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ABSTRACT

Research at the United States Army Aviation School, Fort Rucker, Alabama, sought to improve the school-wide training quality control system. Investigators studied: 1) the relation between the grades a student received from instructors and those he received from a checkpilot; 2) the effect of checkpilots' prior information about students' progress upon the grades they assigned; 3) inter-rater differences in grading practices; and 4) the usefulness of checkpilot comments on grade slips. Performance records from student classes of 1961 and 1962, when grading changes were introduced, were examined. Analysis showed substantial correlations between instructor and checkpilot evaluations when checkpilots were drawn from the instructor pool, but not when they came from outside sources. The individual standards of the rater influenced final evaluations, and optimum procedures were not used in the collection of student performance data. These findings suggested that the flight grading system needed standardization, that an organizational separation of training and assessment functions was desirable, and that the data input for quality control should be made more objective, detailed, and routinized. (PB)

Technical Report 68-3

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Flight Evaluation Procedures and Quality Control of Training

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Paul W. Caro, Jr.

HumRRO Division No. 6 (Aviation)

March 1968

Prepared for

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The George Washington University
HUMAN RESOURCES RESEARCH OFFICE

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The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

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FOREWORD

This report presents an analysis of grading practices and procedures in effect in rotary wing training at the U.S. Army Aviation School at Fort Rucker, Alabama, during 1961-63 instruction periods. The study was requested by the School's Rotary Wing Department in connection with continuing development of quality control procedures in the training program.

A major purpose of this analysis was to compare the results of training and checkflight procedures in effect at that time with the results from a HumRRO study conducted in 1956-57 under Work Unit LIFT. The LIFT study analyzed training and checkflight grades for Army helicopter students at the Aviation School and at the U.S. Army Primary Helicopter School at Fort Wolters, Texas.

Another objective in the present analysis was to use the experience and results as a basis, if appropriate, for generalizations about characteristics needed in data to be used in training quality control systems and procedures in a broader context.

Both this study and the earlier LIFT research were performed by HumRRO Division No. 6 (Aviation) at Fort Rucker. The present study was undertaken as Technical Advisory Service, and initial results were reported to the Aviation School. This report was developed to make the information more generally available to those interested in the development and operation of quality control systems for training.

The present analysis was begun by Dr. Wallace W. Prophet, with Dr. J. Daniel Lyons as Director of Research. It was completed by Dr. Paul W. Caro, Jr., with Dr. Prophet as Director of Research.

Military support for the research was supplied by the U.S. Army Aviation Human Research Unit. MAJ Donald J. Haid was the Unit Chief at the time the research was conducted.

The grading practices analysis conducted under Work Unit LIFT (Army Aviation Helicopter Pilot Training) was reported in HumRRO Technical Report 77, Improving Flight Proficiency Evaluation in Army Helicopter Pilot Training, by George D. Greer, Jr., Wayne D. Smith, and CPT Jimmy L. Hatfield, May 1962. Subsequent work under Work Unit LIFT is described in a Consulting Report, A System of Flight Training Quality Control and Its Application to Helicopter Training, by John O. Duffy and Carroll M. Colgan, June 1963.

HumRRO research for the Department of the Army is conducted under Contract DA 44-188-ARO-2 and Army Project 2J024701A712 01, Training, Motivation, Leadership Research.

Meredith P. Crawford
Director
Human Resources Research Office

SUMMARY AND CONCLUSIONS

Military Problem

A training system—like a factory producing an item for market—can benefit greatly from quality assurance procedures and techniques integrated into a formal quality control system. Such a system can assure that graduates of the training system are able to function at required levels of proficiency, and it can provide managers with diagnostic data for continuing improvement of the training.

The U.S. Army Aviation School, Fort Rucker, Alabama, has had strong interest in establishing a school-wide flight training quality control system. As a step toward this end, the School requested that HumRRO study several aspects of the procedures used in evaluating the training and performance of the School's rotary wing trainees.

A study conducted in 1956-57 by HumRRO Division No. 6 (Aviation) had shown that there was little relationship between the grades assigned to Army helicopter students by flight instructors and those assigned by checkpilots, and that end-of-course evaluations were greatly affected by the individual standards of the checkpilots. Since that time, a number of changes in evaluation procedures had been instituted. The study described in this report was conducted in 1963 to obtain information on the current characteristics of flight grading practices of the Rotary Wing Department of the Aviation School.

Research Problem

A quality control system for training includes the following elements:

(1) Detailed specification of training goals
(2) Accurate and appropriate proficiency evaluations
(3) Effective communication concerning training efficiency
(4) Effective procedures for corrective action
(5) Supervisory support

If quality control evaluation procedures based on data from examiners are to be effective, the examiners must use common standards of evaluation and must provide detailed, reliable, and valid information inputs for the system. In view of these general quality control requirements, the present study was directed toward four main questions about flight grading practices:

(1) What is the relationship between grades given by instructors and checkride grades given by checkpilots?

(2) What are the effects on checkride evaluations of checkpilots' prior information about students?

(3) What variations exist in individual checkpilot standards and grading practices?

(4) What is the usefulness, for quality control purposes, of checkpilot comments on grade slips?

A corollary objective was to seek findings of broad applicability relevant to techniques and procedures for training quality control systems in general.

Procedures

This study was based on the performance records of students in selected rotary wing classes spanning the 1961-63 period.

Flight records for six FY 1961 and seven FY 1962 classes were analyzed to determine the extent of similarity between grades assigned by instructors and those assigned by checkpilots. These two samples of classes were selected to represent "before and after" situations related to changes introduced in the School's grading practices in FY 1962.

Study was also made of whether grades were influenced by the checkpilots' relationship to, or possible familiarity with, the students or their instructors. Two FY 1963 classes, with a combined enrollment of 60 students, were selected for this experiment. At that time it was the practice in the Rotary Wing Department for instructors within an instructing flight to administer checkrides to each other's students and one-third of the 60 students in the experiment were evaluated according to this procedure. The remaining two-thirds were given checkrides by checkpilots drawn from outside the classes studied, a procedure intended to obviate bias in checkpilot grades that might result from prior knowledge of the student's performance.

A third aspect of the research concerned the extent to which the individual checkpilot's own standards might influence the grades assigned to students. The seven 1962 rotary wing training classes were used as the basis for this analysis. In these seven classes, there were 17 checkpilots who had given 12 or more checkrides. The grades assigned by these checkpilots were analyzed in detail. The records of the checkpilots in the two 1963 classes used in the preceding experiment were also analyzed.

A fourth consideration was whether the kind of diagnostic information appropriate for quality control programs was available under the grading system used by the Rotary Wing Department. To ascertain this, comments made by checkpilots on student grade slips were reviewed and classified according to level of specificity.

Results

(1) Substantial correlations—which conflicted with the low correlations reported in the 1956-57 findings—were found between instructor and checkpilot evaluations of student performance, with checkpilots selected from among the instructors of the students' own instructing flights.

(2) There was little relationship between the evaluations of instructors and those of checkpilots when checkpilots were drawn from outside the students' flights.

(3) End-of-stage evaluations of student performance were significantly affected by:

(a) The individual standards and grading practices of the checkpilot.

(b) Whether the checkpilot was a member of the student's own flight.

(c) The stage of training at which flight performance was being evaluated.

(4) Some of the specific information on individual student performance needed for an effective quality control program was recorded by checkpilots under the existing grading system, but it was not collected in a consistent manner or processed for systematic diagnostic use.

Conclusions and Implications

(1) The insufficient correlation between instructor and checkpilot grades, and the large variations in individual checkpilots' standards and practices, suggest the flight grading system falls short of what is needed for an effective school-wide quality control system.

(2) While some information useful for quality control purposes was being collected, additional mechanisms and procedures for assuring consistent collection, recording, summarizing,

and reporting of the data needed to be devised in order to increase the effective use of such information.

(3) A procedure in which instructors evaluate and report upon the quality of the products (students) of their own training unit cannot easily yield information upon which to base an effective quality control system. An optimum system requires the organizational separation of assessment and training functions, and uniform procedures for performance evaluation.

(4) Data input for training quality control purposes must meet certain criteria. Ideally, the data should be based on standardized proficiency tests administered under standard conditions. Data should be detailed, objective descriptors of trainee performances if the feedback of information to the training operation is to allow effective adjustments in that operation.

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INTRODUCTION

Quality Control System Requirements

For many years the concept of quality control has been an accepted feature of industrial management, and a formal quality control system has been a routine aspect of manufacturing operations. The detailed assessment of product quality under such a system serves two basic functions: (a) It assures that the products going to the market meet minimum standards of quality, and (b) it provides relevant feedback to management as to changes needed in the production process to bring more of the products to the minimum standard, to raise the standard, or to lower costs. The procedures used and general organizational structure involved in industrial quality control have become well systematized and documented.

The two general functions of quality control are just as pertinent to a training system as to a manufacturing system. Only recently, however, has there been any systematic application of the concepts of quality control to the production of skilled personnel through training. While proficiency tests and a wide range of training and administrative techniques to measure and upgrade the duty qualifications of trainees are part of every military training program, the planned use of all phases of an integrated quality control system is not yet common in the training environment.

The general concept of training quality control has been discussed in detail by Smith (1), and a specific application of the concept in a military training context is described by Duffy and Colgan (2). They outline five general requirements for an effective training quality control system:

(1) Detailed specification of training goals
(2) Accurate and appropriate proficiency evaluations
(3) Effective communication concerning training efficiency
(4) Effective procedures for corrective action
(5) Supervisory support

While there is little doubt as to the desirability of controlling quality in a training system, particularly in one that is directed toward producing critical and complex skills, the feasibility of conducting an effective training quality control program will vary from one organization to another as a function of many factors..

The rapid growth of Army aviation training, particularly in the rotary wing area, has intensified command interest in developing procedures that will allow for better management of the extensive and complex training system. A training quality control system is one such procedure. The problem of training quality is critical to a school such as the U.S. Army Aviation School (USAAVNS) at Fort Rucker, Alabama, which in recent years has been devoting more and more attention to this subject. That concern has led to the institution of a number of procedural changes at the School and provided the impetus for the research described in this report.

One factor important to the success of a quality control system is the kind of data input on student performance that is available for evaluation purposes.

In flight training, the quality control requirement for "accurate and appropriate proficiency evaluations" can be supplied through indices of performance such as daily flight grades and checkride grades assigned at the end of various stages of training. Performance checks serve two purposes: (a) They demonstrate whether the individual product (student) meets the required standards of performance (i.e., whether the training objectives have been met), and (b) most important for a quality control system, they provide information that serves as feedback to the personnel responsible for [illegible]ring the overall instructional system. Such feedback signals the [illegible]o and forms the basis for, changes or adjustments in the training program.

The effectiveness of a training quality control system will therefore be, in large part, a function of the extent to which information on the quality of the product—student performance—is valid and reliable. Examination, by research analysis techniques, of certain aspects of the information on student flight performance that is available for quality control use at the Aviation School was undertaken at the School's request, as a result of growing interest in establishing a formal training quality control system.

The data which form the principal basis for the various phases of the present study are from Aviation School classes during FY 1961-63. An overview of the grading practices and quality control procedures in effect at the School is presented in the following section. Certain developments in flight grading and quality control that have taken place at USAAVNS during FY 1964-66 are described in the final section of this report.

Flight Grading and Quality Control at USAAVNS

Flight evaluation practices and procedures at the Aviation School differ from those of the U.S. Army Primary Helicopter School at Fort Wolters, Texas, where a formal quality control system is in operation, principally in terms of the type of data input to the system.

The USAPHS system (described by Duffy and Colgan, 2, and Duffy and Anderson, 3), utilizes a detailed, relatively objective checklist of flight performance items. Data are in the form of deviations from desired values in airspeed, altitude, RPM, and so forth. Such data input can be characterized as objective descriptors of performance. The objective checklist is known as the Pilot Performance Description Record (PPDR). Development of the PPDR is described by Greer et al. (4).

The data input available for quality control use at USAAVNS can be described as a subjective evaluation of performance. In this system (described by USAAVNS, 5[1]), the checkpilot or instructor provides a numerical or letter score or rating which is the evaluation of the student's performance. In addition, comments of varying degrees of specificity may be written on the grade record sheet by the checkpilot or instructor.

While USAAVNS has not had a school-wide quality control system, for a number of years a rather thorough and extensive quality control system has been operated by the Department of Fixed Wing Training for the primary phase of their instruction.[2] That system has many features in common with the one

[1]Reference 5 is the USAAVNS Regulation that was in effect at the time this study was conducted. A new USAAVNS Regulation 350-16, dated June 1963, governs current USAAVNS grading practices. However, the system embodied in the current regulation is generally like that described in 5.

[2]During FY 1966, the primary fixed wing system was extended to other phases of fixed wing training, and efforts are under way to extend it to all USAAVNS flight training.

at USAPHS, and in fact provided the impetus for some of the features of the USAPHS system. The principal differences relate to (a) the use of subjective evaluations of overall performance at USAAVNS versus the objective indices of details of the performance at USAPHS, (b) administration of checkrides by instructors from within the student's own flight at USAAVNS versus administration by a separate checkpilot group at USAPHS, and (c) the use of hand-processing of data at USAAVNS versus the use of automatic data processing equipment at USAPHS.

Since the present study dealt with several aspects of the quality control data input at USAAVNS—that is, the daily and checkride flight grades—some additional details on the manner in which these grades are derived will be presented later (see p. 6) to provide background for subsequent description of the research. The general characteristics of subjective flight grades have been discussed by Greer et al. (6), and will not be repeated here.

Army flight training is divided into a number of phases and stages, each of which has certain definable objectives or goals. During the course of the training, each dual instructional flight—unless maneuvers are being demonstrated to the student for the first time—is given a summary letter grade[1] by the instructor. In addition, the instructor will assign a letter grade to the performance of specific maneuvers and to the student's basic qualities, and he may also write narrative comments. As the various stages are completed, the student's proficiency is checked to see whether he has met the objectives of that stage and is prepared to progress to the next stage of training.

These checks on proficiency (or checkrides) are normally administered by someone other than the student's own instructor.[2] In most cases, the checkrides are administered by "checkpilots" who are instructors in the same instructing flight or group as the student's own instructor.[3] In some cases, the checkpilot is an instructor from another flight or is from an administrative office of the instructing department or school, such as the Standards Division.

The assignment of students to particular instructors for the periodic checkrides is generally nonsystematic, in that no method is specified. In the Department of Rotary Wing Training the flight commander concerned usually makes the assignments in accord with current workloads and such other factors as he deems pertinent. In some cases there may be a pattern to the assignments, such as assigning marginal students to particular instructors whom the flight commander considers especially adept at checking weak students.

Details of the checkride grading system are described by USAAVNS (5). The checkride produces a single numerical grade or letter grade that summarizes the evaluation of the student's flight performance on the checkride. Generally, above-average performance is assigned grades in the 90s, average in the 80s, and below-average in the 70s; unsatisfactory performance, or failure, is assigned the letter grade U. In addition, performance on specific maneuvers is assigned letter grades A, B, C, or U, as is the checkpilot's assessment of the student's "basic qualities," such as motivation and coordination. Finally,

[1]The exact terminology for these grades has varied from time to time, but can generally be characterized as versions of a four-point rating scale, e.g., *A*, *B*, *C*, and *U*, or *AA* (above average), *A*, *BA*, and *U*.

[2]The most common exception is the administration of the pre-solo checkride, which may be done by the student's own instructor.

[3]An exception to this involves instruction administered by contractor personnel, i.e., non-military or non-Department of the Army civilian instructors. Students of contract instructors are checked by designated military or Department of the Army civilian checkpilots. Data used in the present study did not involve contract instructors.

the checkpilot may provide narrative comments on specific aspects of the student's performance.

As the student completes a stage of training, his instructor assigns him an "instructor evaluation" grade, which is a numerical grade utilizing the same scaling as the checkride grade, and which can be thought of as the instructor's estimate of the grade the student will receive on his end-of-stage checkride.

In summary, at USAAVNS the following subjective evaluation grades or comments are available for use in quality control:

(1) Instructor daily summary letter grade.
(2) Instructor daily letter grade on specific maneuver performance.
(3) Instructor daily letter grade on student's basic qualities.
(4) Instructor narrative comments on specific aspects of the student's daily performance.
(5) Instructor end-of-stage numerical evaluation grade.
(6) Checkpilot end-of-stage numerical (or letter) summary checkride grade.
(7) Checkpilot end-of-stage letter grade on specific maneuver performance.
(8) Checkpilot end-of-stage letter grade on student's basic qualities.
(9) Checkpilot narrative comments on specific aspects of the student's performance on the checkride.

Rationale for Present Study

As previously indicated, the present study stemmed from USAAVNS concern over quality control procedures that would be appropriate for School use. Earlier studies (1956-57) with Army helicopter students, reported by Greer et al. (6), had raised a number of questions about the reliability and validity of subjective evaluations of flight proficiency. It was decided to examine evaluation data from more recent USAAVNS classes to see whether the data characteristics had changed. The periods selected were FY 1961 and FY 1962, to provide information on evaluations before and after certain changes in USAAVNS grading, the most notable being the introduction of the concept of "basic qualities."

The basic concern in the analyses of grading information for the two time periods covered was with the correlations between instructor-assigned daily flight grades and checkpilot-assigned checkride grades. The earlier study of USAAVNS grading had shown that these two indices were generally not correlated with one another. This lack of correlation between two independent measures of the capabilities of the same students was interpreted as indicating insufficient reliability and validity in the flight grading system. Considerable variation was found in the standards of evaluation used by individual checkpilots in that study, so this matter was also treated in the present study.

Another point of concern which was explored in the present study stemmed from the administrative organization underlying the assignment of personnel to administer checkrides at USAAVNS. In their analyses of quality control systems, Smith (1) and Duffy and Colgan (2) emphasize the importance of having the quality control element of the organization distinct and separate from the instructing element, both as to administrative organization and as to personnel. Such a procedure—which would, in essence, require a separate group of specialists who did nothing but administer quality control checkrides—has not been considered feasible by USAAVNS because of the organizational and personnel problems arising from the many different flight training courses offered at the School and the number of different aircraft types involved. Under the present

organization of USAAVNS, therefore, it is not possible for all checkrides to be administered by persons outside the instructing flights.

To obtain information on how this procedure may affect flight evaluations, data from checkrides under standard USAAVNS practice were compared with results of checkrides administered by personnel who were not members of the student's own instructing flight. These special checkride data were gathered on certain FY 1963 classes as part of the research activities.

The organizational problems that have prevented USAAVNS from having separate, independent groups of checkpilots also make it difficult to utilize objective performance measures such as the PPDR. Use of the PPDR is a specialized checkpilot skill that requires special training, and a checkpilot needs to administer the PPDR regularly if he is to maintain his level of skill in its administration. These factors make it necessary for the checkpilots to be a separate group whose specialty and duty is the administration of checkrides. The less varied flight training mission of USAPHS permits the organization necessary to routine use of the PPDR in the quality control system at Fort Wolters, whereas the much more varied flight training mission of USAAVNS would pose considerably greater problems for efficient operation with such an organization.

Previous HumRRO research (6), as well as that of other researchers (7), has noted the sometimes considerable variability among checkpilots in the standards they use in evaluating student flight performance. It is common practice for students to characterize various checkpilots as "Santa Clauses" and "Hardnoses." Therefore, in another phase of the present research, analyses of checkpilot records from the seven FY 1962 classes were made to determine whether there were significant differences in checkpilot standards reflected in these data.

A final area of concern in the present study was the usability of the narrative comments on USAAVNS grade slips for quality control purposes. The necessity, for quality control, of having detailed and specific information about student performance has been stressed by Smith (1). Since the comments on the grade slips provide the most detailed and specific information in the USAAVNS grading system, these comments were examined for the FY 1963 classes studied.

ANALYSIS OF TRAINING AND CHECKRIDE GRADES

Problem and Approach

The purpose of the first phase of the research was to determine the extent to which the grades assigned to students by instructors agreed with those assigned by checkpilots for the same stage of training. Coefficients of correlation were computed between the instructor's evaluation grade (IE) assigned the student just before an end-of-stage checkride and the checkpilot's grade (CK) assigned the student on the basis of the end-of-stage checkride. If the instructor and the checkpilot are applying similar standards of performance in their respective evaluations of the student, a substantial correlation[1] will exist between the two sets of evaluations (although substantial IE-CK correlations can exist for reasons other than commonality of standards).

[1]The magnitude of such correlations will not approach the test-retest reliabilities usually associated with psychometric tests. For further discussion of this point see Prophet (8).

Near-zero relationships between the two grades had been reported in 1956-57 (6). The flight grading system under which the low IE-CK correlations were found had undergone changes, as described in a 1961 USAAVNS flight grading memorandum (5) instituting a concept of evaluation of flight performance "basic qualities". To determine whether there had also been a change in the IE-CK grade relationships, data from two separate groups of rotary wing classes, representing the "before" and "after" situations with regard to the flight grading system changes, were utilized in the correlational analysis.

Procedure

The flight records for six FY 1961 and seven 1962 classes were selected for study. These classes represented both the Officer Rotary Wing Aviator Course and the Warrant Officer Rotary Wing Aviator Course given at the Aviation School. These 13 classes were selected for the analysis because (a) complete records of student performance were available and (b) these classes represented stable grading practices during periods before and after the changes in grading practices initiated in mid-1961. The classes selected are listed in Table 1.

Table 1

Classes Selected for Analysis of Grading Practices

Before Changes in Grading Practices		After Changes in Grading Practices	
Class Number	Number of Students	Class Number[a]	Number of Students
61-1	36	62-1W	38
61-2	30	62-2W	42
61-3	28	62-3	35
61-4	29	62-5	46
61-5	19	62-6	28
61-6	15	62-7	27
		62-8	43
Total	157	Total	259

[a]Class 62-4 was canceled.

The grade folder of each student in the classes selected was examined, and the daily grades (DG), instructor evaluations (IE), and checkride grades (CK) for each stage of training were abstracted for use in the correlational analysis. The mean daily grade ($\overline{DG}$) for each student for each stage of training was computed. Pearson product-moment coefficients of correlation were then computed among these three variables ($\overline{DG}$, IE, and CK) for each stage of training. These correlations are shown in Table 2.

Results

As previously stated, the correlations of principal interest are those between instructor evaluations and checkride grades. The IE-CK correlations for the six FY 1961 classes combined (the "before" group) and for the seven FY 1962 classes combined (the "after" group) are presented for each stage of training in Table 3. Also shown is the range in correlations for individual classes in

Table 2

Correlations Between Mean Daily Grades, Instructor Evaluations, and Checkride Grades for Each Stage of Training[a]

Training Stage	Variable	Pre-Solo			Advanced			Instrument Cross-Country		
		$\overline{DG}$	IE	CK	$\overline{DG}$	IE	CK	$\overline{DG}$	IE	CK
Pre-Solo	Daily Grade	–	.70	.24						
	Instructor Evaluation	.64	–	.39						
	Checkride	.26	.47	–	.24		.25			
Advanced	Daily Grade			.38	–	.67	.45			
	Instructor Evaluation				.67	–	.55			
	Checkride			.24	.36	.41	–			
Instrument Cross-Country	Daily Grade						.27	–	b	b
	Instructor Evaluation							.54	–	b
	Checkride			.19			.22	.23	.48	–

[a]Coefficients in the upper right hand portion of the Pre-Solo and the Advanced stage analyses were computed from data from six FY 1961 classes ($N = 157$) trained before the changes in flight grading practices in 1961. Coefficients in the lower left hand portions were computed from data from seven FY 1962 classes ($N = 259$) trained after these changes.

[b]The Instrument Cross-Country phase was not included in the training program during FY 1961.

Table 3

Correlations Between Instructor and Checkpilot Grades Before and After Grading Practices Changes

Training Stage	Before Changes in Grading Practices ($N = 157$)		After Changes in Grading Practices ($N = 259$)	
	Total Group Correlation	Inter-Class Range	Total Group Correlation	Inter-Class Range
Pre-Solo	.39	.16–.65	.47	.34–.63
Advanced	.55	.39–.81	.41	.21–.59
Instrument Cross-Country	a	a	.48	.01–.73

[a]Not applicable. This stage was not instituted until FY 1962.

the "before" and "after" samples. Means and standard deviations for the DG, IE, and CK grades for each class are given in Appendix A.

Each of the correlations reported for the total group in Table 3 is statistically significant ($p < .001$). These correlations are similar in magnitude to relationships reported elsewhere in studies of flight training research (7). They indicate substantial agreement between instructors and checkpilots in the assignment of grades in the Department of Rotary Wing Training, both before and after the changes in grading practices. None of the differences between "before" and "after" mean correlations was statistically significant.

Discussion

On the basis of these data, the near-zero correlations observed in rotary wing training in 1956-57 did not obtain in the Department of Rotary Wing Training, USAAVNS, during the period covered by the analyses presented in the present study. On the contrary, substantial relationships did exist between instructor evaluations and checkride grades for all three stages of advanced rotary wing training. These relationships were not significantly affected by grading practice changes introduced by USAAVNS in mid-1961.

However, it is possible for such substantial relationships to exist on bases other than commonality of flight evaluation standards between instructor and checkpilot personnel. The existence of substantial correlation between IE and CK is a necessary condition for a conclusion that instructor and checkpilot grades are based on the same standards for evaluating student performance. It is not, however, in itself enough to justify such a conclusion, since the common frame of reference for instructor and checkpilot could have been based on something other than the student's performance. This aspect of the evaluation was explored in the second phase of the research.

THE EFFECT OF PRIOR KNOWLEDGE ON CHECKPILOT EVALUATIONS

Problem and Approach

The relationship between instructor evaluations and checkride grades can be significantly influenced by a number of factors[1] other than the standards applied by instructors and checkpilots. One possible biasing factor is the amount of information the checkpilot has about the student prior to the checkride. Such information may produce spuriously high correlations.

Ideally, if the checkride grade is to be an unbiased evaluation of the student's performance, the checkpilot should have no prior knowledge of the student's performance capabilities. In practice, it is virtually impossible to attain this ideal in a situation where the checkpilot is an instructor who has been in daily contact with the students and with their instructors.

At the time of the research reported here, a separate check section did not exist in the Department of Rotary Wing Training, USAAVNS. It was the practice for the instructors to administer checkrides to each other's students. The second phase of this study sought to determine whether the organizational assignment or location of the checkpilot—that is, whether he was an instructor within the student's own flight or from outside that flight—influenced the relationship between grades assigned by instructors and those assigned by checkpilots. It is assumed that if such influences do operate, the probable reason would be the information available to the checkpilot, prior to the checkride, concerning the particular student or his instructor. Therefore, a number of checkrides were administered under controlled conditions intended to reduce the amount of prior information to which the checkpilots were exposed.

Procedure

The classes selected for this experiment were Classes 63-1W and 63-3. The combined enrollment of these two classes was 60 students.

[1]Many of the factors that can bias checkride evaluations are discussed in the *PPDR Handbook* (4).

Five pilots were selected by the Department of Rotary Wing Training to administer "Special" checkrides. These checkpilots, who were judged competent by USAAVNS to make evaluations of student performance, had participated in frequent and regular evaluations of students comparable to those in the classes under study, and had no duties that required regular contact with students or instructors in either of the classes in the experiment. Four were instructors from other classes, and the fifth, who served as an alternate, was from the Standards Section of the Department of Rotary Wing Training.

Since these five checkpilots were not instructing in the flights under study, it was assumed they would have little or no exposure to the kinds of information about the performance of students they would be evaluating that would be apt to bias their evaluations. The selection of these five checkpilots did not assure unbiased evaluations of student performance; the only intent was to minimize the amount of information about the students that would be likely to be available to the checkpilots prior to administering the checkrides.

Approximately two-thirds of the 60 students in the selected classes were given checkrides by the Special checkpilots. The remaining students were evaluated by regular pilots in accordance with the procedures then in effect in the Department of Rotary Wing Training.

To further reduce the amount of information that might be available to Special checkpilots prior to the administration of checkrides, the research staff selected the students for special checkrides and assigned the Special checkpilots to evaluate them. This was done, using a random selection procedure, after the flight commander had designated the students who were to be given checkrides on a specific date. The individuals concerned were notified immediately prior to the checkride. Under this procedure there was little opportunity for the Special checkpilot to be exposed to possibly biasing information about the student he was to evaluate.

One restriction—that no Special checkpilot could administer a checkride to a student he had evaluated on a previous checkride—was placed upon the random selection procedure. Therefore, no Special checkpilot administered more than one checkride to a given student. The numbers of students receiving Special and Regular checkrides during each stage of training are presented in Table 4.

Table 4

Correlations Between Instructor and Checkpilot Evaluations[a]

Checkride	Stage of Training					
	Pre-Solo		Advanced		Instrument Cross-Country	
	N	Correlation	*N*	Correlation	*N*	Correlation
Special	36	.28	40	.20	41	.18
Regular	24	.55[b]	20	.73[b]	18	.64[b]

[a]Classes 63-1W and 63-3.
[b]Coefficients significantly greater than zero ($p<.01$).

Results

The Pearson product-moment coefficients of correlation obtained between instructor evaluations and checkride grades for the Special and Regular checkrides

administered during this study are reported in Table 4. For purposes of these analyses, data from the two classes were combined.

For all three stages of training, the checkride grades assigned by the Special checkpilots showed less relationship to instructor evaluations than did the evaluations assigned by Regular checkpilots. Coefficients of correlation between end-of-stage evaluations assigned by instructors and those assigned by checkpilots were substantial ($p < .01$) for each stage of training when the checkrides were administered under the regular system. On the other hand, the corresponding correlations were not significantly different from zero when administered under the special conditions established for this study.

The correlations for the regular group reported in Table 4 are in keeping with the higher correlations found in the first phase of the study for similar comparisons for certain of the FY 1961 and FY 1962 classes. However, under the independent conditions established for the second phase of this study, no significant agreement was found between instructor and checkpilot evaluations.

Discussion

Evidence from the statistical analysis, in the first phase of the present study, of checkride grades in the FY 1961 and FY 1962 classes indicated substantial agreement between instructors and checkpilots in assigning grades. Analysis of checkride grades administered under controlled conditions in the second research phase did not provide indication that such agreement reflected a similarity of evaluation standards between the two groups of evaluators. On the contrary, it suggested that the apparent similarity of evaluation standards may have been an artifact attributable to availability of information to checkpilots prior to checkride performance evaluation.

On the basis of the evidence from the experimental checkrides, it appears that the conclusions of the 1956-57 study with respect to grading standards still had applicability in 1963. The ratings of students' checkride performance still tended to reflect something other than the performance of the students being evaluated. The third phase of the study was designed to investigate the hypothesis that a major factor in the assignment of grades by checkpilots was the checkpilot's own standard of evaluation.

VARIATIONS IN INDIVIDUAL CHECKPILOT STANDARDS AND GRADING PRACTICES

Problem and Approach

A lack of agreement between checkpilots and instructors with respect to the evaluation of end-of-stage student performance was demonstrated in the second phase of the present study. The 1956-57 study reported that such lack of agreement reflected differences in the individual standards of checkpilots (6). An analysis was therefore made of the evaluation records of individual checkpilots to determine whether they had personal standards and grading practices that differed significantly and that significantly influenced the grades of the students whom they evaluated.

Procedure

Data from the seven FY 1962 rotary wing training classes listed in Table 1 were used in this phase of the study. In order to explore the possible variations

in grading practices among checkpilots in the seven classes, grades assigned by each of them were assembled. Since many of these checkpilots had administered too few checkrides to provide a stable indication of their grading standards, it was decided that only those checkpilots who had administered 12 or more checkrides would be included in the analysis. There were 17 such pilots.

Grading data from both Special and Regular checkpilots from the two FY 1963 classes used in the second-phase experiment also were analyzed in the study of individual variations among checkpilots.

Results

The means and standard deviations of checkride grades assigned by the 17 pilots from the FY 1962 classes, for each stage of training and for all stages combined, are reported in Table 5. The mean grades for all stages of training combined ranged from a low of 77.1[1] (Checkpilot Q) to a high of 87.9 (Checkpilot A). The standard deviations ranged from 3.1 (Checkpilot A) to 7.9 (Checkpilot Q).

As might be expected when smaller numbers of checkrides were involved, the means and standard deviations within the various stages showed wider variations than for all stages combined. The largest difference between

Table 5

Means and Standard Deviations[a] of Grades Assigned by Selected Checkpilots

Checkpilot	Stage of Training											
	Pre-Solo			Advanced			Instrument Cross-Country			All Stages		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
A	5	86.4	2.7	4	87.8	3.0	3	90.7	1.2	12	87.9	3.1
B	5	87.4	3.4	8	86.6	4.9	3	91.3	1.2	16	87.8	4.4
C	10	86.5	4.5	19	85.6	3.0	12	91.6	2.4	41	87.6	4.2
D	4	86.5	5.6	10	86.5	3.5	5	90.4	1.5	19	87.5	4.1
E	4	82.8	2.9	5	89.0	3.1	4	87.5	2.9	13	86.6	4.1
F	2	86.0	4.0	9	86.1	3.4	5	87.4	2.6	16	86.5	3.2
G	7	84.7	5.1	9	86.6	2.6	6	87.7	2.1	22	86.4	3.7
H	2	91.0	0.5	4	84.8	2.2	7	85.9	3.4	13	86.3	3.5
I	10	84.4	3.4	5	85.0	1.7	4	90.8	3.7	19	85.9	4.0
J	10	84.3	4.6	3	86.7	1.2	3	88.7	0.5	16	85.6	4.1
K	8	83.0	4.3	8	84.9	3.2	4	88.3	2.1	20	84.8	4.0
L	5	83.0	6.9	5	80.8	8.2	7	84.4	3.1	17	82.9	6.3
M	10	80.2	9.4	10	81.7	4.6	5	87.4	4.3	25	82.2	7.4
N	5	80.8	8.4	7	80.3	5.9	0	–	–	12	81.3	7.1
O	0	–	–	9	79.2	6.6	3	85.7	3.1	12	80.8	6.6
P	3	72.3	7.1	5	79.8	4.9	6	81.5	2.8	14	78.9	5.9
Q	9	78.1	6.9	3	68.7	5.2	3	82.3	6.1	15	77.1	7.9
All Checkpilots	99	83.3	6.7	123	84.1	5.6	80	87.7	4.2	302	84.5	6.3

[a]Formula for unbiased estimate used.

[1]An unsatisfactory *(U)* grade was assigned a numerical value of 65 for computation purposes.

checkpilots was on the Advanced checkride where the means ranged from a low of 68.7 (Checkpilot Q) to a high of 89.0 (Checkpilot E)—a difference of more than 20 points. Similarly, on the Pre-Solo checkride the standard deviations ranged from 0.5 to 9.4 (Checkpilots E and M).

Some of the checkpilots showed a high degree of consistency from one stage to another in terms of their relative standing in the group. For example, Checkpilot Q assigned low grades at all three stages of training, while Checkpilots A and B assigned high grades for all three stages.

The data for total checkrides, all stages combined, were subjected to an analysis of variance, which indicated that the wide differences in mean grades assigned by the checkpilots would not be likely to occur by chance ($p < .001$). Thus, there were statistically reliable differences among these checkpilots in the average checkride grades assigned to students.

The Special checkpilots used in the second phase experiment did not show the same degree of variation in grades assigned to students in Classes 63-1W and 63-3. Mean grades assigned under the special conditions established for these two classes ranged from 79.7 to 84.7 and were not significantly different from each other.[1] The number of unsatisfactory grades assigned by this group, however, was much higher than for any other group of checkpilots discussed in this report. Table 6 compares the number of checkrides administered and failed in the seven FY 1962 classes listed in Table 1 and the two FY 1963 classes reported. The percentage of unsatisfactory checkrides was twice as high in the two FY 1963 classes, and all of the unsatisfactory grades in these classes were assigned by the Special checkpilots. The failure rate for these Special checkrides, therefore, was three times as high as that of the FY 1962 classes.

These data indicated that there was a significant relationship between the number of unsatisfactory checkrides recorded and whether the checkpilot was from within or from outside the student's own flight (Chi square = 5.28, $p < .05$). The student whose performance was evaluated by a checkpilot from his own training flight was more likely to pass, all else being equal, than was the student who had to demonstrate his proficiency to an unfamiliar or outside evaluator.

Eight of the 17 checkpilots in the FY 1962 classes had administered at least four checkrides for each of the three stages of training. These may be identified in Table 5 as Checkpilots C, D, E, G, I, K, L, and M. The mean scores assigned by these eight checkpilots for all stages combined ranged from 82.2 (Checkpilot M) to 87.6 (Checkpilot C). Analysis of variance again indicated that these differences are statistically significant ($p < .001$).

Table 6

Checkride Failures in Selected Classes

Item	Seven 1962 Classes	Classes 63-1W and 63-3		
		Special Check-rides	Regular Check-rides	All Check-rides
Number of Checkrides Administered	777	117	6.2	179
Number Failed	26	12	0	12
Percent Failed	3.3	10.3	0.0	6.7

[1]The alternate Special checkpilot was not included in this analysis.

The mean grades assigned by these eight checkpilots differed significantly ($p < .001$) between stages of training. The means for the eight pilots were 83.8, 85.1, and 88.8 for the Pre-Solo, Advanced, and Cross-Country stages, respectively. Thus, the grade the average student received was also related to the stage of training he was completing.

While the grading system under which these grades were assigned does not define average performance in terms of a specific grade level, it does require that all grades be related to the level of student training (5, p. 3). This is interpreted to indicate that any grade should have the same implications concerning relative student proficiency at one stage of training that it has at any other stage. Thus, the average grade should be relatively constant for all stages of training. Such was not the case in the grades reported here, since the "average" student "improved" from a grade of 83.8 to 88.8 as he progressed from one stage of training to another.

Assignment of students to checkpilots in the Rotary Wing Department was not always a random procedure. Occasionally, students having difficulty with a particular set of flight skills were assigned to a checkpilot judged especially competent to evaluate those skills. Since such assignments would concentrate atypical students with certain checkpilots, the results of the analyses of variance would be influenced to some extent. It was considered desirable, therefore, to determine whether the bias resulting from this system of assigning students to checkpilots was sufficient to account for the significant differences among checkpilots in the assignment of checkride grades.

Since there were significant differences by stage of training in both instructor evaluations and checkrides grades ($p < .001$), the three stages of training were analyzed separately. Therefore, differences between checkpilots could not occur as a result of one checkpilot's having given more checkrides at one stage of training than at another. Three separate analyses of covariance were performed on the end-of-stage evaluations assigned the students by each of the 17 checkpilots identified in Table 5. The covariance technique allowed a test of the significance of between-checkpilot differences in checkride grades that was independent of the differences in the quality of students as indicated by end-of-stage instructor evaluations.

The covariance analyses showed that there were significant differences, other than those attributable to differences in student performance as indicated by instructor evaluations, among checkpilots for both the Advanced and the Instrument Cross-Country stages of training ($p < .001$). Differences in grades assigned by checkpilots at the end of the Pre-Solo stage, however, were no longer significant when allowance was made for differences in instructor evaluations of these same students. It should be kept in mind that both the Pre-Solo instructor evaluation and the checkride were often administered by the same instructor.

Thus, in spite of instances in which checkpilots were not assigned a typical cross-section of students for checkrides, significant differences did exist among checkpilot grading standards that could not be attributed to inequalities in the assignment of students.

Discussion

The foregoing analyses of data available from FY 1962 and FY 1963 classes of advanced rotary wing training showed that end-of-stage evaluations of student

[1]As noted earlier, the most common exception is the Pre-Solo checkride, which may be administered by the student's own instructor.

performance were significantly affected by (a) the individual standards of the checkpilot, (b) whether the checkpilot was a member of the student's own training flight, and (c) the stage of training at which flight performance was being evaluated.

The first two factors affecting grade assignment are of particular concern for quality control purposes. Whether a student received a Below Average, Average, Above Average, or Failing grade on his checkride depended to a considerable extent on whether he was assigned a "hard" or an "easy" checkpilot. If the checkpilot happened to be from another flight, the student's chance of failing the checkride was even greater.

The influence on checkride grades of the stage of training is of lesser concern. A constant error of this type may be expected to have little direct effect upon the relative standing of the students within a class. The general lowering of Pre-Solo stage checkride grades in the classes involved in this study did not appear to have a detrimental effect upon the Rotary Wing Department's trainee output rate; the Department's attrition rate at the time of these studies was low.

Findings from this research phase indicated that individual checkpilots did have standards and grading practices which differed enough that a student's grade could be influenced significantly by chance factors in assignment of students to checkpilots for evaluation. The findings to that effect reported in the 1956-57 study were, therefore, still valid in the Rotary Wing Department as late as FY 1963. While the student's demonstrated flight proficiency undoubtedly influenced the flight evaluation grade he received, for quality control purposes it would be desirable to increase the relationship between grades and student flight proficiency and to reduce the differences in standards between checkpilots.

ANALYSIS OF FLIGHT TRAINING GRADE SLIPS

Problem and Approach

The earlier research activities were concerned with the numerical grades assigned by checkpilots to represent the overall quality of student flight performance. The assignment of a numerical value to a student's performance is only one of the functions of the Uniform Flight Grading System, the evaluation system in use by the Department of Rotary Wing Training, USAAVNS, at the time of this study (5). Another objective is to provide information to the Department about details of student flight performance, an objective similar to that of the inspection and grading functions performed by "quality control" systems in other training and production organizations (1).

Analyses performed in the earlier phases of this study indicated that there were limitations on the information that the Uniform Flight Grading System was providing about the quality of student performance. The grades assigned by the checkpilot "inspectors" were found not to be independent and unbiased evaluations of trainee quality. Therefore, the effectiveness of any corrective action based upon these evaluations was necessarily limited.

In order to detect deficiencies in the training program and to standardize training, detailed information is needed about ways in which student performances deviate from the desired standards. Information of this type was provided through the Uniform Flight Grading System by means of grade slips being used in the Rotary Wing Department at the time of the study.

In addition to the numerical[1] grade itself, the grade slips provided three types of information: (a) identification of procedures and maneuvers performed at or below the desired level of proficiency, (b) evaluations of the student's "basic qualities," and (c) descriptions of specific student behaviors which contributed to, or interfered with, successful performance of certain procedures or maneuvers. The information contained in (c) tended to duplicate and to elaborate upon that contained in (a).

The identification of improperly performed maneuvers and the descriptions of the student's behaviors which resulted in the improper performance of those maneuvers provide information of the type useful for quality control purposes. The evaluation of the "basic qualities" by the Department's checkpilots (5) provides a suggestion of the causes of low student proficiency—for example, lack of motivation. While the "basic quality" concept may contribute to other purposes of the Uniform Flight Grading System, it lacks the specificity that is a necessary characteristic of information required for the effective control of the quality of training.

Procedure

In order to explore the potential value to a quality control system of the descriptive information provided by the grade slips, a number of these grade slips were reviewed by research staff members. This review suggested that information appropriate for accurate proficiency measurement was being recorded, but that the collection of this information depended upon the initiative of the instructor rather than being set up in the systematic manner necessary for effective quality control.

The information was being reported by the checkpilots in the form of narrative comments on the reverse side of the grade slips. These comments not only identified the maneuvers being performed improperly but, in many instances, contained specific descriptions of behaviors which caused the student to be "marked down" on the maneuver. This specific information could provide data for corrective action. An effective quality control system is dependent upon specific information of the type represented by many of the comments that were being provided by rotary wing checkpilots.

To determine the amount and kind of narrative information which was available, comments made by checkpilots during selected FY 1962 classes were reviewed, and a four-category classification was developed. This classification provided a means of identifying the level of specificity of each comment, since the usefulness of a comment to a quality control system is proportional to its specificity. The four-category classification[2] follows, with examples of comments from actual grade slips to illustrate each category:

Category 1: Summary Statement of Performance
Examples: "This was a high average ride."
"Average check flight."

Category 2: Allusion to Specific Discrepancies
Examples: "Minor discrepancies noted and discussed with student."
"Most of student's work is above average."

[1]Under the Uniform Flight Grading System, numerical grades are assigned to checkride evaluations, and letter grades are assigned to all other dual flight evaluations, i.e., following each dual instructional flight, the instructor assigns a letter grade reflecting his evaluation of the student's performance.

[2]The reliability of assignment of comments to this classification, estimated by the contingency coefficient corrected for a restricted upper limit, was found to be .96 when independent raters were used.

Category 3: Specific Discrepancies Noted but Not Related to Specific Flight Situation

Examples: "*RPM Control* - Over red line three times."

"*RPM Control* - Not alert for changes in RPM. Weak throttle-pitch coordination."

Category 4: Specific Discrepancies Noted and Related to Specific Flight Situation

Examples: "*Take-off to Hover* - Jumped aircraft off ground, allowed nose to turn to right, lost RPM down to 2250. Hovered at 10 feet."

"*Airwork* - Airspeed dropped to 45k from normal cruise (70k) while tuning radio."

Results

Table 7 contains a tabulation of the comments, categorized according to the classification system, made by four of the Special checkpilots[1] for the 101 checkrides they administered during the second phase of the research.

Table 7

Summary of Checkpilot Comments About Student Performance[a]

Checkpilot Number	Number of Checkrides	Comment Category				Total Comments
		1	2	3	4	
1	28	1	4	48	28	81
2	23	7	5	12	10	34
3	22	7	4	13	24	48
4	28	17	2	13	14	46
Totals[b]	101	32	15	86	76	209

[a]Frequencies in Comment Categories 1 and 2 were combined, and a Chi square of 43.59 ($p<.001$) was obtained.

[b]Other checkpilots administered 78 checkrides in these two classes and made 187 comments, an average of 2.4 comments per checkride compared with the average of 2.1 comments per checkride for the four Special checkpilots.

Discussion

The following observations were made concerning the data in Table 7:

(1) There was no uniform format for the narrative reports of student performance. A uniform format would have resulted in a greater concentration of comments in a single category.

(2) The total number of comments made varied significantly among checkpilots, even though, as previously reported, there was no significant difference among the grades assigned by the checkpilots.[2] Although Checkpilots 1 and 4 administered 28 checkrides each, Checkpilot 1 made nearly twice as many comments about the students he checked as did Checkpilot 4.

(3) The usefulness of the information provided, as indicated by the categories into which the comments fell, was a function of the checkpilot who administered the flight. For example, specific comments of the type most useful to a quality control program (Category 4) were made 50 percent of the time by Checkpilot 3 and only 22 percent of the time by Checkpilot 2.

[1]The alternate Special checkpilot was omitted from this analysis.

[2]See page 14.

(4) Checkpilots did attend to the kind of specific information about student performance needed for an effective system of quality control. Although this information was not recorded in a systematic manner, the fact that each checkpilot noted and recorded specific discrepancies in students' performance is significant. It indicates that checkpilots can gather detailed information about student performance, and that they see the necessity of such information for an adequate description.

The adaptation of information such as was found to be available from the grade slips prepared by the Rotary Wing Department's checkpilots to a program of student performance quality control depends upon the establishment of provisions for uniform observation and reporting of student behaviors by all checkpilots. For quality control purposes, evaluation information should be comparable in amount, type, and validity regardless of who provides the information.

IMPLICATIONS FOR QUALITY CONTROL

Flight Training Quality Control

The establishment of a system for the uniform evaluation of student flight performance is no simple matter. Nevertheless, many of the procedures and techniques necessary for such a system have been established in actual practice. The desired characteristics of such a system include:

(1) Comprehensive and consistent testing of student flight proficiency.
(2) Accurate and equitable evaluation of the efficiency of training personnel.
(3) A high degree of uniformity of flight check procedures and scoring practices.
(4) Objective and detailed School standards by which individual students or classes can be evaluated.

The present study indicated that the evaluation data used at the Aviation School in 1961-63 had some shortcomings in terms of the broad requirements of a quality control program. The results from rotary wing training evaluations may be summarized as follows:

(1) While there was a relationship between the instructor evaluation and checkride grades, this relationship was influenced by whether the checkpilot was from within or without the student's flight. This raises some question as to the validity and reliability of the subjective grade information.

(2) There were significant and consistent differences among the checkpilots in their individual grading practices.

(3) While the checkpilot comments provided some detailed information on student performance, these comments lacked specificity, and uniformity from one checkpilot to another, and there was no mechanism for systematically using the information.

The kind of information necessary for quality control (1) was being collected by the Rotary Wing Department at the time of this study. To be used with full effectiveness for quality control purposes, however, this information must be gathered systematically and with a high degree of checkpilot standardization. It would be part of a quality control program which contains the following additional elements:

(1) A detailed statement of training objectives based on job requirements.
(2) Effective communications concerning performance of students on the checkrides.

(3) Effective procedures for corrective action where such action is indicated by checkride performance.

(4) Supervisory support.

The grading practices research in the present study was not directed toward determining the presence and effectiveness of any of these four additional quality control elements in the Rotary Wing Department at the time of the study.

As previously indicated, during FY 1966 the Aviation School took steps to extend the quality control system already in operation in the primary phase of fixed wing training to all phases of fixed wing training. The use of automatic data processing of flight grading information for quality control purposes was instituted during FY 1967, for rotary wing training as well as fixed wing training. The kinds of outputs from this latter application are very similar to those provided by the quality control system at the Primary Helicopter School, but go beyond that to include daily grade information.

Also during FY 1966-67 the Aviation School embarked on a tryout at Fort Rucker of the PPDR system for checkride purposes in the Rotary Wing Qualification Course. Technical assistance in this effort was provided by HumRRO Division No. 6 (Aviation). New PPDRs, appropriate to the aircraft and training content of the "Q" course, were developed and checkpilots were trained in their use. As a result of this tryout the Aviation School concluded that the PPDR was inappropriate for their requirements, even though many of the advantages of objective flight performance recording were recognized. The principal areas of difficulty the School found in using PPDRs were related to the necessity of having separate and independent groups of personnel who specialize in administration of checkrides (this aspect of School organization was discussed in the first section of this report). In addition, possible flight safety problems were noted by the School, as a result of the considerable mixture of aircraft types (fixed and rotary wing), training curricula, and student types. Additional exploration toward developing new measures of performance—non-PPDR, but yielding detailed and objective results—will therefore be needed in furthering the School's quality control objective.

In a related activity, personnel in the Department of Primary Fixed Wing Training, U.S. Army Aviation School Element, Fort Stewart, Georgia, have recently (FY 1967-68) been preparing fixed wing PPDRs for possible tryout. HumRRO Division No. 6 has also provided technical assistance for this effort. The administrative problems noted in the PPDR tryout at Fort Rucker—that is, the requirement for a separate checkpilot section—are not likely to be a matter of concern at Fort Stewart, nor should there be as much difficulty resulting from mixtures of aircraft, curricula, and so forth. In both these respects, Fort Stewart is more like the Primary Helicopter School at Fort Wolters than the Aviation School at Fort Rucker.

General Quality Control Implications

While the occasion initiating the present study was USAAVNS interest in improving quality control practices and procedures at that school, for HumRRO a corollary objective was to develop implications for quality control in general. Study and analysis were focused on aspects of the proficiency data not only with reference to flight evaluation, but also for possible implications with regard to proficiency data characteristics applicable in any formal quality control system. While such a system is comprised of more than proficiency data, this information is the fundamental ingredient for quality control.

The results of this study suggest a number of general implications about ways in which proficiency data may be made maximally useful for quality control:

(1) Two distinct functions of proficiency data should be recognized in training quality control—description of performance and evaluation of performance. It is especially critical for quality control purposes that the data be descriptive of the actual performance if records of the performances of numerous students are to be pooled to provide indications of how the overall training system is functioning and where and what corrections should be instituted.

(2) The basic data on performance proficiency are most valuable when they are objective—that is, when the data are close to being clear, unambiguous observations, free of personal judgment. With objective data, observations do not depend upon who is observing, and there can be assurance that the proficiency data are a dependable measure of performance rather than a reflection of personal or other factors in the testing situation.

(3) Proficiency testing should be done with standardized subject matter and under carefully standardized conditions, so the evaluations will be demonstrably comparable in content and administration, regardless of who is being tested or who is doing the testing.

(4) To attain maximum objectivity, the collection of data on proficiency needs to be clearly separated from the process of evaluating the performance reflected in the data.

(5) Criteria and standards for evaluation need to be developed in such a way that they are uniform for all evaluators, for all students, and for all stages of training.

(6) Diagnostic information regarding the effects of training is needed, specifically and in detail, if the needs for modifying training are to be clearly identified. Detailed instructions to evaluators and a uniform format for reporting on a student's performance can help make diagnostic information most usable.

(7) Ideally, for quality control purposes, proficiency testing and evaluation should be performed by an administering unit and personnel who are independent of the training function. At a minimum, the evaluators ought to be separate from the personnel directly concerned with training the particular students being evaluated.

(8) In order to insure objectivity and standardization in performance observation and evaluation, quality control personnel need special preparation in the concepts and techniques of observation, measurement, and evaluation.

Implications for Future Research

Basic concepts, techniques, and procedures for quality control systems have been in existence for a long time, especially those having to do with industrial production of material goods, so "ideal" conditions for quality control are quite well known. It is not always possible, however, to achieve ideal conditions since a quality control system—whether it be industrial or training—must fit into the resources that can be made available by the organization. A fruitful avenue for further study is in determining how to consider and evaluate the trade-offs between the ideal and the practical—that is, what kind of loss would be incurred by what kind of deviation from the ideal? In considering establishing an ideal feature in quality control, knowing the loss without it—compared to the probable cost of adding it—can provide a basis for establishing the best cost-benefit balance, and therefore, for practical solutions to quality control that are realistic in terms of the facilities and needs of the school or training center.

There are a number of other promising directions for further study of flight training quality control, especially to consider situations where administrative or other factors preclude the kind of specialized evaluation unit available to USAPHS. Essentially, they are approaches to providing detailed proficiency measures that will meet quality control needs without specialized personnel trained in measurement and evaluation to the extent needed in PPDR-type systems.

One direction for study is development of different types of objective measures of performance. In HumRRO Work Sub-Unit ECHO III, for example, a time-lapse motion picture camera has been used to record instrument panel readings in flight. If this approach proves to be practical and effective in terms of the cost and the quality of information developed, detailed objective performance information for quality control purposes could be collected automatically for analysis after a flight. Such analysis might be done by clerical rather than checkpilot personnel, and could be completely independent of the evaluation function. While use of a camera could minimize the detailed and standardized observations required of the checkpilot, it would make it especially critical that all students perform a standard set of test maneuvers under standard conditions.

A contrast was drawn earlier between the PPDR—a relatively objective description of performance—and the Uniform Flight Grading System at USAAVNS—a relatively subjective evaluation of performance. One possibility for a study is to consider combinations of these approaches. Consideration of various flight proficiency studies suggests that a subjective-objective approach to flight proficiency measurement may be promising; it might be feasible to develop some joint system that would be practical and effective and yet require less specialized training for checkpilots.

Still another direction for study concerns the base for comparison used in flight proficiency evaluation. Generally—assuming a basic minimum proficiency above a failing level—flight evaluation tends to be based on comparing performance among students in terms of above or below "average" proficiency for a given level of training. An alternate approach would be to evaluate a student's performance using an anchored scale that would allow comparison of his capabilities with those of an expert pilot. It might not be desirable or economical to bring student pilots to an expert's level, but using expert performance as an anchor point for scaling student performance could be a way of emphasizing the perspective of operational capability as the goal for training. Such a change in scaling would be likely to affect what portions of training are identified for improvement, on a basis of operational needs rather than inter-student comparisons.

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Appendix A

MEAN DAILY GRADES, INSTRUCTOR EVALUATIONS, AND CHECKRIDE GRADES FOR EACH STAGE OF TRAINING

Table A-1

Means and Standard Deviations of Scores for Selected FY 1961 Advanced Rotary Wing Training Classes

Training Stage	Variable	Class Number						All Classes (N = 157)
		61-1 (N = 36)	61-2 (N = 30)	61-3 (N = 28)	61-4 (N = 29)	61-5 (N = 19)	61-6 (N = 15)	
Pre-Solo	Daily Grade[a]							
	Mean	3.0	2.9	2.9	3.0	2.9	3.0	2.9
	SD	.21	.24	.20	.21	.29	.17	.22
	Instructor Evaluations							
	Mean	85.8	83.6	84.9	84.9	84.4	83.9	84.7
	SD	3.4	4.9	4.8	4.7	4.0	5.0	4.5
	Checkride Grades							
	Mean	84.5	79.2	83.1	83.3	84.2	83.5	82.9
	SD	4.6	7.1	6.3	6.0	6.5	8.3	6.6
Advanced	Daily Grade[a]							
	Mean	3.1	3.0	3.0	3.0	3.1	3.1	3.0
	SD	.22	.19	.37	.24	.24	.11	.25
	Instructor Evaluations							
	Mean	86.8	85.3	85.6	85.3	87.7	86.8	86.1
	SD	3.4	4.7	5.9	4.9	3.1	4.1	4.6
	Checkride Grades							
	Mean	82.6	83.9	84.0	83.8	85.5	85.3	83.9
	SD	7.2	5.0	5.7	6.0	4.8	4.1	5.9

[a]Daily grades were scaled on the basis of: Excellent (A) = 4; Good (B) = 3; Low to Fair (C) = 2; and Unsatisfactory (U) = 1.

Table A-2

Means and Standard Deviations of Scores for Selected FY 1962 Advanced Rotary Wing Training Classes

Training Stage	Variable	Class Number							All Classes (N = 259)
		62-1W (N = 38)	62-2W (N = 42)	62-3 (N = 35)	62-5 (N = 46)	62-6 (N = 28)	62-7 (N = 27)	62-8 (N = 43)	
Pre-Solo	Daily Grade[a]								
	Mean	2.9	3.0	2.9	3.0	2.9	3.0	2.9	2.9
	SD	.29	.28	.36	.26	.26	.33	.25	.29
	Instructor Evaluations								
	Mean	85.6	85.0	85.2	85.3	84.2	84.1	85.1	85.0
	SD	4.6	4.2	4.6	5.0	3.7	5.3	4.6	4.6
	Checkride Grades								
	Mean	82.4	80.1	83.8	84.4	83.4	82.8	83.1	82.8
	SD	7.0	8.4	6.5	6.0	6.2	7.0	6.1	6.9
Advanced	Daily Grade[a]								
	Mean	2.9	2.9	3.0	3.0	3.0	3.0	2.9	3.0
	SD	.33	.27	.18	.29	.16	.26	.25	.26
	Instructor Evaluations								
	Mean	85.8	85.0	87.5	87.2	86.6	85.7	85.2	86.1
	SD	4.8	5.5	3.9	4.3	3.1	3.7	4.7	4.6
	Checkride Grades								
	Mean	82.8	81.6	83.3	84.1	86.3	83.8	82.8	83.4
	SD	6.9	7.4	7.0	5.1	4.1	6.1	5.5	6.3
Instrument Cross-Country	Daily Grade[a]								
	Mean	3.3	3.2	3.0	3.4	3.3	3.2	3.2	3.2
	SD	.31	.31	.38	.31	.29	.26	.35	.33
	Instructor Evaluations								
	Mean	88.8	86.8	88.0	89.0	88.1	87.8	86.8	87.8
	SD	3.6	3.3	4.9	3.6	3.9	3.2	4.0	4.0
	Checkride Grades								
	Mean	87.6	85.9	87.6	87.2	89.6	86.6	85.9	87.0
	SD	4.1	4.7	4.7	6.2	2.7	6.0	5.8	5.2

[a]Daily grades were scaled on the basis of: Excellent (A) = 4; Good (B) = 3; Low to Fair (C) = 2; and Unsatisfactory (U) = 1.

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13. ABSTRACT
Aspects of flight evaluation data input at the Rotary Wing Department, U.S. Army Aviation School, during 1961-63, were studied with reference to formal quality control system requirements. It was found that significant agreement did exist between instructor and checkpilot evaluations, but that this agreement could be a reflection of information available to the checkpilot prior to the checkride, rather than commonality of instructor and checkpilot standards. Checkride grades were also found to reflect individual checkpilot standards and the student's stage of training. Current grading practices were studied to determine the usefulness, for quality control purposes, of the kinds of detailed diagnostic information available on individual student performance.

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1 CG US ARMY JAPAN APO 96343 SAN FRAN ATTN G3
1 CG US ARMY FORCES SOUTHERN COMC ATTN SCARCD APO 09834 NY
1 CG US ARMY ALASKA ATTN ARACC APO 98749 NY
2 CG US ARMY EUROPE APO 09403 NY ATTN OPNS DIV
1 CC ARMY TRANS RES COMC FT EUSTIS ATTN TECH LIB
1 CG US ARMY AD COMC ENT AFB ATTN ADCCB
2 CG 1ST ARMY FT GEORGE G MEADE
1 CG 3RD US ARMY FT MCPHERSON GA
1 CG FOURTH ARMY FT SAM HOUSTON ATTN G3
3 CG FIFTH ARMY FT SHERIDAN ATTN ALFOC INC
1 CG SIXTH ARMY PRES OF SAN FRAN ATTN AMAAV
1 CG ELSA ATTN AG-AC APO 96301 SAN FRAN
1 DIR HEL APG MD
2 ENGNR PSYCHOL LAB PIONEERING RES CIV ARMY NATICK LABS NATICK MASS
1 TECH LIB ARMY NATICK LABS NATICK MASS
1 REDSTONE SCIENTIFIC INFO CTR US ARMYMSL COMD ATTN CHF DDC SEC ALA
1 CC USAPA MBLTY DET TOBYHANNA ARMY DEPOT
1 CG ARMY ELEC PG FT HUACHUCA ATTN TECH LIB
1 CG US ARMY CDC EXPERIMENTATION COMC FT ORD
1 SIXTH U S ARMY LIB DEPOT BLDG M 13 14 PRES OF SAN
1 PLANS OFFICER PSYCH HOSPRES USACCECFORT DRC
5 CG FT ORD ATTN G3 TNG DIV
2 DIR WALTER REED ARMY INST OF RES WALTER REEC ARMY MED CTR
ATTN NEUROPSYCHIAT DIV
1 CC HQ ARMY ENLISTED EVAL CTR FT BENJ HARRISON
1 DPTY FOR BIOASTRONAUT PG AIR PG CTR EGLIN AFB
1 DIR ARMY ENGNR R+D LABS FT BELVOIR ATTN TECH DOCU CTR
1 CC FRANKFORD ARSNL ATTN SMUFA-N6400/202-4
3 6TH RGN USARADCOM FT BAKER
1 4TH ARMY MSL COMC AIR TRANSPORTABLE SAN FRAN
1 PERS SUBSYS DIV CREW SUBSYS DRCT AERONAUT SYS DIV WRIGHT-PATTERSON AFB
1 DIR ARMY BD FOR AVN ACCIDENT RES FT RUCKER
1 DEF SUPPLY AGY CAMERON STATION ATTN LIB
1 REF P MS 15 NASA ALA
1 CBT OPNS RES GP ARMY CBT DEVEL COMC FT BELVOIR
ATTN OPNS ANLS HUMAN FACTORS
1 CC ARMY CBT DEVEL COMC FT KNOX ATTN ARMOR AGY
1 CC US ARMY CDC AVN AGCY FT RUCKER
3 CC ARMY CBT DEVEL COMC CBT SUPPORT GP
3 ARMY WAR COLL CARLISLE BKS ATTN LIB
1 US MILIT ACAD WEST POINT ATTN LIB
1 COMDT ARMY AVN SCH FT RUCKER ATTN SCH LIB
1 COMDT ARMY SECUR AGY TNG CTR + SCH FT DEVENS ATTN LIB
1 MED FLD SERV SCH BROOKE ARMY MED CTR FT SAM HOUSTON ATTN STIMSON LIB
3 DIR OF INSTR ARMOR SCH FT KNOX
1 COMDT ARMY CHEM CORPS SCH FT MCCLELLAN ATTN EDUC ADV
1 ARMY INF SCH FT BENNING ATTN EDUC ADV
1 USA INF SCH ATTN DIR OF INSTR FT BENNING
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5 ASST COMDT ARMY AIR DEF SCH FT BLISS ATTN CLASSF TECH LIB
5 CG ARMY ARTY + MSL CTR FT SILL ATTN AVN OFFR
1 COMDT ARMED FORCES STAFF COLL NORFOLK
1 COMDT JUDGE ADVOCATE GENERALS SCH U OF VA
1 EDUC CONSLT ARMY MILIT POLICE SCH FT GORDON
6 COMDT ARMY ENGNR SCH FT BELVOIR ATTN AIBBES-SY
1 COMDT ARMY AVN SCH FT RUCKER ATTN EDUC ADV
1 COMDT ARMY PRIMY HEL SCH FT WOLTERS
1 SPEC WARFARE SCH FT BRAGG ATTN LIB
4 USA SPEC WARFARE SCH ATT: COUNTERINSURGENCY DEPT FT BRAGG
2 SECY US ARMY MSL & MUNITIONS CTR & SCH REDSTONE ARSNL
2 HQ ABERDEEN PG ATTN TECH LIB
1 COMDT US ARMY INTEL SCH FT HOLABIRD
2 DIR BRGD + BN OPNS DEPT USAIS FT BENNING
1 DIR COMM ELEC USAIS FT BENNING
1 DIR COMPANY TACTICS DEPT USAIS FT BENNING
1 CG US ARMY SIGNAL CTR + SCH ATTN SIIGVL-3(COBET 11)
1 SECY OF ARMY
1 DCS-PERS DA ATTN CHF C&S DIV
1 DIR OF PERS STUDIES + RES DCCSPER CA ATTN BG WALLACE L CLEMENT
1 CC FOREIGN SCI + TECH CTR NUN BLDG
2 AGS FOR FORCE DEVEL CA ATTN CHF TNG DIV
1 HQ ARMY MAT COMD R+D DRCTE ATTN AMCRD-RC
2 CG ARMY MED R+D COMD ATTN BEHAV SCI RES BR
1 US ARMY BEHAVIORAL SCI RES LAB WASH. D.C. ATTN: CRD-AR
1 OFC PERS MGT DEV OFC ATTN MDS SEC (NEW EQUIP) OPDMD
1 ARMY PROVOST MARSHAL GEN
1 OFC RESERVE COMPON CA
50 ADMIN DDC ATTN: TCA (HEALY) CAMERON STA ALEX.+ VA. 22314
1 CC US ARMY MED RES LAB FT KNOX
1 CG ARMY ELECT COMD FT MONMOUTH ATTN AMSEL CB
1 CHF OF R+D DA ATTN CHF TECH + INDSTR LIAISON OFC
1 PERS + TNG DIV ORCHC OFC OF CHF OF ORD CA
2 CG ARMY MED R+D COMC ATTN MECCH-SR
1 U S ARMY BEHAVIORAL SCI RES LAB WASH. D.C. ATTN CRD-AIC
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2 PRES ARMY AVN TEST BD FT RUCKER
1 DPTY PRES ARMY MAT COMC BD ABERDEEN PG
1 US ARMY ARCTIC TEST CTR R & C OFFICE SEATTLE
1 CG 2D ARMORED DIV FT HOOD ATTN DIV AVN OFCR
6 CG 4TH ARMORED DIV APO 09326 NY
4 CC 2D ARMORED CAV REGT APO 09696 NY
1 CC 3D ARMORED CAV REGT APO 09034 NY
1 CC 14TH ARMORED CAV REGT APO 09026 NY
1 CC 2D BN 34TH ARMOR FT IRWIN
2 CALIF NG 40TH ARMORED DIV LOS ANGELES ATTN AC OF SG3
1 55TH COMD HQ DIV ARMY NG JACKSONVILLE FLA
4 CC 150TH AVN BN NJ AIR NG ELIZABETH
1 CG HQ 27TH ARMORED DIV NY AIR NG SYRACUSE
1 TEXAS NG 49TH ARMORED DIV DALLAS

2 CG 1ST INF DIV FT RILEY ATTN G3
1 CG 3RD INF DIV ATTN G3 NY
3 CG 4TH INF DIV FT LEWIS ATTN G3
1 CG 7TH INF DIV SAN FRAN ATTN G2
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1 CG 5TH INF DIV (MECH) FT CARSON
3 CG 24TH INF DIV ATTN G3 APO 09112 NY
3 CG 82D ABN INF DIV FT BRAGG ATTN G3
1 CC 197TH INF BRGD FT BENNING ATTN S3
3 CG 25TH INF DIV APO 96225 NY
1 CC 3D BN 39TH INF APO 09029 NY
1 CC 2ND BN 15TH INF NY ATTN S 3
1 CC 1ST BN (MECH) 52D INF 1ST ARMORED DIV (OLD IRONSIDES) FT HOOD
2 4TH BN (MECH) 54TH INF FT KNOX
1 CC ARMY PARTIC GP NAV TNG DEVICE CTR PT WASHINGTON ATTN CODE OIA
1 CHF ASDIC VISUAL APPLICAT OFC ARMY PICTORIAL DIV OFC OF CHF SIG OFCR
1 CG MILIT DIST OF WASHINGTON
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1 CHF OF MILIT HIST CA ATTN GEN REF BR
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1 US ARMY TROPIC TEST CTR PO CRAWER 942 ATTN BEHAV SCIENTIST FT CLAYTON
1 CINC US ATLANTIC FLT CODE 312A NORFOLK ATTN LTC DOTY
1 CDR TNG COMMAND US PACIFIC FLT SAN DIEGO
1 CHF BLR OF MED + SURG DN ATTN CODE 513
3 DIR PERS RES DIV BUR OF NAV PERS
1 TECH LIB BUR OF SHIPS CODE 210L NAVY DEPT
1 CC + DIR NAV TNG DEVICE CTR ORLANDO ATTN TECH LIB
1 CC FLT ANTI-AIR WARFARE TNG SAN DIEGO
1 CC NUCLEAR WEAPONS TNG CTR PACIFIC U S NAV AIR STA SAN DIEGO
1 CC NAV AIR DEVEL CTR JOHNSVILLE PENNA ATTN NADC LIB
2 HUMAN FACTORS DEPT CCMM PSYCHOL DIV NAV TNG DEVICE CTR PT WASHINGTON
1 CL FLEET TNG CTR U S NAV STA SAN DIEGO
1 CC FLT ANTI-SUB WARFARE SCH SAN DIEGO
1 CHF OF NAV RES ATTN SPEC ASST FOR R & D
1 CHF OF NAV RES ATTN PERS + TNG BR CODE 458
1 DIR US NAV RES LAB ATTN CODE 5120
5 CC OFF OF NAV RES BR OFFICE BOX 39 FPO 09510 NY
1 CHF OF NAV AIR TNG TNG RES DEPT NAV AIR STA PENSACOLA
1 CC NAV SCH OF AVN MED NAV AVN MED CTR PENSACOLA
1 CC MED FLD RES LAB CAMP LEJEUNE
1 COR NAV MSL CTR POINT MUGU CALIF ATTN TECH LIB CODE 3022
1 DIR AEROSPACE CREW EQUIP LAB NAV AIR ENGNR CTR PA
1 DIC NAV PERS RES ACTVY SAN DIEGO
2 CDR NAV MSL CTR POINT MUGU CALIF ATTN HUMAN ENGNR DIV CODE N-335
1 COMDT MARINE CORPS HQ MARINE CORPS ATTN CODE AO-1B
1 HQ MARINE CORPS ATTN AX
1 DIR MARINE CORPS INST ATTN EVAL UNIT
1 CHF OF NAV AIR TECH TNG NAV AIR STA MEMPHIS
1 DIR OPS EVAL GRP OFF OF CHF OF NAV OPS OPO3EG
2 COMDT PTO COAST GUARD HQ
1 CHF SCI DIV DRCTE SCI + TECH DCS R+D HQ AIR FORCE AFRSTA
1 CHF OF PERS RES BR DRCTE OF CIVILIAN PERS DCS-PERS HQ AIR FORCE
1 CHF EVAL BR(AFPDPCE) CAREER DEVEL DIV DRCTE OF PERS PLAN HQ AIR FORCE
1 FAA CHF INFO RETRIEVAL BR WASH D.C.
1 FED AVN AGY MED LIB HQ-640
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1 HQ BALLISTICS SYS DIV PERS SUBSYS BR BSDSP NORTON AFB
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1 CDR ELEC SYS DIV LG HANSCOM FLD ATTN EST1
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1 AIR FORCE SCH OF AEROSPACE MED BROOKS AFB ATTN AEROMED LIB
1 CCMDR ARCTIC AEROMED LAB APO 98731 SEATTLE
1 6570TH PERS RES LAB PRA-4 AEROSPACE MED DIV LACKLAND AFB
1 PSYCHOBIOLOGY PROG NATL SCI FOUND
1 DIR DIV OF DATA SOURCES & STAND NATL CTR FOR EDUC STATISTICS
OFC OF EDUC
1 DIR NATL SECUR AGY FT GEO G MEADE ATTN TOL
5 CENTRAL INTEL AGY ATTN CCR/CC STANDAD DISTRIBUTION
1 SYS EVAL DIV RES DIRECTORATE DDC-OCO PENTAGON
1 DEPT OF STATE BUR OF INTEL + RES EXTERNAL RES STAFF
1 SCI INFO EXCH WASHINGTON
2 CHF REGL TNG BR TNG DIV FED AVN AGY ATTN PT 3B
1 BLR OF RES & ENGR US POST OFC DEPT ATTN CHF HUMAN FACTORS BR
1 EDUC MEDIA BR OE DEPT OF HEW ATTN T D CLEMENS
1 OFC OF INTERNATL TNG PLANNING & EVAL BR AID WASH DC
1 SYS DEVEL CORP SANTA MONICA ATTN LIB
1 OLNLAP + ASSCC INC CARTEN ATTN LIB
2 RESEARCH ANALYSIS CORP MCLEAN VA 22101
1 DIR RAND CORP SANTA MONICA ATTN LIB
1 U OF SO CALIF ELEC PERS RES GP
1 COLUMBIA U ELEC RES LABS ATTN TECH EDITOR
1 MITRE CORP BEDFORD MASS ATTN LIB
2 U OF PGH LEARNING R+D CTR ATTN DIR
1 HUMAN SCI RES INC NORFOLK
1 HUMAN SCI RES INC MCLEAN VA
2 TECH INFO CTR ENGNR DATA SERV N AMER AVN INC COLUMBUS O
1 CHRYSLER CORP MSL DIV DETROIT ATTN TECH INFO CTR
2 EDUC + TNG CONSULTANTS LOS ANGELES ATTN PRINCIPAL SCI
1 GEN DYNAMICS POMONA CALIF ATTN LIB
1 AVN SAFETY ENGR & RES DIV OF FLIGHT SAFETY FOUND INC PHOENIX
2 PARGLARDI CORP POMONA CALIF ATTN DEPT 580
1 CTIS ELEVATOR CO DIV ATTN LIB STAMFORD CONN
1 CHF PERS SUBSYS AIRPLANE DIV MS 74-90 RENTON WASH
1 THICKOL CHEM CORP HUMETRICS DIV LOS ANGELES ATTN LIBN
1 INST FOR DEF ANLS RES + ENGNR SUPPORT DIV WASHINGTON
1 HUGHES AIRCRAFT COMPANY CULVER CITY CALIF
1 DIR CTR FOR RES ON LEARNING + TEACHING U OF MICH
1 EDITOR TNG RES ASSTR AMER SOC OF TNG DIRS U OF TENN
1 HUMAN FACTORS SECT R+D GEN DYNAMICS ELECTRIC BOAT GROTON
4 BRITISH EMBSY BRITISH DEF RES STAFF WASHINGTON
3 CANADIAN JOINT STAFF OFC OF DEF RES MEMBER WASHINGTON
3 CANADIAN ARMY STAFF WASHINGTON ATTN GSO2 TNG

1 GERMAN LIAISON OFCR ARMY AVN TEST BD FT RUCKER
3 ACS FOR INTEL FOREIGN LIAISON OFCR TO NORWEG MILIT ATTACHE
1 ARMY ATTACHE ROYAL SWEDISH EMBSY WASHINGTON
1 NATL INST FOR ALCOHOL RES OSLO
1 DEF RES MED LAB ONTARIO
2 FRENCH LIAISON OFCR ARMY AVN TEST BD FT RUCKER
1 BRITISH LIAISON OFCR ARMY AVN TEST BD FT RUCKER
1 CFC OF AIR ATTACHE AUSTRALIAN EMBSY ATTN: T.A. NAVGN
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1 HEAD DEPT OF PSYCHOL UNIV OF SC COLUMBIA
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1 AMER INST FOR RES PALO ALTO CALIF
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1 OHIO STATE U LIBS GIFT + EXCH DIV
1 PENNA STATE U PATTEE LIB DOCU DESK
1 PURDUE U LIBS PERIODICALS CHECKING FILES
1 STANFORD U LIBS DOCU LIB
1 LIBN U OF TEXAS
1 SYRACUSE U LIB SER DIV
1 U OF MINNESOTA LIB
1 STATE U OF IOWA LIBS SER ACQ
1 NC CAROLINA STATE COLL CH HILL LIB
2 BOSTON U LIBS ACQ DIV
1 U OF MICH LIBS SER DIV
1 BROWN U LIB
2 COLUMBIA U LIBS DOCU ACQ
1 DIR JOINT U LIBS NASHVILLE
2 DIR U LIB GEO WASHINGTON U
2 LIB OF CONGRESS CHF OF EXCH + GIFT DIV
1 U OF PGH DOCU LIBN
1 CATHOLIC U LIB EDUC & PSYCHOL LIB WASH DC
1 U OF KY MARGARET I KING LIB
1 SO ILL U ATTN LIBN SER DEPT
1 KANSAS STATE U FARRELL LIB
1 BRIGHAM YOUNG U LIB SER SECT
1 U OF LOUISVILLE LIB BELKNAP CAMPUS
1 M E EASTER SCH OF AVN OHIO STATE UNIV COLUMBUS
1 R E FLEXMAN DIR OF ADV ING REQUIREMENTS LINK PRECISION CO NY
1 W B BOAEY CAR NTOC FLA
1 H KERBER LIFE SCI RSCH GOODYEAR AFROSPACE CO OHIO
1 E HALL PELPAR FALLS CHURCH VA
1 D E PEYER ING RSCH DIV BEHAV SCI LAB WRIGHT-PATTERSON AFB
1 G B POTTER DIR AVN SAFETY DIV UNIV OF S CALIF
1 OFC OF SURGEON GEN ATTN AVN SEC DA WASH D C
1 USA TRANS RSCH COMC ATTN F MCCOURT FT EUSTIS VA
1 R A PONTY CORNELL AERONAUTICAL LAB BUFFALO NY
1 K B DEGREENE UNIV OF S CALIF
1 LEARNING RESOURCES CEN UNIV OF TENN KNOXVILLE
1 L W CURETON SCH OF EDUC UNIV OF TENN KNOXVILLE
1 G REID SPRINT HUMAN FACTORS MARTIN CO FLA
1 J A GROSSLIGHT DEPT OF PSYCH FLA STATE UNIV

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