance	3.5	32.5
8. INTERCEPTING A PREDETERMINED TRACK AND TRACKING AWAY FROM STATION IN CLIMB		
(1) Setting Gyro or Azimuth	3.5	3.5
(2) Direction of Turn to Intercept Track	0	3.5
(3) Interception Angle	3.5	10.75
(4) Leading Track at Interception	32.25	51.75
(5) Accuracy of Tracking	0	0
(6) Airspeed in Climb	14.25	17.75
9. MINIMUM SPEED MANEUVERING AND APPROACH TO STALL		
(1) Airspeed During Maneuvering	3.5	28.5
(2) Altitude During Maneuvering	51.75	59
(3) Attitude During Approach to Stall	3.5	14.25
(4) Recognition of Stalling Point	14.25	3.5
(5) Recovery	0	10.5
(6) Power in Recovery	7	18
(7) Use of Aileron in Recovery	0	7

Maneuver and Item	Upper	Lower
10. STEEP TURNS WITH ENGINE FAILURE(S)		
(1) Holding Altitude in Turns	64.25	91
(2) Constancy of Degree of Bank	18	32.5
(3) Speed of Recovery After Engine Failure	3.5	14.25
(4) Engine-Out Procedure	7	36
(5) Altitude During Engine-Out Procedure	28.75	91
11. RAPID DESCENT AND PULL-UP		
(1) Airspeed in Descent	0	28.5
(2) Heading in Descent	14.25	14.25
(3) Holding Altitude at Minimum Altitude	32.5	73.25
(4) Accuracy of Timing	14.25	10.5
(5) Use of Power	3.5	21.75
(6) Airspeed in Climb	0	35.75
12. MANUAL LOOP ORIENTATION AND TRACKING		
(1) Tuning for Null	7	21.5
(2) Knowledge of Manual Loop Procedure	0	14.25
(3) Altitude During Orientation	50	73
(4) Accuracy of Estimate of Time to Station	60.5	57.5
(5) Accuracy of Tracking	3.5	39.5
(6) Recognition of Station	0	7
13. ADF APPROACH WITH ENGINE FAILURE		
(1a) Accuracy of Tracking Outbound	7	17.75
(1b) Accuracy of Tracking Inbound	14.25	41.25
(2) Hitting Track after Procedure Turn	25.	68.
(4) Airspeed on Letdown from Station	14.25	50.25
(5) Tracking from Station to Field	14.25	28.75
14. ENGINE-OUT LANDING		
(1) Coordination on Approach	0	10.75
(2) Glide Angle	3.5	44.5
(3) Alignment with Runway	7.	25.
(4) "Over-the-fence" Airspeed	7.	51.75
(5) Beginning Flare-Out	3.5	7.
(6) Touch-Down	14.25	28.5
(7) Landing	25.25	21.5
15. CROSSWIND TAKEOFF AND ENGINE FAILURE AFTER TAKEOFF		
(1) Heading on Roll	7.	10.75
(2) Length of Roll	7.	18.
(3) Engine-out Procedure	0	14.25
(4) Recognition of Bad Engine	0	14.25
(5) Getting Engine-out Climb Speed	0	14.25
(6) Heading in Climb	0	14.25

Maneuver and Item	Upper	Lower
16. APPROACH UNDER SIMULATED 400 AND 1 CONDITIONS (CONTACT)		
(1) Remaining within 1 Mile of Field	0	14.25
(2) Adequacy of Pattern	3.5	10.75
(3) Maintaining Altitude	21.5	39.5
(4) Approach to Runway	7.0	35.75
(5) "Over-the-fence" Airspeed	0	53.5
(6) Touch-Down	21.25	25.
17. ILS APPROACH		
(1) Pre-landing Check	3.5	0
(2) Hitting Localizer after Procedure Turn	39.5	39.5
(3) Airspeed During Approach	17.75	25.
(4) Maintaining Localizer Path	0	7.
(5) Maintaining Glide Path	7.	39.5
18. CROSS-WIND LANDING		
(1) "Over-the-fence" Airspeed	0	39.5
(2) Alignment with Runway on Final Approach	10.5	25.
(3) Starting Flareout or Level-out	0	28.75
(4) Attitude at Touch-down	3.5	7
(5) Taking Off Crab Before Touch-down	0	21.75
(6) Alignment Above Runway	7.	21.5
(7) Heading on Roll	7.	14.25